# THE BIOARCHAEOLOGY OF GENDERED SOCIAL PROCESSES IN PRE- AND POST-CONTACT NATIVE AMERICANS: AN ANALYSIS OF MORTUARY PATTERNS, HEALTH, AND ACTIVITY IN THE OHIO VALLEY

by

**Robyn Wakefield-Murphy**

BA, University of Pittsburgh, 2008

MSc, University of Sheffield 2009

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This dissertation was presented

by

Robyn Wakefield-Murphy

It was defended on

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and approved by

Dr. Kathleen Allen, Senior Lecturer, Department of Anthropology

Dr. Mark Mooney, Professor and Chair, Department of Oral Biology

Dr. James Richardson, Professor Emeritus, Department of Anthropology

Dissertation Advisor: Dr. Margaret Judd, Associate Professor, Department of Anthropology

**THE BIOARCHAEOLOGY OF GENDERED SOCIAL PROCESSES IN PRE- AND POST-CONTACT NATIVE AMERICANS: AN ANALYSIS OF MORTUARY PATTERNS, HEALTH, AND ACTIVITY IN THE OHIO VALLEY**

Robyn Wakefield-Murphy, PhD

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This dissertation employs a gendered theoretical perspective to examine the interaction between social status and biological processes in light of social change (subsistence, environment, and contact) in the Ohio Valley region of North America throughout five time periods: Early Woodland (3000BP-2200BP), Early Monongahela (1150AD-1250AD), Middle Monongahela (1250-1580AD), Late Monongahela (1580- 1635AD) and Post-Contact (1756AD-1778AD) periods. Burial data (body position, orientation, location) from site reports was integrated with data from skeletal analysis (n=330). Age and sex estimation were utilized to determine demographic structure. Skeletal and dental pathology was assessed to evaluate population health, and musculoskeletal stress markers (MSMs) were examined to infer activity patterns. Two cluster analyses were performed: traditional mortuary clustering (burial data by biological sex) and biosocial clustering (burial data, skeletal data, age and sex).

During the Early Woodland, there was little differentiation in activity, health, and burial pattern by sex or age. An elite burial class was revealed, likely tied to shamanistic practitioners, representing a third gender. Among the Monongahela, older adults may have had a higher status in the Early and Middle periods, with no differentiation by age or sex in the Late period. The Monongahela group employed a system of gender equality, with emerging status in later adulthood. Activity patterns demonstrated that males performed more hunting related activities with both sexes involved in craft production and agricultural labor, with intensification in these patterns in the Late period initiated by climate change. European contact had a detrimental effect on health for the post-contact Delaware as indicated by a catastrophic mortality assemblage. No differences in male and female MSMs were found among the Post-Contact group, and overall robusticity was lower than earlier periods. Although there is historical evidence of male leaders among the Delaware, this was not reflected in burial or activity patterns. This research is significant as it presents a diachronic view of gender, social status, and biological status integrating current theoretical models to infer nuanced aspects of biosocial life among indigenous Ohio Valley groups before and after contact.

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# PREFACE

This research would not have been possible without the support and advice of several individuals and organizations. First and foremost, I would like to thank my advisor, Dr. Margaret Judd, for the continued advice, assistance, encouragement, and support during data collection, analysis, and writing. In addition, she has always been a sounding board and source of support in terms of professional development and career opportunities. In the future, I hope I can hold myself to her standard for both research quality and mentorship.

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# 1.0 INTRODUCTION

This dissertation study examines the integration of traditional mortuary analysis and biosocial bioarchaeological inquiry to provide a detailed view of gendered social processes in the Ohio Valley region of North America using samples from the Early Woodland (3000BP-2200BP), the Early Monongahela (1150AD-1250AD), the Middle Monongahela (1250-1580AD), the Late Monongahela (1580-1635AD) and the Post-Contact (1756AD-1778AD) periods. Very little past research utilized mortuary analysis or bioarchaeological methods to examine social aspects of life in the past for the Ohio Valley. This diachronic perspective provides an intriguing view of agents of social change over time and their effects on both cultural developments and human biological responses. Multiple processes can induce alterations to the social landscape including environmental events, subsistence change, disease epidemics and contact. In this study, subsistence and settlement change as well as contact are focused upon from a gendered lens, integrating traditional models of mortuary analysis with more nuanced bioarchaeological inquiry to uncover significant shifts in social structure following the prediction that indigenous populations developed varied social and biological responses to agents of change.

Subsistence-settlement change has been documented to have a notable effect on both cultural processes and patterns of human health. Patterns of physical labor become altered following shifts from hunting and gathering to agriculture (Eshed et al. 2004; Shuler et al. 2012), and these shifts can have considerable ramifications for social organization (O'Shea 1984; Robb et al. 2001; Zuckerman and Armelagos 2011). Significant decline in health in terms of stress, infectious disease, and dental pathology have also been recorded with marked shifts in demographic patterns at the time of and following this epidemiological transition (Cohen and Armelagos 1984; Gage and DeWitte 2009; Larsen 1995, 2006). European contact and colonization also had a profound effect on the biological and social landscapes of indigenous peoples in the forms of radical shifts in population health and social change (Baker and Kealhofer 1996; McElroy and Townsend 1996; Pfeiffer and Fairgrieve 1994; Silliman 2005). Marked increases in the rates of infection, stress, and male mortality are noted in skeletal samples following European contact in North America (Pfeiffer and Fairgrieve 1994; Sempowski and Saunders 2001). Significant changes in activity have also been observed as reflected by activity induced skeletal markers and rates of degenerative joint disease (Larsen et al. 1996, Reinhard et al. 1994). Social realities were altered by the presence of European trade systems with shifts in gendered social status as evidenced by burial practices in indigenous contexts following contact (Nassaney 1989, 2004).

Gender is a fundamental facet of human social relationships and is constituted by cultural perceptions of the similarities and differences between individuals in societies throughout the life course (Sofaer 2006). Gender thus serves as a structuring principle, which establishes functional parameters for the roles of people in societies as well as how individuals express their identities (Arnold 2006; Conkey 1991; Conkey and Gero 1991; Sofaer 2006a,b). Researchers attempt to "engender" the past by exploring productive roles of individuals through investigations of division of labor, craft production, household archaeology, and mortuary analysis (Arnold 2006; Brumfiel 2006; Conkey 1991). Current theoretical models for the study of gendered social realities emphasize the need for a departure from utilizing binary distinctions such as male vs. female in interpretations of archaeological and bioarchaeological data, as gender is based upon factors beyond biological sex, such as social status, age, kinship, and ritual (Sofaer 2006a).

With respect to gender, traditional archaeological analysis and bioarchaeological investigations can build on one another to provide a deeper view of human social organization (Robb et al. 2001). Divisions between ranks in society may emerge in traditional mortuary analysis (Beck 1995; Binford 1972; O'Shea 1984; Robb et al 2001). The archaeological interpretation of grave goods commonly entails conclusions regarding social roles, wealth, and status. The interpretation of grave goods as material culture relating to social roles and status deserves a contextual analysis; while artifacts may have a utilitarian value, symbolism plays an important role in the meaning of material culture (Arnold 2006; Doucette 2001; Robb et al. 2001). Additional properties of burial have interpretive value such as treatment of the body and the facilities in which the preparation of funerary activities took place (Binford 1972; O'Shea 1984). Traditional avenues of mortuary analysis examined these patterns by differentiation of burials by binary sex (male vs. female) and age (child vs. adult) (Doucette 2001).

Additional avenues of anthropological inquiry add to the contextual interpretation of burials, including bioarchaeological analysis of bodies (Robb et al. 2001). Static, androcentric interpretations of the meaning of grave goods in conjunction with sexed burials deny the complicated aspects of variability in individualized identity, group identity, and the interactions between these processes (Arnold 2006; Doucette 2001; Sofaer 2006a,b). Mortuary variability may not only reflect the social "status" of an individual but rather the interpretation of such by the living members of the group (Robb et al. 2001). Factors such as life course, productive roles, and health and disease carry vital aspects of individual and group understanding of identity in regards to status and gender (Fugelesveldt 2014; Sofaer 2006a,b). In this regard, "biological status" refers to patterns of stress, activity, trauma, and disease (Robb et al. 2001). Within this framework, these biological responses to outside factors are interpretable from the human skeleton as seen as a site of social performance (Sofaer 2006a,b). Biological traces of social and physical landscapes of interaction can be interpreted from skeletal markers, as the skeleton is developmentally plastic (Sofaer 2006a). Elements of life course are an important axis of analysis in this interpretational framework, as markers of activity, disease, and can be altered by productive roles throughout the lifespan as well as the biological process of growth, development, and aging (Appleby 2010; Lewis 2007; Sofaer 2006a,b). Robb et al. (2001) emphasize that the interaction between "social" status and "biological" status provides contextual interpretation into archaeological models for social processes in the past. Mortuary analysis and bioarchaeological analysis in conjunction with one another provide a detailed level of analysis, as any observed interactions between these factors provide deeper contextual meaning (Robb et al. 2001).

## 1.1 THEORETICAL FRAMEWORK: GENDER

### 1.1.1 Anthropological Definitions and Criticisms of Sex and Gender

Sex and gender are arguably interrelated concepts, with sex having a biological basis and gender being a social construct (Sofaer 2006a,b; Sørensen 2000; Walker and Cook 1998). Sex is most commonly defined on a simple biological basis. Sex is viewed as the differences between males and females that are determined at conception and enhanced in growth and development, marked by differences in genitalia and skeletal morphology. These differences are identifiable in the skeleton via the contrasts in anatomy due to hormonal differences between biological males and females (Armelagos 1998:1-4; Sofaer 2006a:90).

In the late 1990s, archaeologists began to theoretically criticize the notion of biological sex as a male/female binary, given that individuals may be intersexed or transgendered, that biological sex is not stable, or that it is culturally rather than biologically constructed (Arnold 2002, 2006; Geller 2005, 2008; Gilchrist 1999; Hodder 1997; Joyce 2000a,b, 2006; Knapp and Meskell 1997; Meskell 1996, 2001). Criticisms of binary sex categorization note that osteological sex determination methods (Acsádi and Nemeskéri 1970; Buikstra and Ubelaker 1994) classify sex on a continuum from hyper-female to hyper-male, with categories of probable male/female and ambiguous. Osteological scoring recognizes the potential for variation in the physical expression of sexual dimorphism although final sex determinations fall into only two categories: male or female (Sofaer 2006a). Critics of sex assessment tend to overlook the implicit concern in osteoarchaeology with the ways that the physical expression of sex changes over the lifespan, such as changes at puberty and with senescence (Sofaer 2006a: 95). These debates regarding the nature of sex have considerable ramifications for methodologies in bioarchaeology, especially in relation to the relationship between sex and gender (Geller 2005; Hollimon 2011; Sofaer 2006a; Sørensen 2000).

Gender scholarship has questioned the use of binary distinctions of "male vs. female" in working definitions of gender, as biological sex is only one element of gendered performativity (Bolger 2013). Gender and its performance in society is not limited by biological sex and must involve more than the "male vs. female" dichotomy (Butler 1990). The category of gender must go deeper than simplistic definitions of gender as social ramifications of being male or female (Lesick 1997). Recent critiques by bioarchaeologists of gender archaeology have followed these ideas, and emphasize a need for a departure from "male vs. female", and even age categories such as "child vs. adult" (Sofaer 2006b). Binary distinctions such as these are limiting; gender is far more nuanced and is part of a complicated set of principles governing identity, social status, and activity in cultural context (Geller 2005, 2008, 2016; Sofaer 2006b; Sørensen 2000; Voss 2008). Gender and life course are interrelated, as the identity, status, and function of individuals in societies may change over the lifespan according to sex and different stages of the life course (Agarwal and Beauchesne 2011; Appleby 2010; Glencross 2011; Halcrow and Tayles 2011; Lewis 2007; Sofaer 2006b, 2011). Biological sex and age should be treated as variables in bioarchaeological reconstructions of the social dynamics of past societies (Sofaer 2006b, 2011).

### 1.1.2 Debates and Methodologies

There is a tension in gender theory about the relationship between sex and gender, which has methodological outcomes (Sofaer 2006a). Butler (1990, 1993) theorized that sex and gender were both constructed by society. Butler (1993) emphasized that there is not a natural fixed a-priori individual identity outside the performative acts constituted by societal normativity. It is through repetitive action according to this normativity that sex is materialized, and gender performativity is in turn materialized through the performance of sex (Butler 1993). Scholars following this re-definition of sex as a cultural construct, such as Joyce (2000a,b, 2002), Gilchrist (1999), and Geller (2008), argued that the use of purely objective methods in bioarchaeology, such as sex determination, masks the social context in which sex is materialized. Following the criticisms of Butler (1993), one of the most salient theoretical models employed by these scholars is embodiment, which is defined by Joyce (2004:84) as "the shaping of the physical person as the site of the experience of subjectivity, a shaping that is simultaneously the product of material and discursive actions". Joyce (2000) applied this concept methodologically, in bioarchaeological analyses of Maya and Aztec burials, by connecting material objects representing portions of the physical body such as figurines, other material aspects of personal ornamentation, and body-processing in burials targeting the same parts of the physical body. Joyce (2004:84) identified the relationship between the treatment of living and dead bodies and material objects associated with the body, which emphasized the importance of material culture and the body in performing cultural perceptions of sex, following Butler (1993).

Conversely, Sofaer (2006a) emphasized sex and gender as separate but related concepts, following definitions by Walker and Cook (1998). Sofaer (2006a:96) rejected criticisms by Geller (2005), Joyce (2000 a,b), and Meskell (1998), citing that sex has a material reality; the differences between males and females are not simply a mirage, and that biological sex is an important analytical axis. Under this framework, the ambiguity in terms of the relationship of the physical body to gender in mortuary contexts complicates reconstructions of gendered social realities and often leads to equating sex directly with gender. Sofaer (2006a:105) stated that "lacking direct observation of person-object interaction, archaeologists can neither disassociate objects from the biology of the individual without losing a point of reference, nor associate objects with the body without falling into the trap of biological determinism".

This results in a tension between biology, associated with the physical body, and material objects, associated with burials. Sofaer (2006a) suggested a methodological approach that resolves this tension by viewing the body as material culture. Bodies, while relied upon for biological sex and burial position and type, are rarely viewed as sites of gendered performance (Sofaer 2006a:105). The skeleton is plastic and is thus subject to alterations from social life and environment. Bodies should be regarded as products of human action with gender articulated in the skeleton (Sofaer 2006a:105). For example, body modification, activity markers, disease and trauma are all the results of gendered performance and identity according to cultural norms (Sofaer 2006a). Combined with other biological indicators such as age and life course as well as associated material items, a multifaceted view of gendered social realities in past societies can be reconstructed by viewing the body as material culture, akin to archaeological interpretation of the social meaning of material objects (Fugelesveldt 2014, Ghisleni et al. 2016, Sofaer 2006a,b, 2011).

### 1.1.3 Elements of Life Course

Sofaer (2011) argued for a bioarchaeology of age, emphasizing the importance of life course in interpretations of social patterns in the past. Age is interpreted in a number of ways by bioarchaeologists. Life course theory is a view of the social and physical aspects of an individual's lived experience throughout different life stages such as infancy, childhood, and senescence (Sofaer 2006a). Under a tri-partite framework of the interpretation of physiological age, chronological age, and social age, bioarchaeologists seek to reconstruct social patterns relating to life course (Sofaer 2011, 2013). The skeleton is developmentally plastic over the lifespan, exhibiting markers of human growth, the emergence of sexual dimorphism, age-related degeneration, and senescence (Agarwal and Beauchesne 2011; Sofaer 2011, 2013). The element of life course is relevant to the bioarchaeology of gender, as the social age of the individual is an important variable in societal interpretations of gender roles; age may be an important factor in the expression and recognition of personhood in a society (Gowland 2006; Sofaer 2013). Sofaer (2006a,b, 2013) emphasizes that engendering is a process that takes place over the lifespan, as the societal expectations and abilities of an individual evolve during different stages of life as well as the biological processes that alter the body's appearance and physical capabilities. Thus engendering is a process of "becoming" that is continual, and several studies, such as Appleby (2010) and Glencross (2011), have illustrated the ways in which the body, as interpreted as material culture, is a site of social responses to aging via analyses of activity, injury patterns, and community burial patterns (Sofaer 2013:236).

#### 1.1.3.1 Childhood

Childhood is a complicated area of bioarchaeological analyses of gendered social processes due to the fact that subadult remains cannot be accurately sexed using osteological methods (Mays and Cox 2000). Gowland (2006) argued that the attainment of adulthood and gendered social roles is relatively unexplored in archaeology, a phenomenon exacerbated by historical and ethnographic accounts of childhood as a social category that is ambiguously gendered and that identity becomes more strongly aligned with gender sexuality during the development of sexual maturity. Material culture plays a key role in bioarchaeological reconstructions of sex and gender among subadults in past societies, and is in many cases the only evidence available for such analyses in the absence of funding, time, and preservation factors suitable for determination of biological sex via ancient DNA (Gowland 2006). Burial type and comparisons between subadults and adults may reveal social interpretations of childhood mortality and evidence of the ways in past societies conceptualized childhood (Littleton 2011).

The analysis of children in bioarchaeology is also hindered by under-representation of children in the archaeological record (Lewis 2007). Differential burial practices and preservation biases may account for some of these differences (Lewis 2007). Osteological analyses of subadults may shed light on social processes in the past. Patterns of disease and trauma may indicate at which age children were incorporated into labor practices, which are inherently gendered in many societies (Halcrow and Tayles 2011; Lewis 2007). For example, Lewis (2007) suggested that patterns of trauma may indicate when a child was initiated into apprenticeship or labor, which increased the risk of injury. Patterns of skeletal trauma and injury vary throughout the life course and are dependent on a number of factors including age, occupation, and underlying pathological conditions (Glencross 2011). Dental disease and stress indicators, as well as stable isotope studies, may also shed light on the nature of childhood through analyses of diet (Lewis 2007; Halcrow and Tayles 2011).

#### 1.1.3.2 Senescence

Appleby (2010) argued that senescence and old age were important socially recognized categories of identity in the past, and there is a need for a bioarchaeology of old age to address the nuances of the social aspects of the aging process. It is emphasized that bioarchaeological interpretations of old age in relation to degenerative processes of skeletal aging are biased and may be incongruent with social interpretations of age (Appleby 2010). Skeletal aging methods are limited in their scope; most define old age as 50+ years (Buckberry and Chamberlain 2003). This is both a theoretical and methodological concern in bioarchaeology, as people in prehistory may not have had life expectancies over age 50; in a given society an individual who died at age 40, for example could have been considered to be elderly (Appleby 2010).

Age-related osteological changes that are commonly employed in age estimation standards may not manifest in a noticeable difference in the appearance or ability of an individual, such as cranial suture closure, remodeling of the auricular surface of the ilium, remodeling of the pubic symphysis, and histologically related age-changes. Appleby (2010) notes that social aspects of old age may begin to be recognized with visible changes to the appearance or ability of an individual, such as fractures relating to loss of bone density in osteoporosis, tooth loss and wear, and osteoarthritic conditions of the extremities. Gender roles are an important factor in the aging process; it is shown that occupational differences between populations may affect the appearance and degree of osteoporotic change in older females (Agarwal 2012) and diet is also an important factor in dental health (Appleby 2010). The biocultural aspects of aging, combined with funerary evidence, may thus aid in interpretations of gendered social processes and gendered identity in the past (Agarwal 2012; Appleby 2010).

### 1.1.4 Material Culture, Gender, and the Mortuary Context

Early archaeological analyses of gender from the late 1980s and early 1990s sought to make women visible and to highlight evidence of the importance of women in prehistory (Conkey and Gero 1991; Brumfield 1991; Hastorf 1991; Sørensen 2006). These early studies were guided by the perception of material culture as a passive entity, which was reflective of social relations. Mortuary studies were focused on the association of material objects in the mortuary context with women; women's rank and wealth was reflected by the wealth of material objects in the burial context. In this way, material culture was equated with the importance of the individual (Sørensen 2006). By the late 1990s, theoretical shifts in the discipline of archaeology placed the meaning of objects into the forefront, as the relationship between objects and people is intimate and part of the life histories of both. Material objects are entrenched 1) in the negotiation and legitimization of power, 2) the productive roles of individuals as producers and partners in complex economic strategies, and 3) the role of the individual in economic micro-units as well as the society at large in differentiated gendered categories (Brumfiel 1991; Hastorf 1991; Stalsberg 2001). Following Butler (1993) and the movement in anthropology towards the view of sex and gender as fluid entities materialized through performance according to societal norms, material objects are viewed as one means through which gender is constructed and negotiated as material culture is a medium of gendered performance (Sørensen 2006). Through objects and associated activities, gender is performed and becomes a recognizable aspect of personal and social life. Thus, material culture is a medium or partner to social discourse (Sørensen 2006)

Echoing the notions of embodiment as defined by Joyce (2004), archaeologists view material culture as a praxis through which gender is experienced through the body in the landscape. Through this discourse, the interaction of the body and material culture frames the lived experience of an individual and provides archaeologists with a view of constructions of gendered identity (Sørensen 2006). One of the properties of the study of gender and material objects is the meaning of the tangible qualities of material culture that convey the qualities of social discourse. Objects are produced and used in specific contexts which shape how, when, and who may be using them which reinforces and alters societal interpretations of their meanings. In this view, material objects are symbolic of the social, cultural, and individual meanings as they are tangible representations of the social context in which they were created and used. Gender and material culture are inexorably linked as gender gains reality as it is performed and experienced through material culture (Sørensen 2006). While the physical properties of an object may reflect the societal context in which it was used or by whom it was used, the meaning of material objects is not static. For example, a sword in a burial, in a blade cache, or in iconographic representations may not convey the same meaning in those contexts (Sørensen 2006).

According to Parker Pearson (2000), funerary archaeology is an essential analytical framework for the categorization of gendered social processes in the past, as social relationships are solidified in burial ritual in many societies (Arnold 2006). Gender is one aspect by which burials are differentiated; burial context can be defined by burial location, position of the body, orientation of the grave, and the associations of collection of material objects with a particular gender (Arnold 2006, O'Shea 1984). Arnold (2006) emphasized that the relationship between gender of death and gender of the living is not concrete as death is a liminal process that confounds our ability to draw inferences from burials to social processes within living societies. Though this interpretational bias in funerary archaeology exists, burial analysis provides an important context in which to study gender in the past (Arnold 2006).

Material culture in the burial context provides an important connection between gender and the life cycle as objects may mark key events in the life course. Thus, material objects are mediators of gender relations and life course, as gender is not static throughout the life course (Sørensen 2006). This echoes Sofaer's (2006a,b) assertion that the body itself should be viewed as an element of material culture and that life course is an important analytical axis in mortuary studies. Material culture is, in turn, modeled as the means through which gender is materialized and performed, and these processes are clearly associated with burial ritual. Sørensen (2006) suggested that burial events were composed of distinct stages, such as the funeral and the burial itself, and that these are contexts of action in which gender was emphasized. The burial event itself would have been designed around a societal understanding of what kind of body was being buried based upon gender or biological sex, and the position, body treatment, and associated funerary material culture associated with gender and sex. Funeral dress, appearance, and associated burial objects are emphasized as means by which gender is performed through material culture in the burial context (Sørensen 2006).

#### 1.1.4.1 Queer Studies

Geller (2005; 2008) and Voss (2000; 2008) as well as Alberti (2013) emphasized the intriguing approach to the study of gender as outlined by queer theory. The term queer has been given multiple working definitions by recent anthropological scholarship (Alberti 2013). Alberti (2013:88) emphasized that queer is a difficult term to define, as queer theory emerged from a movement to complicate the issue of sexual identity, as there was a tendency to utilize medico-legal terminology in the labeling of sexual identities which resulted in a dissonance between the physical body and identity. Voss (2008) defined the notion of queer as the relationship between the deviant and the normative, with deviance reflexively related to the normative by continual reference to one another. Alberti (2013:88) defined queer as "an internal, contradictory tension between two positions – the critical and continually in flux and the stable and categorical around which the former must turn." Queer theory is thus a rejection of heteronormativity and its definitions of sex, gender, and sexuality. Queer studies seek to investigate the ways in which sex, gender, sexuality, and identity are mutually constructed (Voss 2008). Alberti (2013) emphasized that, like the work of feminist archaeologists working under the framework of Butler (1993), queer studies emphasize a departure from male/female binaries and view sex as a fluid concept. Queer theoretical frameworks echo the ideas of Joyce (2004), Geller (2008) and Sofaer (2006a), in that bodies and material objects should be interpreted as conduits through which identity is expressed.

Hollimon (2011) argued that bioarchaeology is a field that is uniquely suited to this line of inquiry in its ability to examine multiple social factors which are constructed in the physical body, such as gender and identity, even in the absence of grave goods and ethnohistorical information. Bioarchaeological studies have demonstrated that in operating under a queer framework, important aspects of social identity may be revealed. For example, Hollimon (1997, 2011) argued for the presence of non-binary gendered identity among the prehistoric Chumash of California, evident in a group of young adults with spinal osteoarthritis as observed in older females of the group. These individuals were buried with digging sticks and other artifacts indicating a relationship to the occupation of grave digging. This mortuary pattern, along with evidence of repeated stress induced degenerative disease, indicated that younger males and older females constituted a separate category of identity in Chumash society associated with mortuary ritual. This evidence also suggests that some young males were initiated into this class as early as adolescence (Hollimon 1996, 1997). Rodrigues (2006), in an analysis of MSMs among the Ohio Hopewell of the Middle Woodland period of North America, suggested that a third gendered category may have existed for shamanistic practitioners based upon differential health, activity patterns, and burial treatment from the lay population. Following such examples, bioarchaeological studies fit within queer theory frameworks to elucidate bodily changes in conjunction with material objects as markers of identity that were the result of socially sanctioned events in prehistory associated with initiation rites to gender, social age, occupation, or membership to a specific class such as ritual practitioner or undertaker (Hollimon 2011).

## 1.2 THEORETICAL FRAMEWORK: MODELING CONTACT

Contact between Native Americans and Europeans can be examined following models from medical anthropology and archaeological studies (McElroy and Townsend 1996; Silliman 2005). Using evidence from both physical and social landscapes through analyses of mortuary contexts from Native American archaeological sites, anthropologists have applied such models to characterize the nature of cultural and biological continuity and change following European contact and in subsequent periods (Ferris 2009; Nassaney 2004; Panich 2013; Rodning 2011; Silliman 2005).

### 1.2.1 Models from Medical Anthropology

Anthropologists studying cultural contact in the medical context have discussed the dynamics of interaction between distinct cultural groups. When two or more population groups encounter one another, stress episodes may occur, especially in cases where the dynamics of contact are defined by intrusion of one group into the territory of another or in cases where groups have distinctly disparate technologies (McElroy and Townsend 2008). Group survival is often at stake, as contact episodes can have drastic epidemiological, environmental, and social consequences. McElroy and Townsend (2008) modeled contact in five distinct stages: pre-contact, early contact, acculturation, assimilation, and revitalization. Epidemiological and social trends are observable in each of these stages (McElroy and Townsend 2008). While evident in ethnohistorical reports, however, reconstructions of the epidemiological and social processes associated with culture contact may not be as easily identifiable in the archaeological and bioarchaeological contexts due to a lack of written accounts and the nature of archaeological and osteological samples, especially in early stages of contact (Silliman 2005). For example, the spread of certain disease pathogens such as measles and smallpox are not distinguishable osteologically as these are acute diseases that kill the host rapidly, and in the absence of written records these would not be distinguishable archaeologically from other mass mortality events (Warrick 2003).

It is important to emphasize that archaeologists have critiqued these types of approaches. Terms such as acculturation and assimilation are essentialist and deny the important nuances of social agency of indigenous communities (Ferris 2009; Rubertone 2000). Defining contact into a series of predictable stages also emphasizes that these models view assimilation and decline as almost inevitable consequences of colonialism, when it has been documented archaeologically, that maintenance of local traditions occurred among Native American groups along with the incorporation of new technologies, religion, and migration associated with European colonialism (Ferris 2009; Panich 2013).

### 1.2.2 Archaeological Modeling: Native Lived Colonialism

Historical models of contact and colonization in North America have focused primarily on the perspective of rapid decline of indigenous peoples and dependency on Europeans, and until recently historical archaeology was viewed as a discipline which sought to echo a-historical narratives of the indigenous past, rife with assumptions and modern western biases (Ferris 2009; Rubertone 2000; Panich 2013). Panich (2013) emphasized that historical archaeology has had a tendency to reinforce acculturation narratives of the past through research agendas that were narrowly focused on demographic, cultural and technological changes during the colonial period. Change has been conceptualized through interpretive frameworks such as acculturation, which ties indigenous cultures to static, externally defined lists of cultural traits (Rubertone 2000; Panich 2013). While change did occur with the onset of colonialism, the archaeological and historical approaches that equated change with loss fostered the idea that extinction of indigenous cultures was an inevitable consequence of colonialism, effectively ignoring the presence of modern indigenous groups with their own histories who negotiated contact and colonialism through myriad means (Panich 2013).

Ferris (2009) has emphasized that the role of archaeology in colonial narratives should not be merely a ‘handmaiden to history’ but rather focus local and detailed contexts to provide deep meaning to patterns over time, viewing change and continuity in the past as an interconnected whole. Archaeologically imagining the past involves piecing together patterns from a fragmented collage of data rather than the reconstruction of one broad, singular truth (Binford 1975). The archaeological record, by its very nature as a collection of material culture, settlements, burials etc., can accommodate multiple interpretations and emphases of continuity and change, making archaeological presentation an essential element to illustrate indigenous histories (Ferris 2009). Panich (2013) emphasized that this recent approach to indigenous pasts challenges terminal narratives and considers the multiple ways in which native peoples actively negotiated social institutions and identity during the colonial period, which resulted in the persistence of native communities that still exist in many forms today. The approach of viewing contact as an interconnected whole of continuity and change in which human agents actively negotiated new material culture and peoples, and meanwhile persisted with their own traditions leaves researchers with many open areas of interpretation. The shift in theoretical perspective within the field from simple acculturation narratives to changing continuities allows researchers to place colonialism within the context of indigenous histories (Ferris 2009; Panich 2013). This leads to an archaeological exploration of how Native Americans drew on their own cultural institutions to negotiate the presence of a new power (Panich 2013).

This new approach to colonialism within archaeology is grounded in several tenets of archaeological theory (Ferris 2009, Panich 2013). Ferris (2009) drew upon Bourdieu's (1977) concept of practice theory and the construction of habitus. Habitus represents the durable dispositions and attitudes that people have about themselves and the world around them works, or rather, concepts of "knowing and doing". These dispositions operate underneath daily living and represent cultural conventions and assumptions around the way in which the world is ordered, passed on through generations via enculturation (Bourdieu 1977, Ferris 2009). New experiences, such as contact, are negotiated through embedded practices such as class, gender, labor and authority, and are thereby naturalized into the existing cultural framework (Ferris 2009). This theoretical approach does not, however, view existing cultural patterns as static entities, as these are interactive with lived experience, daily practices, and dispositions that are in constant re-negotiation. New experiences and unpredictable circumstances under this view thus trigger a reinforcement of existing habitus (continuity) or a greater paradigmatic revision (change). Giddens (1982) further explained that societal structures and agency are interconnected through an ongoing process of maintaining one another, with agency being a continuous process of cultural practices.

Through these theoretical frameworks, interpretive archaeology then focuses on social processes such as power, identity, and gender (Ferris 2009). Material culture is the framing of agency through which practice emerges as technology operates through a sequence of dynamic processes that reflect the culturally and historically specific contexts of interaction, meaning, and choice. A material object in an archaeological context is viewed as a medium through which a range of social actions are negotiated, such as procurement of materials, division of labor and craft specialization, purchasing or trading, as well as the function and link to the social status of the person using the object (Ferris 2009; Sørensen 2000, 2006). The goal of archaeology of the colonial period is then to bridge the gap between pre-contact and post-contact archaeology by focusing on the material dimensions of lived life via multiscalar investigations of the daily lived experience of indigenous people to see beyond the historical "otherness" over Native Americans and into the historical context of lived experiences of people in their own time (Ferris 2009; Sassaman 2000).

Material culture is the medium through which archaeologists may understand this interaction (Ferris 2009). Silliman (2005) stated that histories of interaction are a continuum of contexts and recursive social processes. In relation to colonialism, there was continual exchange between local and widespread indigenous communities as well as Europeans (Silliman 2005). Past archaeological investigations of contact and colonialism focused on trait lists of material objects in which the appearance of European made goods was interpreted as a sudden, wide-scale adoption of European lifeways and social alteration (Ferris 2009; Rubertone 2000). This approach ignores how indigenous interest in and use of European objects was selective and that these items would have operated inside pre-existing Native American conceptions of material culture (Ferris 2009; Lightfoot 2015; Panich 2013). Holistic analyses of material assemblages may focus on the fact that the social meaning of European goods is not directly transferred and adopted into an indigenous social structure as the objects themselves were subject to interpretation within the worldview of indigenous peoples rather than foreign to it (Ferris 2009; Panich 2013).

Thus the critical way in which archaeologists may examine contact, interaction, and social practice is through investigations of social processes such as gender or subsistence-settlement patterns. Ferris (2009) emphasizes that subsistence-settlement strategies represent how the world was negotiated in everyday living, through which meaning and cultural structures operate. Multiple factors accounted for in subsistence decisions become translated as social choices or priorities that are weighed differently from community to community. Such practices of daily living are shaped by economic, social, and ritual dimensions of human experience and contribute to defining group and individual identity (Ferris 2009; Lightfoot 2015). Changes or continuities in subsistence settlement patterns over time indicate how colonialism was lived and experienced by indigenous populations. For example, even into the colonial period, the Ojibwa of the Great Lakes maintained seasonal movement patterns and subsistence well into the 1840's, despite Europeans encroaching on their traditional lands. While European made goods were used and adopted by the Ojibwa, their use and meaning was incorporated into existing social and cultural processes (Ferris 2009). This type of evidence rejects the omnipresent historical narrative of decline and assimilation, and demonstrates the myriad ways in which indigenous peoples co-existed and maintained local traditions (Ferris 2009).

### 1.3 OHIO VALLEY PREHISTORY: FILLING IN THE GAPS WITH BIOARCHAEOLOGY

The Ohio Valley region of southwestern Pennsylvania had a rich and diverse cultural past during history and prehistory. The region's bygone eras were colored by the presence of major indigenous cultural developments. During the Early Woodland period (3000-1950BP), the landscape was dotted with conical shaped burial mounds in which presumably mobile hunters and foragers buried their dead in an elaborate system of log tombs, bundle burials, and single graves with grave goods made of exotic materials (Milner 2004; Seeman 1987). Researchers have linked the Adena complex with the later Hopewell cultural interaction sphere, based upon shared geographic distribution, artifact iconography, and widely distributed trade networks (Milner 2004; Neusius and Gross 2013). Very little is known the settlement and subsistence aspects of Adena-Hopewell complex, as very few habitation sites have been discovered (Greber 2005; Keener and Nye 2007; Seeman 1987). Milner (2004) hypothesized that the nature of sociopolitical ties consisted of mobile bands of kin groups, through which emergent leaders maintained a system of trade and clan networks. Mounds served not only as burial places, but also as a reaffirmation of shared group identity (Milner 2004).

Later in prehistory, during the Late Prehistoric period (1000-1635AD), the Monongahela tradition defined the human occupation of the Ohio Valley region. Archaeologists have typically divided the Monongahela into three phases: Early (1150-1250AD), Middle (1250-1580AD), and Late (1580-1635AD) based on pottery typology and settlement data (Johnson 2001). The Monongahela people were maize agriculturalists settled into nucleated, palisaded villages located on hill bluffs and upland terraces (Butler 1939; George 1974; Hart 1993; Mayer-Oaks 1955; Means 1999, 2007a). While the usefulness of defining these groups as a distinct archaeological culture has been debated (Hart 1993; Means 2007a), it is likely that the people in these villages were genetically related (Sciulli 1995). The mortuary program consisted of children buried in house floors, and adolescents and adults in the villages between the houses and palisades (Johnson 2001; Means 1999, 2007a). Very little differentiation by sex in burials by sex or age has been discovered for the Monongahela, as only a small portion of burials contained grave goods (Clark 2014; Davis 1984).

Following the arrival of Europeans in the mid 1600's, the Ohio Valley region became a confluence of indigenous settlement, trade, and conflict (McConnell 1992). By the early 18$^{th}$ century, western Pennsylvania was inhabited by several tribal entities: the Delaware, the Shawnee, and the Seneca (McConnell 1992). The Delaware had been pushed out of their original territory in New Jersey by encroaching European settlement during the 1680s and had settled into towns in western Pennsylvania by 1737 (Obermeyer 2009). Seneca groups had also infiltrated the region from New York State, as well as Shawnee from the lower Ohio area (McConnell 1992). Settlements in the Ohio country consisted of mixed indigenous towns in which native peoples grew crops and kept small livestock (LeRoy and Leininger n.d., M'Cullough n.d.). Indigenous communities were also heavily engaged in trade with the English, French, and Dutch; groups in western Pennsylvania traded furs, pelts, and other local resources for silver, glass beads, European cookware and nails (Cowin 2003; McConnell 1992). Conflict erupted by the mid-18$^{th}$ century, with the Delaware, Seneca, and Shawnee engaged in both the French and Indian War (1754-1763) and Pontiac's Rebellion (1763-1764) (Brown et al. 2014; McConnell 1992).

Previous archaeological research regarding prehistory of the Ohio Valley region focused primarily on the Monongahela tradition, though Dragoo (1963) published a detailed guide to the Adena Cresap Mound site and early archeological efforts in the 1880's in Pittsburgh excavated several Adena mounds. Monongahela pottery typologies were extensively studied and defined. There was a preference for shell tempered round bottomed vessels with Z-twist cordage impressions and fluted rims, though limestone grit tempered vessels and incised wares also made up part of the pottery assemblage at Monongahela sites (Johnson 1996; Mayer-Oaks 1955). Questions regarding the subsistence, settlement, and social structure have been central to Monongahela archaeology. Multicropping in the form of maize, beans, and squash was practiced, though maize made up approximately 70% of the Monongahela diet (Greenley 2006; McConaughy 2008). Monongahela settlements consisted of clusters of houses arranged around a central plaza that functioned as an *axis mundi* for social interaction and spatial organization (Means 2007a). It is hypothesized that the household was the key unit of social interaction for peoples of the Monongahela tradition; small house clusters represented related kin groups within larger frameworks of clans (Means 2007a). By the Late period (1580-1635AD), community ceremonial centers began to appear at Monongahela sites in the form of petal shaped appendages on traditional round house structures; charnel houses began to appear in these periods, indicating the presence of emergent elites and alterations to the social structure surrounding the household as the primary unit (Anderson 2002). Trade with Europeans may have brought on significant changes to leadership structure, with the Monongahela acting as middlemen in trade networks with the Chesapeake Bay area and groups to the north of the Ohio Valley (Lapham and Johnson 2002).

There was little focus on mortuary archaeology and bioarchaeological analysis for the Monongahela and other Ohio Valley groups. Monongahela burials did not contain large caches of grave goods; Davis (1984) reviewed the distribution of grave goods by sex. Few burials contained grave goods with items of personal adornment predominating in the mortuary assemblage; Davis (1984) suggested this pattern was indicative of emergent elites, given that few adults were buried with any grave goods. Further studies of Monongahela mortuary assemblages have shown that there were sex specific classes of grave goods, with males buried with drills, lithic points, snail shells, and whole marine shells whereas females were associated with shell pendants, beads, disks and ceramic chain production items (Clark 2014). Preliminary skeletal analyses were performed by Sciulli (1995, 2002); these studies indicated high rates of dental disease and skeletal indicators of stress, along with a number of cases of trauma and infectious diseases such as tuberculosis. These studies leave considerable gaps in knowledge of social organization in the Ohio Valley, which is why the current study's integration of traditional mortuary analysis and bioarchaeological inquiry is essential to provide a deeper nuance.

### 1.4 RESEARCH QUESTIONS AND HYPOTHESES

The goal of this study was to isolate shifts in patterns of gendered social relations and population health among the indigenous populations of the Ohio Valley in five time periods: Early Woodland (3000-1950BP), Early Monongahela (1050-1250AD), Middle Monongahela (1250-1580AD), Late Monongahela (1580-1635AD), and Post-Contact (1756-1778AD). The project combined analyses of grave goods, burial contexts, demography, patterns of health and disease, and activity induced musculoskeletal markers (MSMs) to elucidate the fluctuations of these processes through time. This research followed criticisms of gender theory by Sofaer (2006a), integrating nuanced aspects of life course into these analyses to provide deeper contextual meaning of gender. Both mortuary and skeletal variables were integrated and compared using multivariate analyses juxtaposed against the null hypothesis that no difference existed in gendered patterns of social status, health, and activity. This approach was grounded in several research questions that framed the analysis:

1. Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time period?

2. Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?

3. What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course in indigenous societies?

### 1.4.1 Hypotheses

Multiple testable predictions were developed for each of these research questions, following previous archaeological research discussed in Chapters 3 and 4 of this volume.

#### 1.4.1.1 Research Question 1

*Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time Period?* This question addresses how biological sex, age, and labor interacted to influence social status among the Ohio Valley groups, as evidenced by differences in burial pattern between individuals of different sexes, ages, and different activity patterns (from musculoskeletal stress markers). For each burial, grave goods were inventoried by number and type (wood, lithics, ceramic, copper etc.), and for each skeleton, sex and age were estimated, and musculoskeletal stress markers (MSMs). These data were then compared via cluster analysis and ANOVA tests. In this analysis, MSMs were considered to be the skeletal proxy for patterns of labor differentiation. Sex and age were important variables as well, as both can be factors in identity and status (Robb et al. 2001; Sofaer 2006b, 2011).

For the Monongahela specifically, Iroquoian models for labor and social organization were used for comparison, though the cultural affiliation of the Monongahela tradition is debated. Johnson (2001) suggested a connection between the Monongahela and Iroquoian groups; bulbous, low to medium-high collared vessels with oblique tool incision similar to Iroquoian pottery styles were recovered in low frequencies from Late Monongahela sites. Other artifact classes have few notable similarities. Johnson (2001) listed isolated finds at Late Monongahela sites of copper items such as beaver effigies and shell earspools similar to those found at Seneca village sites.

Swauger (1974) and George (1994) made a more convincing argument for a connection to Algonkian speaking groups to the west and north of the Ohio Valley. Throughout the entire Monongahela sequence, petroglyph art was widespread throughout the Ohio Valley region (Swauger 1974; Weeks 2002). There are striking similarities in animalistic iconography between Monongahela petroglyphs and those associated with proto-Algonkian cultures (George 1994; Swauger 1974; Weeks 2002). It may be that the Monongahela tradition is merely an archaeological construct that bears little to no affiliation with any aboriginal entity (Hart 1993; Means 1999; Weeks 2002).

Despite this, Iroquoian studies provide workable models for comparison of activity and health patterns (Noel 2011; Pfeiffer and Fairgrieve 1994; Venables 2010). While the cultural connection with the Monongahela is tenuous, the Iroquoians and the Monongahela shared some similarities in subsistence strategy and geographic location, as both practiced maize agriculture with multi-cropping, lived in large palisaded villages, and occupied regions in the American northeast. There is a relative wealth of ethnohistorical information regarding the Iroquoians, with several working models for gendered patterns of labor and social organization (Noel 2011; Venables 2010). Models of Iroquoian social organization suggested by Noel (2011) and Venables (2010) were thus utilized as a starting point for modeling Monongahela social patterns.

Prior to analysis, several hypotheses were formed in regards to each research question based upon previous research. In regards to funerary treatment, it was expected that in the Early Woodland burial mounds, little differentiation in terms of grave good frequency by sex would be observed, with few subadults included in the sample. Previous studies on the Hopewell, which may have been linked to earlier Adena groups, have demonstrated that distribution of grave goods in both elite burials and non-elite burials was not strictly delineated by sex, and that subadults are not frequently found in Adena mounds (Field et al. 2006; Milner 2004, Rodrigues 2006). The identification of elite burial classes was also expected; shamanic practitioners were identified with large grave caches of exotic items with religious iconography in similar Hopewell contexts by Carr and Case (2006) and Rodrigues (2006). It was also expected that lower MSM scores would be noted in higher status burials, following Rodrigues (2006).

Different patterns in funerary treatment and activity by sex and age were expected for the Monongahela from the previous sample. It was hypothesized that very little differentiation in burial pattern between the Early and Middle periods would exist, based upon Davis (1984). A burial pattern with children buried in house floors and late teens to older adults buried in the village along the palisades was anticipated following upon previous excavation reports from Monongahela villages (Davis 1984; Johnson 2001). Age based differentiation was hypothesized in grave good distribution, with older adults having a larger number and greater variation. This was based upon the model proposed by Noel (2011) that Iroquoian groups valued older adults as emergent leaders. A marked shift in burial pattern by sex was expected for the Late Monongahela, as charnel houses have been noted at several Late period sites (Anderson 2002). It was expected that individuals buried in charnel houses in the Late Monongahela sample would represent a class of emergent elites, and would therefore show a marked decrease in MSM robusticity and would likely be adults of an advanced age, with males represented more than females following Anderson (2002). For the Early and Middle periods, it was anticipated that males would have greater robusticity in the lower limb, with females exhibiting higher scores in the shoulder and lower arm, based on models of labor from Iroquoians (Noel 2011; Venables 2010). Younger and middle aged individuals were expected to have higher MSM scores than older adults, as in several European agriculturalist samples it was shown that MSM robusticity decreased among older adults (Niinimäki 2011; Stefanovic and Porcic 2013), and it was hypothesized that older adult among the Monongahela took on leadership rather than labor roles (Noel 2011). Younger and middle aged individuals were expected to have higher MSM scores than older adults, as in several European agriculturalist samples it was shown that MSM robusticity decreased among older adults (Niinimäki 2011; Stefanovic and Porcic 2013), and it was hypothesized that older adults among the Monongahela took on leadership rather than labor roles, with status linked to increased age following Noel (2011). An increase in general muscle robusticity was anticipated for the Late Monongahela sample, as the Little Ice Age made maize cultivation more difficult due to drought conditions; carrying water over distances, land clearing for new crop cultivation, and foraging farther afield may have occurred (Richardson et al. 2002).

For the Post-Contact group, it was anticipated that male elites would be evident in grave good distributions based on historical accounts of male authority figures among the Delaware, with older age as a contributing factor to high status (Morris 1759, M'Cullough n.d., Noel 2011). Labor patterns similar to those of the Iroquoians were expected to persist into the historical period with women as agricultural laborers and men as hunters and traders (Gist 1759; LeRoy and Leininger n.d.). MSMs were expected to decrease with age following Stefanovic and Porcic (2013), as older adults were hypothesized to have transitioned into occupations with less physical labor, such as community leadership and resource distribution (Noel 2011).

#### 1.4.1.2 Research Question 2

*Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?* This question investigated whether or not differential patterns of health and activity were evident in different social classes. This assumes that prehistoric and historic Ohio Valley societies were ranked. There is some evidence, if limited, for ranking in each society in this study. Among the Adena, ranking is assumed because in many Adena-Hopewell contexts, elite log tomb burials were identified with large caches of rare, exotic item grave goods (Carr and Case 2006). Ranking may not be as evident in the Early and Middle Monongahela periods, as emergent elite status is not clearly indicated in the mortuary record until the Late Monongahela phase (Anderson 2002). In the Post-Contact sample, high ranking is expected to fall along gendered lines, as males were historically documented political leaders with considerable prestige among the Delaware (Morris 1756).

Disease was measured via several skeletal conditions including non-specific infection indicators, specific infectious disease lesions (maxillary sinusitis, tuberculosis, and treponemal disease), and skeletal indicators of stress. Dietary consumption was investigated via rates of different skeletal pathologies: caries, antemortem tooth loss, periodontal disease, and dental abscesses. High dependence of cariogenic foodstuffs such as maize caused higher rates of dental disease in the past (Lukacs 2008, Sciulli 2002). Differential dietary consumption between individuals of different social statuses may be indicated in varied rates of dental disease between groups.

A significant difference between time periods was expected in rates of disease, dental pathologies, osteoarthritis, and indicators of stress. Specifically, it was anticipated that the Early Woodland Adena would have low incidences of dental disease, infectious disease, and stress. This was due to several factors: the subsistence pattern was likely mixed foraging and hunting and less labor intensive than agriculture, foods consumed were less cariogenic than maize, and rates of disease are reportedly lower in Early Woodland contexts than in later periods (Seeman 1987; Milner 2004; Sciulli 2002). Activity patterns were expected to be differentiated by rank (Rodrigues 2006).

For the Monongahela, an increase in infectious disease was anticipated from the Early Woodland period, as periostitis and tuberculosis have been reported in Monongahela skeletal samples (Sciulli 2002). Tuberculosis is hypothesized to have increased among Late Woodland indigenous groups as higher population aggregates were settled into villages (Buikstra and Williams 1991). Maxillary sinusitis rates were anticipated to increase from previous periods, as more time would have been spent in indoor houses with exposure to wood smoke within a contained space (Roberts 2007). Rates of dental disease were expected to be high, and more so amongst females; maize is a highly cariogenic food source and females have been shown to have higher rates of dental disease due to decreased resistance to oral bacteria from reproductive demands (Lukacs 2008). These patterns were expected to intensify in the Late period, as resource stress was expected due to environmental changes from the Little Ice Age. Stress indicators were expected to increase along these lines as food insecurity may have occurred during the Late Monongahela period (Richardson et al. 2002).

MSM scores were expected to increase with the Early and Middle Monongahela periods, as these groups were involved in intensive maize agriculture. Patterning of MSM robusticity was hypothesized to be different among males and females following Iroquoian models of labor organization (Noel 2011; Venables 2010). This was suggested due to the Iroquoian connection with the Monongahela proposed by Johnson (2000). MSM scores were expected to increase from the Middle Monongahela period to the Late period. MSM pattern was also expected to vary along according to rank in the Late Period; it was anticipated that emergent elite males, following Anderson (2002) would exhibit less MSM robusticity than the rest of the group as a function of increased status and occupation in trade and political organization.

Rates of dental disease were expected to decrease among the historic Delaware, as it was documented that agriculture was frequently disrupted by conflicts in the Ohio Valley region in the mid-18$^{th}$ century. Historians indicate that a return to hunting and foraging occurred amongst indigenous communities during these periods (McConnell 1992). As many researchers noted an increase in stress indicators and infectious disease following contact in indigenous skeletal samples (e.g. Baker 1994; Pfeiffer and Fairgrieve 1994), these skeletal lesions were anticipated to increase amongst the historic Delaware as a function of contact.

#### 1.4.1.3 Research Question 3

*What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course?* In this question, age is the most important factor as individuals at different stages of life course have varied identities and roles within societies (Sofaer 2006b). Using similar skeletal proxies as in question 2, grave goods, and burial analyses, these patterns were examined with respect to estimated skeletal age in narrow age categories ranging from fetus to old adult (See Chapter 5 for discussion of methods and age categories). In all periods, it was expected that older adults would achieve higher status than that of youths and younger adults. In many indigenous societies, age is a significant factor in status, with community elders holding important roles in councils, leadership, and resource distribution (Noel 2011).

In the Early Woodland period it was expected that few subadults would be included in the mortuary assemblage, as children are rare in Adena contexts (Dragoo 1963, Milner 2004). Of the adults, it was expected that emergent status and leadership would emerge among older adults, as evidenced by increased elaboration in funerary context including: log tomb burials, high numbers of grave goods, exotic items. MSM scores were anticipated to decrease with age as older individuals transitioned from labor into community leadership and trade negotiators (Noel 2011). Dental disease was expected to increase with older adults as longer periods of attrition and exposure to cariogenic foods occur in tandem with weakening of the enamel from wear over the lifespan (Appleby 2010).

While status was expected to increase with age among the Monongahela in terms of an increased number of grave goods with older adults, archaeologists recorded differential burial patterns by age (Johnson 2001). Children were buried in house floors, indicating a preference to keep them close to the home and kinship lines following death (Clark 2014; Means 1999). Adolescents were buried with adults in the villages, indicating that attainment of adult social status occurred at the boundary of perceived sexual and social maturity (Johnson 2001). These patterns were anticipated for the Early and Middle periods, though for the Late period it was expected that older adults would be buried in the charnel house structures identified at Late phase sites by Anderson (2002). Patterns of health were also expected to vary among age ranges: stress was expected to be higher among subadults, as growth and development periods are most susceptible to insult. It was anticipated that indicators of stress would be highest during the Late Monongahela period, as a function of increase resource stress from the Little Ice Age (Richardson et al. 2002). Rates of periodontal disease and AMTL were expected to be highest among older adults as a factor of the aging process, though an increase from the Early Woodland in the instance of caries in subadults and young adults was also expected as reliance on maize intensified during the Monongahela periods. MSM scores were also expected to decrease with age for all periods, as with the Early Woodland sample, as older adults transitioned into different social roles (Noel 2011).

For the Post-Contact sample, it was expected that older adult males would hold higher social status as reflected by an increase in grave goods, especially European silver and glass bead trade items (Nassaney 2004, McConnell 1992). Stress indicators were expected to increase in subadults during sensitive developmental periods such as young childhood, as resource stress from warfare may have affected corn planting (Gist 1759), though cribra orbitalia and porotic hyperostosis can develop in adulthood. The demographic profile was expected to represent a catastrophic assemblage due to the spread of European disease; smallpox epidemics were reported among the indigenous settlements in the Ohio Valley in the 1750s (Gist 1759). Rates of dental disease and infectious disease were also expected to increase with contact across all age groups as health markedly declined following contact (Baker 1994; Pfeiffer and Fairgrieve 1994).

## 1.5 DISSERTATION CONTENTS

Chapter 2 focuses on the myriad ways in which bioarchaeologists have investigated gendered social processes. This literature review summarizes previous research avenues such as activity reconstruction, analysis of trauma, and paleopathology. Key publications in each of these areas are discussed and the limitations of these lines of research are reviewed in regards to interpreting gender in the past. Multivariate studies that integrate both biological and social factor variables are outlined as models for this dissertation study.

Chapter 3 provides a review of the cultural history of the Ohio Valley as viewed from larger cultural developments in the American Northeast. Major cultural traditions and developments in subsistence/settlement patterns, material culture, the mortuary pattern, and population health are reviewed for each major period included in this study. These begin with the Late Archaic and are continued through to the Late-Prehistoric and Protohistoric periods, as these occur just prior to European contact. The purpose of this review is to place the samples from this study within geotemporal, social, and biological context in light of major developments in prehistory.

Chapter 4 focuses on indigenous peoples during the period of European contact and colonialism. This discussion is framed by a review of the physical and social landscapes of contact and examples of change and continuity in indigenous lifeways during these events. This is followed by an outline of the major developments in historical archaeology and a discussion of the Delaware group during the turbulent 18$^{th}$ century. As with Chapter 3, this discussion of historical developments of contact and colonialism provides the historical backdrop for the Delaware sample and places the Delaware within a frame of reference in regards to the varied responses that indigenous communities had to European contact.

Chapter 5 outlines the multiple methods utilized in this study and the rationale for each. First, each sample is described in terms of the number of individuals, location, and time period. Methods for evaluation of completeness and preservation, age estimation, sex estimation, stature estimation, paleopathological scoring, and MSM scoring are reviewed. Statistical procedures for quantitative analysis are then discussed ranging from simple parametric and non-parametric methods to more detailed multivariate analyses such as PCA/MCA and cluster analyses.

Chapter 6 reviews the results of completeness, preservation, and paleopathological analyses. Demographic profiles are discussed and charted for each time period. Reviews of dental disease, stress, trauma, non-specific infection, and other pathologies are presented for each sample, and compared with relevant literature from comparative samples.

Chapter 7 outlines key patterns in and reviews statistical results by time period, sex, and age for musculoskeletal markers. Differences in muscle use patterns between time periods are explored, as well as activity reconstructions based upon Murdock and Provost (1973). Comparative samples are also discussed to provide context for patterns of labor and activity observed in the current study samples.

Chapter 8 reviews multivariate statistical results for evaluating social and biological status via analyses of burial patterns, grave goods, and biological features. Each time period is discussed in terms of cluster analysis, previous investigations of social structure, patterns of "social status" and "biological status" revealed by cluster analysis, and specialized mortuary contexts in light of gender.

Chapter 9 revisits the original research questions and hypotheses posed in this introduction in terms of the results presented in Chapters 6-8. Chapter 10 summarizes gender in each major time period and discusses the implications of this research study as well as avenues for future bioarchaeological inquiry.

## 2.0 BIOARCHAEOLOGICAL APPROACHES TO GENDER

Bioarchaeology is a discipline that seeks to merge biological and archaeological data in order to shed light on the social and biological aspects of the human past (Buikstra 2006). It is thus an interdisciplinary area of anthropological inquiry, bringing together multiple lines of evidence from nutrition, disease, growth and development, activity, population history and genetics, as well as social interpretive aspects from mortuary studies to provide a nuanced view of human history (Larsen 2006). Bioarchaeology is particularly well suited to provide biocultural models for the myriad ways in which humans have conceived their own identities through gender (Hollimon 2011; Sofaer 2006a). In the absence of material culture, ethnohistories, ethnographies, or in the case of undifferentiated burials, bioarchaeological skeletal analysis is a key aspect of the modeling of gendered social patterns of the past. This chapter outlines multiple lines of methodological inquiry and their interpretational limitations. For the present study, mortuary patterns, paleodemography, paleopathology, and activity reconstruction are integrated to address questions pertaining to social ranking, division of labor, and community health. Osteoarthritis and trauma are included in activity, despite the fact that these are pathological conditions, as they are the result of activity and injury. These areas of inquiry are important for research pertaining to how societies were structured socially and biologically, with the integration of burial ritual, material culture, and by extension skeletal analysis to provide contextual models.

### 2.1 ANALYTICAL METHODS IN BIOARCHAEOLOGY: MORTUARY ANALYSIS

Bioarchaeological studies of mortuary contexts have traditionally analyzed the relationship between osteologically sexed skeletons and material culture, transcribing gender onto objects and skeletal remains via statistical correlates of grave good patterns (Hollimon 2011; Sofaer 2006a). Numerous key studies have examined gender via mortuary processes in various regions of the world for example: Mesoamerica (Ardren 2002; Bell 2002; Gillespie 2001; González Cruz 2004; Joyce 1999, 2000b, 2002), the Near East (Guerrero et al. 2009; Keswani 2004; Nordström 1996; Savage 2000); Europe (Aranda et al. 2009; Arnold 1991, 2001, 2002; Becker 2000; Effros 2000; Fisher 1995; Graslund 2001; Härke 1997; Knüsel 2002, Lucy 1997; O'Shea 1995, 1996), East Asia (Bacus 2007; Higham 2002; Jiao 2001; Linduff 2008), Eurasia (Berseneva 2008; Davis-Kimball 1998, 2001; Legrand 2008; Rubinson 2008), and North America (Cannon 2005; Carr and Case 2006; Clark 2014; Charles 1995; Crass 2001; Doucette 2001; Field et al. 2006; Gamble et al. 2001; Hollimon 1996, 2001; Milner 2004; Nassaney 2004; O’Gorman 2001; O’Shea 1984, Rubertone 2001; Sempowski 1987). Central to the concept of archaeological modeling of gendered social patterns, mortuary analyses integrate aspects of material culture and its performative aspects as a reflection of gender, taking into account the confounding factors of using gendered social interpretations from mortuary contexts as proxies for gendered social realities in living societies (Arnold 2006).

### 2.1.1 Methods of Mortuary Analysis: Case Studies of Material Culture from North America

A central viewpoint of funerary archaeology and gender studies is the idea that grave goods, as material objects through which social processes are embodied, can provide important clues to gender roles in past societies with respect to aspects of social inequalities, socialization, and symbolic representations of the importance of individuals (Bentley 1996; Crass 2001; Hamlin 2001; Sullivan 2001). O'Shea (1984) published a landmark volume, *Mortuary Variability*, using archaeological mortuary research as a means to elucidate societal variability from the archaeological record. This study analyzed burials from North American indigenous cultures: the Pawnee, the Arikara, and the Omaha. O'Shea (1984) emphasized that mortuary treatment was directly correlated with an individual's status in life and was a very robust analytical tool for establishing patterns of social rankings such as status and gender, using variables such as sex, treatment of the body, and grave good counts with statistical approaches of cluster analysis and principle component analysis. This type of study became traditional in archaeology for differentiating social status, gender, and social roles.

Several North American studies illustrate how mortuary analysis can investigate questions pertaining to gendered social divisions. Crass (2001) argued that through the analysis of grave goods, social information may be gained in situations where complete bioarchaeological inventory may not be possible due to repatriation laws. From archival reports of archaeological investigations of burials among the Inuit, Crass compared reported grave goods against sexed burials or records of male/female cairn use. Items traditionally associated with the female gender (sewing implements) and the male gender (kayaks, sleds, weapons) were found in relatively equal distribution across male, female, and subadult burial contexts. Crass (2001) described the gendered social structure of the Inuit as "gender fluid" with little differentiation between types of material objects, sex, and age.

O'Gorman (2001) challenged the hypothesis that the Oneota (1000-1600AD), a group of protohistoric people from the American midcontinent, were truly egalitarian by comparing same-sex/gender and between-sex/gender patterns at the household, inter-household, and community levels. Ethnographic studies demonstrated that women were primarily associated with agricultural activities and men with bison hunting, though some ethnographic accounts reference women as active participants in warfare, as well as integral actors for processing bison kills (O'Gorman 2001). It was demonstrated, via inventory of grave goods, that some groups of women within and between longhouses had achieved a high emergent status, based on differential frequencies of grave goods made of non-local material sources. It was hypothesized that, based upon settlement and household data, increasing size of Oneota households and settlements and increased scalar stress may have provided a mechanism for emergent social inequalities (O'Gorman 2001). As some households developed surpluses of trade goods and other items, women may have used these surpluses to gain prestige and status as distributors of wealth and supplies for group endeavors, such as warfare (O'Gorman 2001).

There are additional studies that investigate gender in North America in the mortuary context (Cannon 2005; Carr and Case 2006; Charles 1995; Clark 2014; Crass 2001; Doucette 2001; Field et al. 2006; Gamble et al. 2001; Hollimon 1996; Milner 2004; Nassaney 2004; O'Gorman 2001; O'Shea 1984, Rubertone 2001; Sempowski 1987). These studies have generally focused on the distribution of grave goods and mortuary ritual patterns with respect to biological sex. However, these are numerous avenues in which gender is an important aspect to mortuary analysis, notably contact (Cybulski 1992; Nassaney 2004; Rubertone 1989), productive roles (Doucette 2001; Gamble et al. 2001; Hollimon 1996), and expression of social status (Cannon 2005; Carr and Case 2006; Clark 2014; Charles 1995; Crass 2001; Field et al. 2006; Milner 2004; O'Shea 1984; Sempowski 1986). These studies have demonstrated that material culture and mortuary ritual are important components for the development of functional models for gender and social status in North American prehistoric and historic contacts with respect to various social factors. While the mortuary context is a prominent feature of archaeological inquiry into gendered social processes in North America, mortuary analysis is limited in its approach to gender. Bioarchaeological methods provide deeper context in the present study.

### 2.1.2 The Limitations of Mortuary Studies

Bioarchaeologists have become increasingly critical of studies which utilize only correlates of material inclusions of burials with sexed skeletons, as the theoretical relationship between biological sex and identity goes beyond simple associations (Cannon 2005; Hollimon 2011). This is of key relevance in the study of non-binary genders, and it is emphasized by Arnold (1991) and Knüsel (2002) in their studies of the "Princess of Vix" (dated 500-480BCE), a burial from Hallstott period of central Europe. This is an atypical burial of a probable biological female, though some of the features of the cranium appear to be ambiguous, with an admixture of "male" and "female" goods, indicating third gender (Arnold 1991; Knüsel 2002). Arnold (2001) noted that the limitation of mortuary analysis, with a focus on gender, is that the patterns and interpretations of material culture and bodies offered by archaeologists may not reflect how past people viewed themselves as agents of social processes. This issue and the limitations of mortuary analysis in bioarchaeological interpretations of gendered social patterns are demonstrated in the relative differences between ethnohistorical reports and bioarchaeological investigations of burials (Arnold 2001; Noel 2011). For example, historians and indigenous scholars have promoted the idea of gender equality and age related status systems among the Iroquoians of northeastern North America, but Cannon (2005) noted a division in grave good distribution by sex (Noel 2011; Venables 2010).

Material culture is not merely a static entity that is inexorably tied to being "male" or "female", but rather is imbued with complex meaning as a reflection of its use, function, and role in the identity of the person who used it (Sofaer 2006a; Sørensen 2006). Bodies themselves are products of material culture; interpreting social processes and aspects of identity such as gender without integrating the biological variables from the human skeleton provides a limited view of many aspects of social performance (Fugelesveldt 2014; Sofaer 2006a). This disconnect between the physical body and material objects is an interpretive limitation in traditional mortuary studies that used binary sex distinctions as a single sorting category (Sofaer 2006a; Sørensen 2006). The interaction between life course, biological sex, activity markers, disease, and material culture are important for understanding aspects of gendered identity and performance, with biological sex and age, grave goods, and burial treatment as important interpretive variables (Sofaer 2006a).

## 2.2 ANALYTICAL METHODS IN BIOARCHAEOLOGY: PALEODEMOGRAPHY

### 2.2.1 Paleodemography

The goal of paleodemographic modeling is to determine the mortality structure (e.g. age/sex structure) of a sample. The age/sex structure of a population has significant implications for social and paleopathological inference (Gowland and Chamberlain 2004). Two primary profiles may emerge from the mortality structure, an attritional or catastrophic profile (DeWitte 2009; Gowland and Chamberlain 2004; Margerison and Knüsel 2002).

Attritional mortality profiles reflect the following pattern: a higher number of infant deaths, low numbers of adolescent deaths, and a gradual increase in mortality as age increases (Gowland and Chamberlain 2004). Several nuances may be observed in the age/sex structure of an attritional mortality pattern. While the number of infant deaths is expected to be high, researchers have noted that stress and juvenile deaths may slightly increase at the age of weaning. Weaning is a time of important nutritional transition during childhood as it is the period of decreased reliance on breast milk and the introduction of solid food sources as the dentition emerges (Eerkens et al. 2011). Breast milk is a nutrient rich food that also provides important antibodies to the growing child, but during this transition it is supplemented by less nutrient rich food sources. The developing child may undergo a period of stress from this dietary change. Infectious disease may also be introduced through food sources at this age causing exacerbated or subsequent stress, as breast milk no longer aids in disease resistance (Katzenberg et al. 1996). Data from the Middle and Late Woodland in North America suggest that weaning stress occurred on average at age 3, based on the timing of enamel hypoplasias in samples from the Midwest (Cook and Buikstra 1979). Enamel hypoplasias are areas of decreased enamel thickness on the tooth crowns that form during periods of stress when developmental processes are disrupted by disease or malnutrition (Goodman and Rose 1990). The timing and duration of weaning is highly variable among human populations, as some groups may begin the process at earlier or later ages and the supplementary weaning foods are varied (Eerkens et al. 2011; Sellen 2006). Weaning may also be influenced by times of hardship and reproductive demands of women (Katzenberg et al. 1996). Quinlan (2007) reported that for several pre-industrial societies, maternal investment decreased with occurrences of famine or warfare, with an earlier reported age at weaning than in non-hardship scenarios. Female reproduction is another factor in age and length of weaning as breastfeeding decreases fertility, and some societies may wean at earlier ages due to the need for larger family size for farming or other labor needs (Eerkens et al. 2011).

Maternal deaths may also be evident in the paleodemographic profile in attritional mortality. This is evidenced by increased female deaths among youths and young adults (Margerison and Knüsel 2002). Stone and Walrath (2006) noted that in pre-contact sites from North America, female mortality rates are higher than those of males and suggest that maternity related deaths may be a contributing factor in this pattern. Analysis of pelvic morphology in relation to obstetric hazard has been suggested as an avenue of research into the relative risk of death from childbirth in the past, although measurements of the pelvic canal from several osteological studies have not noted the likelihood of obstructed pelvic canals as the cause of female mortality (Arriaza et al. 1988; Sibley et al. 1992; Stone 2000).

Catastrophic mortality profiles differ from attritional mortality (Gowland and Chamberlain 2004). Catastrophes that affect the demographic profile at significant levels are events such as war, famine, epidemic disease, or natural disasters. Catastrophic events, such as the Black Death, are unusual throughout human history (Gowland and Chamberlain 2002; Margerison and Knüsel 2002; Paine 2000). The living age/sex structure of a population is evident in catastrophic mortality, as the risk of death is approximately the same across the lifespan irrespective of biological sex (DeWitte 2009; Gowland and Chamberlain 2004; Keckler 1997). The signature age/sex structure of a catastrophic assemblage includes a high number of infant, childhood, adolescent, and young adult deaths, with fewer deaths in older age ranges (Margerison and Knüsel 2002).

### 2.2.2 Limitations of Paleodemography

Several limitations are key in the interpretation of mortality models (Margerison and Knüsel 2002). Sample bias is a large confounder as preservation and differential burial practices have a significant effect on the ability to accurately depict the age/sex structure of the mortuary assemblage. The bones of small children and infants are fragile and subject to greater surface erosion, leading to an underestimation of infants in burial groups (Lewis 2007). Poor surface preservation may also hinder the ability to accurately estimate age and sex for a proportion of skeletons (DeWitte 2009; Gowland and Chamberlain 2004). Burial practices also effect sample bias as inclusion in a burial ground may be dependent upon age, sex, or social status. In many cultures, infants and young children were afforded burial in separate contexts than older children and adults (Lewis 2007). Bias also exists in age estimation methods, especially in the older adult age ranges (Buckberry and Chamberlain 2003). Commonly used estimation methods such as Lovejoy et al. (1985) tend to underestimate age among older adults (Appleby 2010; Buckberry and Chamberlain 2003). This may lead to an underestimation of elderly individuals in an assemblage, thus skewing the mortality curve towards younger ages.

## 2.3 ANALYTICAL METHODS IN BIOARCHAEOLOGY: PALEOPATHOLOGY

Population studies and case studies regarding disease epidemiology in past societies have been integral to bioarchaeological research (Hollimon 2011; Sofaer 2013). Hollimon (2011) noted that the specific attention to health patterns with respect to sex and gender has been a relatively recent phenomenon with the Pecos Pueblo study recognized as the earliest effort (Hooton 1930). Numerous studies address the nature of pathological conditions in relation to sex and the social implications therein, notably changes in health patterns by sex with the transition to agriculture and after conquest (Baker 1994; DeWitte 2009; Grauer et al. 1998; Grauer and Roberts 1996; Hollimon 2000; Judd 2008; Judd and Roberts 1999; Jurmain and Kilgore 1998; Kerr 2004; Klaus and Tam 2008; Klaus, et al. 2009; Larsen 1998; Lukacs 2008; Martin 2000; Martin et al. 2010; Mays 2006; Ortner 1998; Peterson 2000; Redfern 2005; Reinhard, et al. 1994; Robb 1997; Robb et al. 2001; Roberts et al. 1998; Silliman 2005; Sofaer Derevenski 2000; Storey 1998; Stuart-Macadam 1998; Sullivan 2004, 2005; Weaver 1998).

### 2.3.1 Physiological Stress

One central area of anthropological inquiry is the effect of stress on human populations, with a common interpretation that stress episodes are “unhealthy” as they represent disruptions in physiological function. Bioarchaeological research emphasizes the interaction between environment, biological needs, cultural buffering, and psychosocial trauma as contributing factors to physiological stress response, integrating aspects of life history and cultural context (Reitsema and McIlvaine 2014). Goodman et al. (1984) modeled stress episodes as a linear process beginning with stressors, such as extreme climate, or limited resources, such as famine. Cultural behavior in turn could buffer or introduce stress; Temple and Goodman (2014) suggested that cultural food systems could be altered to mitigate the effects of a famine or shortage, but political systems could exacerbate a stress episode by limiting food production. In this model, both the physical and cultural environment interact with an individual, but different host resistance factors, such as sex and age, may further buffer or exacerbate the physiological reaction to the stressor (Goodman et al. 1984). If the environmental, cultural, and host responses cannot remain in homeostasis, then physiological disturbance occurs (Goodman et al. 1984; Temple and Goodman 2014). Goodman and Armelagos (1989) defined physiological disturbance (stress) in terms of skeletal manifestations: growth disruptions, disease, and death. The hypothesized effects on the population at large were decreased health, decreased work capacity, decreased fertility, and cultural disruption. Though several skeletal stress indicators are available, stress markers used in this study included cribra orbitalia, porotic hyperostosis, and dental enamel hypoplasia (Goodman et al. 1988: 179, Table 1) (See Figures 1-2).

**Figure 1**: Left - porotic hyperostosis, right parietal, FC#5700, early adult female, Middle Monongahela – Bunola site. Right - cribra orbitalia, right orbit, FC#1491, adult female, Middle Monongahela – Bunola site

**Figure 2:** LEH, right mandibular canine, FC#7493, late child, Early Monongahela – Murphy Old House site

#### 2.3.1.1 Etiology: Physiological Stress

Cribra orbitalia and porotic hyperostosis are formed by the expansion of hemopoietic bone marrow in the skull. Cribra orbitalia can be described as “sieve like” lesion of the upper eye orbit, consisting of increased porosity or expansive changes that have a spicule-like appearance in severe cases (Wapler et al. 2004). Porotic hyperostosis is characterized by the appearance of microporosity on the ectocranial surface of the skull, usually involving the parietals (Waldron 2008; Wapler et al. 2004). The specific etiology of the marrow expansion process is debated. These lesions are rarely seen in clinical contexts (DeWitte and Stojanowski 2015), but anthropologists have traditionally linked cribra orbitalia with iron deficiency anemia following Britton et al. (1960). Histological and clinical research has shed some doubt on this widely used diagnosis, as it is unlikely that iron deficiency anemias cause the expansive marrow changes that form cribra orbitalia (Walker et al. 2009; Wapler et al. 2004). This type of marrow expansion is more commonly seen in genetic hemolytic and megaloblastic anemias such as thalassemia (Walker et al. 2009). Because the etiology of cribra orbitalia and porotic hyperostosis is debatable (Walker et al. 2009) they should be interpreted as an indicator of stress rather than of a specific condition due to multifactorial etiology (DeWitte and Stojanowski 2015).

Dental enamel hypoplasias (DEH) are described as areas of decreased dental enamel thickness (Goodman and Rose 1990). Dental enamel is entirely inorganic in its structure and is laid down on the developing tooth dentin by specialized cells known as amelobasts during infancy and childhood (Goodman and Rose 1990). Ameloblasts are responsible for secreting enamel matrix, and it is during this secretory phase that DEHs form. Ameloblastic activity has been shown to be particularly sensitive to perturbations in development caused by a number of factors: diet, low birth weight, infections, systemic illnesses, and genetic conditions (Pindborg 1982; Hillson 2005). Due to this multifactorial etiology, these defects are generally classified as non-specific indicators of stress episodes during childhood (Goodman and Rose 1990). They are most commonly identified as visible rings of decreased enamel thickness, also known as linear enamel hypoplasias (LEH) (Goodman and Rose 1990).

#### 2.3.1.2 Discussion: Physiological Stress indicators and Gender

Gendered differences in the expression of non-specific stress indicators have been investigated with respect to the general pattern of health and nutritional deficiency in past populations (Guatelli-Steinberg and Lukacs 1999; Ribot and Roberts 1996; Sullivan 2005). Nutrition, social status and gender are of particular relevance to reconstructions of gender in the past. Sullivan (2005) examined the rate of cribra orbitalia as a possible indicator of iron deficiency anemia in medieval York. Among individuals of lower social status, cribra orbitalia was more prevalent than in cohorts of higher status. Low status women were disproportionately affected by these lesions and more likely to have the condition than males in other social classes. It was argued that iron deficiency anemia factored in the lives of medieval York women and that high demands on reproductive systems along with cultural factors such as social class exacerbated this pattern (Sullivan 2005).

Patterns of childhood stress are often used as proxies for general population health for past populations through evaluation of rates of pathology and growth curves (Mays et al. 2009; Ribot and Roberts 1996). The interpretation of these results is complicated by the fact that there are often no significant differences between stressed and unstressed cohorts in terms of skeletal growth in bioarchaeological studies (Lewis 2002; Mays et al.

2009; Wakefield 2009). The long-term effects of childhood stress may be over-estimated, though studies of specific conditions have shown differential rates of childhood disease according to biocultural factors. Ortner et al. (2001) studied scurvy in North American skeletal collections, and noted that the frequencies of the condition varied among populations and were highest in those with high maize consumption. Thus, high rates of skeletal indicators of stress may suggest a more general pattern of dietary intake, as well as the interplay between environment and resource exploitation (Ortner et al. 2001).

DEH are one of the most frequently recorded stress indicators, and gendered social practices along with biological buffering may have some influence on differential rates between the sexes (Guatelli-Steinberg and Lukacs 1999). Non-human primate studies have demonstrated that males have a longer period of tooth formation, resulting in increased "recording" of stress events via enamel hypoplasias and sex influenced female buffer for hypoplasia formation was suggested due to this developmental difference (Guatelli-Steinberg and Lukacs 1999). However, sex differences were not statistically significant for many samples, and it was emphasized that cultural practices can influence LEH formation. For example, there may be a sex preference in parental investment during episodes of stress; male children in indigenous groups in Mexico were more likely than girls to receive adequate nutrition in times of food insecurity (Guatelli-Steinberg and Lukacs 1999).

### 2.3.2 Non-specific infection

The emergence, frequency, and patterns of lesions in infectious disease are of central importance to bioarchaeologists as this information can provide clues to prehistoric epidemiology and host-pathogen responses (Roberts and Manchester 2007). Barrett et al. (1998) identified three notable epidemiological transitions. First, the transition to agriculture during the Neolithic revolution introduced a rise in infectious disease as population aggregates increased (Barrett et al. 1998). Infection rates fell following industrialization with improvements to medicine and sanitation, though in the modern era a third transition is occurring with antibiotic resistance, new emerging diseases, and re-emerging infections (Barrett et al. 1998). These transitions are of special importance to bioarchaeological models of prehistoric infection, as they demonstrate how cultural changes have significant influence on population health.

Specific pathogens such as tuberculosis, treponematosis, and leprosy leave distinct osteological indicators as part of the disease process and are referred to as specific infections (Aufderheide and Rodriguez-Martín 1998). Differential exposure, geographic location, subsistence, access to medical care or treatment, and genetic risk factors can explain differences in rates of these diseases in modern populations (Roberts et al. 1998). For example, males in India are more likely to be diagnosed with leprosy but cultural factors such as differential access to medical care and family duties may limit data on female infection rates (Roberts et al. 1998). Specific diseases are often identified on the skeleton by the patterning and location of non-specific disease lesions (Roberts 2007; Santos and Roberts 2008;

Waldron 2008). The presence of lesions of non-specific infection is considered to be a proxy for poor health (Goodman et al. 1988).

#### 2.3.2.1 Etiology: Non-specific infection

Non-specific infection is characterized by two conditions: periostitis and osteomyelitis. Periosteal reaction is characterized by the formation of new woven bone along the periosteum as a response to pathological stimuli and is clinically referred to as “inflammation of the periosteum” (Weston 2012). This inflammatory response can be the result of multiple conditions: trauma, neoplasms, infection, and compression of blood vessels Weston (2012). Periostitis is thus commonly classified as a “non-specific” indicator of infection as the etiology is often unknown and can result from multiple conditions (Weston 2012). Periostitis can be visually described as a layer of immature bone overlaying the external cortical surface (Figure 3) (Weston 2012). Periosteal new bone formation can occur with multiple conditions including maxillary sinusitis, identified by pitting or new bone formation in the maxillary sinus cavity as a result of infection or irritation from pollutants (Roberts 2007). The tibia is the most common site of periostitis as it is less vascularized and subject to inflammation from trauma or infection from skin lesion (Weston 2008, 2012).

Osteomyelitis is distinguishable from periostitis in both formation processes and etiology. Osteomyelitis is formed when bacteria enter the medullary cavity via the bloodstream, and multiply considerably (Waldron 2008). This results in an immune response in which pus is secreted, creating increased pressure within the marrow cavity, resulting in the formation of drainage channels or holes in the bone known as cloaca, through which pus drains. Simultaneously, the presence of pathogens underneath the periosteum stimulates the formation of a thick sheath of bone, known as an involucrum, over the area of infection. This cuts off the blood supply to the infected bone, known as a sequestrum, resulting in necrosis (Roberts and Manchester 2007). Osteomyelitis persists for years if left untreated and can cause subsequent fractures to the damaged bone or death if the infection is transmitted to other organ systems (Waldron 2008). This condition is identifiable in bone by marked expansive changes to the diaphysis with thick, disorganized deposits of new bone (Roberts and Manchester 2007; Waldron 2008) (Figure 4).

**Figure 3:** Periosteal reaction on the right tibial diaphysis, FC#4450, female youth, Early Monongahela – Ryan Site

**Figure 4:** Osteomyelitis of distal left femur, FC#2158, middle aged male, Early Monongahela – Varner site

#### 2.3.2.2 Discussion: Non-Specific Infection and Gender

Non-specific infections may result in periostitis and osteomyelitis lesions as a result of multiple etiologies, and differences in the risk and expression of these conditions have been noted by Ortner (1998) in skeletal collections from North America and Britain. Ortner (1998) noted that in clinical and bioarchaeological reports, male mortality associated with infectious disease is higher than that of female mortality. Similar results were indicated in non-human primate studies (Ortner 1998). Ortner (1998) suggested that gendered patterns of food access and labor may contribute to sex differences in the rates of infectious disease.

Differential patterns of maxillary sinusitis may provide context through which labor and gendered space can be interpreted, as its etiology is linked to exposure to respiratory irritants, such as wood smoke and soils (Merrett and Pfeiffer 2000; Roberts 2007). Merrett and Pfeiffer (2000) noted that the condition is a general indicator respiratory health and reported a prevalence of 50% in 15th century Iroquoian ossuaries, a rate that was comparable to those from medieval York and Chichester in addition to 19th century New York State populations. Roberts (2007) examined sex differences in the frequency of maxillary sinusitis 15th century Iroquoians, archaic hunter-gathers in the American Midwest, Woodland Period agriculturalists in Eastern North American, the Kulubnarti of Sudan, and in the Christchurch, Spitalfields collection. North American female agriculturalists had marked increases in the rate of lesions compared to males. Roberts (2007) has argued that these females were more likely to spend more time in enclosed spaces with poor air quality from wood smoke than their male counterparts based upon division of labor and were thus more at risk for the disease. This is dependent on the climate as these patterns were observed among North American indigenous groups. In areas where cold season temperatures are present for a significant portion of the year, individuals whose occupation may not directly involve exposure to wood smoke, such as hunting or craft production, will likely have intensive seasonal exposure due to increased time spent in enclosed spaces with wood smoke (Roberts 2007).

### 2.3.3 Dental Disease

Dental disease is an indicator of oral health and diet for modern and past populations (DeWitte and Stojanowski 2015). Multiple conditions fall under this purview: dental caries, periodontal disease, abscesses, calculus, and antemortem tooth loss. Recent clinical literature emphasizes the relationship between dental pathology and general health, as oral infections can increase risk for multiple systemic complications such as spread of infection to other systems, cardiovascular disease, renal disease, cancers, and poor childhood growth (Glodny et al. 2013; Johnston and Veiera 2014; Williams et al. 2008; Ylostalo et al. 2006). The presence of periodontal disease and caries may also be an indicator of underlying disease causes such as compromised immunity (e.g. frailty) (DeWitte and Stojanowski 2015; Michaud et al. 2008). Dental disease is associated with age as dental attrition over long periods can erode enamel (Appleby 2010).

#### 2.3.3.1 Etiology: Dental Diseases

Dental caries are areas of eroded dental enamel through which infection enters a tooth and their etiology and formation is multifactorial (Featherstone 2004; Fejerskov 2004). Oral bacteria are encapsulated in organic biofilm (plaque) that adheres to the teeth. Bacilli metabolize carbohydrates in the oral cavity, causing fermentation and the production of acids that in turn demineralize tooth enamel. Caries can expose the underlying dentin and pulp cavity to oral bacteria, leading to further complications such as abscesses and periodontal disease (Featherstone 2004; Fejerskov 2004). Caries are recognizable on the dentition as discolored pits on the enamel and can occur on any tooth surface (Buikstra and Ubelaker 1994; Hillson 2005) (Figure 5). Starchy foods such as cereals and maize are known to be cariogenic, as they increase levels of fermentable carbohydrate in the oral cavity (Lieverse 1999).

Dental abscesses infections of the tooth pulp cavity with associated destruction of the alveolar bone at the base of the tooth root (Dias and Tayles 1997) (Figure 6). Pus forms and travels through the tooth root and out through the bone into the surrounding oral soft tissues, including the nasal cavities. Abscesses result in tooth loss and considerable pain and swelling (Dias and Tayles 1997). These lesions are recognizable osteologically as fistulas in the alveolar bone at the base of the tooth root (Lukacs 1989).

Dental calculus is mineralized dental plaque, predominantly composed of calcium phosphate. It occurs both on the tooth crown and tooth root, and is highly associated with poor oral hygiene (Waldron 2008). Calculus is observable on the dentition in the form of hardened-plaque like film, which can range from flat to extensive formation (Dobney and Brothwell 1987). Calculus formation is associated with high protein diets, rather than starchy foods (Lieverse 1999).

Periodontal disease is an infection of the alveolar bone surrounding the tooth socket (Kinane 2000; Page 2002). The surrounding gingival tissue becomes irritated and bleeds from the presence of cariogenic oral plaque, introducing bacteria into the tooth socket. The interaction between the host and bacteria produces an inflammatory process resulting in the formation soft tissue pockets between the tooth and gums. This ultimately results in the loosening of the tooth and subsequent tooth loss, with recession and remodeling of the alveolar bone (Kinane 2000; Page 2002). This condition is observable osteologically via receding alveolar bone, with associated pitting and remodeling. When severe, the alveolar bone may be completely receded to the base of the tooth root (Lukacs 1989) (Figure 5).

Antemortem tooth loss results from all of the above processes as well as trauma and intentional extraction for health or body modification purposes (Roberts and Manchester 2007; Waldron 2008). This condition is recognizable when the tooth socket is completely resorbed (Dobney and Brothwell 1987). Risk for this condition is associated with age and can result in poor nutrition if the individual becomes completely edentulous (Waldron 2008) (Figure 6).

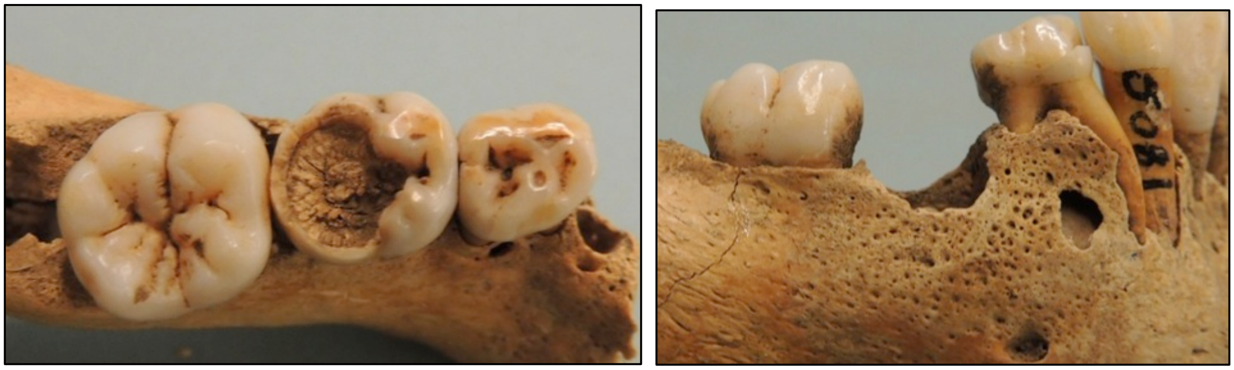


**Figure 5:** Dental caries (left and periodontal disease (right), FC#5081, child, Middle Monongahela – Bunola site

**Figure 6**: Dental abscess (right) and AMTL (left), FC#5072, middle aged male, Middle Monongahela – Bunola site

#### 2.3.3.2 Discussion: Gender and Dental Disease

Lukacs (2008, 2011a) argued that the transition to agriculture had lasting and detrimental consequences on gendered health patterns with specific reference to oral pathologies. The transition to agriculture has traditionally been associated with a significant decline in oral health due to the cariogenic properties of agricultural cereals (Cohen and Armelagos 1984; Eshed et al. 2006; Larsen 1995, 2002). Lukacs (2008, 2011a) documented a marked difference in caries rates between males and females following this event and offered an explanation for this pattern: female caries rates increase following the agricultural transition due to an increased demand in fertility and the concomitant effects of increased reproductive demands on other physiological systems as at the time of agricultural transition, population sizes increased while birth intervals decreased (Lukacs 2008, 2011a). He argued that female resistance to cariogenic bacteria decreases during pregnancy, relating the relative risk of caries among females to hormonal influences. The type of agricultural grain varies from region to region and these patterns are observable in multiple populations from varied environments. This demonstrates that hormonal levels are one of the primary risk factors in female oral pathology as female caries rates are high in multiple regions. Lukacs (2008, 2011a) offered a model based upon the complex etiology of caries, emphasizing that hormonal influences, dietary changes, and gendered behavior contributed to patterns of oral pathology in the past.

Modern anthropological studies utilizing clinical data can shed light on the effect of gendered cultural practice and health. Lukacs (2011b) used metadata to assess the interaction between dental disease, sex, and gendered cultural behavior in South Asia via evaluations of reported rates of periodontal disease, tooth loss, and filling treatments for caries in modern clinical samples from India, Nepal, Bangladesh and Sri Lanka. He demonstrated that male caries rates were higher than those of females during childhood, but the gender bias reversed at reproductive maturity through old age. Some samples diverged from this predominant pattern with rare male gender bias in adults and others samples showed no significant difference by sex (Lukacs 2011b). Lukacs (2011b) suggested this pattern of female bias was due to several biological factors: genetic factors and hormonal influence from childbearing. Aside from these biological influences, Lukacs (2011b) found that gendered social norms played a significant role in the differences between the sexes in expression of dental disease. A cultural preference for a son may have considerable effect on female oral health as boys are given preferential food access, with the result being that chronic undernourishment of females in early childhood decreases resistance to caries (Lukacs 2011b). Pearson (1996) described practices of religious fasting among Hindu women, who frequently fast for short-term (2-3 days) and long-term (week to 10 days) periods, while males rarely or never participate in these activities. Women in South Asia also engage in restricted diets during pregnancy due to cultural beliefs about low birth weight and easy childbirth (Vallianatos 2006). Undernourishment and dietary restriction can alter saliva flow and biochemical composition that promote cariogenesis, so these cultural practices could have a marked impact on female oral health (Lukacs 2011b). Gendered dietary practices such fasting or preferential food access could have also affected oral health in prehistoric populations, and should be considered in bioarchaeological interpretations of dental disease.

### 2.3.4 Limitations in Paleopathology: The Osteological Paradox

Biocultural factors also influence the rates of pathology as the function and value of gendered individuals in society affects health (Roberts et al. 1998). Lifestyle, occupation, age, and social status are important factors in the risk and expression of disease (Roberts et al. 1998). For example, females may be at a higher risk for developing conditions related to malnutrition and oral pathologies due to the interplay between a range of biocultural factors including reproductive demands, gender roles, social status, and age (Lukacs 2008). Traditionally, disease presence in past populations has been inferred from the presence of osteological pathology or via demographic modeling (Gowland and Chamberlain 2004; Wood et al. 1992).

The problem for bioarchaeology, with particular respect to paleodemography and paleopathology, is that the research goal is to model past human lifestyles and patterns of health from biased samples of the dead (DeWitte and Stojanowski 2015; Wood et al. 1992). Wood et al. (1992) introduced the concept of the 'osteological paradox' that skeletons with disease lesions may in fact have been "healthier" than skeletons without any skeletal lesions. The first aspect of this interpretive problem is that every individual of the same age in a given population does not have the same risk of death, commonly referred to in the literature as 'heterogeneous frailty' (Wood et al. 1992). Varied risk of death within birth cohorts exists due to varied genetic immune responses, differential exposure to disease due to behavior, differences in nutritional status, variations in environmental conditions, fetal environment, epigenetic influences or other cultural factors (Wood et al. 1992). 'Selective mortality' acts upon heterogeneous frailty; individuals who die at a certain age are not likely to be representative of the entire population of the same age as those with higher frailty will more likely to succumb to disease and other stress events (Wood et al. 1992). Due to heterogeneous frailty and selective mortality, Wood et al. (1992) emphasized that infectious disease lesions and osteological stress markers, such as enamel hypoplasias and cribra orbitalia, may take weeks, months or even years to form, and individuals without these markers may have perished sooner due to higher frailty and were thus less "healthy" than those individuals with lesions. Many conditions leave osteological traces, but these may also only occur in a small number of cases (DeWitte and Stojanowski 2015). For example, only 5% of cases of tuberculosis have any skeletal involvement (Santos and Roberts 2006).

The osteological paradox is an important factor in the interpretation of lesions in skeletal samples, with particular attention paid in recent literature to the term "health". This term is used broadly to include aspects of quality of life, daily functioning, and community involvement (Reitsema and McIlvaine 2014). Though the term health has wide colloquial use and is at the crux of anthropological and medical research, various disciplines quantify this vague concept in different ways as they deal with different metrics; for example, a physician may equate health with the ability to perform daily functions, whereas anthropologically this is quantified via frequencies of pathology and stress indicators (DeWitte and Stojanowski 2015; Reitsema and McIlvaine 2014). This debate within bioarchaeology and paleopathology is unsettled, though expanding areas of research into the etiologies of stress markers, the relationship of stress to childhood mortality patterns, integration of deeper cultural context and epigenetic studies are enhancing the ability of bioarchaeologists to delve deeper into defining and quantifying past health (DeWitte and Stojanowski 2015).

### 2.3.5 Limitations in Paleopathology: Sample Bias

Sample bias is another limitation in bioarchaeological evaluation of disease. Due to taphonomic influences, many skeletal elements may not preserve rendering it impossible to evaluate all skeletal elements for the presence of physiological stress or disease indicators. A missing bone or tooth may exhibit a lesion and with incomplete skeletons it is impossible to state that disease is entirely absent (Roberts and Manchester 2007). In this regard, infectious disease may be underestimated in skeletal collections (Roberts and Manchester 2007).

## 2.4 ANALYTICAL METHODS IN BIOARCHAEOLOGY: ACTIVITY

An important aspect of gendered identity is occupational activity, which is evidenced in the skeleton in numerous ways (Baker et al. 2012; Boutin 2012; Douglas and Pietrusewsky 2012; Jurmain 1999; Peterson 2002; Stodder and Palkovich 2012). Researchers have identified these patterns via enthesopathies and musculoskeletal stress markers (MSMs), osteoarthritis, and trauma (Jurmain 1999; Peterson 2002). The usefulness of these markers has been debated. Occupational reconstructions are problematic because there is no direct association between specific activities and musculoskeletal markers (Stirland 1991, 1998). Weiss and Jurmain (2007) stressed the multifactorial nature (activity, genetics, hormones, nutrition, age, and disease) of occupational stress markers is a confounding factor in the interpretation of activity patterns, whereas Larsen (1997) argued that analytical methods that integrate the activity markers with archaeological data can be informative in elucidating general patterns of behavior in the past. Bioarchaeologists thus use activity markers in conjunction with archaeological data in order to reconstruct diachronic shifts in population specific gendered activity patterns as well as gendered occupational changes associated with subsistence change and contact (Bridges 1991, Jurmain 1999; Peterson 2002).

### 2.4.1 Musculoskeletal Stress Markers (MSMs)

Musculoskeletal stress markers (MSMs), one of many markers of occupational stress, are one of the primary avenues through which activity patterns in the past can be investigated (Kennedy 1998). The distribution of MSM robusticity does not allow for the reconstruction of specific activities, but these patterns when considered with appropriate ethnographic studies provide a useful approximation for elucidating culturally relevant activity models (Hawkey and Merbs 1995; Rodrigues 2006).

#### 2.4.1.1 Etiology of MSMs

The use of muscle groups is evident in the skeleton via bony remodeling at muscle insertion sites. The periosteum is well vascularized and the number of capillaries increases when tendon and ligament junction sites are regularly subjected to minor stress (Hawkey and Merbs 1995). Increased blood flow induces osteon remodeling with repeated stress, resulting in hypertrophy at the insertion site (Hawkey and Merbs 1995). These MSMs are identified by rough patches and surface irregularities at muscle attachment sites from this bone buildup associated with frequent, repetitive use (Hawkey and Merbs 1995; Peterson 2002). Stress lesions, evident as furrows or pitting, result from severe and continuous utilization of a muscle beyond its capacity results in muscle fiber tears that reattach to the periosteum and disrupt blood flow. Daily micro trauma of this nature would prevent healing from taking place, leaving a furrow in the cortical surface of the bone (Hawkey and Merbs 1995). Ossification exostoses may also occur as spurs of ossified bone that are formed when abrupt macro trauma occurs, with new bone formation incorporated into the ligament or muscle fibres (Hawkey and Merbs 1995). Hawkey's (1998) landmark thesis introduced a systematic method to identify and score these markers on a continuum from no expression to robust in most methods (Hawkey and Merbs 1995).

#### 2.4.1.2 Discussion: Gender and MSMs

Numerous studies have integrated the expression of MSMs with archaeological mortuary data to investigate gendered occupational patterns in past societies in relation to population specific gendered identities as well as gendered activity changes associated with the shift to agriculture and cultural contact (Chapman 1997; Churchhill and Morris 1998; Dutt 2012; Hawkey and Merbs 1995; Lovell and Dublenko 1999; Martin et al. 2010; Molnar 2010; Perry 2004; Peterson 2000, 2002; Robb 1998; Rodrigues 2006; Schrader 2010; Shuler et al. 2012). For example, Hawkey and Merbs (1995) examined activity patterns among Hudson Bay Eskimos and concluded that there were differential gendered occupational roles for men and women throughout the Early and Late Thule periods (1200-400BP), with substantial diachronic change in male subsistence roles based upon MSM robusticity scores. They (1995) stressed that subtle differences in gendered occupation are not always observable in the archaeological record, rendering bioarchaeological studies essential for reconstructions of gendered social identities, especially in the absence of ethnohistorical or ethnographic studies. Robb (1998: 375) also observed patterns of a gendered division of labor according to social class among individuals from an Italian Iron Age cemetery dated to the 7$^{th}$ to 3$^{rd}$ centuries BC, with elite burials associated with MSM robusticity in areas of muscle use associated with sport or warfare, and a laborer class, mostly consisting of males, associated with skilled artisan work and common labor.

One of the central tenets of bioarchaeological analysis of human adaptation is the biocultural aspect of the shift to agricultural economies, and it has been noted that health and cultural patterns were drastically altered during this transformation in many societies (Peterson 2000, 2002). Peterson (2000, 2002) proposed an engendered model of social change with the introduction of sustained agriculture to the Levant during the Neolithic period. Female MSM robusticity indices remaining relatively constant over time in comparison to males, who had decreased indices with the appearance of agriculture, associated with dramatic shifts in male labor practices. Peterson (2002) equates this pattern with an ethnographic model of agro-pastoralists in Afghanistan, as female adults and young girls perform milking, churning, and other food preparatory tasks associated with a high workload, whereas males and young boys are responsible for herding.

#### 2.4.1.3 Limitations of MSM Studies

Recent analyses of methods associated with activity reconstructions from MSMs have called into question the use and interpretation of these patterns (Cardoso and Henderson 2010; Davis et al. 2013; Robb 1998; Stefanović and

Porčić 2013; Weiss 2012). Robb (1998) stressed that it is highly difficult to reconstruct or infer specific activities from MSMs, but they are a useful analytical tool for establishing differences in general activity patterns between groups, such as genders and social rankings. There are multiple confounding factors in the expression of MSMs, not limited to body size, stature, and life course (Cardoso and Henderson 2010; Niinimäki 2011; Stefanović and Porčić 2013). Intra-observer error was also noted to be high in a review of Hawkey and Merbs (1995) (Davis et al. 2013). Cardoso and Henderson (2010) found little correlation between MSM expression and occupation in a skeletal collection of known age, sex, and occupation from Portugal, and instead stress the expression of MSMs as a factor of age related degeneration. Peterson (2002) and Stefanović and Porčić (2013) noted that the expression of MSMs is more pronounced in older adults if they remain active, and thus age is an important variable in reconstructions of gendered labor patterns, echoing Sofaer (2006b, 2011). However, MSMs may also reduce over time if activity decreases, which complicates interpretations of patterns of muscle use in populations (Cardoso and Henderson 2010).

### 2.4.2 Osteoarthritis

Traditionally, osteoarthritis (OA) was interpreted by bioarchaeologists as an indicator of activity and load bearing labor that placed biomechanical stress on the joints, causing the breakdown of articular cartilage and the formation of new bone (osteophytes) (Larsen and Ruff 1994; Lovell and Dublenko 1999, Sofaer Derevenski 2000; Walker and Hollimon 1989). However, the etiology of OA is multifactorial and variable between populations (Weiss and Jurmain 2007).

#### 2.4.2.1 Etiology of Osteoarthritis

The etiology of OA is multifactorial (Weiss and Jurmain 2007). This condition primarily affects synovial joints, which are mobile capsulated joints filled with lubricating fluid. Within the joint capsule, bone surfaces are covered with articular cartilage, which provides a buffer against friction and weight bearing forces (Waldron 2008). Long term-biomechanical loading of the joint causes the breakdown of articular cartilage resulting in new bone formation on the edges of the joint surfaces (marginal osteophytes) and on the joint surfaces, pitting on the joint surfaces, and changes to the contour of the joint surface (Rogers and Waldron 1995; Waldron 2008). Eburnation, which is a highly polished area on the joint surface, occurs from constant motion and friction between exposed bone surfaces (Waldron 2008).

Clinical research shows factors such as age, weight, genetics, activity, and biological sex have a significant effect on the etiology of OA (Dumond et al. 2003, Manek et al. 2003, Manninen et al. 2002; Spector and Macgregor 2004; Wilson et al. 2001; Zhang et al. 2004). Age plays an especially significant role in the development of OA, as breakdown of articular cartilage is a factor of aging in multiple clinical and anthropological studies (Knüsel et al. 1997, Merbs 2001, Waldron 1997, Weiss 2005, Weiss 2006) Obesity causes increased biomechanical stress on the joints and also plays a significant role in the etiology of OA (Weis and Jurmain 2007). Genetic predispositions also have considerable influence (Waldron 2008). In a review of osteoarthritis and its complicated etiology, Weiss and Jurmain (2007) stressed that these factors should be weighed when considering OA as a proxy for activity levels, as OA may not necessarily be a direct correlate to increased biomechanical stress from habitual labor.

#### 2.4.2.2 Discussion: Gender and Osteoarthritis

Many bioarchaeological studies have addressed osteoarthritis as a marker of gendered labor activities (Bartelink 2001; Bridges 1994; Larsen and Ruff 1994; Lovell and Dublenko 1999; Martin et al. 2010; Merbs 1983; Rathbun 1987; Sofaer Derevenski 2000). Rathbun (1987) examined the effects of slavery in the American South on gendered division of labor and noted a marked difference in the pattern of OA between adult males and females. Females had higher instances of OA in the joints of the shoulders and knees, whereas OA was most prevalent in the elbow and hip joints among males (Rathbun 1987). Changes to the division of labor following European contact were noted by Lovell and Dublenko (1999) and Larsen and Ruff (1994). Their findings suggested that OA and musculoskeletal robusticity increased following the imposition of European lifeways in North America, with varying patterns among males and females from previous periods. Osteoarthritis has also been found to increase in individuals in captivity, as noted by Martin et al. (2010) in a study of female captives in the American Southwest. Merbs (1983) and Sofaer Derevenski (2000) emphasized the importance of ethnographic reports in interpretations of the patterning of OA. For example, Sofaer Derevenski (2000) equated the pattern of osseous changes to the apophyseal regions of the spine in the thoracic vertebrae of females at the site of Ensay to the use of creels in the hauling of heavy materials.

#### 2.4.2.3 Limitations of Osteoarthritis Studies

The primary limitation for using OA as an indicator of activity is its complicated, multifactorial etiology. Clinical studies demonstrated that OA can be caused by not just increased biomechanical loading but several other risk factors including genetics, weight, injury, sex and age **(**Dumond et al. 2003; Manek et al. 2003; Manninen et al. 2002; Spector and Macgregor 2004; Weiss 2005, 2006; Wilson et al. 2001; Zhang et al. 2004). The tendency to utilize OA as a one to one proxy for activity does not take into consideration these other factors, especially with respect to age (Weiss and Jurmain 2007). OA is also not a good indicator for the intensity of activity nor for patterns of activity associated with specific muscle use, whereas MSMs provide more clear data on patterns of muscle use and degrees of intensity (Hawkey and Merbs 1995; Weiss and Jurmain 2007).

### 2.4.3 Trauma

Trauma patterns have been demonstrated to vary with occupation and life course, with risk for specific injuries at different life stages (Buhr and Cooke 1959; Glencross and Stuart-Macadam 2000). Children, prior to becoming ambulatory, are most at risk for cranial fractures from falls and older children, once able to walk, are most at risk for fractures of the forearm. The most commonly noted types of skeletal injury in subadults are torus, greenstick, plastic bowing, and epiphyseal fractures (Glencross and Stuart Macadam 2000). Occupation related trauma is most commonly associated with young to middle age adults. In an analysis of fracture patterns in post-industrial Britain, Buhr and Cooke (1959) stated that injuries to the hands and feet were most common among industrial workers, though patterns of occupation related injury may not fit this pattern in every case, as reported in clinical reports of osteological trauma due to farming accidents (Judd and Roberts 1999). Older adults are more likely to sustain fractures to the hip and forearm, related to osseous changes in the aging process due to osteoporosis (Appleby 2010).

Bioarchaeological analyses of occupational trauma have revealed that there are differences in the patterning of fractures due to accidental injury between rural and urban communities. Comparing modern clinical data to fracture prevalence in the rural medieval sites of Raunds and Jarrow Abbey and urban cemeteries (St. Helen on Walls, St. Nicholas, Blackfriars), Judd and Roberts (1999) reported a gendered pattern of occupation related long bone fracture in rural groups. The authors noted that females in the rural populations demonstrated higher incidences of forearm fracture and males had comparatively higher rates of clavicle and lower limb fractures (1999). This pattern suggests that the threshing, harvesting, and milling of agricultural grain had high labor demands that were hazardous, much like farming practices among modern farmers (Roberts and Judd 1999).

Until recently, the frequency and distribution of violent injury has been interpreted across sex categories according to heteronormative ideals of gendered performance. Violent injury among males was thought to be due to combat whereas female trauma was interpreted as evidence that females were the victims of small-scale raiding or domestic violence (e.g. Jiménez-Brobeil et al. 2009). Bioarchaeologists have listed several types of injury as evidence of violence: parry fractures, blunt force cranial trauma, scalping, embedded projectiles, cutmarks, and decapitations (Chacon and Dye 2007; Milner et al. 1991; Milner 1995, 1999; Hollimon 2001a, 2011; Torres-Rouff 2008). These analyses are complicated by multiple interpretations of the causes of such injuries. Judd (2008) demonstrated that the parry fracture, once the hallmark of violent injury in bioarchaeological research, is often caused by falls (accidental or from being pushed) rather than protecting the head from a blow. The timing of skeletal injury is also problematic. Timing of injury falls into three categories: antemortem (long before death), perimortem (at or around the time of death), and postmortem (after death). Antemortem injury is evidenced by healing. Following a fracture, a callus of new woven bone encapsulates the injury, providing a matrix for mature bone to form. Fractures may heal without proper union resulting in loss of function, severe deformity, and the development of false joint surfaces (Lovell 1997). Perimortem injury is characterized by hinging, smooth fracture surfaces and acute or obtuse fracture angles (Wieberg and Wescott 2008). Recent experimental forensic research has shown that the signatures of perimortem trauma can persist in skeletal remains far into the postmortem interval, complicating analyses of violent injury vs. post-mortem ritual funerary dismemberment (Wieberg and Wescott 2008).

Despite the emphasis in bioarchaeological theory regarding gender as a rejection of male/female binary relationships and an emphasis on the departure from heteronormativity through queer studies, interpretational dichotomies focusing on male violence and female victims persist. Male violence has been paid particular attention in a recent volume edited by Chacon and Dye (2007) dedicated to the interpretation of the taking of body trophies in the prehistoric Americas. Seeman (2007) reported the presence of male trophy skulls in burials and equated this with a culturally inscribed role for males in warfare among the Ohio Hopewell of the Middle Woodland period. However, this issue was previously explored by Johnston (2002) who rejected Seeman's (1988) previous claims for the widespread nature of male violence among the Hopewell. It was concluded that the skulls in burials represented males and females, and the cutmarks on the "trophy" skulls were due to funerary processing. Johnston (2002) suggested that this pattern indicated ancestor veneration rather than trophy taking from widespread warfare. Elsewhere in North America, the taking of body trophies has been interpreted as a marker of the male warrior ethos, as hand bone "necklaces" were discovered among burials in the Great Plains (Owsley et al. 2007). Conversely, Martin et al. (2001) and Martin et al. (2010:1) interpreted cranial trauma, parry fractures, and osteological evidence of activity via MSMs among women in the prehistoric American Southwest as evidence that female captives were "beaten down and worked to the bone", perpetuating the idea of male warriors and female victims.

Another important aspect of the interpretation of violence is the gender and age patterns of so-called "victims" of violent massacres. Walker (1997) noted diachronic changes in the age and sex composition of the victims massacre sites. Adults were not the only victims of violence, as ancient massacre sites frequently contain assemblages with females and children, while modern assemblages such as mass graves in the Balkans are primarily composed of higher incidences of trauma among males (Novak 2006; Walker 2001). Warfare is contextualized by Walker (2001) as being primarily concerned with group membership and identity rather than the social lines of gender and age; the mortality profile of ancient massacres cross-cuts gendered categories as adult males and females, as well as children are often represented. Warfare, in this respect, is associated with the violent treatment of "the other" (Walker 2001).

Massacre sites in North America are indicative of this assertion (Hollimon and Owsley 1995; Milner et al. 1991; Olsen and Shipman 1995; Sempowski et al. 1988; Willey 1990). For example, the 14th century site of Crow Creek in South Dakota represents an ancient massacre consisting of the remains of at least 486 women, children, and men. At this site 95% of intact skulls showed signs of scalping as well as mutilation by dismemberment (Willey 1990). Similar patterns were noted by Milner et al. (1991) for the Late Prehistoric Norris Farm assemblage of Illinois (1300AD), with equal representation of males and females among the remains; here, violent trauma included scalping, blunt force trauma, mutilation and decapitation.

The biases in the interpretations of male and female injury patterns of in prehistoric groups do not mean that gender roles did not associate males with violent behavior in the past. Robb (1997) and Robb et al. (2001) examined skeletal remains from Italian Pontecegnano site, and noted that males had noticeably increased rates of all trauma, both violent and occupational, after the Neolithic transition and into the Iron Age. Robb (1997) interpreted these patterns as falling along gendered social categories that placed males in occupations with high risk of injury such as heavy labor and warfare, whereas females were precluded from such activities. These interpretations are congruent with MSM data from Pontecegnano: males were associated with heavy muscle markings whereas females did not exhibit these patterns (Robb 1998). Males of low social status also had higher incidences of Schmorl's nodes and tibial periostitis when compared with females (Robb et al. 2001). Multiple lines of evidence combined, Robb (1997; 1998) and Robb et al. (2001) provide a nuanced approach to the interpretation of skeletal activity and trauma in relation to gendered social patterns. Robb's approach to skeletal activity, burial patterns, and trauma is an example of how multiple lines of evidence can be combined to provide a more nuanced view of social identity, in line with Sofaer's (2006a) assertion that material culture and the body are inexorably tied.

#### 2.4.3.1 Were All Warriors Male?: A View from Eurasia and North America

Heteronormative interpretations of burial iconography and skeletal trauma have long associated males with warrior status and females as passive victims (Hollimon 2011). Bioarchaeological scholarship has challenged the notion of warriorhood as a male entity in prehistory. Hanks (2010) emphasized that warriorhood itself is a social process connected with social memory and symbolic contexts rather than merely a status within ranked societies, in which mortuary contexts are embodied with the meaning of warfare as a social practice. Following Treherne (1995), the mortuary context is one element in which warriorhood is constituted, as the mortuary treatment of the dead warrior is an imbued with social meaning. Hanks (2010) stressed that while Treherne's (1995) emphasis on the masculinity and beauty of the warrior image is an important aspect of the construction of the warrior ethos, age categories such as puberty and old age are also important in the iteration of identity through material culture and bodily modifications.

Much of the evidence for the involvement of females in the social process of warriorhood comes from Eurasia and North America (Hollimon 2011). Davis-Kimball (1998, 2001) brought this notion to the forefront of archaeology and bioarchaeology through studies of Iron Age burials at the Eurasian site of Pokrovka, in which individuals where interred in tumuli known as kurgans. Davis-Kimball (1998) identified a number of gendered social classes for females including hearth women, priestess, warrior, and a specialized ritual class she categorized as "warrior-priestess". These categories were defined based on grave good distributions, with the female warrior priestess class associated with the presence of weaponry as well as ritual items such as shells, mirrors, and animalistic art; in contrast, hearth women were buried with items such as jewelry and spindle whorls (Davis-Kimball 1998). Hanks (2008) noted a number of interpretational problems in Davis-Kimball's (1998, 2001) studies of "warrior women": the osteological sex determination of subadults, the direct correlation of grave goods with gendered social processes, and models of social organization in relation to warriorhood in late prehistoric Eurasian steppe societies. This demonstrates the need for more integration of bioarchaeological analysis in the social archaeology of personhood and identity (Bolger 2013; Hanks 2008; Sofaer 2006b). Other studies of prehistoric burials in Eurasia have emphasized the importance of females in prehistoric societies and have noted that warrior iconography in burials often crosscuts sex and age (Berseneva 2008; Legrand 2008; Olsen and Harding 2008). Hollimon's (2001) bioarchaeological research of massacre sites in the North American cites ethnographic support for the presence of an additional gendered class for warriors among North American indigenous societies; observed patterns of perimortem violent injuries on female skeletons from these sites suggest that women may not have been passive victims but rather active participants in prehistoric warfare. However, males may also have been victims of raiding and warfare outside the context of being the perpetrators, following evidence from Oneota cemeteries where men had similar injury patterns (cranial fractures, scalping, mutilation) to females (Milner et al. 1991).

#### 2.4.3.2 Limitations of Trauma Studies

Studies of trauma can provide insight into prehistoric occupation, injury, and violence. However, these cases are limited to bone injury only and do not account for soft tissue trauma (Milner 2005). In an evaluation of 19$^{th}$ century arrow wounds, Milner (2005) stated that approximately 50% of arrow wounds occurred in the thorax and abdomen, with a lower likelihood of affecting bone. Fatal trauma may occur even if bone is not involved (Milner 2005). The impact of trauma on other areas of functioning is another interpretative challenge in bioarchaeological studies. Healed head trauma could have caused considerable brain injury at the time of impact, which in turn may have had serious consequences for motor control, speech, vision, memory, and behavior (Martin et al. 2001). Poor motor control could have resulted in later injury due to falls or accidents (Martin et al. 2001). Both bone and soft tissue injury could have resulted in considerable physical disfiguration as well, which may have had a large impact on the social role of the individual (Martin et al. 2001).

## 2.5 BIOARCHAEOLOGY OF GENDER: A SUMMARY

Through varied levels of study, bioarchaeologists seek to interpret gendered social patterns of the human past (Buikstra 2006; Hollimon 2011; Sofaer 2013). Bioarchaeological methods of investigation of gender include mortuary analysis, paleopathology, and activity reconstruction. Each one of these lines of exploration into the human past is confounded with interpretational biases, so they have limited interpretative value individually. It is essential to consider the formational processes and etiologies of lesions, injuries, and activity markers when making inferences about patterns of community health and activity with associated gendered social mechanisms (Judd 2008; Roberts 2007; Waldron 2008; Walker et al. 2009; Weiss and Jurmain 2007). Despite these concerns, bioarchaeological inquiry is a holistic viewpoint through which to address questions about identity and gender. Studies such as Robb et al. (2001) which take an integrative approach through evaluation of burial treatment, age, sex, activity, and trauma are examples of how multiple lines of evidence provide a deep, nuanced view of the gendered social past.

# 3.0 CULTURAL HISTORY: THE PRE- CONTACT OHIO VALLEY IN CONTEXT

North American archaeological culture areas have been defined based upon geographic areas within which ethnic groups tend to have similar cultural traits as a factor of adaptation to similar environmental circumstances (Neusius and Gross 2013:34). This chapter summarizes the widespread regional dynamics of settlement and subsistence patterns, material culture, mortuary ceremonialism and population health from the Early Woodland Period at ~3000BP to the time of European contact in Northeastern North America (Table 1) via archaeological and bioarchaeological investigations (Neusius and Gross 2013). These time periods relate to the samples in this study of Ohio Valley region cultural dynamics: the Early Woodland, the Monongahela, and the post-contact Delaware. The archaeological Northeast encompasses present-day New England, New York, New Jersey, Pennsylvania, Ohio, the Great Lakes Region, Indiana, and Illinois, as well as southern Ontario and the eastern maritime provinces of Canada (Figure 7). This discussion will put the Ohio Valley subregion into its broader regional cultural and geographical context to provide a review of the rich cultural history and developments just prior to and during the time periods for this dissertation study.

This chapter covers a widespread time span and geographic region, rather than simply focusing on the Ohio Valley region for several reasons. The Late Archaic is discussed first, as many scholars regard the Early Woodland period to be an extension of subsistence-settlement patterns (Crowell et al. 2005; Fiedel 2001). This is an example of how systems of subsistence-settlement and material culture can persist despite other developments in mortuary ritual and community health. Cultural developments outside of the Ohio Valley region are also discussed for each time period; trade networks in the past may have facilitated relationships between cultural groups in various areas of the northeast. This comparative approach also places cultural developments in the Ohio Valley in context with contemporary groups to provide a picture of lifeways in the Ohio Valley in direct contrast with other indigenous groups in similar environments, notably the Iroquoians. Johnson (2001) argued for a cultural connection between the Monongahela and Iroquoian groups during the terminal phase of the Monongahela tradition (1580-1635AD) based upon the presence of Iroquoian style pottery, whelk shells, and copper objects in Late Monongahela phase sites. Though this hypothesis is debated for cultural affiliation, the relative wealth of archaeological and historical sources regarding Iroquoian lifeways provide workable models for gender, politics, and subsistence for the Monongahela in the absence of these lines of evidence in Monongahela archaeology.

**Table 1:** Time periods and dates for the American Northeast

| Time Period | Dates | Tradition |
|---|---|---|
| Late Archaic Period | 5000-3000BP | Old Copper Culture |
| Early Woodland | 3000-1950BP | Adena |
| Middle Woodland | 1950-1300BP | Hopewell |
| Late Woodland | 1300BP – 500BP | Iroquoians Monongahela |
| Late Prehistoric | 1000BP-500BP | |
| Protohistoric | 500BP - Contact | |

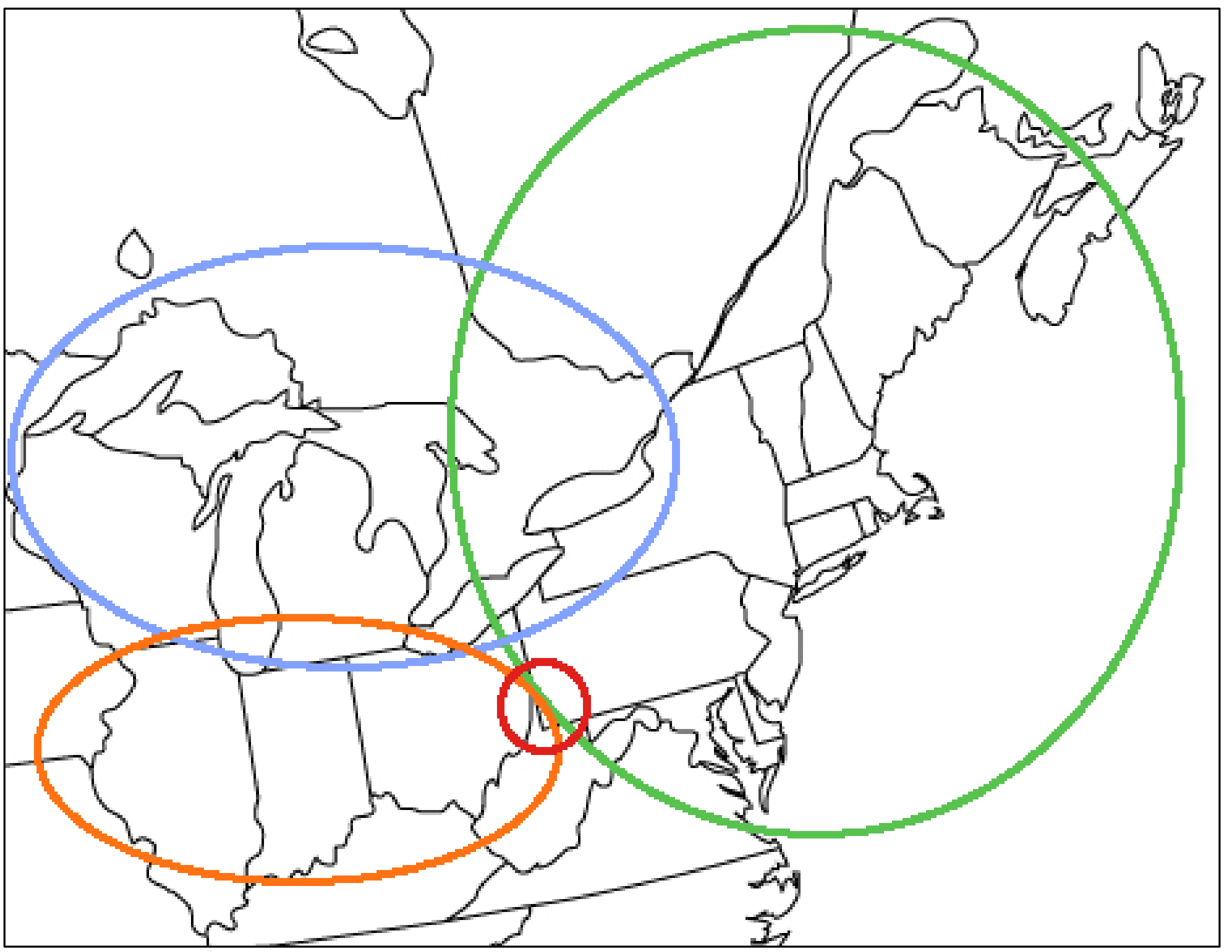


**Figure 7**: Map of Ohio Valley in regional context
Red Circle = Ohio Valley, Green Circle = American Northeast, Blue Circle = Great Lakes Region, Orange Circle = American Midwest

## 3.1 ARCHAIC DEVELOPMENTS IN THE NORTHEAST

Many scholars consider the Early Woodland period to be an extension of Late Archaic period, as it is hypothesized that Archaic patterns of settlement and subsistence persisted into this period (Crowell et al. 2005; Fiedel 2001). The Archaic in the American Northeast can be divided into three time periods: the Early Archaic (10,000BP-8000BP), the Middle Archaic (8000BP-5000BP), and the Late Archaic (5000BP-3000BP) (Neusius and Gross 2013). For most archaeologists, the Early Archaic is treated merely as a period of time, rather than a significant archaeological phase. Adovasio and Carr (2009) note that the changes at the junction of the Late Paleoindian Period and the Early Archaic period are minor alternations in lithic technology, rather than significant changes in subsistence and settlement patterns.

### 3.1.1 Subsistence and Settlement

Subsistence and settlement patterns in the Middle and Late Archaic periods can be characterized by the shift from mobile mixed foraging and hunting bands to increasing sedentism (Milner 2004). There were two notable features of Archaic subsistence patterns: the increasing reliance on aquatic resources as well as the appearance of the first cultigens (Neusius and Gross 2013). For example, the subsistence assemblage at the Koster site in Illinois reflected the shift from generalized foraging towards a reliance on shellfish and aquatic resources towards the Middle Archaic (Neusius 1986). Shell mounds appeared at sites as early as 7000BP, and it was theorized that these indicated a ritualized practice of feasting and ceremony (Kidder and Sassaman 2009). This idea was refuted by later research, suggesting that these mounds were merely shell middens (Marquardt 2010). The appearance of cultigens was also of great importance during the Middle/Late Archaic. The Eastern Agricultural Complex (EAC) consisted of the spread of eastern domesticates such as cucurbits, sumpweed, marshelder, goosefoot and chenopodium (Smith 1992). In the Ohio River Region, the cultivation of chenopodium was clear by 1500BCE as well as sumpweed, sunflower, and squash by the end of the Late Archaic (Simon 2009). While the presence of cultigens was more abundant in the Midwest during the Archaic, several sites in the Northeast pointed to early adoption of horticultural practices of the earliest domesticates. Early squash specimens appeared as far afield as Michigan, Pennsylvania, and Maine where they were postulated to be cultigens as they fall outside the known distribution of wild gourds (Hart and Asch-Sidell 1997; Petersen and Asch-Sidell 1996; Simon 2009). Storage of plant material in sites in New England revealed that chenopodium was a significant food source exploited by people living in Archaic semi-permanent villages, but it is not clear whether or not it was a domesticate (George and Dewar 1999).

### 3.1.2 Mortuary Program

According to Charles (1995) the Middle Archaic represented a paradigm shift in mortuary practices in North America. This is particularly evident in the American Midwest, where large mortuary complexes were discovered dating to the Middle and Late Archaic Periods (Charles 1995). Two emergent patterns of mound burial characterized the Middle Archaic in the far Midwest: hilltop bluff sites with single social group membership such as the Elizabeth site in Illinois (4400BC) and bluff sites with large caches of local and non-local artifacts, such as the Bullseye site in Illinois (4000BC). These differences were hypothesized to coincide with variations in mobility regimes among Middle Archaic societies in the far Midwest. Status competition, in periods of high mobility, would have coincided with the control of movable wealth. This pattern would have correlated with the expression of increased status in the accumulation of non-local "prestige" items, as evident in the burials of the Bullseye site in Illinois (Charles 1995). In the Late Archaic of the far Midwest, the settlement pattern began to favor large, permanent settlements, yet bluff cemeteries continued to be utilized along main valleys, with similar constructions constructed in small river tributaries in the Illinois Valley. Burials in the main valleys were primary inhumations, yet along the river tributaries secondary burials were also utilized (Charles 1995). It was hypothesized that communities along the main valleys exerted control over a smaller subsistence range, occupying territories in close proximity to cemeteries, whereas groups in the tributaries occupied larger subsistence ranges and had to travel longer distances (Charles 1995).

Two more burial complexes were present in the Midwest during the Middle and Late Archaic: the Red Ocher Burial Complex and the Glacial Kame Burial Complex. The Red Ocher Burial tradition was characterized by burials of individuals in the flexed position in red ocher lined pits with sand fill. Grave good assemblages included: large "ceremonial" white flint blades; "turkey-tail" points made from high quality chert from southern Indiana; worked copper in the form of tubular beads, celts, adzes and knives; and tubular marine shell beads. In some contexts, bundle or cremation burials, or mound burials have been associated with this complex (Ritzenthaler and Quimby 1962). The Glacial Kame Burial Complex was characterized by primary inhumations in kames left by retreating glaciers. The artifact assemblage was similar to that of the Red Ocher tradition, but the definitive grave good association with Glacial Kame was sandal-sole shell gorgets (Ritzenthaler and Quimby 1962).

Large-scale mortuary analyses have been performed from the site of Indian Knoll, Kentucky (Doucette 2001; Johnson and Snow 1961; Nealis and Seeman 2015; Rothschild 1979; Webb 1946). Over 1000 burials were recovered from this site, with 261 males and 281 females identified (Rothschild 1979). Early reports such as Rothschild (1979) suggested little differentiation in grave good distribution by sex with males as hunters based on the presence of atlatls (Webb 1946). More recent analyses of gender in the mortuary contexts argued that female burials with atlatls represented the importance of women as hunters in the Archaic, challenging previously held assumptions of the role of hunter as an exclusively male activity (Doucette 2001). The Indian Knoll site was also important because grave goods such as copper gorgets indicated long distance trade networks with the Great Lakes and Gulf regions during the Archaic (Webb 1946; Claassen 2001).

In other subregions of the northeast, Archaic burial practices were varied, though the Moorehead tradition defined the mortuary program for northern New England and the Canadian Maritime provinces (Richardson 2006; Robinson 1996a,b). The Moorehead tradition was characterized by cemetery use along riverbeds, subsidiaries, and channels with a grave good assemblage including red ochre, whetstones, adzes, stone rods, and bone tools; cremations and single inhumations were the predominant burial types, though the remains recovered from Moorehead sites are generally too fragmentary to allow for age and sex estimation (Richardson 2006; Robinson 1996a,b). In summary, the mortuary program throughout the American northeast was characterized by varied traditions throughout the different sub-regions including burials in glacial kames, individual pits, and cemeteries with diverse grave good assemblages. This pattern was observed throughout other time periods; the means by which indigenous peoples conceived of death, status, and funerary ritual was by no means homogenous throughout prehistory, although mortuary traditions may be related (Dragoo 1963).

## 3.2 THE EARLY WOODLAND PERIOD

The Early Woodland Period in Northeastern North America can be characterized by the adoption of ceramic technology and increasing mortuary ceremonialism that developed in the American Midwest (Fiedel 2001; Milner 2004). The Early Woodland spanned from 3000BP to 2200BP in the Midwest, beginning with the appearance of the Adena mortuary tradition and ending with the appearance of the Hopewell tradition (Neusius and Gross 2013). In the Northeast, the distinction is not as clear, but Neusius and Gross (2013) cited 3000-1950BP as a date range for the Early Woodland, as Hopewellian interaction was evident in the region after 1950BP.

The Early Woodland was previously characterized by the widespread adoption of cultigens, but studies have shown that cucurbits and native seed plants were utilized at Northeastern sites during the Late Archaic (Hart and Asch-Sidell 1997; Asch-Sidell 2002). Archaeologists recognized the beginning of the Early Woodland throughout the Midwest and Northeast as the time of the adoption of ceramic technology (Fiedel 2001). The chronology of the Early Woodland in the Northeast is complicated, as the date adoption of ceramic technology is variable by subregion (Fiedel 2001). There is little other evidence for the Northeast that marks the transition from the Archaic to the Early Woodland as Archaic lifeways seemingly continued throughout this period. Archaeologists referred to the Early Woodland in the Northeast as “the Archaic with pottery” (Fiedel 2001:102).

### 3.2.1 Subsistence and Settlement

Evidence for settlement in the Ohio Valley for the Early Woodland was not abundant, but spatial analyses have revealed that residential sites were generally located near floodplains and terrace zones (Crowell et al. 2005). Early Woodland residential sites generally followed the pattern exhibited in the Late Archaic for this region: seasonally occupied camps. There was preference for terrace zones in the Early Woodland, which would have afforded populations access to wild and garden plants, such as those from the Eastern Agricultural Complex (Crowell et al. 2005; Keener and Nye 2007). Sites such as County Home and Boudinot 4 in the Hocking Valley of Ohio suggested increasing sedentism towards the Middle Woodland period (Crowell et al. 2005). Seeman (1986) commented on the scarcity of settlement data, but noted a small number of seasonal camps and use of rockshelters in the Ohio Valley in the Early Woodland points to a mixed hunting-gathering subsistence strategy. This hypothesis was supported by site survey data, such as the study by Crowell et al. (2005).

Seasonally occupied base camps were also evident in the far Northeast regions of New England and the Canadian Maritime provinces (Tache 2011). There was no data to suggest cultivation of wild seed plants in this subregion during the Early Woodland, but fishing-hunting-gathering economies are evident (Tache 2011). Habitation sites were most commonly located along major waterways, and remains of fish and mammals in midden contexts reinforced the notion of a continuation of Late Archaic foraging strategies in New England, New York, and eastern Canada (Tache 2011).

### 3.2.2 Material Culture

Early Woodland pottery throughout Northeast was generally thick walled, coil constructed, with coarse temper agents such as crushed igneous rock, which favors a preference for high storage capacity containers and slow diffuse heat cooking (Hart 1980:95, Tache 2005:174). These vessels were cylindrical shaped with either conoidal bases, such as Vinette I wares from New England, or flat bases such as Crab Orchard ceramics in the Midwest (Hart 1980:95). The pottery was often cordmarked as a result of the use of cord wrapped paddles and anvils to smooth coils (Tache 2005).

Great lithic variability existed in the Early Woodland for Northeastern North America. Adena blades were widespread, consisting of ovate based, stemmed lithics and are typically made of high quality flints and cherts (Dragoo 1963; Pollack et al. 2005). Other diagnostic projectiles included the Meadowood "cache blade" and side notched Meadowood point, characteristic of the Meadowood Interaction Sphere, covering Southern Ontario, New England, and the Maritime provinces (Spence et al. 1990: 128; Tache 2011).

In the widespread mortuary complexes of the Early Woodland, elaborate items of personal ornamentation and status were included (Dragoo 1963; Milner 2004; Spence et al. 1990; Woodward and McDonald 2002). These items ranged from carved stone tablets, pipes, copper breastplates, copper bracelets and rings, cut mica ornaments, shell and copper beads, slate and copper gorgets, and pottery sherds (Dragoo 1963; Milner 2004; Pagoulatos 2012). Dragoo (1963) suggested that the material culture of Early Woodland mortuary complexes is related to the Late Archaic "Old Copper Culture" in which individuals with high status brought with them material culture into the Ohio Valley and other regions of the American northeast during migrations and established trade networks with groups in the Midwest. This hypothesis has been questioned by more recent analyses; element concentration testing revealed that copper from Eastern Adena sites in Pennsylvania and Delaware was sourced locally from drift copper (Lattanzi 2007).

### 3.2.3 Mortuary Program

Archaeologists identified mortuary complexes for the eastern portion of the Midwest and the Northeast including: the Adena, Middlesex, and Meadowood (Figure 8). These traditions remain ambiguously defined and overlap in artifact assemblages, territory, and time frame (Pagoulatos 2012). Researchers suggested that these traditions may represent "interaction spheres" or complexes rather than single cultures (Ritchie 1969; Tache 2011). Caldwell (1964:135) defined an interaction sphere as "the interactions of separate societies … resulting in what appears to be a distinctive set of phenomena". While the Early Woodland samples from the current study only include remains from Adena mounds, it is important to note the emergent patterns of other mortuary traditions in the surrounding cultural area to place the eastern Adena into regional context.

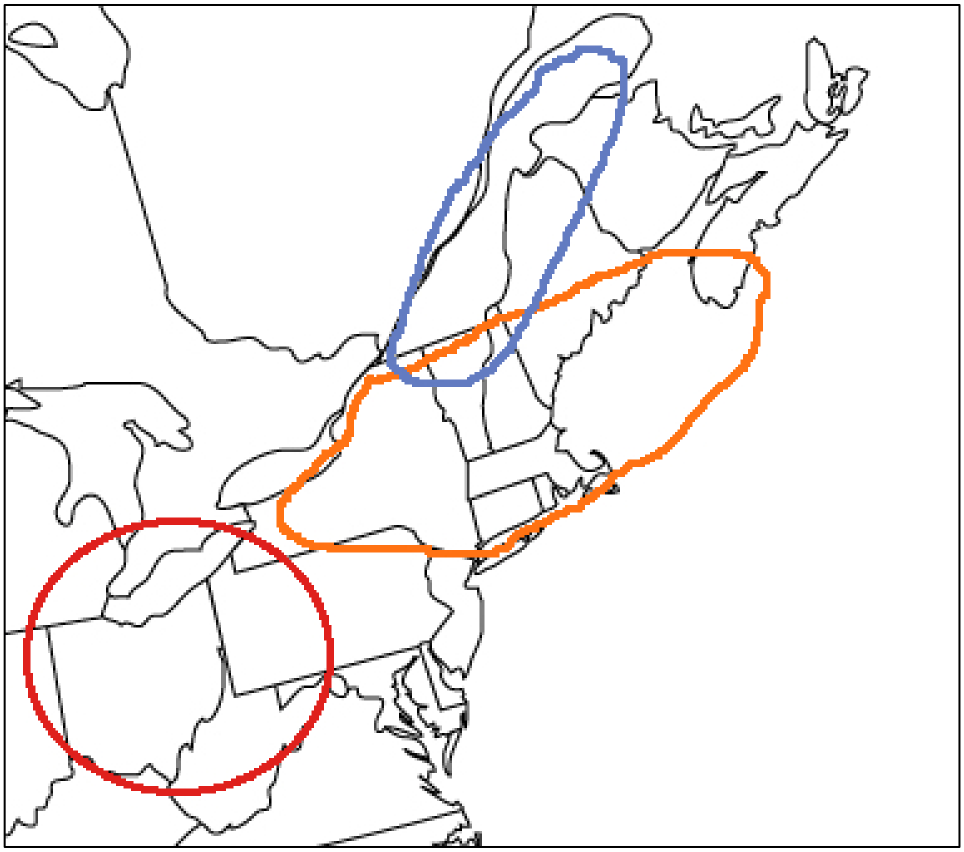


**Figure 8**: Map of Early Woodland burial traditions
Red = Adena, Orange = Meadowood, Blue = Middlesex

#### 3.2.3.1 The Adena Tradition

The Adena tradition (2500-2000BP), the name derived from the type-site at Adena, Ohio, included the Ohio Valley into West Virginia, western Pennsylvania and northern Kentucky (Dragoo 1963, 1976; Fitting and Brose 1970). The Adena tradition was most commonly associated with conical shaped burial mounds constructed over wooden house structures, as evidenced by post-holes in the foundations (Dragoo 1963; Milner 2004). These structures, once thought to be houses, were most likely charnel houses for the storing of human remains then buried under the mound, with additional burials included in the fill or surface (Rafferty 2005). Burials in these mounds fell into several categories: subfloor pit graves lined with bark or logs, elaborate log tombs above or below the mound floor, extended burials in mound fill, cremated remains in situ or deposited with other burials/features, and burials of bundled disarticulated remains (Dragoo 1963; Milner 2004). Elaborate artifact assemblages were characterized by Cresap, Adena, and Robbins stemmed blades, engraved stone tablets with geometric or zoomorphic designs, slate gorgets of various shapes, pendants, plain or effigy tubular pipes, copper beads, bracelets, finger rings, Fayette Thick and Adena Plain pottery wares, and worked mica (Dragoo 1963; Milner 2004) (Figures 9-13). Less commonly found are animalistic effigy masks (Dragoo 1963). Studies of skeletal remains from Adena mounds are limited (Webb and Snow 1945) and analyses incorrectly identified most of the adults as males, leading archaeologists to believe that status was linked to the male gender (Milner 2004). Re-analyses of this material demonstrated that males and females were equally represented in Adena mortuary contexts, though fewer subadults than adults were buried in mounds (Milner and Jeffries 1987; Milner 2004).

The majority of excavations of Adena mounds took place from the 1890's into the 1950's (Dragoo 1963; Webb and Snow 1945). Larger mound sites, such as McKees Rocks Mound in Pittsburgh, Pennsylvania, were less common in the eastern periphery of the Adena tradition (Dragoo 1963), while artifacts are dispersed further afield (Ritchie and Dragoo 1959; Ford 1976). Webb and Snow (1945) originally hypothesized that the origin of the Adena had roots in Mesoamerican cultures, but Dragoo (1963) cited similarities between early Adena sites and the Red Ocher and Glacial Kame traditions of the Late Archaic.

Very little evidence of subsistence and settlement in relation to the people who built Adena mounds existed in the archaeological record (Greber 2005; Milner 2004). The limited settlement data suggested that population aggregates were generally low, and that people of the Ohio Valley Early Woodland were hunters and gatherers, with some limited horticultural practices (Greber 2005; Keener and Nye 2007). Greber (2005) proposed a continued subsistence-settlement pattern from the Late Archaic into the Early Woodland, with an emphasis on mortuary ritual and symbolism. Great variability existed in Adena mortuary contexts in the nature of burial ritual and associated artifacts, rendering the taxonomy of Adena difficult (Greber 2005). Hays (2010) suggested that the reason for this phenomenon is in the way that ritual itself is constituted; there may be no set pattern for a particular tradition but an inclination for ritual to manifest under similar symbolic frameworks. The ritual connotation for Woodland moundbuilding societies sought to re-affirm the status of important individuals in that group; burial objects made of rare and prestigious materials served as symbols that connected people with the supernatural (Milner 2004). Milner (2004) proposed that the appearance of large earthworks, such as Adena mounds, also signals the development of systems of centralized authority in Woodland societies, as moundbuilding requires organization, cooperation, and planning. This was echoed by Abrams and LeRouge (2008) who proposed that the increased architectural energetics required to construct Adena mounds correlated to an increase in emergent political authority and power by tribal leaders.


**Figure 9:** Stone celt, burial 26, Cresap Mound


**Figure 10:** Stemmed point, burial 25, Cresap Mound


**Figure 11:** Carved turtle effigy, burial 25, Cresap Mound

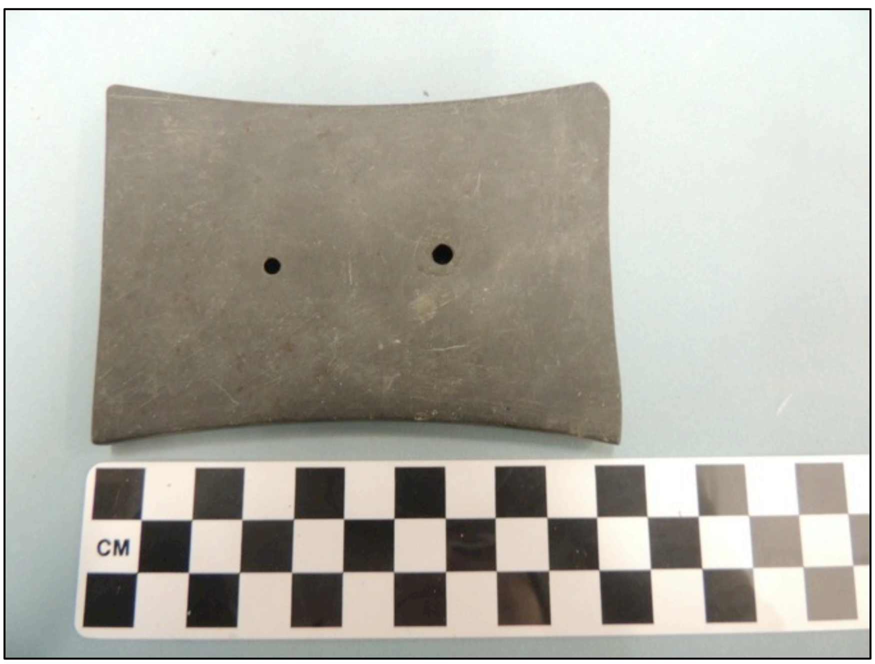



**Figure 12:** Reel shaped slate gorget, burial 25, Cresap Mound

**Figure 13:** Worked hematite, burial 11, Cresap Mound

### 3.2.3.2 The Middlesex Tradition

The Middlesex Burial Tradition was identified by Ritchie in 1937, but was poorly defined (Heckenberger et al. 1990; Ritchie 1969). Spanning much of the upper Northeast, including New York State, New England, and Southern Ontario, this mortuary tradition had features similar to Adena, namely the presence of blocked end pipes and stone artifacts from the Ohio region (Ritchie 1969). Analysis of 19 burial components revealed that over half of the artifact assemblages attributed to Middlesex are also present in Adena assemblages (Ritchie 1969). The use of burial mounds and earthworks was not part of the Middlesex complex, and burials took the form of inhumations, cremations, and bundle burials (Ritchie 1969; Pagoulatos 2012).

Importantly, burials from this complex have been analyzed in terms of gender and social status (Heckenberger et al. 1990). At the Boucher site in northern Vermont, grave goods were differentiated by sex; utilitarian objects such as pipes were associated with women, whereas lithic items were associated with men (Heckenberger et al. 1990). Only a small number of skeletons could be reliably sexed in an osteological analysis: 9 males and 5 females, 21 subadults, and 37 adults were identified, for a total of 72 individuals (Heckenberger et al. 1990). Feasting rituals may have also been associated with funerary behavior in the Early Woodland, as evidenced by hearth features on top of burial pits at sites in the Middlesex complex (Heckenberger et al. 1990; Pagoulatos 2012). In Southern Ontario individuals were buried with items such as copper beads and jewelry, as well as blocked end tube pipes such as those indicative of Adena (Spence and Fox 1986). This study, in combination with data from Ritchie (1969) suggested that by the Early Woodland people in the Northeast had engaged in broad networks of social interaction with peoples from the Ohio Valley, with expressions of gender evident in their social structure (Heckenberger et al. 1990).

#### 3.2.3.3 The Meadowood Complex

The Meadowood Burial complex is more differentiated from Adena than the Middlesex Complex (Tache 2011). Identified by Richie (1965), the Meadowood Complex was identified by the presence of “cache blades” manufactured from Onondaga chert, a high quality stone from western New York and southern Ontario (Tache 2011). Mortuary and habitation sites are widespread throughout New York state, New England, Ontario, Quebec, and the Canadian Maritime provinces (Tache 2011:9). Burials consisted of cremations, bundle burials, flexed burials, multiple primary, and multiple secondary inhumations in cemeteries containing a small number of individuals (Tache 2011:155). Cemeteries were most often located along major streams or waterways without associations to habitation sites (Tache 2011: 153). Poor preservation of osteological material was noted, rendering bioarchaeological analyses of the social implications of burial difficult. In cases where sex determination was possible, it was reported that adult males appear more frequently in burial contexts and fewer subadults are represented than adults (Tache 2011). No correlations were observed in burial type according to sex or age but lithics, ceramic and bone artifacts were more common in adult burials and were more often associated with males (Tache 2011). Tache (2011) suggested that the social implications of multiple burials, cluster burials, and secondary burials supports the idea of distinct lineage groups and kinship ties among Meadowood peoples. Ritual feasting was represented by uncooked faunal inclusions such as deer and birds found in burials at sites such as Bruce Boyd in Southern Ontario (Tache 2011). It was clear, from analyses of habitation sites, that the people participating in the funerary complex were hunter-fisher-gatherers, as evidenced by the presence of wild plant sources, fishing implements, and mammal remains (Tache 2011).

## 3.3 THE MIDDLE WOODLAND: THE HOPEWELL INTERACTION SPHERE

The Middle Woodland period (2200BP-1450BP) (Neusius and Gross 2013) in the American Midwest was dominated by the Hopewell Interaction Sphere: a phenomenon characterized by the widespread exchange of raw materials, ceremonial craft items, elaborate burial customs and mounds, and the construction of large-scale earthworks (Dancey 2005). Beyond the Midwest, the Middle Woodland was dated to approximately 1950BP-1450BP (Neusius and Gross 2013) and was characterized by cultures that practiced seasonal mobility with some experimentation in horticulture (Chilton 2002; Kingsley 1999). The core area of Hopewell was the Scioto region of Ohio extending into southern Illinois (Figure 14), with exchange networks reaching into the Great Lakes region in the North, the Mississippi Gulf region in the South, as far east as New Jersey and as far west as Missouri (Abrams 2009; Brashler et al. 2006; Dancey 2005; Jeffries 2006; Jeske 2006; Logan 2006; Steinen 2006). Trade connections further afield were evidenced by obsidian from the Yellowstone area (DeBoer 2004).

The term “Hopewell” doesn’t refer to a single, unified society but rather a community of Middle Woodland societies participating in a wide scale regional integration reflected through large-scale earthworks and burial mounds and assemblages of exotic artifacts in burial contexts (Abrams 2009). The relationship between the Hopewell interaction sphere and the earlier Adena phenomenon was poorly understood (Abrams 2009). Researchers hypothesized that the Hopewell emerged from the Adena (Carskadden and Morton 1997; Clay 2002; Seeman 1986), though funerary and site analysis has shown that sites on the Adena periphery of Kentucky and West Virginia were contemporary with Hopewell and that funerary behavior was varied (Abrams 1992; Greber 1991; Pollack et al. 2005; Richmond and Kerr 2005). It was hypothesized that these communities were of mixed sedentary-mobile nature as a few sites, such as Smiling Dan in Illinois, suggest long-term occupation whereas other seasonal camps were disbursed throughout the Hopewell regional sphere (Abrams 2009). Seeds and native cultigens (maygrass, sumpweed, chenopodium) at occupation sites and camps indicated that these communities participated in horticultural propagation of wild plants (Abrams 2009). The political structure of these societies has been hypothesized to have been a collective alliance of local communities in the form of clans and larger kinship lineages (Ruby et al. 2006; Thomas et al. 2006). The creation of clans and the materialization of these relationships through collective earthwork construction and exchange of materials reflected regional integration models (Abrams 2009).

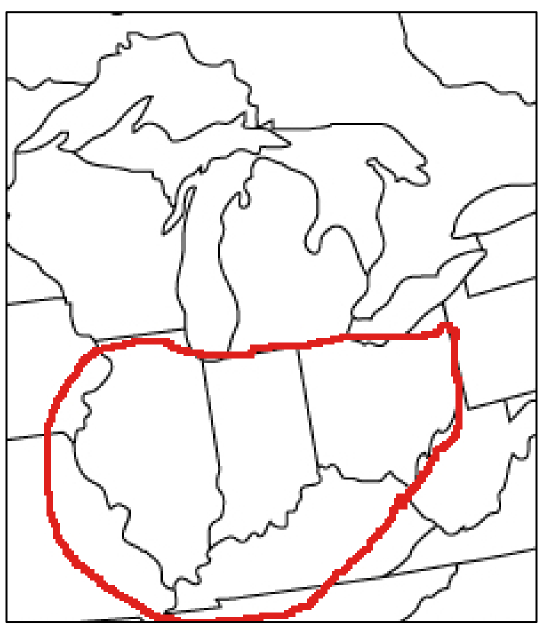


**Figure 14:** Map of Hopewell core area

### 3.3.1 Mortuary Program

During the Middle Woodland, constructed earthworks and burial mounds comprised the ceremonial landscape (Riordan 1998). Conical burial mounds, some of which had geometric earthwork enclosures surrounding them, were constructed that covered charnel houses containing multiple burial types (Dancey 2005; Riordan 1998). Low platform burial mounds were also a significant feature of Hopewellian mortuary architecture (Dancey 2005). Elaborate geometric earthworks existed at large ceremonial sites, such as Newark Earthworks and Fort Ancient in Ohio (Dancey 2005). Hilltop enclosures were also common architectural features of the Hopewell core area, and may have functioned as symbolic expressions of control over territory or fortifications (Lepper 1998; Riordan 1998).

A number of ideas have been suggested about the use and meaning of Hopewell earthworks and burial mounds in that they had both economic and social functions. Romain (2000) suggested that many Hopewell earthworks were aligned with solar and lunar astronomical landmarks, but there is little consensus regarding this association among archaeologists (Dancey 2005). Buikstra, Charles, and Rakita (1998: 94) argued that Hopewell burial complexes were multicommunity mortuary encampments where residents conducted mortuary rituals, and that these complexes were a mechanism of structuring social, political, and economic relationships between dispersed communities. Cowan (2006) and Pacheco and Dancey (2006) stressed the importance of earthwork sites in networks of peer polities in Hopewell core areas as places of economic and ritual activity, where dispersed communities gathered in the exchange networks of valuable items and the performance of elaborate rituals. It has also been hypothesized that earthworks were constructed for purely social reasons in that Middle Woodland people participated in their construction and elaborate rituals at these sites as a means to maintain ties between dispersed communities (Hall 1997). Byers (2006) suggested that habitation sites and earthworks/burial mounds were dual ritual spheres in which domestic sites were linked in open-ended networks by kinship and alliance and earthworks were sacred places for autonomous sodalities or cults. Members of Hopewell society were members of both domestic and ritual networks and these spheres were separated by both geography and material usage (Byers 2006). Lepper (2006) stated that earthworks were sites of pilgrimage and that the degree of uniformity in Hopewell symbolism, raw material, and monumental architecture was a result of a shared iconographic vocabulary in which individuals felt a sense of *communitas* with those whom these ritual aspects were shared. The common thread throughout the multiple hypotheses for the meaning and use of mounds and earthworks was that of community interaction along kinship ties, following the conceptualization of the Hopewell as an interaction sphere of separate societies linked together through kinship, ritual, and trade networks (Abrams 2009).

From the many archaeological investigations of Hopewell mortuary mounds and earthworks, it was clear that the mortuary program was diverse (Dancey 2005). Hopewell burial practices included flexed and extended single and group inhumations, secondary bundle burials, cremation and secondary burial cremations (Dancey 2005). Commonly, Hopewell burials were in crypts of various forms, such as subfloor or floor level log tombs, where bodies were left in the extended position to decompose and were then deposited in secondary bundle burials. Charnel houses were also utilized and often had crematoriums, where bodies were left to decompose and were subsequently cremated and re-deposited within burial mounds and earthworks. Single and group primary inhumations were also utilized, and elaborate caches of burial goods are often found in direct association with these individuals (Carr 2006b; Dancey 2005). The elaborate funerary toolkit associated with elite Hopewell burials has been suggested by several researchers to be connected with shamanic practitioners and community leaders (Brown 2006; Carr and Case 2006); burial artifacts such zoomorphic and anthropomorphic effigy pipes and ceramic figurines, quartz and other minerals, and animal effigy headdresses indicated ritually important individuals or shamans in Hopewell societies. Religious iconography and symbolism as reflected by these burials may have been a unifying principle through which the Hopewell communities were linked (Abrams 2009). However, with great variation in mortuary practices, it was stated that the mortuary program was not institutionalized in Hopewell societies and was mostly likely embedded in local traditions (Dancey 2005).

### 3.3.2 Population Health

Skeletal analyses of remains from Hopewell mounds have demonstrated that all age group and sexes were represented, indicating that age and sex categories did not exclude individuals from inclusion in this burial type (Buikstra 1976). Studies of MSMs noted that female elites or shamanic practitioners in Hopewell contexts did not have significantly different activity patterning than their lay counterparts. Male elites had significantly lower MSM scores than the rest of the group. There was thus a gendered division of labor, with females performing tasks heavily utilizing the upper limbs and men utilizing the lower limbs (Rodrigues 2006). Field et al. (2006) studied the distributions of ritually important “prestige” items in Ohio Hopewell burials, and concluded that both males and females were ritually important and residence patterns were likely matrilocal. This conclusion was supported by DNA studies of biological sex (Bolnick and Smith 2007). Pathological conditions observed in Hopewell contexts included osteoarthritis, fractures, periostitis, and treponematoses, indicating that age or occupation related joint modifications and trauma affected this population as well as infectious disease (Buikstra and Cook 1981; Frankenberg et al. 1988; Lovejoy and Heiple 1981; Powell and Cook 2005). Cutmarks found on skulls and mandibles were interpreted as trophy taking or post-funerary processing as a practice of ancestor veneration (Johnston 2002; Seeman 1988). Bioarchaeological research revealed much information about the biocultural aspects of life among Hopewellian societies with individuals of both sexes in high status burials and gendered division of labor. These analyses indicated that clan and kinship groups among the Hopewell had similar political and economic structure throughout the interaction sphere with some local variations (Abrams 2009; Field et al. 2006).

### 3.4 LATE WOODLAND, LATE PREHISTORIC, AND PROTOHISTORIC PERIODS

The chronology of the Late Woodland period is variable, with the sequence starting at different points with various regional cultures. Neusius and Gross (2013) proposed that the Late Woodland began at about 1500BP in both the American Midwest and at approximately 1300BP in the American Northeast. Some scholars subdivide later portions of the Late Woodland into the Late Prehistoric and Protohistoric periods, with the Late Prehistoric beginning at approximately 1000BP and the Protohistoric period at approximately 500BP (Neusius and Gross 2013). The Late Woodland was primarily associated with the spread of maize agriculture throughout North America. Archaeologists and paleoethnobotanists suggested that maize may have been introduced into northeastern North America either from a migratory population or by cultural diffusion (Hart 2008; Hart and Lovis 2012; Hart et al. 2003; Smith and Crawford 2002). Regional cultures characterized by shared subsistence-settlement practices, mortuary ceremonialism, and material culture emerged throughout this period, notably the Iroquoians and the Monongahela (Figure 15) (Birch 2012; Custer 1986; Engelbrecht 2003; Johnson 2001; King 1993; Means 2007a; Prezzano 1997; Smith and Crawford 2002).

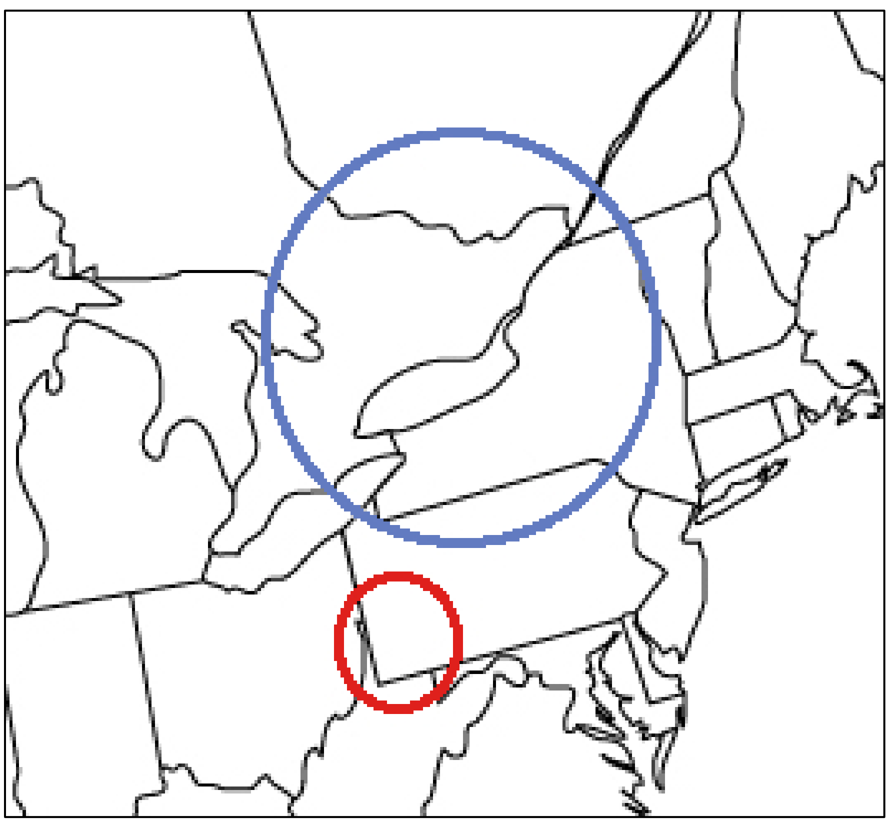


**Figure 15**: Culture map of Late Woodland/Late Prehistoric
Red= Monongahela, Blue = Iroquoians

### 3.4.1 The Iroquoians

Iroquoians were a group of several distinct populations, which were linked culturally and linguistically through similar settlement-subsistence patterns, material culture, socio-political organization, and linguistics (Birch 2012; Engelbrecht 2003; Fenton 1978; Fenton 1998; Morgan 1870; Prezzano 1992; Prezzano 1997; Trigger 1990). Prior to European contact, the Seneca, Cayuga, Onondaga, Oneida, and Mohawk groups formed an alliance known as the League of the Haudenosaunee; the exact date of the formation of the confederacy was unknown though the emergence of distinct polities was recognized archaeologically in sites dating to the 15th and 16th centuries (Engelbrecht 2003:92; Ritchie 1980: 317). While these groups have received considerable attention from archaeologists and anthropologists studying indigenous cultural patterns in North America, Iroquoian cultural patterns were present in other populations such as the Huron-Petun of the Great Lakes, the Neutral Iroquoians of southern Ontario, the Erie of western New York, groups such as the Susquehannocks in northern Pennsylvania, as well as the St. Lawrence Iroquoians (Custer 1986; Kapches 1990; Pendergast 1975; Sempowski 1994; Varley and Cannon 1994; Warrick 2000; Warrick 2008; Wonderley 2005). Much of the data regarding culture of these groups came from the early 17th century accounts of European explorers and Jesuit missionaries, primarily those who wrote accounts of daily life, activities, settlements, agriculture, and political organization and ritual of the Huron (Champlain 1608-1631; Lafitau 1724; Sagard 1614-1636). The picture of Iroquoian cultural patterns was less clear in earlier periods at the Middle to Late Woodland transition of how and where Iroquoian cultural patterns developed, though archaeological investigations revealed considerable information regarding shifts in settlement-subsistence patterns as well as changes in material culture and social structure of these societies (Engelbrecht 2003). For example, Chapdelaine (1993) outlined the pace of cultural change that occurred from AD 500-1300, and concluded that Iroquoian communities were not year-round sedentary villages until after 1300AD following wide scale adoption of maize as a staple food source. The Iroquoians represent a unique case for the study of past indigenous populations in North America as there is a large amount of ethnohistorical information (Fenton 1978; Morgan 1870) regarding these groups, some of which still exist today, as well as archaeological evidence of cultural patterns in the past (see Engelbrecht 2003 for a general review).

#### 3.4.1.1 Subsistence and Settlement

The typical Iroquoian subsistence-settlement pattern was characterized by large villages consisting of longhouses surrounded by palisades, with a reliance on maize-bean-squash agriculture supplemented by hunting, fishing, and gathering, but these patterns did not develop until much later in prehistory than originally hypothesized in the Northeast (Engelbrecht 2003: 88; Hart and Brumbach 2003: 745). Ritchie (1969) defined the Owasco culture as the antecedent for Iroquoian patterns in New York State with the emergence of nucleated settlements, fortifications, and maize-bean-squash agriculture beginning at 900-1000AD. Data from New York settlement sites revealed that longhouses and nucleated settlements did not appear among early Iroquoian traditions until approximately 1300AD, with small hamlets or camps predominating prior to this date (Hart 2000; Hart and Brumbach 2003; Prezzano 1992). It is important to emphasize that Hart and Brumbach (2003) criticized the notion of Owasco as a distinct cultural sequence in that pottery types assigned to Owasco appear several centuries earlier than described by Ritchie (1969); villages, maize agriculture and associated matrilocality did not appear until much later at around 1300 AD. Thus, the authors argued that Ritchie's (1969) cultural scheme does not hold up under chronological scrutiny (Hart and Brumbach 2003).

Analyses of settlements in New York and southern Ontario Iroquoian settlement sites revealed a trend of increasing settlement size and wider spread of communities towards the beginning of the 14th$^{th}$ century onwards (Birch 2012; Ritchie and Funk 1973). Birch (2012) studied coalescent Iroquoian communities in southern Ontario, likely ancestors of the Huron. She found that through analyses of households and community organization, such as at the Draper and Mantle sites, communities and households began to grow in size and decrease in number after 1300AD with a trend in greater increase in size and fortification by the latter half of the 15$^{th}$ century AD (Birch 2012). The impetus for the trend of coalescence of smaller communities may have been conflict, as evidenced by an increase in fortifications as well as instances of skeletal trauma during this period (Birch 2015). Resource stress brought about by over-exploitation of faunal resources and the climactic instability of the Little Ice Age may have exacerbated political tensions during this period (Birch 2015; LeBlanc 2008). Researchers suggested the need for larger political institutions and kinship systems resulting from community aggregation and settlement movements as necessitated by this conflict (Birch 2012; Trigger 1990). Sempowski et al. (1988) noted similar trends for the New York Seneca, with increasing settlement size and population aggregation towards the beginning of the 16$^{th}$ century AD. It has been suggested that geopolitical realignments of communities into large settlements of over 1,000 individuals provided the impetus for the formation of nations among the Iroquoians, such as the New York Mohawk, Seneca, Cayuga, Onondaga, and Oneida as a means to reduce warfare and conflict (Birch 2015). By the end of the 1400's and into the early 17$^{th}$ century, these tribal entities were recognized in the archaeological record (Engelbrecht 2003:92).

Other than the village, the household unit was important for the understanding of Iroquoian social organization and settlement systems (Prezzano 1997). Ritchie (1969) stated that longhouses were present by 900-1000AD at the Roundtop site in New York, but new radiocarbon dates from this site indicated that the earliest longhouses did not appear until the late 13$^{th}$ century and were not prevalent until the early 14$^{th}$ century AD (Hart 2000). Along with village size, after 1300AD there was a trend in increasing longhouse size sites (Birch 2012). Iroquoian longhouses were large wooden dwellings, generally 5 to 7 meters across, and in some cases were over 500 feet long (Tuck 1971). These were generally multi-family dwellings, whose members belonged to the same clan and resided under a system of matrilocality (Prezzano 1992). These structures also served as meeting places for councils and other ceremonial functions (Fenton 1998; Sagard 1636). Historical accounts of the Huron corroborated archaeological investigations of house structure. Sagard (1636:93), a Jesuit missionary, noted that the longhouses were divided into family compartments and were the centers of domestic activities such as food preparations as well as craft production (Sagard 1636:109). Archaeological analyses of Iroquoian households noted that while traditionally associated with female ownership and activities, longhouses were also areas of male and female activity (Allen 2010; Snow 2012). Food production and craft production took place in households, as evidenced by broken sherds and hearths within family compartments, as well as male associated activities such as pipe making and lithic production, as revealed by spatial analyses of household floors (Allen 2010, Snow 2012). Nonetheless, missionaries and ethnohistorians such as Sagard (1636) and Morgan (1870), as well as anthropologists such as Brown (1970), Fenton (1978), and Prezzano (1997) concluded that longhouses were especially tied to gender and female power and resource distribution.

Ritchie (1969) also tied the period beginning in 900-1000AD with the appearance of maize-bean-squash agriculture in the Iroquoian cultural area. Maize-bean-squash agriculture was documented at Iroquoian sites in New York State and Ontario as described by ethnohistorians (Hart 2008; Sagard 1636;). Multicropping systems such as this were beneficial both economically and nutritionally; maize provided a stalk to support bean vines and bean plans fix nitrogen in soils, while squash provided weed suppression with thick ground cover (Hart 2008). There was clear evidence of squash, or *Curcurbita pepo*, cultivation or horticulture in New York state by the 3rd millennium BP, in the form of seeds in site matrices and phytoliths from pottery cooking residues (Hart et al. 2003; Hart 2008). Current paleoethnobotanical studies demonstrated a long history of maize exploitation in the Northeast (Hart 2008). Phytolith studies from the Finger Lakes region of New York revealed that cultures inhabiting this area were cooking maize by 2270BP, and its use and cultivation was widespread by 1500BP (Hart et al. 2003). Both of these lines of evidence corroborated Ritchie's (1969) assertion that Iroquoian horticultural patterns were present by 1000AD, but bean cultivation began much later than previously thought (Hart 2008). There is no conclusive evidence for bean agriculture in the Northeast or among the Iroquoians prior to 700BP, much later than Ritchie (1969) hypothesized. The earliest accepted date for the congruence of the cultivation this three-crop system comes from the Roundtop site in NY, dating to 667BP (Hart et al. 2003). It appears then, that the adoption of tripartite multi-cropping was not a catalyst for community aggregation and matrilocal residence patterns among the Iroquoians as once hypothesized by archaeologists, as the adoption of squash and maize occurred nearly a millennium before (Hart 2008).

The Iroquoian diet was not entirely comprised of agricultural products; hunting, fishing and gathering were all extremely important (Champlain 1615; le Mercier 1669; Sagard 1636). Deer was the most exploited meat source and is the most common animal represented in zooarchaeological assemblages from Iroquoian villages (Kuhn and Funk 1994). Jesuit missionaries and European explorers reported that men with bows and arrows or snares hunted deer, with near full abandonment of villages by men during the winter hunt (Champlain 1615; le Mercier 1669:117). Ethnohistorical accounts described that deer were butchered on-site and parts that were eaten were carried back to the villages by hunters and women (Trigger 1990). Evidence of this practice has been observed at Mohawk village sites, where the lower limb and foot bones of deer were most frequent in zooarchaeological collections (Engelbrecht 2003). Bear and birds game were also hunted (Kuhn and Funk 1994). Fishing was also an important, though fish are underrepresented in the archaeological record due to the fragility of their bones (Thomas 1997). This may be due to the fact that fish were cooked and eaten whole (Brumbach 1986). Fish were caught with harpoons and nets seasonally (de Quens 1656: 97). Wild plant foods were gathered, including wild fruits such as blackberries, raspberries, pin cherries, plums, strawberries and elderberries, as well as nuts and edible tree sap (Monckton 1992).

#### 3.4.1.2 Gender and Iroquoians

Ethnohistorical accounts stressed the importance of women in Iroquoian societies as the people in Iroquoian societies who defined kinship, political power, and economic duties (Lafitau 1724; Morgan 1870). Jesuit documents indicated that Iroquoian societies were matrilineal (Lafitau 1724). This occurred through a system of clans, which were comprised of maternal families whose lineages were traced from common female ancestors (Fenton 1978:309; Morgan 1870). The Iroquoians practiced exogomous matrilocality; after marriage a husband would reside with his wife's clan and maternal family, and these marriages were generally arranged by female elders (Morgan 1870). Archaeologists hypothesized that the formation of matrilineages and matrilocal residence among the Iroquoians occurred shortly after Iroquoian groups migrated into the American Northeast and these social factors served as a means to reduce male competition and aggression within groups following warfare and migration (Bruhns 2006; Prezzano 1997).

Regardless of the reasons behind the formation of this social structure, female relationships constituted the social fabric of Iroquoian societies (Noel 2011). Property, titles, and names were inherited through these female networks within clans, thus reinforcing the importance of women (Noel 2011). There exists some scholarly debate over the extent of the economic and political function of women, as Tooker (1984) and Rosaldo and Lamphere (1974) argued that Iroquoian societies were not truly matrilineal entities with women in positions of considerable political influence. However, recent research, with contributions from indigenous scholars, as well as the fields of women's studies, anthropology, and archaeology have revealed that the system of gender among the Iroquoians was that of gender reciprocity in which the economic and political function of both men and women was equally important (Mann 2000; Noel 2011; Vicks 2009; Venables 2010).

Historical and indigenous scholarship emphasized gendered patterns of space and activity (Venables 2010). There was a division of labor and gendered space among the Iroquoians, with men and women having different yet equally important economic functions. This dichotomy, known as "The Clearings" and "The Woods", was constituted in everyday subsistence activities as well as the distribution of resources in Iroquoian groups (Venables 2010). In "The Clearings" women were responsible for cultivation of maize, beans, and squash, craft production of clothing, pottery, and other items, gathering wild plant foods, raising children, and distributing food and material wealth among individuals in the longhouses (Brown 1970; Noel 2011; Venables 2010). Women produced pottery, and this was likely a commodity traded among women in the domestic sphere (Martelle 1999). Resource distribution was important, both economically and politically, which reinforced the importance of women (Brown 1970). "The Woods" was the area of male interaction, with males responsible for hunting, long distance trade, warfare, and political activities that took them away from the village (Venables 2010). The notion of gendered categories, space, and activities was fluid; for example, men participated in some subsistence activities related to horticulture, and women often accompanied men on hunting or trading expeditions (Trigger 1990). Archaeological analyses of households reinforced this idea, as they revealed that the household was not a purely female space. Evidence of lithic production in Iroquoian households indicated that male productive activities, as well as women's activities, took place within the longhouses and villages (Allen 2010).

Political authority was distributed among both men and women. Ethnographic sources report that elders held the highest positions of authority (Fenton 1998; Noel 2011). Women, as resource distributors, had political functions of high importance. Food surpluses, prestige items, and supplies for warfare were considered to be the wealth of a village or group and women had control of the distribution of these items, including gifting during political negotiation (Brown 1970). Women also supplied warriors in times of warfare, and their refusal to do so could prevent conflict (Brown 1970; Noel 2011). Women held their own councils, with important issues raised to the men by the clan mother or an elected representative (Noel 2011). Councils of women were present at political negotiations as well (Noel 2011). Men held the formal political offices, however, in the form of peace chiefs and war chiefs. Peace chiefs were responsible for hosting visitors and diplomats, trade, exacting tribute and local efforts such as rituals, feasts, construction of palisades, and community projects (Fenton 1998; Trigger, 1990). War chiefs were responsible for organizing warfare and raiding parties, disposal of prisoners and slaying of witches (Fenton 1998; Trigger 1990). The peace and war chiefs did not generally make decisions regarding warfare and diplomacy alone, as consensus among male and female councils was necessary (Fenton 1998; Noel 2011; Trigger 1990). While it may seem that women's and men's political authority was unequal, this was not the case. Balance of power was achieved as female elders had the authority to depose chiefs who wielded too much power and to promote male chiefs (Fenton 1998; Noel 2011). Women's political clout should not be underestimated, as resource distribution was highly important for political negotiations and warfare, and the presence of women at peace and war negotiations speaks towards the balance of political power between men and women in Iroquoian societies (Mann 2000; Noel 2011).

#### 3.4.1.3 Iroquoian Mortuary Practices

A variety of mortuary practices have been noted but predominantly are associated with the Iroquoians after European contact (Engelbrecht 2003:59-60). Jesuits recounted that the Huron and Iroquoians of southern Ontario used ossuaries, in which individuals were interred together in secondary graves (Sagard 1636:205-210). Sagard (1636:205-212) described the Huron burial ritual where individuals, once deceased, were wrapped in a shroud and placed on a scaffold with burial items such as tomahawks, kettles, and other personal belongings. Every 10 years there was a re-burial ceremony in which the bones of the deceased were removed from scaffolds and placed in a collective ossuary in a ceremony known as the Feast of the Dead (Sagard 1636: 211-212). There were ossuaries in southern Ontario, such as the Fairty site, that pre-date contact, so it is unlikely that this phenomenon resulted from the arrival of Europeans (Pfeiffer and Fairgrieve 1994). There was very little evidence for burial for the New York state Iroquois prior to the late 16$^{th}$ century, and it is likely that individuals were buried far away from village sites in individual contexts prior to this period (Engelbrecht 2003:67). Most of the data regarding New York Iroquoian burial practices came from Seneca cemeteries, in which men, women, and children were placed in either multiple or single graves in a flexed position, with the exception of infants who were buried in the extended position (Wray et al. 1987).

Grave goods were common in Iroquoian burials among the New York State Iroquoians, but were not found in high frequencies in pre-contact ossuaries in Ontario and western New York (Cannon 2005; Pfeiffer and Fairgrieve 1994; Wray et al. 1987, 1991). Among the Seneca, males were more likely to be buried with grave goods than females (Wray et al. 1987: 175). Adult males were most frequently associated with pipes and tools such as awls, knives, axes, stone celts, and whetstones (Wray et al. 1987). Males were associated with fewer ornamental objects than women; the ornamental objects in male burials tended to be brass or shell beads. Very few males were associated with high numbers of shell artifacts, and it was suggested by Wray et al. (1987, 1991) that these individuals had high status as shell was considered to be a prestige item. Female graves were associated with high frequencies of items or personal ornamentation such as shell beads, antler combs, and after contact, glass beads (Wray et al. 1987: 178; Wray et al. 1991: 175). The graves of children and adolescents contained large quantities of glass/shell beads, brass spirals, shell pendants, and pottery (Wray et al. 1987: 176). The pattern of female burials with fewer and less varied grave goods than male burials among the Seneca was interpreted by Sempowski (1987) as evidence that women were not given as high a status in Iroquoian societies. It was noted by Ritchie (1954) that the function of grave goods in Iroquoian burials was not to mark status or importance of an individual, but these items played an important role in dream guessing rituals associated with mortuary ceremonies. This hypothesis was supported by Sagard's (1636: 172) accounts in which he observed that grave goods accompanying the dead among the Huron were viewed as having a spiritual essence in which the items served the dead in the afterlife.

#### 3.4.1.4 Population Health

Social information was also deduced from skeletal analyses from Iroquoian sites, particularly in relation to violent trauma and the spread of conflict prior to the formation of the League of the Iroquois (Engelbrecht 2003). Several males from Owasco sites had arrow points embedded in bone, linking trends with widespread conflict with the period in which population aggregation and village coalitions began to occur in southern Ontario (Birch 2012; Engelbrecht 2003: 39). Historic period Iroquoians favored scalping, and human skull trophies were discovered in Seneca burial sites (Wray et al. 1987:45-46). Evidence of cannibalism was present in post-contact Seneca burials, though was not noted in earlier periods (Wray et al. 1987: 28-33; 186-191; Wray et al. 1991: 207-209). Few cases of trauma were indicated for late 16$^{th}$ century Seneca burial sites though fibular dislocation, healed cranial depression fractures, healed parry fractures, comminuted fractures of the radius and clavicle, and hematomas were identified (Wray et al. 1987: 28-33, 186-191). Rates of trauma in pre-contact ossuaries are also low, with evidence of accidental injury rather than violent trauma. For example, at the Fairty site 11 healed limb fractures were identified from 295 individuals, with no injuries attributable to interpersonal conflict (Pfeiffer and Fairgrieve 1994: 54). This pattern does not mean that violent injury did not occur as differential preservation from secondary ossuary burials may play a role in observed rates of trauma.

Dental pathologies have been reported in detail for Ontario ossuaries (Patterson 1984; Pfeiffer and Fairgrieve 1994). It has been suggested that dental caries increased with time and this increase was associated with the adoption of maize into the diet (Patterson 1984; Pfeiffer and Fairgrieve 1994). For example, at the pre-contact ossuaries of Glen Williams and Fairty, the percentage of teeth affected by caries was 22.4% and 28% respectively (Pfeiffer and Fairgrieve 1994:56). Abscesses were not observed to increase after the adoption of maize in Ontario ossuaries; at Glen Williams 8.4% of teeth were affected (Patterson 1984; Pfeiffer and Fairgrieve 1994:57). At Seneca burial sites, rates of caries were extremely high; for example, the individual caries frequency at the Adams site was 84.2% (Wray et al. 1987:28). Advanced periodontal disease, correlated with antemortem tooth loss, was recorded for the Adams and Culbertson sites (Wray et al. 1987).

Along with dental pathologies, non-specific stress lesions were observed in both Ontario ossuaries and Seneca cemeteries, with cribra orbitalia more prevalent in subadults; this lesion was recorded for 38% of Fairty's subadults, with an overall prevalence of 19.6% of individuals (Pfeiffer and Fairgreive 1994:55; Wray et al. 1987: 186-191). Enamel hypoplasias were recorded in high frequencies in both ossuaries and Seneca cemeteries, such as at the Glen Williams ossuary where 57.7% of teeth were affected (Pfeiffer and Fairgrieve 1994: 57; Wray et al. 1987:30). Five cases of spinal osteoarthritis were observed at the Seneca Culbertson cemetery (Wray et al. 1987:189)

Periostitis was the most frequently reported infectious disease response recorded for Iroquoians (Pfeiffer and Fairgrieve 1994:53). Adults in pre-contact ossuaries had extremely high frequencies of periostitis, such as at the Fairty site where 100% of adults show periosteal bone reaction of the right tibia (Pfeiffer and Fairgrieve 1994: 53). Severe inflammatory processes, predominantly on the tibia, were noted by Wray et al (1987:30) for the late 16$^{th}$ century sites of Adams and Culbertson, and the authors suggested that these could have resulted from periostitis, treponemal infections, or osteomyelitis. Inflammatory responses on the tibia, known as "saber shin" deformity, were associated with treponemal infections, notably syphilis (Baker 2005). Evidence of treponemal disease was reported by Baker (2005) for pre-Iroquoian and Iroquoian pre-contact sites in Ontario and New York, with at least four probable cases recorded for Seneca burial sites (Baker 2005: 64-68, 70-71; Wray et al. 1987:28-31; Wray et al. 1991:28-32). These lesions included periosteal reactions of the limb bones as well as cranial cavitations (Baker 2005: 71). All cases were confined to adults and there are no definitive lesions for congenital syphilis recorded in the Northeast prior to European contact (Baker 2005). Tuberculosis was recorded in Iroquoian collections dating to after 1400AD (Pfeiffer and Fairgrieve 1994:53). Cases of Pott's deformity, a lesion associated with vertebral tuberculosis, were observed in skeletal collections from pre-contact Fairty and Glen Williams and periosteal rib lesions were also noted on remains from Glen Williams (Pfeiffer 1991; Pfeiffer and Fairgrieve 1994:53). Tuberculosis lesions were not recorded among the Seneca burial sites evaluated by Wray et al. (1987, 1991).

Samples from northeastern North America were evaluated for maxillary sinusitis, which was considered to be a general indicator of respiratory disease caused by pathogens or poor air quality (Merrett and Pfeiffer 2000;

Roberts 2007). Several samples from northeastern North America were evaluated for this lesion, including the $15^{th}$ century Uxbridge ossuary from Ontario (Merrett and Pfeiffer 2000), as well as sites such as the pre-contact Moatfield ossuary from Ontario (Roberts 2007:796). Merrett and Pfeiffer (2000:307-311) noted that 49.8% of Uxbridge maxillae observed (MNI = 207, 114 adults, 22 adolescents, 38 children, 33 infants) had lesions consistent with maxillary sinusitis, with increasing cases with age. Maxillary remodeling was more common in adolescents and children, though cases of sinusitis in adults were often observed in conjunction with alveolar abscessing, especially in adults in the 50+ age category (Merrett and Pfeiffer 2000:311). The authors concluded that crowded conditions in longhouses with long exposure to wood-smoke had an adverse effect on the general quality of life and respiratory health, which may have increased susceptibility to respiratory pathogens such as tuberculosis. This conclusion was supported by the presence of tuberculosis lesions of the spine and ribs in the Uxbridge sample (Merrett and Pfeiffer 2000: 315).

Roberts (2007:797) observed similar rates of sinusitis among the Moatfield group. She (2007:799) concluded that populations who practiced a hunter-gatherer lifestyle had significantly lower rates of sinusitis than agricultural populations. Across nearly all sites examined, the rates of sinusitis were higher for females than males, for example at the Moatfield ossuary in Ontario, 92.9% of females and 62.5% of males had maxillary sinusitis lesions (Roberts 2007: 799). Roberts (2007:802 – 804) concluded that populations such as the Iroquoians and Fort Ancient people of the Late Prehistoric period in North American lived in crowded conditions in villages and were exposed to poorer air quality and more contaminants than earlier hunter-gatherer groups. She (2007:802 – 804) argued that the higher rates females likely spent more time indoors exposed to wood smoke than males or performing agricultural activities associated with poor air quality.

### 3.4.2 The Monongahela

In contrast to Iroquoians, there is comparatively less information in the literature regarding the Monongahela tradition in the absence of historical accounts. The Monongahela culture of the Late Woodland and Protohistoric periods spanned the majority of southwestern Pennsylvania, southeastern Ohio and portions of West Virginia. The cultural tradition is dated to approximately 900 AD with the intensification of maize horticulture in this region to 1635AD when evidence of the culture disappeared from the regional landscape (Johnson 2001). Johnson (2001) identified three key time periods for the Monongahela based upon shifts in pottery technology and settlement pattern (Table 2). The demise of the Monongahela during the Protohistoric period has been attributed to the interplay between the spread of European disease, the effect of the Little Ice Age on maize horticulture, and Seneca forays into Monongahela territory (Richardson et al. 2002). The Little Ice Age was a period of cooling spanning the period from 1400AD to 1900 AD during which global temperatures decreased, along with the number of frost-free days (Richardson et al. 2002). The Ohio Valley region was affected by severe droughts during this period. Monongahela settlements became more fortified, with a preference for upland villages, situated to protect crops from wind vectors during early spring and late fall frosts (Richardson et al. 2002). By the Late Monongahela phase, territory had decreased from a wide area covering western Pennsylvania and portions of West Virginia, Maryland and Ohio to just a few counties in western Pennsylvania (Figure 16).

**Table 2:** Dates for Monongahela time periods

| Time Period | Dates |
|---|---|
| Early Monongahela | 1100-1250AD |
| Middle Monongahela | 1250-1580AD |
| Late Monongahela | 1580-1635AD |

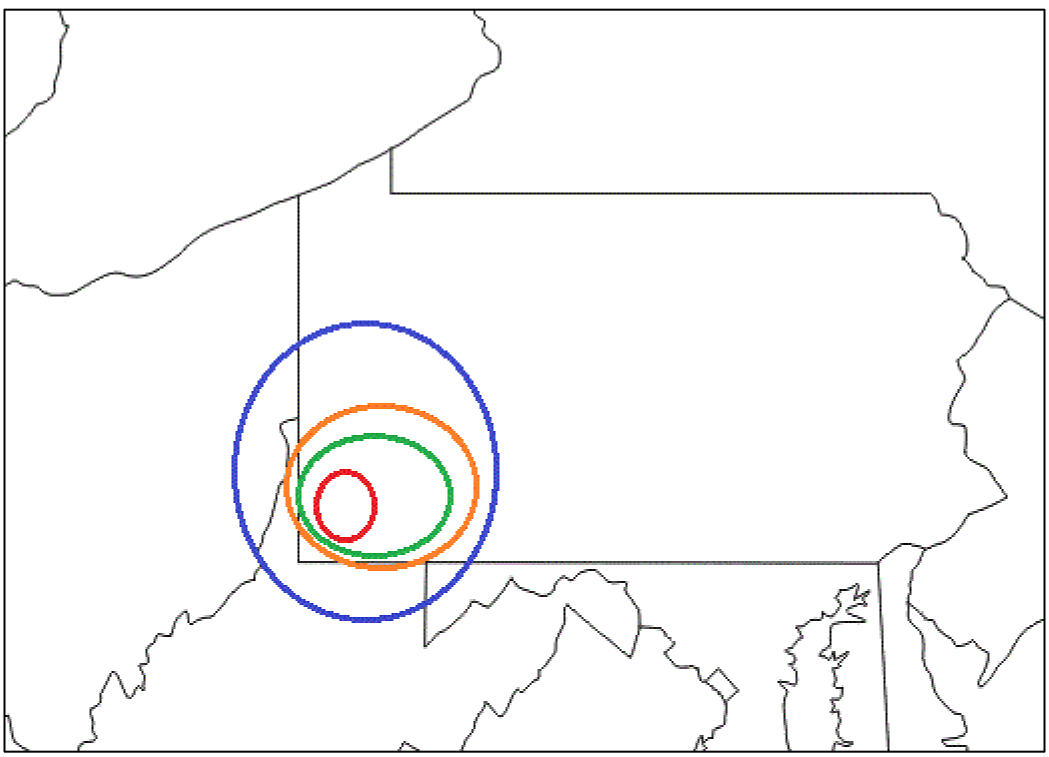


**Figure 16**: Monongahela territory map, Early through Protohistoric periods

### 3.4.2.1 Defining the Monongahela Tradition

First defined by Mary Butler (1939), the Monongahela “culture” was identified from several sites from Somerset County, Pennsylvania in conjunction with relief excavations. Prior to the 1930’s excavations, it was debated whether or not the southwestern Pennsylvania region had significant aboriginal occupation throughout prehistory (Means 2007a). Butler (1939) described three sites: Montague, Clouse, and Hanna. The original definition described the Monongahela as a cultural phenomenon delineated by prehistoric palisaded village sites with houses arranged in a circular fashion with commonalities in pottery type. Subsequent redefinitions of this sequence were published by Mayer-Oaks (1955), George (1974), Hart (1993) and Johnson (2001). Mayer-Oaks (1955) examined the technological aspects of the Monongahela tradition; pottery was described as round bottomed vessels, both grit and shell tempered, with cord marked exteriors. George (1974) expanded the definition of Monongahela settlement patterns as including sites in West Virginia, Ohio, and portions of Maryland with a preference for upland locations along known trade routes. It was argued that upland locations for settlements indicated a need for defensive positioning due to conflict (George 1974). Hart (1993) suggested that the settlement pattern was suggestive of a system of trade and interaction between large villages and small habitation sites, between which subsistence items and trade goods were exchanged.

The most detailed and widely used schematic for defining Monongahela culture is that proposed by Johnson (2001). Johnson (2001) described the geographical distribution of the Monongahela culture as occupying the portion of the unglaciated Allegheny Plateau, confined to areas of the Upper Ohio Valley region that are characterized by having an average growing season of 140 or more frost free days. The most distinctive feature of the culture was the settlement pattern; this is characterized by series of villages, hamlets, and isolated farmsteads occupying upland, river bluffs and hilltops (Johnson 2001). While previous literature argued for the presence of villages in upland locations for defensive reasons (George 1974, 1975, 1978, 1983; Mayer-Oaks 1955), Johnson (2001) suggested that this positioning was for deliberate economic reasons as the soils in upland regions of Pennsylvania are known to be highly productive for agriculture.

More specifically, Johnson (2001) divided the Monongahela culture into three distinct phases (See Table 3.2 for dates): Early, Middle and Late. Early Monongahela phase sites were defined by limestone and shell tempered pottery with Z-twist cordage impressions. Houses during this period were circular or oval shaped and ranged from 5 to 9 meters in diameter (George 1974, 1978, 1983; Herbstritt 1981; Johnson 2001). Storage facilities generally were subterranean, roofed structured occurring randomly in the circular confines of village space or connected to houses (Johnson 2001). The mortuary program for the Early phase was define by infants and young children buried in house floors while adults were in flexed burials between village houses and palisades. Grave inclusions were rare, but when they occurred they primarily consisted of items of personal adornment such as beads (Davis 1984). The Middle Monongahela period was defined by abandonment of peripheral territories and community consolidation into larger villages (Johnson 2001). A key development during the Middle phase was the appearance of “petal” like extensions to houses which may have functioned as storage facilities, sweat lodges, or community ceremonial centers

(Anderson 2002; Herbstritt 1984). The Late period was characterized by dramatic decrease in territory and retreat into the Monongahela core area. During this phase, mortuary behavior shifted; charnel houses were identified at the Sony and Household sites at the transition of the Middle and Late Monongahela periods (Johnson 2001).

Central debates in defining the Monongahela phenomenon are whether or not these collections of sites represented a single, defined archaeological “culture” and if this phenomenon was culturally or linguistically linked to any other known group (Johnson 2001; Means 1999, 2007a). Means (2007a) argued that the use of the Monongahela culture taxon leads to an overgeneralization of the similarities between community organization at Monongahela sites and a suppression of the variation that exists geographically and temporally for the Monongahela sequence as a whole (Hart 1993; Means 2003). Means (2007a) thus defined the Monongahela as a “tradition” rather than a culture to address the variability in settlement location, village structure, and community organization that occurred through time.

Several authors made cases for linguistic-cultural affiliations with other known groups (George 1994; Johnson 2001; Richardson and Swauger 1996; Swauger 1974). Swauger (1974) noted that petroglyphs were widespread throughout the Ohio Valley, and these were stylistically similar to Central Algonquin rock art and later Midewiwin, birch bark scrolls by the nineteenth century Ojibwe. Petroglyphs were made by pecking and rubbing rock surfaces. Common features of Ohio Valley rock art contemporaneous with the Monongahela included animalistic designs with spirit bands, heart lines, and power projections (Swauger 1974). Strikingly similar designs were found on later Ojibwe birch bark scrolls. Swauger (1974) suggested that these connections in art forms were evidence of a shared religious/linguistic tradition between the Monongahela and Algonquin speaking groups. It was further argued that the Monongahela represented a proto-Algonquin group based on these religious artworks. Weeks (2002) posited that the Monongahela petroglyphs were teaching rocks to protect sacred knowledge, and other symbols may have been boundary markers. George (1994) echoed an Algonquin cultural linguistic affiliation, noting the same similarities in petroglyphs and Ojibwe birch bark scrolls. Restored body sherds from pottery at the Monongahela Gnagey site also exhibited similarities in the form of incised winged creatures with Algonquian designs (George 1994). These observations make a convincing argument for a cultural connection between Monongahela, as rock-art is an artifact of place, as it remains a part of the landscape where it was made and used, and is thus one of the most reliable artifacts to track the movement of people and ideas throughout the landscape (Weeks 2002).

Conversely, Johnson (2001) stated that the Monongahela were culturally and linguistically tied to the Iroquoians, particularly southern Iroquoians such as the Susquehannock. This hypothesis is based on the presence of Iroquoian type goods at Monongahela sites during the Late Monongahela phase and possible historic references to Monongahela migrations into Susquehannock region following 1635AD (Johnson 2001: 76-82). Bulbous, low to medium-high collared Iroquoian style pottery vessels with horizontal incised marks were found in low frequencies at Late Monongahela phase sites. Pedestaled vessels similar to those recovered at Huron and Neutral Iroquoian sites were also discovered at the Late phase Foley Farm site in western Pennsylvania (Johnson 2001). The majority of Monongahela pottery vessels, however, were shell-tempered coil constructed cord-marked vessels, inherently different from Iroquoian style and construction (Mayer-Oaks 1955). Copper, glass, and shell items similar to those found at Iroquoian sites also made up part of the Late Monongahela artifact assemblage such as beaver copper effigies like those from Seneca villages and the Oneida Cameron site. Copper spirals similar to those found at the Seneca Cameron, Dutch Hollow and Factory Hollow sites were also part of the Late Monongahela artifact assemblage in low frequencies along with blue glass beads commonly found at Seneca and Neutral Iroquoian sites (Johnson 2001: 76-78). Isolated numbers of Iroquoian style shell whelk spirals and acorn shaped pipes were also discovered at Late Monongahela phase sites (Johnson 2001). Johnson (2001:80) suggests that at the time of the Monongahela demise (1635AD), remaining people were dispersed by Seneca raiding in the Ohio Valley region, as supported by Dutch historical accounts. Johnson (2001) argued that this dispersed group is the Black Minqua or Massawomeck, referred to by Dutch and Swedish historical accounts. This group was associated with the lower Susquehannock in the 1640’s and 1650’s, evidenced archaeologically by an influx of non-Susquehannock cordmarked ceramics (Johnson 2001: 81). While Johnson argues that this is evidence for cultural affiliation, low frequencies of Iroquoian artifact types in Monongahela sites could be the result of trade networks. It is important to stress that the cultural-linguistic affiliation question may not be entirely resolved, as the Monongahela tradition represents an archaeologically defined group rather than a historically known culture (Means 1999, 2007a).

#### 3.4.2.2 Subsistence and Settlement

Means (2007a) extensively modeled the nature of settlement and community organization among the Monongahela. Settlement patterns consisted of ring shaped villages constructed around a central plaza or post, which served as an *axis mundi* around which village organization and activities were centered (Means 2002, 2007a). These nucleated settlements were mostly fortified by wooden palisades indicating the need for defense, and were commonly located in uplands away from river valleys (Hart 1993). House structures consisted of rounded huts and these structures predominated Monongahela villages until late in the cultural sequence, when after 1580AD, structures with teardrop or “petal shaped” appendages appeared, which may have functioned as sweat lodges, council houses, or community ceremonial centers (Anderson 2002; Herbstritt 1984). Anderson (2002) argued that the “petal shaped” appendage structures at late sequence Monongahela sites such as Sony and Household were community centers for ritual and ceremony. At the Sony site community centers atypical faunal assemblages were discovered such as the remains of poisonous snakes, snapping turtles, and birds of prey (Davis and Wilkes 1997). . These rare faunal assemblages indicated a ceremonial or ritual context in which the animals were utilized as part of feasting activities or part of the ritual “toolkit” (Anderson 2002).

Community organization as modeled by Means (2007a,b) was defined as a system of formally linked households via kinship or corporate group identities. In this scheme, small groups of households organized spatially in villages in clusters represented multi-family dwellings, whereas larger dwelling clusters represented broadly defined clan identity. Households were thus the basic unit of social interaction among the Monongahela. There was little to no evidence for dual organization at Monongahela village sites, though Means (2007a) stressed these types of sodalities and emergent leaders could have left few tangible material correlates. Patterns of social organization for the Monongahela thus cannot be divorced from patterns of community organization in terms of the negotiation of physical space (Means 1999). Villages were not merely spaces for dwelling, but rather areas that dictated the regulation of private vs. communal performance (Means 1999; 2007a). The arrangement of palisades, households, plazas, and middens were all orchestrated by socially conditioned concepts of private and communal space through which household, leadership, and ritual activities interacted (Means 2007a). This pattern differs from Iroquoian style settlement, as the multi-family dwelling longhouse was the primary unit of social organization rather than clusters of small houses (Birch 2015).

Subsistence was characterized by intensive maize horticulture, evidenced by a preponderance of maize at Monongahela village sites as well as high $\delta^{13}C$ levels in Monongahela burials, which indicated that maize constituted 50-70% of the Monongahela diet (Greenley 2006; Johnson 2001; McConaughy 2008; Sciulli 1995). Squash and beans supplemented the diet as well as deer and wild game (Johnson 2001). High rates of dental pathologies as reported by Sciulli (2002) are reflective of this dietary pattern as maize is a highly cariogenic food source.

#### 3.4.2.3 Material Culture

Material culture mainly consisted of pottery, lithics, and items of personal adornment discovered in burials and middens (Johnson 2001). Monongahela pottery was characterized primarily by small coil constructed globular shaped jars, which were shell tempered and cordmarked, with fluted rims (Mayer-Oaks 1955; Means 2005). A small proportion of Monongahela ceramics were limestone grit tempered (Mayer-Oaks 1955). Monongahela lithics were small triangular points, such as the Scarem arrow point (Johnson 2001). Trends in lithic production among the Monongahela indicate that projectile points became smaller over time throughout the cultural sequence (George and Scaglion 1992). Other aspects of material culture among the Monongahela included trade shell earspools, bone and shell beads, clay pipes, native copper animal effigies, and in Protohistoric/Contact era burials, glass beads (Davis 1984; Johnson 2001; Anderson 2002).

#### 3.4.2.4 Mortuary Pattern

Bioarchaeological analyses of Monongahela burials are limited (Anderson 2002). The general mortuary program for the Monongahela consisted of child and infant burials in house floors, with adults interred in village spaces along palisades (Anderson 2002; Johnson 2001). Davis' (1984) analysis of 684 burials from 66 sites revealed that social ranking may have been an aspect of Monongahela societies, as evidenced from the higher distribution of grave goods associated with personal clothing decoration in at least 15 burials. This analysis did not examine the effect of the introduction of trade goods on the social structure of the Monongahela, though it was argued that the presence of artifacts in only a small percentage of burials was an indication of ranking (Anderson 2002; Davis 1984). Means (1999, 2007a,b) argued that the presence of a small percentage of "status" burials with a large number of shells or beads did not indicate a strictly stratified society, as even in egalitarian societies individuals can achieve high personal status through actions of war or ritual. Such positions, as economic leader of a corporate group or shaman, may not be full-time occupations and may disappear with the death of the individual (Means 1999). The interpretation of grave “furniture” in this respect should thus not be tied simply to the presence or absence of goods, but also to the utilitarian properties of the objects themselves; many artifact classes in Monongahela burials fit under “mundane” usage such as simple pottery and lithics.

Clark (2014) analyzed status and gender among the Monongahela via mortuary analysis; body position, head orientation, grave good distributions, and sex were examined. He identified several sex specific artifact classes. Males were associated with drills, lithic points, snail shells, and whole marine shells whereas females were associated with shell pendants, beads, disks and ceramic chain production items. Sex specific artifacts were associated with subadult burials at different age rages; female specific artifact classes were found in infant and child burials, whereas male specific classes were not identified in burial contexts associated with individuals younger than adolescence (Clark 2014).

Ritual associated burial items, such as snail shells and marine shells, increased in number from the Early, Middle and Late Periods (Clark 2014). It was suggested by Anderson (2002) that shifts in mortuary ceremonialism in the Protohistoric period, with the inclusion of charnel houses at two Monongahela sites, along with shifts in mortuary processing of remains and the higher incidence of European trade items recovered from villages suggests a system of emergent elites in the Late Monongahela phase. Large central hearth features often accompanied charnel houses. At the Household site, 16 burials (included in the current study sample) were recovered from large charnel house featuring a central hearth. At the Sony site, where 24 burials were recovered from a charnel house, burials following the typical pattern with children in house floors and adults in flexed village burials were also uncovered. Anderson (2002) argued that the presence of charnel houses indicates a unique social ranking system in which emergent elites were given specialized treatment in death. The construction of building burial structures and coordinating associated feasting events would have required significant effort and organization on the part of the community (Anderson 2002).

#### 3.4.2.5 Population Health

Studies of Monongahela skeletal remains have revealed some information regarding the general health and distribution of disease among these populations (Sciulli 2002). Degenerative joint disease (DJD) was prevalent in the vertebral column, shoulder joint, elbow and knee among the Monongahela, with a sharp rise in cases in individuals over 35 years of age, with the percentage of young adults with DJD at 23.6%, adults aged 35-45 at 82.4%, and adults aged 45+ at 80% (Sciulli 2002:44). Sciulli interpreted this as evidence for a relatively high workload among the Monongahela, but these results should be viewed with caution as osteoarthritis has a complex etiology involving genetics, aging, weight, and activity (Weiss and Jurmain 2007). Healed fractures of the cranium, nasal area, radius, ulna, fibula, and clavicle were observed as well as several cases of shoulder dislocation (Sciulli 2002). One case of cutmarks was observed on the skull of a subadult, though it is possible that these were the result of perimortem mortuary processing rather than violent trauma (Sciulli 2002). While these incidences of trauma were observed, frequencies were relatively low among the Monongahela, similar to other Late Woodland populations. For example, rates of trauma for the Monongahela were broken down in terms of individual prevalence for the following regions by Sciulli (2002:46): arm (4.8%), leg (2.6%), nasal (2.4%), face (2.2%), and skull (3.5%). Rates of dental pathologies such as caries, antemortem tooth loss, and periapical abscesses were high among the Monongahela; this phenomenon is consistent with maize reliant cultures as maize is a highly cariogenic food source (Sciulli 2002). Rates of linear enamel hypoplasias were lower among the Monongahela than in other contemporary populations (Sciulli 2002). Cribra orbitalia, porotic hyperostosis and generalized osseous infections such as periostitis were more common in subadults than adults among the Monongahela (Sciulli 2002). Only two cases of specific infection were noted: one case of Pott's deformity in a young adult female from the Bunola site indicating tuberculosis (Krill and Siegel 1978) and a hydatid cyst in a subadult from the Fuller's Hill site indicating canine tapeworm or echinococcosis (Sciulli 2002). Considering the rates of pathological conditions among Monongahela burials, Sciulli (2002) concluded that the Monongahela had at least adequately adapted to maize horticultural lifestyle supplemented by wild plant and animal sources, though reliance on maize as the primary food source had deleterious effects on dental health. Anderson (2002), however, remarked on the need for more detailed analyses of Monongahela skeletal remains to shed more light on the biological and social nature of these populations.

# 4.0 EUROPEAN CONTACT IN NORTHEASTERN NORTH AMERICA

The nature and consequences of contact are important features of debates regarding the role of cultural change on gendered social realities in the past (Nassaney 2004). This chapter provides a backdrop of historical and anthropological context for the relationship between biological and social landscapes of European contact in the Northeast, placing the Ohio Valley area into regional patterns of interaction. One of the key areas of inquiry in this study was to assess the impact of European contact and colonialism on indigenous groups living in the Ohio Valley region during the 18th century, specifically the Delaware tribe. This review of culture history on the eve of European contact in the Northeast outlines socio-political and geotemporal trends in the American Northeast during the colonial era, provides archaeological and historical models for the varied responses of indigenous societies to encroaching European powers, and summarizes central aspects of Delaware community history.

## 4.1 NATIVE AMERICANS ON THE EVE OF CONTACT

The separation of widespread cultural tradition into tribal polities had occurred throughout most of eastern North American by the contact period. The Ojibwa, Pottawatomi, Illinois, and Ottawa inhabited the Great Lakes region (Loren 2008). Iroquoian groups populated New York and southern Ontario: the Seneca, Mohawks, Oneida, Onondaga, Cayuga, the Neutral Iroquoians, and the Huron-Petun (Loren 2008:31-34; Warrick 2008). The Middle Atlantic region including Pennsylvania and New Jersey was home to the Lenape or Delaware, and the Susquehannocks of north central Pennsylvania (Loren 2008:32). The Monongahela disappeared from the regional landscape, with their territory reduced to only a small area of western Pennsylvania, by 1635 (Johnson 2001; Richardson et al. 2002). In present-day Canada, Maine, and New Hampshire, there were several tribal entities: the Maliseets, Passamaquoddys, Penobscots, Micmacs, Abenakis, Innus, and Beothuks (Loren 2008:30). The archeological record for the 16th century in this area is spotty, though there is more historical documentation regarding these groups after 1605 (Loren 2008: 30). To the south, in modern-day New England, were the Wompanoags, Massachusetts, Nipmucs, Pequots, Pawtuckets, and Narragansetts. The archaeological record suggested that most of these groups practiced a mixed hunting-foraging and horticultural economy with seasonal movements in groups lead by both male and female sachems, or chiefs (Loren 2008:31; Nassaney 2004). This data also suggested minimal exchange of prestige items, ritual distinctions, or monumental architecture that distinguished groups in the American Southeast (Gallivan 2004; Johnson 2001).

## 4.2 EUROPEANS IN THE NORTHEAST

There was clear evidence suggesting that the Micmacs and Beothuks had earlier contacts with small groups of Norse explorers in the 1300's, though the age of intensive European exploration of North America did not occur until the late 15th century (Loren 2008:30). Multiple European forays and explorations of northeastern North America occurred starting in 1497 with the arrival of John Cabot's English expedition in modern day Newfoundland, Labrador, and New England (Loren 2008:35). Many other expeditions by French, English, and Dutch explorers and traders followed (Loren 2008:35). The French explored present day Canada, the Great Lakes, and parts of the American Southeast. Expeditions by Cartier and Champlain throughout the St. Lawrence River established settlements and trading posts, as well as Jesuit missions, in the 16th and 17th centuries, (Champlain 1615; Lafitau 1724; Sagard 1636). This region was claimed by France as a colony known as "New France". One feature of the establishment of this colony was the fur trade, which drove the French economy in Europe (Loren 2008). The French also brought missionaries and attempted to convert indigenous populations to Catholicism, and the writings of these Jesuit priests are some of the most detailed documentation of Native American groups at the time of contact and colonization (Loren 2008; Sagard 1636). The primary justification for French colonization was religious ideology as well as economic trade, with new colonies directly under control of the French crown, unlike the colonies of the English and the Dutch (Loren 2008:40-41).

The Dutch established settlements and colonies in northeastern North American in the early 17th century, following Henry Hudson's 1609 expedition to find a Northwest Passage to Asia. Instead, this expedition landed in present-day New York, where trade relations were established with indigenous polities (Loren 2008:45). The Dutch colony of New Amsterdam was established in just a few years following Hudson's expedition, and by 1621 the colony of New Netherlands had been claimed by Dutch traders in the Delaware, Hudson, and Connecticut River Basin (Loren 2008:46). Archaeological projects at Dutch settlements indicated that the Dutch did not rely on many native industries as there were few indigenous artifacts uncovered in these contexts, though fur and pelts were important commodities (Rothschild 2003). Trade items such as glass beads and brass kettles were found in Seneca burials, indicating that the Dutch had established economic ties with Iroquoians (Wray et al. 1991).

English exploration and colonization was widespread throughout Northeastern North America following Cabot's 1497 exploration of Newfoundland and surrounding regions (Loren 2008). In 1620, the Plymouth colony was established in New England, following religious tensions in England (Loren 2008:51). The majority of English settlers were farmers and laborers, with a small percentage of upper class individuals (Loren 2008:51). Diversification in religious practices among English settlers led to the founding of other colonies such as Rhode Island, Massachusetts Bay, and Connecticut in New England by the mid-late 17th century (Lodge 1881). The English established New Jersey after they captured the New Amsterdam territory from the Dutch in 1664 (Lodge 1881). Pennsylvania was established in 1681, with its territory including only portions of present-day eastern Pennsylvania until after mid-18th century conflicts in western Pennsylvania (Lodge 1881). New York was not established as an English colony until

1685 as there were political tensions after its capture from the Dutch in 1664 (Lodge 1881). The English presence in these areas had drastic consequences with surrounding indigenous groups. Trade networks were established, however, conflict between European polities complicated the nature of Native American lifeways throughout the remainder of the 17$^{th}$ and 18$^{th}$ centuries (Loren 2008). Native groups were caught up into land wars with Europeans throughout this period as well as into conflicts between the French and English in the mid 1700's (Loren 2008). Warfare, disease, and European encroachment into Native American territory lead to the dispersal of indigenous groups, pushed westward by European settlements following the establishment of colonies (Lodge 1881; Loren 2008).

## 4.3 PHYSICAL LANDSCAPES OF CONTACT

Silliman (2005) cited contributions from bioarchaeology and archaeology in modeling contact in North American following the arrival of Europeans in the late 15$^{th}$ century. The physical and social landscapes of Native Americans were studied in relation to the impact of European contact and colonization on indigenous populations (Silliman 2005). The physical landscape associated with Native American contact with Europeans was defined by changes in environment, disease, demography, and diet (Silliman 2005). Native Americans in and of themselves were not wholly unfamiliar with human modifications to the natural environment, as many groups had domesticated wild plants and animals (Dobyns 1983; Silliman 2005). Heavy European exploration and settlement into North America after 1492 resulted in the introduction of European agricultural plants and livestock, intrusive wild plant and animal species, as well as European diseases. Demographic collapse and population loss following European epidemics occurred, having drastic effects on indigenous groups, along with the adoption of European trade goods and plant/animal products (Dobyns 1983; Silliman 2005; Warrick 2003). Additionally, European encroachment on indigenous territories caused population movements towards the interior of the northeast, especially into the Ohio Valley Region, following the arrival of Europeans (Brown et al. 2014).

### 4.3.1 Demographic Decline

The degree of the impact of European disease on indigenous population numbers has been highly debated by bioarchaeologists (Baker and Kealhofer 1996; Dobyns 1983; Hutchinson and Mitchem 2001; Ubelaker 1992). There are multiple methodological difficulties with determining the impact of European diseases. Many pathogens, such as measles and smallpox, carried by Europeans to the New World do not leave osteological markers thus rendering skeletal collections unreliable to document outbreaks of these diseases among native populations (Hutchinson and Mitchem 2001). These conditions generally tend to be acute rather than chronic infections, resulting in death before any skeletal involvement can occur (Hutchinson and Mitchem 2001). Mass mortality events such as mass burials and cremations were not observed or were not distinguishable from pre-contact mortuary ritual, though demographic analysis of skeletal assemblages may shed light on the nature of mortality (attritional vs. catastrophic) (Gowland and Chamberlain 2004; Hutchinson and Mitchem 2001). While written accounts of disease outbreaks were recorded by missionaries in the 17th century, these accounts did not describe the symptoms of diseases or the death tolls of these events, rendering this line of evidence unreliable at best (Baker 1994; Snow 1992). Thus, the best available estimates for population decline in North America were derived from demographic models (Hutchinson and Mitchem 2001).

Multiple models were suggested to illustrate the extent of demographic and population collapse following European contact among indigenous groups (Baker and Kealhofer 1996; Dobyns 1983; Ubelaker 1992). Dobyns (1983) suggested epidemic diseases resulted in extreme population decline. This “disease impact model” estimated that indigenous populations in North America prior to contact reached approximately 18 million, with a 90-95% loss of population after the rapid spread of European diseases throughout native groups (Dobyns 1983). Most scholars disagree with these figures as they overestimate the impact of population decline (Baker and Kealhofer 1996; Hutchinson and Mitchem 2001; Ubelaker 1992). Archaeological data regarding population size via settlement studies in the American Northeast showed that population decline following epidemic events did occur, but that populations can experience recovery within just a few generations and therefore the population impact of disease is not as severe as hypothesized by Dobyns in 1983 (Jones 2010). Ubelaker (1992) provided more conservative estimates of population collapse, estimating that the population of the American northeast at the beginning of the 17th century, when contact with Europeans intensified in the region, was approximately 345,700 but had shrunk to approximately 149,360 by the 18th century, a 56.8% population loss (Ubelaker 1992: 175).

This figure is substantiated by reports of population collapse among the Huron-Petun following a series of historically documented 17th century epidemics resulting from measles, influenza and smallpox; from 1636-1640 the Jesuits documented the population decreased from 30,000 individuals to 12,000 individuals, a 60% population decrease (Warrick 2003). Disease and depopulation was modeled by Jones (2010) and later by Jones and DeWitte (2012). The primary source of information regarding population estimates and percentage of population loss were derived from historical sources (Jones 2010). Jones and DeWitte (2012) utilized spatial mapping in conjunction with historical data to estimate differences in population decline between Iroquoian and Algonkian groups in northeast during the 17th century. They concluded that responses were varied; the Mohawk were significantly impacted, as they did not retain any of their ancestral territory following multiple disease epidemics whereas the Seneca, Onondaga, and Oneida experienced some population re-growth (Jones and DeWitte 2012). It was hypothesized that several factors may have either contributed to or mitigated population collapse including: multiple disease events resulting in weakened immunity, genetic resistance, and adoption of outsiders by the Haudenosaunee (Jones and DeWitte 2012). Other evidence suggestive of demographic collapse came from Iroquoian ossuaries and New England cemetery sites, where in post-contact contexts the demographic profile fit that of epidemic disease due to a large percentage of adolescents in these collections (Baker 1994; Pfeiffer and Fairgrieve 1994; Warrick 2003). Higher percentages of women were present in New England cemeteries after contact, though it is unlikely that males were less susceptible to disease and this disparity in sex distribution is likely due to male burials outside the group's settlement due to various social factors such as warfare, subsistence activity and trade (Baker 1994).

### 4.3.2 Skeletal Analysis

While European disease epidemics might not be detectable osteologically, shifts in demographic patterns as well as other factors of population health were observable in skeletal collections from the contact period (Baker 1994; Pfeiffer and Fairgrieve 1994). Analyses of skeletal collections from pre-contact and post-contact groups have revealed information regarding the presence of specific pathogens following contact (Baker 1994; Pfeiffer and Fairgrieve 1994). In pre-contact Huron ossuaries, spinal tuberculosis lesions were observed, with an increase in cases in post-contact assemblages (Pfeiffer and Fairgrieve 1994). A high number of cases of tuberculosis were also noted by Baker (1994) for New England cemeteries; at the RI1000 Narragansett cemetery in Rhode Island, 30% of individuals (17 of 56) exhibited lesions of the spine, ribs, and hip joint associated with tuberculosis (Baker 1994). In the cemetery of Ponkapoag, associated with a missionary Praying Town in Massachusetts where English Puritans assimilated indigenous individuals to Christianity, tuberculosis lesions were not reported (Baker 1994). Only 5% of cases of tuberculosis manifest with skeletal lesions, and individuals with these lesions may have been healthier than those without them as this group survived long enough with the disease for extensive lesions to form (Santos and Roberts 2006; Wood et al. 1992).

Treponematoses were not observed for the Huron ossuaries by Pfeiffer and Fairgrieve (1994) but one possible case with cranial lesions was recorded by Baker (2005) at the Narragansett cemetery RI1000. Other post-contact cases of treponematoses were observed among Seneca sites, though none of the cases in the Northeast either prior to or post-contact have indicated congenital syphilis (Baker 2005).

Evidence of non-specific infection in the form of periostitis was noted by Pfeiffer and Fairgrieve (1994) for Huron ossuaries, with no increase in frequency from pre-contact sites; these conditions were not reported for New England cemeteries except in two isolated cases (Baker 1994). It was suggested that lesions were more advanced in late contact period ossuaries, suggesting that contact may have had an impact on general population health (Pfeiffer and Fairgrieve 1994). Other stress lesions such as cribra orbitalia and enamel hypoplasia were observed among the Iroquoian samples. The pattern remains unclear as to the extent that contact played upon physiological stress in these populations as cribra orbitalia was reported in higher frequencies at pre-contact sites and rates of enamel hypoplasias increased after contact (Pfeiffer and Fairgrieve 1994).

Dental disease frequencies also increased among contact era Iroquoians, though whether or not this trend was exacerbated by contact was debated (Pfeiffer and Fairgrieve 1994:56). For example, the rates of dental caries in pre-contact ossuaries such as Fairty and Glen Williams were 28% and 22.4% respectively, but at the post-contact ossuary at Kleinberg the rate increased to 40.6% of teeth affected (Pfeiffer and Fairgrieve 1994:56). Among the New

England indigenous groups of the post-contact period, there was a high rate of caries (77.4% of individuals, 32.9% of teeth affected) noted for one cemetery, RI1000, associated with the Narragansetts and this was attributed to the increased consumption of flour and sugar introduced by Europeans into the indigenous diet after the establishment of colonies in the region (Baker 1994:42). This pattern is not evident for all New England collections, where dental disease rates were low especially in the Praying Towns associated with native assimilation to Christianity, such as at Ponkapoag where the individual caries rate was 11.1% (Baker 1994). This trend was explained by the possibility that native groups still preserved their own native subsistence practices after settlement in Praying Towns and that the impact of acculturation on some groups did not have deleterious effects on health (Baker 1994).

Evidence of interpersonal violence was present in pre-contact Huron ossuaries, but higher frequencies of traumatic lesions associated with violence were recorded for post-contact sites, such as at the Uxbridge ossuary where 6 cranial wounds, 22 infracranial fractures, and 21 vertebral compression fractures were identified in a sample of 457 individuals (Pfeiffer and Fairgrieve 1994:54). Some of these lesions, though it was not stated which specifically, were associated with interpersonal violence indicating that conflict increased among Iroquoians following the arrival of Europeans (Pfeiffer and Fairgrieve 1994:54). Baker (1994) noted that only two cases of vertebral trauma are suggestive of violence in New England contact assemblages, whereas other isolated cases of trauma are indicative of falls or accidents.

## 4.4 SOCIAL LANDSCAPES OF CONTACT

The social landscape of contact was characterized by a variety of contexts ranging from indirect trade networks to direct colonization (Silliman 2005). One of the most salient features of this social interaction landscape was the trade and exchange of physical objects. These networks were documented not only through bioarchaeological investigations from burials, but also historical records written by Europeans about existing trade relationships with native peoples (Silliman 2005). The introductions of “prestige items” such as glass beads and brass objects into indigenous trade network lead to drastic alterations of the social and political structure of these societies, especially in relation to gender and social status (Anderson 2002; Nassaney 1989; Rubertone 2001).

### 4.4.1 Shifts in Mortuary Patterns

Shifts in mortuary practices in the Northeast have been one means of examining the social dynamics of European contact in the region, along with trends in subsistence, settlement, and trade relations (Anderson 2002; Ferris 2009; Nassaney 1989; Panich 2013). This was primarily within the social changes associated with the spread of European trade goods throughout Native American networks and the associated alterations in mortuary practices and implications of these for social status within indigenous groups (Silliman 2005). Native American groups may have valued trade items more for their social importance rather than functional or utilitarian properties, as prestige and social status can be tied to the accumulation of goods associated with wealth (Silliman 2005). According to Silliman (2005:290), "Native Americans negotiated cultural traditions whenever they incorporated particular European items into fashion and ethnic identity. Individuals may have made, used, traded, or displayed items as a way of materializing their identities." Changes also appeared in iconography in Native American art in the northeast as a result of contact, such as in Iroquoian and Algonkian clothing design with the integration of European motifs (Richardson 1977:113-114). Shifts in burial practices and emergence of elites may be detectable archaeologically prior to direct contact, but studies demonstrated a degree of continuity in social and economic practices among native groups even into the 18th century in northeastern North America (Anderson 2002; Nassaney 1989; Scott 1991).

#### 4.4.1.1 The Narragansett

The Narragansett skeletal series was one example of the types of analyses that integrated both "biological status" and "social status" to answer questions regarding the impact of contact and colonialism on existing power dynamics among indigenous groups (Nassaney 2004). Nassaney (1989) examined the inclusion of European items in Native American mortuary contexts in the northeast in a 17th century Narragansett cemetery, RI 1000. This cemetery was dated to the period between ~1630 and 1670 AD. Having maintained contact with Europeans since at least 1620, the Narragansetts were an example of sustained contact between Europeans and native groups given their proximity to the English in Plymouth Colony (Nassaney 1989). RI1000 was a partially disturbed burial ground in which 56 individuals were buried in single inhumations. These individuals were placed in a flexed position, facing east, with the tops of their heads oriented southwest. Associated grave goods were usually found to the east of the individual near the torso (Nassaney 1989).

Nassaney (2004) argued that these individuals represented Native entrepreneurs using imported European material items as grave goods as a marker of symbolic status and inequalities within Narragansett societies. These inequalities appeared to be tied to gender, as females were typically buried with artifacts such as hoes, pestles and brass kettles, whereas men were typically buried with knives, clay pipes, gun parts, and most notably, wampum (small worked shell beads). The exception to this general pattern was younger adolescent females who were often accompanied by a wealth of goods, and it was suggested that this was a recognition of their loss to society (Nassaney 2004). It was important to emphasize that there was an abnormal distribution of males and females at this site with very few male burials; it was likely that males were buried elsewhere given involvement in conflict or trade, were not recovered in excavations, or were not interred at all (Baker 1994). Along with shifts in the distribution of burial artifacts, there remained continuity in burial practice with one standardized burial type: single inhumations with individuals in a flexed position, oriented in a southwest direction. This continuity in burials between pre- and post-contact Narragansett burials suggested some resistance to European domination through the retention of traditional religious and ritual practices (Nassaney 1989).

#### 4.4.1.2 Monongahela Mortuary Patterns

Analyses of mortuary contexts from protohistoric Monongahela sites in southwestern Pennsylvania yielded information about how the introduction of European goods altered sociopolitical systems and ritual behaviors prior to direct contact (Anderson 2002). Prior to contact through trade networks, juveniles and infants were buried in house floors, whereas adults were interred in pits within the enclosed palisade of Monongahela village sites; grave goods were sparse (Anderson 2002; Johnson 2001). The presence of charnel houses at the Household and Sony sites of western Pennsylvania in the protohistoric period represented a marked shift in burial practices (Anderson 2002). There was also evidence for increased burial ceremonialism at Sony with the inclusion of high amounts of marine shell and a central pit-fire feature. Furthermore, at the Foley Farm there were several burials associated with European trade goods, such as glass trade beads (Anderson 2002; Lapham and Johnson 2002). Anderson (2002) hypothesized that a social division between individuals with access to prestige items and those without existed after European trade based upon this evidence (Anderson 2002). Given the increase in burial complexity and ceremonialism coupled with the inclusion of European trade goods at the Foley site during the protohistoric period, researchers suggested that during this period there was system of emerging elites (Anderson 2002). This emergence cannot be directly attributed to the introduction of European trade goods alone, as there was increased evidence of increased interaction with Iroquoian groups in protohistoric Monongahela sites (Anderson 2002; Johnson 2001).

### 4.4.2 Social Continuity Following Contact

Continuity was also observed in indigenous lifeways, even in cases where groups had been incorporated into multi-ethnic communities where they were forced or willingly assimilated to some European social practices (Baker 1994; Ferris 2009; Scott 1991). For example, in 1640 John Eliot, an English Puritan missionary, established 14 “Praying Towns” in New England as a means to convert indigenous people to Christianity. Archaeological investigations of burials in these towns revealed a pattern similar to that in Narragansett cemeteries in which there was some continuity in native burial practices with the retention of native goods in burials such as wampum and beads, though they adopted Christian extended burials (Calloway 1997:76). Calloway (1997) suggested that this practice was a means of constituting shifting identities while maintaining ties to tradition. Baker (1994) noted that skeletal analyses of collections from New England “Praying Towns” revealed much lower instances of dental pathology in these groups, suggesting a resistance to the addition of European flour and sugar into the diet, unlike the contemporary Narragansett settlements. Maintenance of native subsistence practices was also evident in settlements even into the 18$^{th}$ century in French colonies (Scott 1991). For example, Scott (1991) observed that native inhabitants of 18$^{th}$ century Machilimackinac in the Great Lakes region maintained a diet of wild animal sources, despite evidence that Europeans in this settlement kept and ate pigs (Scott 1991). It was also hypothesized that native agricultural products were tended to by women among the Ottawa groups residing in this region, indicating a maintenance pre-contact gendered labor practices (Scott 1991). Continuity vs. change is a key focus of archaeological modeling of contact, settlement, and subsistence (Ferris 2009). Ferris (2009) outlined settlement strategies among the Ojibwa, Delaware, and other indigenous communities in the Great Lakes following contact. Archaeological and historical evidence suggested that while incorporation of European technology and settlement patterns did occur, traditional hunting and foraging lands, foodstuffs, and social systems were also maintained (Ferris 2009). Ferris (2009) emphasized that indigenous peoples were not passive recipients of European social regimes and lifeways, but rather incorporated new technologies and ideas into existing native worldviews and sociopolitical frameworks.

## 4.5 HISTORICAL ARCHAEOLOGY: 17TH CENTURY TO 1793

One of the main areas of study in historical archeology in North America has been the nature of European settlement and life in colonies in terms of architecture of settlements, subsistence and economic activities, as well as burial practices (Loren 2008:51; Loren and Beaudry 2006: 257; Mulholland 1999; Nassanney et al. 2007; Richardson and Wilson 1976; Scott 1991;). Many archaeological investigations were the result of salvage excavations of early settlements and cemeteries (Lawrence et al. 2009; Scharfenberger 2009). Early colonial efforts were identified throughout northeastern North America. The earliest attempt at colonization by the British occurred in 1607 with the establishment of Popham colony in present-day Maine, but was abandoned within several years after its inception (Loren 2008: 50). Archaeological survey of this settlement revealed that the fortress was constructed by unskilled laborers and consisted of several dwellings as well as a storehouse (Brain 2001, 2003; Morrison 2002). Architectural analyses of these houses indicated that similar construction techniques were utilized in this colony as in 17th century England (Morrison 2002). Ceramic assemblages from the site revealed that colonists imported British pottery wares and there were no native ceramics present in this settlement indicating that these items were not exchanged between Popham colonists and the local Wabnaki groups (Morrison 2002). Archaeological investigations at Plymouth colony have identified households of historical figures such as the John Alden Houses of 1627 and 1653 (Mulholland 1999:237-248).

### 4.5.1 European Settlements

Multiple studies of European settlements revealed information for populations outside of New England, especially for the 18th century such as the Kuskuskies Towns and other settlements in western Pennsylvania (Brown et al. 2014; Lawrence et al. 2009; Nassaney et al. 2007). One prominent settlement in western Pennsylvania's frontier was Hannastown, where European settlers practiced a mixed economy of animal husbandry and agriculture. Richardson and Wilson (1976) noted that European pottery and chinaware were recovered from households and taverns, as well as personal items such as buttons and combs. Bone assemblages at the site indicated that the settlers in this village kept pigs, cattle, and chickens in addition to practicing agriculture (Richardson and Wilson 1976). Salvage excavations of cemeteries in New Jersey provided information about European mortuary ritual in the early 18th century colonies; adults were typically buried with marriage partners in family plots with possible changes in practices just prior to the American Revolution in the 1770's with the presence of German immigrants to the region (Lawrence et al. 2009). Investigations of fur trading settlements showed that European life in the Great Lakes region French fur trade posts was characterized by multi-ethnic communities, with subsistence based upon a mixture of native cultigens, European livestock, and economic activities based upon exchanges of fur and locally made trade items (Nassaney et al. 2007; Smith 1991).

### 4.5.2 Conflict

One of the prominent features of life in the historical period was warfare, for both European and Native communities. Several historically documented conflicts erupted after the arrival of Europeans in North America: The Pequot War (1637) and King Philip's War (1675-1676) in New England (Loren 2008:50), the Beaver Wars of the latter half of the 17th century among the Iroquoians and French (McConnell 1992), the French and Indian War (1754-1763) (McConnell 1992), Pontiac's Rebellion (1763-1764) (McConnell 1992) and the American Revolution (1776-1783) (McConnell 1992). The nature of early warfare between indigenous people and Europeans was likely small skirmishes or raids with few casualties. Skeletal remains from late 16th century and early 17th century Seneca sites exhibit very little evidence of injury (Wray et al. 1987, 1991; Engelbrecht 2003). Studies demonstrated that Iroquoians adopted European metal points and muskets by the mid-17th century, as evidenced by musket wounds at the Seneca Marsh site (Sublett and Wray 1970). During this era, the Iroquoians were in conflict with surrounding indigenous groups as a result of competition in the fur trade (Engelbrecht 2003). Archaeological analyses of sites corroborated historical records that these conflicts resulted in the dispersal of Native groups throughout eastern Canada, the American northeast, and the Ohio River Valley (Engelbrecht 2003; McConnell 1992).

As conflicts escalated into full-scale warfare between colonists, Europeans and Native Americans, full-scale fortifications were built during the French and Indian War and the American Revolution (Starbuck 1999). Battlefields and skirmish sites dotted the regional landscape during these periods of conflict (McConnell 1992). Locating battle sites became a frequent focus of historical archaeology in northeastern North America (Johnson and Johnson 2010). For example, Johnson and Johnson (2010) performed a geophysics study of the area surrounding Bushy Run, an important battle site associated with Pontiac's Rebellion (Johnson and Johnson 2010). Full-scale excavations of French and Indian War forts revealed more about the nature of life and warfare in the American frontier during the mid-18th century (Starbuck 1999). Ft. William Henry was the site of a massacre in 1757, where Native Americans attacked British soldiers and prisoners, scalping and taking prisoners (Starbuck 1999:83). Historians estimated the death toll of this massacre to be between 800 and 1000 individuals (Starbuck 1999). Excavations of the fort and military cemetery in the 1950's showed that victims were buried hastily without coffins. Skeletal analyses revealed a rather gruesome picture of warfare in the 18th century; Liston and Baker (1996) identified cutmarks on the lower ribs and os coxae, tomahawk trauma, musket wounds, shot out knee caps, and limb amputations on 5 individuals from a mass grave at the fort. In this sample there was evidence of disease and stress as several individuals exhibited tuberculosis lesions, herniated disks, as well as evidence of anemia. Anthropologists even found preserved lice embedded in buttons in the gravesites (Liston and Baker 1996). Further excavations in the 1990's revealed the shape of the fortification, kitchen middens with butchered animal remains, and exploded mortar shells (Starbuck 1999:100-101).

Archaeological information on the nature of warfare in the Americas and fortifications was not limited to the French and Indian War. Investigations, both archaeological and bioarchaeological, were conducted on battle sites and skeletal samples from the American Revolution (Sciulli and Gramly 1989; Starbuck 1999:124; Williamson et al. 2003). For example, archaeological surveys conducted in the 1970's and the 1990's revealed many previously unknown encampments and small fortifications at the Mount Independence battle site in Vermont. These analyses showed that the soldiers encamped at this site lived in small crowded barracks and had a diet consisting of pork and fish (Starbuck 1999:136-142). There was a two-story hospital with multiple hearths (Starbuck 1999:152).

Skeletal analyses from battle sites have also provided information about the nature of skirmishes and battles in the American Revolution (Sciulli and Gramly 1989; Williamson et al. 2003). Williamson et al. (2003) examined skeletal remains from Ft. Laurens, Ohio, where American soldiers were attacked by the British and their Native American allies. At least 13 individuals from this site exhibited evidence of scalping (Williamson et al. 1998). Twelve of these thirteen individuals exhibited perimortem cranial sharp force and blunt force trauma, likely associated with tomahawk wounds (Williamson et al. 2003). It was hypothesized that the extent of these injuries represented "overkill" as the extent of the wounds, such as sharp and blunt force trauma made by several weapons and possible attackers, was tactically unnecessary. All 13 individuals were scalped likely after these blows were delivered (Somerville 2011:93). It was suggested that the sociopolitical and cultural dynamics of the turbulent 18$^{th}$ century contributed to the aggressive form of attacks during the American Revolution (Somerville 2011:94-95).

### 4.5.3 The Delaware Indigenous Group During the Historic Period

The Delaware are a tribe of Native Americans that were originally settled in the New Jersey and Eastern Pennsylvania in the era prior to contact. They are descendant organizations of coastal Algonquian speaking peoples of the Atlantic coast stretching from the Hudson River Valley to the Chesapeake Bay consisting of the Munsee, Mahican, Unami, Nanticoke and Conoy groups. During the historic period, these groups were culturally related but politically distinct entities. Displaced by European settlers and colonizers, this group was forced out of their original territory in large migrations in the period following 1737AD (Figure 17). Migratory groups settled in areas of western Pennsylvania and Eastern Ohio in what is the modern day Susquehanna and Ohio River valleys in coalescent communities around Unami and Munsee leaders. This coalesced group formed what is known as the Delaware Tribe by the mid-eighteenth century (Brown et al. 2014). Negotiations with the English and other Europeans brought out emergent elite leaders where traditional headsmen took on the role of “town leader”. As the Delaware were traditionally matrilineal, these leaders were likely endorsed by important female elders (Brown et al. 2014).

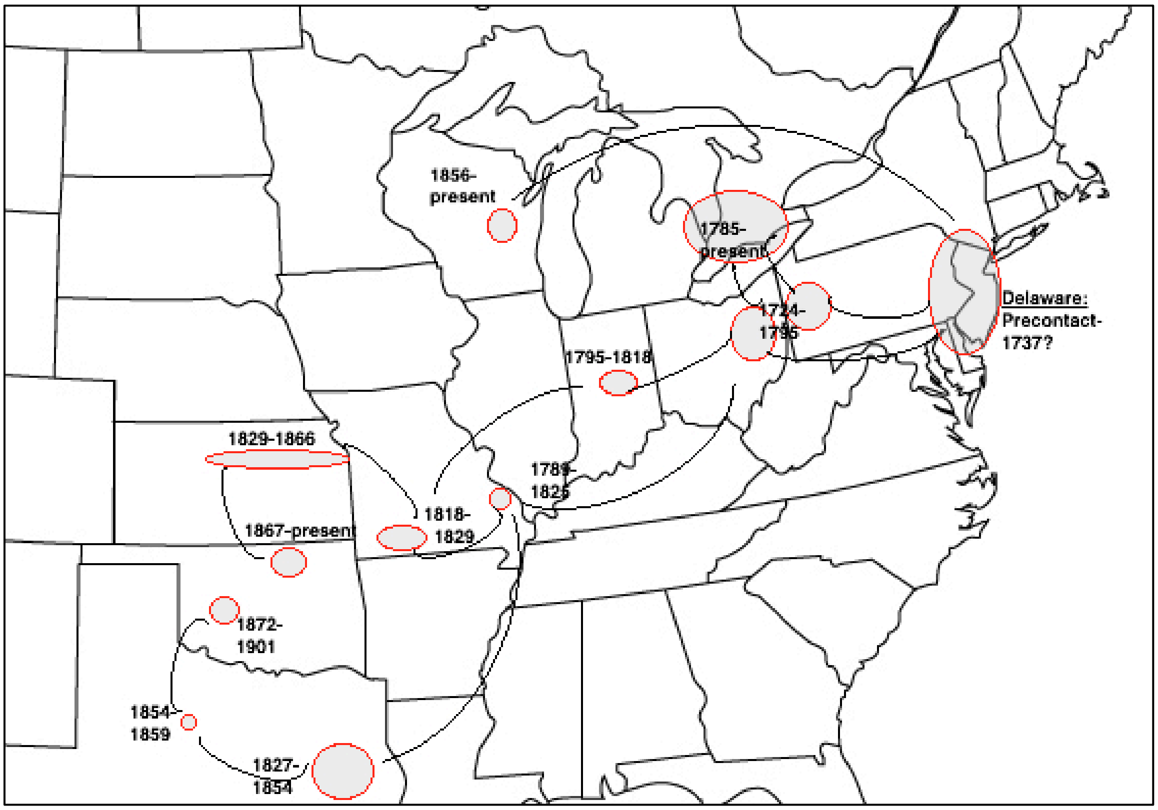



**Figure 17:** Migration of Delaware Tribe from original territory to Ohio Valley, Midwest, and Oklahoma (adapted from Brown et al. 2014; Obermeyer 2009).

The Kuskuskies Towns consisted of a group of four Delaware towns along the Mahoning River in western Pennsylvania. The period of intensive occupation of these towns has been estimated to have been from 1750-1778 (McConnell 1992). Interactions with Europeans are documented through historical sources; British and French accounts of indigenous populations indicate that the Delaware and other groups such as Shawnee occupied the area during this period (McConnell 1992). Encounters between the Delaware and Europeans were not always peaceful. The Delaware towns in the Ohio Valley region participated in anti-British raids prior to the French and Indian conflict (McConnell 1992). In 1756, the British destroyed the town of Kittanning in western Pennsylvania, killing many Delawares (Gist 1759; McConnell 1992). Refugees from this settlement, including white captives, settled into indigenous communities such as the Kuskuskies (LeRoy and Leininger n.d; Weslager 1972). The Kuskuskies Towns grew in size following this event, but were subsequently accompanied by food shortages and an outbreak of smallpox

(Gist 1759). Emergent Delaware leaders, such as Tamaqua, tempered peace between the Europeans and the indigenous groups in the Ohio Country until 1763, when the French-Indian War broke out. During this conflict, indigenous populations in the Ohio Valley established more settlements to the west. During the conflict, the size of the Kuskuskies Towns decreased due to these movements. However, the settlements were likely engaged in trade with towns such as Pittsboro (Pittsburgh) and other nearby towns (McConnell 1992).

Due to the proximity of the Kuskuskies Towns to several trading partners, they were joined by Christianized groups of Native Americans, known as the Moravians, as early as 1768. There was some friction between Christian and non-Christian Delawares in the Kuskuskies Towns. The Delaware towns became a stopping point for missionaries during this period until 1772, when the Moravian missionaries and their converts moved into settlements towards the west (Brown et al. 2014). By the mid-1770s, large-scale conflict and encroaching settlements by Europeans increased pressure on the Delaware towns in the Ohio Country, and the Kuskuskies Towns were largely abandoned by 1778 (McConnell 1992).

Associated with the Kuskuskies settlement was a cemetery site, known as the Chamber's site. This cemetery was likely in use during the period of intense Delaware settlement between 1756 and 1778 AD. The site was excavated by the Carnegie Museum of Natural History from 1959-1960 (Brown et al. 2014). Analysis of the skeletal remains from this site revealed much information about the nature of subsistence, health, and demography of the indigenous groups in the Ohio Country during this turbulent period. Skeletal analyses of 58 individuals revealed much lower rates of dental pathology, trauma, and infection when compared to other post-contact native groups (Wakefield-Murphy 2013) (Figure 18). For example, the caries rate at Chamber's was 4.17%, whereas at the post-contact site Iroquoian ossuary at Kleinberg, Ontario the caries rate was 40.6% (Pfeiffer and Fairgrieve 1994; Wakefield-Murphy 2013). It is hypothesized that the widespread nature of warfare during the occupation of the towns by the Delaware due to the French and Indian War and Pontiac's Rebellion in the Ohio region interrupted maize-based agriculture, indicating less reliance on cariogenic food products such as maize (McConnell 1992; Sciulli 1993; Wakefield-Murphy 2013). The absence of trauma in this collection may, however, have been a factor of differential burial practices with males involved in warfare dying away from the settlements (Wakefield-Murphy 2013). This was supported by historical documentation, which details the involvement of the Delaware as guides and in warfare during the mid-eighteenth century in the Ohio Valley Region (Gist 1759).

**Figure 18:** Dental caries, FC#3369, adult female, Chamber's site

# 5.0 MATERIALS AND METHODS

## 5.1 SKELETAL SAMPLES

The study sample consists indigenous skeletal remains from the Ohio Valley region of North America. The samples and field notes for this study are curated at the Carnegie Museum of Natural History (CMNH) in Pittsburgh, Pennsylvania. While there are over 500 individuals in the CMNH skeletal collections, burials were included in the sample for the present study according to the following criteria: reliable date, completeness and/or contextual information (e.g. burial data from archaeological reports), in total 330 individuals (Table 3).

### 5.1.1 The Early Woodland Sample

The Early Woodland sample (n=105) consists of burials from two sites associated with the Adena culture: The McKees Rocks Mound (36AL6) and Cresap Mound (46MR7). The McKees Rocks Mound was said to be the largest mound in the Eastern Adena tradition. The site of the original mound is in present day Pittsburgh, Pennsylvania. The McKees Rocks Mound was built in at least two stages, consisting of Early Woodland constructions between 2450-2050BP. The original construction was estimated to have been 16 feet tall (McConaughy 2015). The mound was partially excavated in 1896 by archaeologist Frank M. Gerrodette through the Carnegie Museum of Natural History. These excavations uncovered an area roughly half the size of the total mound. While the 1896 excavations only investigated half of the mound, recent visits to the site indicate that quarrying activities in the early 20$^{th}$ century destroyed the remaining portion of the mound and there are no remains of the structure at the original site (McConaughy 2015). According to the original site notes (Swauger 1940), 31 burials were uncovered; several burials contained multiple inhumations and some of the single graves were incorrectly labeled, bringing the total number of individuals to 48.

The Cresap Mound was excavated during the summer of 1958 through efforts by the Carnegie Museum of Natural History, the Hanna Coal Company, and the Historical Society of West Virginia (Dragoo 1963). The original mound was 15.0 feet in height and roughly 70 feet at its maximum diameter and was located at Cresap Bottom, West Virginia. This site was a low sloping terrace on the east side of the Ohio River. According to the Sciulli (1991) inventory, 54 burials were uncovered, but during this dissertation analysis several additional fragmentary skeletons were discovered bringing the total to 57. These burials contained partial and fragmentary skeletons as well as burial artifacts (Dragoo 1963). Commonly associated funerary objects included copper and slate gorgets, pottery, lithics, as well as beads made from copper, shell, and bone.

### 5.1.2 The Monongahela Samples

The Monongahela tradition described a group of indigenous peoples settled in the Ohio Valley Region of southwestern Pennsylvania and parts of West Virginia, Ohio, and Maryland during the period from 1000AD-1635 AD. Monongahela burials generally followed the pattern of adults interred in the village near the palisades with infants, children, and adolescents buried in house floors (Davis 1984, Johnson 2001). Excavations of Monongahela sites were conducted by amateur groups, researchers at the Carnegie Museum of Natural History and the University of Pittsburgh extensively during the period between the 1950s-1980s. The sample from this group can be divided into three subperiods: the Early Monongahela (1050-1250AD) (n=49, 9 sites), the Middle Monongahela (1250-1580AD) (n=74, 7 sites), and the Late Monongahela (1580-1635AD) (n=43, 5 sites). The samples from each of these periods consist of burials from multiple sites (Table 3) (Figure 19).

### 5.1.3 The Post-Contact Sample

The Post-Contact sample represents the historic Delaware tribe in the Ohio Valley Region following European contact. The 58 individuals in this sample were from a historic Delaware cemetery at the Chamber's site (36LR11), associated with native settlements in Lawrence County, Pennsylvania (Brown et al. 2014). It was hypothesized that the cemetery was in use from 1758-1774AD, during the occupation of surrounding settlements by the Delaware (Brown et al. 2014). While other groups such as the Seneca, Shawnee, Mahican, Mohican, and Wyandot were settled in the region during this period, the burial styles as well as the burial artifacts from the Chamber's site individuals are consistent with Delaware ceremonial dress and customs (Brown et al. 2014). The Chamber's Site cemetery was excavated from 1959-1960, and the site originally consisted of a raised mound approximately 50 feet in diameter and 6 feet high at its tallest point (Zakucia 1960). The site itself was named for the landowner and had no historical or contextual connection to the Delaware burials at the site (Brown et al. 2014).

**Table 3:** Skeletal sample totals and time periods

| Site Code | Site | Time Period | Number of Individuals |
|---|---|---|---|
| 46MR7 | Cresap Mound, WV | Early Woodland | 57 |
| 36AL6 | McKees Rocks Mound | Early Woodland | 48 |
| **TOTAL EARLY WOODLAND** | | | **105** |
| 36AL32 | Miller's Farm | Early Monongahela | 4 |
| 36AL62 | Drew | Early Monongahela | 5 |
| 36AR129 | Murphy Old House | Early Monongahela | 2 |
| 36GR1 | Varner | Early Monongahela | 7 |
| 36GR23 | Hartley | Early Monongahela | 3 |
| 36SO15 | Quemahoning | Early Monongahela | 2 |
| 36SO55 | Gnagey | Early Monongahela | 7 |
| 36WH19 | Boyle | Early Monongahela | 9 |
| 36WM23 | Ryan | Early Monongahela | 11 |
| **TOTAL EARLY MONONGAHELA** | | | **50** |
| 36AL4 | Bunola | Middle Monongahela | 34 |
| 36AL17 | McJunkin | Middle Monongahela | 5 |
| 36AL39 | Goodwin-Portman | Middle Monongahela | 12 |
| 36BV4 | Shippenport | Middle Monongahela | 2 |
| 36FA17 | Fuller's Hill | Middle Monongahela | 6 |
| 36WH48 | Lang | Middle Monongahela | 8 |
| 36WH283 | Wylie | Middle Monongahela | 7 |
| **TOTAL MIDDLE MONONGAHELA** | | | **74** |
| 36BT43 | Bonnie Brook | Late Monongahela | 1 |
| 36FA26 | Campbell Farm | Late Monongahela | 7 |
| 36IN2 | Johnson | Late Monongahela | 15 |
| 36WH34 | Beazell School | Late Monongahela | 2 |
| 36WM61 | Household | Late Monongahela | 18 |
| **TOTAL LATE MONONGAHELA** | | | **43** |
| 36LR11 | Chamber's Site | Post-Contact | 58 |
| **TOTAL POST-CONTACT** | | | **58** |
| **TOTAL SAMPLE** | | | **330** |

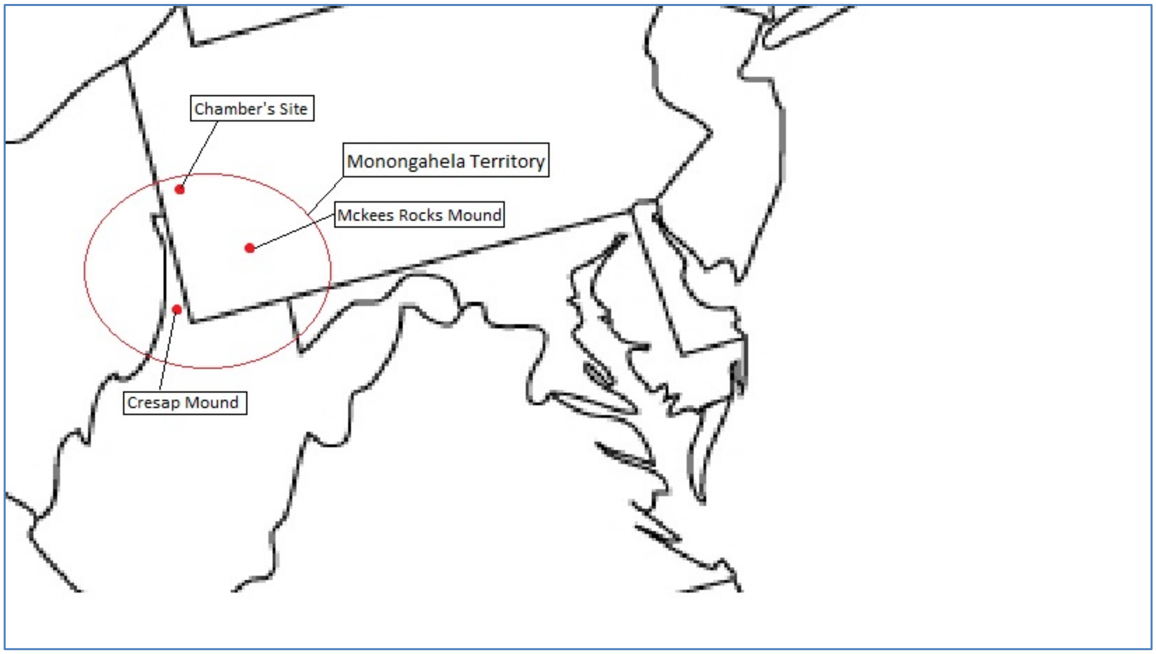



**Figure 19:** Map of sites and Monongahela territory

## 5.2 METHODS OF DATA COLLECTION AND SKELETAL ANALYSIS

The samples were previously inventoried by Sciulli (1991). The skeletal sample ranged from infants to older adults, as well as adult males and females, so it representative of all age and sex categories. The burial contents were compared with site notes and published reports as to inventory grave goods and burial data. Subsequently, each skeleton was systematically inventoried and analyzed for sex, age, stature, preservation, dental and skeletal pathology, and MSMs. All data collection took place in a laboratory at the Carnegie Museum Annex building in Pittsburgh, PA.

### 5.2.1 Recording of Burial Data

Burial information was collected from field notes and site reports. Burial data was coded in a ranked system, following Ventresca-Miller (2013). Burial location was coded as within burial mound (0), within household (1), within a burial structure in a settlement (2), within settlement but outside of household or structure (3), within a (non-mound) cemetery (4), or unknown (5). Mound burials were further coded: in center of mound (0), within a buried wooden (charnel house or log tomb) structure (1), in mound fill (2), in area surrounding mound (3) or unknown (4).

Grave size and depth was recorded according to specific dimensions stated in fieldnotes: length, width, and depth. If original notes used measurements in standard (inches and feet), these figures were converted into metric (cm).

Body position and treatment were recorded according to cardinal direction, head orientation, leg flexure, side, and burial type. Cardinal direction will be coded as north (0), south (1), east (2), west (3), northeast (4), northwest (5), southeast (6), southwest (7), or unknown (8). The position of the body was noted as follows: left side (0), right side (1), supine (2), prone (3), other (4), or unknown (5). Leg flexure was recorded as straight (0), legs bent right (1), legs bent left (2), other (3), tightly flexed <90 degrees (4), loosely flexed >90 degrees (5), or unknown (6). Treatment of the body was coded as single primary inhumation (0), single secondary inhumation (1), multiple primary inhumations (2), multiple secondary inhumation (3), cremation (4), other (5), or unknown (6).

Grave goods were inventoried and recorded for each burial as to total number and type following Ventresca-Miller (2013). The distribution of grave goods included stone carvings (tablets and effigies), lithics and groundstones, copper beads and figurines, silver items, ceramic pots and figurines, faunal remains, bone beads, glass beads, and seed beads. A total count of grave goods was coded as none (0) or numbered (1, 2, 3, 4...). Grave goods were subdivided material type: stone: bone, groundstones or lithics, ceramics, copper, silver, or glass. For each artifact type, a count was recorded of the total number in each category: none (0) or numbered (1, 2, 3, 4...). Beads were counted in a separate category as to number, type and location. Bone, shell, metal and glass beads were included in the burials. The number of beads were recorded according to type as follows: none (0) or numeric count (1, 2, 3, 4). Location of the beads was coded as not present (0), head/neck (1), torso (2), pelvic region (3), upper limb (4), hands (5), lower limb (6), and feet (7), multiple locations (8), and unknown (9).

### 5.2.2 Skeletal Inventory and Preservation

Each skeleton was inventoried following the method of squares for long bones (Judd 2002). Other skeletal elements were recorded based upon the percentage of bone present; bones were considered complete if >90% of the bone was present. The inventory of the dentition followed Buikstra and Ubelaker (1994), using the Universal system that numbers the adult dentition as 1-32, and the deciduous dentition 51-70.

Skeletal preservation is of key importance in this study (Andrews and Bello 2006; Duday 2006). Differential preservation may affect the ability to record other skeletal variables. In such cases, information on the preservation of the cortical surface as to the severity of damage and decay may account for missing data. All bones were evaluated for preservation according to standards by Brickley and McKinley (2004). This method was devised for recording preservation of skeletal material in prehistoric burials, so it is preferred over other preservation standards (e.g. Behrensmeyer 1978; Buikstra and Ubelaker 1994). Each bony element was scored, and an overall preservation score was assigned to each skeleton.

### 5.2.3 Age Determination

Where applicable, multiple methods were used to provide estimates of biological age. Features scored included the revised method for the auricular surface of the ilium (Buckberry and Chamberlain 2002), the pubic symphysis (Katz and Suchey 1986, Brooks and Suchey 1990), and the first rib (DiGangi et al. 2009). The auricular surface method is the most preferable of adult age determination methods, as it provides the narrowest age ranges and has a low incidence of intraobserver error (Buckberry and Chamberlain 2002). The revised auricular surface method devised by Buckberry and Chamberlain (2002) was utilized, as this method corrects for interpretational difficulties and statistical biases in the original auricular surface method by Lovejoy et al. (1985). Tests of this method have shown it to be an accurate estimator of age-at-death in known skeletal samples. These tests also demonstrated that intraobserver bias is low with the revised method, making it easier in application (Mulhern and Jones 2005).

While standards for the sternal rib ends are applied in the forensic context, methods such as Iscan et al. (1984), require the use of the fourth rib, which is not easily identifiable in incomplete or archaeological contexts. Therefore, the first rib (DiGangi et al. 2009) was used and this method scores age related changes to the costal facet as well as the tubercle facet. This method can accurately age individuals from the mid-teens to old age (DiGangi et al. 2009).

Subadults were aged according to dental formation (Moorrees et al. 1963a,b), dental eruption (Ubelaker 1978), and epiphyseal fusion (Ferembach et al. 1980). Dental standards are the preferred method for subadult aging, as dental formation is less sensitive to environmental insult than epiphyseal fusion, and may provide earlier and narrower age ranges as the majority of epiphyses do not begin to fuse until adolescence (Cardoso 2008a,b; Lampl and Johnston 1996). Formation methods can be applied macroscopically to isolated teeth in which the root stage can be observed (Saunders et al. 1993). According to investigational studies (Saunders et al. 1993), the Moorrees et al. (1963a,b) standards for subadult aging from the dentition produce age estimations with the highest accuracy in comparison with other systems such as Anderson et al. (1976), Demirjian et al. (1973), and Demirjian and Goldstein (1976). In cases where the teeth are isolated and separated from the maxilla/mandible, the Moorrees et al. (1963a,b) dental formation standards were used. For subadults in which the dentition was still enclosed in the jaw, dental eruption standards by Ubelaker (1978) were applied, as radiographs were not available for the assessment of root formation in these cases.

Multiple methods for epiphyseal fusion have been devised (Ferembach et al. 1980; McKern and Stewart 1957) but the recently developed standards such as Cardoso (2008a,b) and Coqueugniot and Weaver (2007) were designed for use on modern Portuguese skeletal samples and were therefore applicable to indigenous populations of North America. McKern and Stewart's (1957) standards were devised from males, and it has been demonstrated that males and females begin fusion of epiphyses at different ages (Cardoso 2008a,b). This method did not include ages in early adolescence in which the early stages of fusion for many epiphyses begin (Cardoso 2008a,b). Therefore, the Ferembach et al. (1980) standards, though devised from European collections, were utilized for this study, as these estimates include age ranges that account for early stages of epiphyseal fusion.

**Table 4**: Age categories, ranges, and codes

| Stage | Range | Coding |
|---|---|---|
| Unknown | Unknown | 0 |
| Fetus | < birth | 1 |
| Neonate | < 6 months | 2 |
| Toddler | 6 months – 2 years | 3 |
| Early Childhood | 3 – 6 years | 4 |
| Late Childhood | 7 – 11 years | 5 |
| Adolescent | 12 – 16 years | 6 |
| Youth | 17 – 20 years | 7 |
| Early Adult | 21 – 25 years | 8 |
| Young Adult | 25 – 35 years | 9 |
| Middle Aged Adult | 35 – 50 years | 10 |
| Old Adult | 50 + years | 11 |

Following the use of multiple methods of age determination, all individuals were placed into age categories following Judd (2012) (Table 4). This scheme of age categories follows Bogin's (1999) thresholds of chronological age and biological development, utilizing dental eruption by Ubelaker (1978) as clear markers of different subadult age categories, based on major dental eruption events. For adult age categories, this method follows Buikstra and Ubelaker (1994). Utilizing narrow age categories allowed for a more detailed reconstruction of mortality profiles in different time periods in the present study, as the demographic pattern by age and sex may be indicative of normal attritional mortality vs. catastrophic mortality (Chamberlain 2006). Furthermore, these stages can be collapsed into larger categories if necessary for statistical analysis.

### 5.2.4 Sex Estimation

The Sexualization Index developed by Acsádi and Nemeskéri (1970) was used to estimate adult sex. According to these standards, sexually dimorphic features of the skull and os-coxae are scored on a continuum from hyperfemale to hypermale. This method is preferable because it shows the range in variation of the expression of sexual dimorphism in human populations and uses multiple features of the skull and ox-coxae, so it is applicable in cases of fragmentary remains (Sofaer 2006a).

The femur superior-inferior neck diameter (Seidemann et al. 1998) and distal humerus (Rogers 1998) methods were also applied. These methods are useful for fragmentary remains or in the absence of the skull and os coxae. Both are associated with >90% accuracy when tested in collections of known age at death (Rogers 1998; Seidemann et al. 1998). Once a final sex estimation was determined, biological sex was coded as follows: unknown (0), female (1), male (2), indeterminate (3). The unknown category was utilized for skeletons in which differential preservation or age-at-death does not allow for analysis and indeterminate was assigned for cases in which a mix of male and female features were recorded. Myriad standards for the osteological sex determination of subadults have been developed (e.g. Fazekas and Kósa 1978; Holcomb and Konigsberg 1995; Loth and Henneberg 2000; Schutkowski 1993; Weaver 1980) but tests of these methods have not produced accurate results (Komar and Buikstra 2009).

### 5.2.5 Pathological Analysis

Dental pathology was identified and scored for severity according to the following standards: dental caries and enamel hypoplasias (Buikstra and Ubelaker 1994); periodontal disease (Lukacs 1989); calculus (Dobney and Brothwell 1987), and enamel hypoplasias (Buikstra and Ubelaker). Steckel et al. (2005) was applied for the scoring of osteoarthritis, infectious disease, and skeletal indicators of nonspecific stress (porotic hyperostosis and cribra orbitalia). Maxillary sinusitus was scored following Roberts (2007). For less commonly identified conditions in which lesions are not systematically scored, paleopathological sources such as Aufderheide and Rodriguez-Martín (1998), Ortner (2003), Resnick (2002), and Waldron (2008) were utilized to identify and describe pathologies.

Timing of injury is crucial in bioarchaeological analyses in the distinction of injury versus post-mortem funerary processing of remains (Chacon and Dye 2007; Wieberg and Westcott 2008). A micoscope was used to aid in the determination of microscopic features of pathological lesions as well as injury timing. Definitions of injury timing will follow those described by Wieberg and Wescott (2008): unknown (0), antemortem (1) - before death with evidence of remodelling), perimortem (2) - surrounding the time of death, and post-mortem (3) - after-death. Blunt force trauma was identified and described according to Lovell (1997) including injury timing, length of bone, apposition, rotation, and angulation (Lovell 1997). Sharp force injuries were identified and described following Lewis (2008) and Lynn and Fairgrienve (2009).

### 5.2.6 Activity Markers

Muscoloskeletal activity markers (MSMs) were scored via the method devised by Hawkey and Merbs (1995) (Table 5). The Hawkey and Merbs (1995) method is preferable in bioarchaeological studies as each muscle insertion site is scored separately, allowing for its application with fragmentary remains. For this project, 60 muscle insertion were scored for robusticity from the clavicles, scapulae, humerii, ulnae, radii, os coxae, femora, and tibiae (Table 6).

Assymmetry was calculated according to Eshed et al. (2004). For individuals with both left and right MSMs, this coefficient was calculated as follows: (left side/right side) X 100. Coefficients under 100 were indicative of right dominance and values above 100 were indicative of left dominance. Scores of 100 equaled complete symmetry.

**Table 5**: MSM scoring protocol*

| CODE | SEVERITY | ROBUSTICITY |
|---|---|---|
| | | Localized swelling, ridging, or cresting of bone at attachment site |
| 0 | Absent | Feature Not Visible |
| 1 | Faint | Cortex slightly rounded, elevation scarcely visible but apparent to touch |
| 2 | Moderate | Cortex uneven, with defined margin and easily observable |
| 3 | Robust | Strounng mounding with distinct sharp edges or crests |

*(Hawkey and Merbs 1995)

**Table 6:** MSMs recorded by bone

| BONE | MSMs |
|---|---|
| Clavicle | Costoclavicular ligament, subclavius, trapezoid ligament, conoid ligament, deltoid |
| Scapula | Trapezius, pectoralis major |
| Humerus | Supraspinatus, Infraspinatus, Teres minor, pectoralis major, latissimus dorsi, teres major, deltoid, coracobrachialis, common extensors, common flexors |
| Ulna | Brachialis, anconeus, triceps brachii |
| Radius | Biceps brachii, pronator teres, supinator, pronator quadratus |
| Innominate | Gluteus maximus, gluteus medius, gluteus minimus, tensor fascia latae, adductor brevis, adductor longus, adductor magnus, pectineus, gracilis, iliacus, obturator externus, obturator internus, piriformis, superior gemellus, inferior gemellus, quadratis femoris |
| Femur | Gluteus maximus, gluteus medius, gluteus minimus, adductor magnus, vastus intermedius, vastus medius, vastus lateralis, piriformis, obturator externus, obturator internus, quadratus femoris, popliteus, gastrocnemius, iliacus, pectineus |
| Tibia | Soleus, popliteus, semimembranosus, tibialis posterior, tibialis anterior, flexor digitorum |

## 5.3 METHODS OF STATISTICAL ANALYSIS

Kruskall-Wallis H tests, the non-parametric equivalent to one way analysis of variance (ANOVA), were utilized to evaluate differences between the samples in terms of age and sex distributions. Kruskall Wallis tests were also performed to evaluate similarity or difference between and within these samples for severity scores of skeletal pathologies such as osteoarthritis and infectious disease, dental pathologies, and MSM activity scores according to sex and age to illustrate the pattern of distribution of pathologies and activity between the sexes and individuals in different stages of life course. Kruskall-Wallis H tests are the most appropriate statistical approach for ranked ordinal data such as sex and age categories, severity or location scores for pathology, and MSM rankings. These tests will be meaningful in ascertaining significant differences between sex and age categories with and between skeletal sample in terms of population health, diet, and activity patterns. Any signficant result were followed up with post-hoc Mann-Whitney U-tests to elucidate which specific groups were statistically different.

Parametric data was analyzed utilizing ANOVA tests, which are appropriate for the evaluation of continuous measured data. As in the case with non-parametric data analysis, significant differences and similarities illustrated by parametric statsistical procedures between samples and within samples according to age and sex categories may be explained as functions of social and biological change resulting from subsistence-settlement shifts, environment, and acculturation.

Mortuary analysis from a gendered perspective can be done through multivariate methods. Multivariate statistics were utilized to compare burial trends based on binary sex and age categories following O'Shea (1984). These mortuary analyses served as a baseline for comparison to ascertain whether or not a biosocial gendered view of burial treatment can be done statistically.

Variables for grave data, grave goods and biological attributes were analyzed using two types of component analysis: Principal Component Analysis (PCA) and Multiple Correspondence Analysis (MCA). These methods examine the linear relationship between variables to allow for simpler interpretation of cluster analysis data by performing dimension reduction. Dimension reduction has two goals: to balance the weight of each category of data and increase interpretability of clusters. The data was divided into three main categories for PCA/MCA: grave attributes (body location, orientation, body position, leg flexure, burial type, and grave size), grave goods (number and type of each type of grave good, bead number, and bead location), and biological attributes (infectious disease presence, osteoarthritis presence, dental disease presence, stress presence, injury presence, and MSM scores). For this procedure, the PCAmixdata package in R statistical software was utilized. For each of the 3 data areas, three main data components (combinations of variables) were identifed.

Cluster analysis was performed as a multivariate method for analyzing gendered social processes. Cluster analysis is particularly well suited for bioarchaeological studies of gender as it can illustrate patterns of data according to time period or kin group, biological parameters (age, sex, health, activity, diet), and social parameters (burial treatment, grave good distribution) (McHugh 1999; Shelach 2009; Ventresca-Miller 2013). Following PCA/MCA analysis, the same data divisions were utilized for cluster analysis: grave attributes, grave goods, and biological attributes. To do the cluster analysis, Euclidean norm was used to create a distance matrix to calculate the distance between cases. Using Euclidean distance, Ward's method (1963) was applied to complete the cluster analysis. This method creates clusters within the data in order to understand the relationships between individuals in the data. This procedure was completed for each time period sample, and 4 clusters were identified for each of these.

The Ward's method (1963) of cluster analysis was performed twice for each time period sample: one mortuary cluster analysis and one biosocial cluster analysis. The first set of clusters was performed utilizing only the grave attributes and counts of grave goods, followed by calculating the simple frequencies of males, females, subadults, and unknowns in each cluster. This follows the more traditional type of mortuary analysis utilized by O'Shea (1984). The second set of cluster analyses represented a biosocial view following Robb et al. (1998) and Sofaer (2006a). The second set combined grave attributes, grave data, and biological attributes. Four clusters were obtained for each set of analyses, but the structure was altered. For each cluster, the age/sex structure was calculated (e.g number of old adult males, number of middle aged females). Following cluster analysis, frequencies of grave goods and burial attributes were compared using ANOVA (continuous variables) and chi square (categorical variables) tests (Appendix C).

# 6.0 RESULTS AND DISCUSSION: DEMOGRAPHY, PRESERVATION, AND PATHOLOGY

In this chapter, results for demography, preservation, and pathology are presented and discussed. For the purposes of this chapter, several abbreviations may be used in tables and in text. Time periods are abbreviated as follows: Early Woodland (EW), Early Monongahela (EM), Middle Monongahela (MM), Late Monongahela (LM), and Post-Contact (PC).

## 6.1 DEMOGRAPHY

Demographic data is tabulated by time period and age/sex categories (Tables 7-9). The specific age/sex structure of each time period is charted to visually represent demographic distributions for inference into sample mortality profiles (Figures 20-24). In total, 330 skeletons and their burials were available for analysis, though preservation was variable: 61 males, 82 females, 95 subadults, and 92 unknown adults.

**Table 7:** Number of individuals (N, %) of broad age category by sex per sample*

| Early Woodland | Male | | Female | | Subadult | | Unknown Adult | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % |
| Subadult | 0 | 0 | 0 | 0 | 16 | 15.2 | 0 | 0 | 16 | 15.2 |
| Adult | 17 | 16.2 | 21 | 20.0 | 0 | 0 | 51 | 48.6 | 89 | 84.8 |
| Total | 17 | 16.2 | 21 | 20.0 | 16 | 15.2 | 51 | 48.6 | 105 | 100 |
| **Early Monongahela** | **Male** | | **Female** | | **Subadult** | | **Unknown Adult** | | **Total** | |
| | N | % | N | % | N | % | N | % | N | % |
| Subadult | 0 | 0 | 0 | 0 | 21 | 42.0 | 0 | 0 | 21 | 42.0 |
| Adult | 9 | 18.0 | 11 | 22.0 | 0 | 0 | 9 | 18.0 | 29 | 58.0 |
| Total | 9 | 18.9 | 11 | 22.0 | 21 | 42.0 | 9 | 18.0 | 50 | 100.0 |
| **Middle Monongahela** | **Male** | | **Female** | | **Subadult** | | **Unknown Adult** | | **Total** | |
| | N | % | N | % | N | % | N | % | N | % |
| Subadult | 0 | 0 | 0 | 0 | 26 | 35.1 | 0 | 0 | 26 | 35.1 |
| Adult | 20 | 27.1 | 18 | 24.3 | 0 | 0 | 10 | 13.5 | 48 | 64.9 |
| Total | 20 | 27.1 | 18 | 24.3 | 26 | 35.1 | 10 | 13.5 | 74 | 100 |
| **Late Monongahela** | **Male** | | **Female** | | **Subadult** | | **Unknown Adult** | | **Total** | |
| | N | % | N | % | N | % | N | % | N | % |
| Subadult | 0 | 0 | 0 | 0 | 14 | 32.6 | 0 | 0 | 14 | 32.6 |
| Adult | 10 | 23.3 | 16 | 37.2 | 0 | 0 | 3 | 6.9 | 29 | 67.4 |
| Total | 10 | 23.3 | 16 | 37.2 | 14 | 32.6 | 3 | 6.9 | 43 | 100 |
| **Post-Contact** | **Male** | | **Female** | | **Subadult** | | **Unknown Adult** | | **Total** | |
| | N | % | N | % | N | % | N | % | N | % |
| Subadult | 0 | 0 | 0 | 0 | 18 | 31.0 | 0 | 0 | 18 | 31.0 |
| Adult | 5 | 8.6 | 16 | 27.6 | 0 | 0 | 19 | 32.8 | 40 | 69.0 |
| Total | 5 | 8.6 | 16 | 27.6 | 18 | 31.0 | 19 | 32.8 | 58 | 100 |
| **TOTAL SAMPLE** | **Male** | | **Female** | | **Subadult** | | **Unknown Adult** | | **Total** | |
| | N | % | N | % | N | % | N | % | N | % |
| Subadult | 0 | 0 | 0 | 0 | 98 | 28.7 | 0 | 0 | 98 | 28.7 |
| Adult | 58 | 18.5 | 84 | 24.8 | 0 | 0 | 90 | 28.0 | 232 | 71.3 |
| TOTAL | 58 | 18.5 | 84 | 24.8 | 98 | 28.7 | 90 | 28.0 | 330 | 100 |

* subadult = <17years, adult = 17-50+ and unknown (N= number present)

**Table 8**: Number of individuals (N, %) per sample by age and sex group*

| Early Woodland | Male | Female | Subadult | Unknown | Total |
|---|---|---|---|---|---|
| Fetus (<40 wks.) | 0 | 0 | 0 | 0 | 0 |
| Neonate (<6 mos.) | 0 | 0 | 1 (.9%) | 0 | 1 (.9%) |
| Toddler (6 mos-2yrs) | 0 | 0 | 0 | 0 | 0 |
| Early Child (3-6 yrs.) | 0 | 0 | 4 (3.8%) | 0 | 4 (3.8%) |
| Late Child (7-11yrs) | 0 | 0 | 2 (1.9%) | 0 | 2 (1.9%) |
| Adolescent (12-16yrs) | 0 | 0 | 5 (4.7%) | 0 | 5(4.7%) |
| Unknown Subadult | 0 | 0 | 1 (.9%) | 0 | 1(.9%) |
| Youth (17-20yrs) | 1(.9%) | 2(1.9%) | 3(2.9%) | 0 | 6(5.7%) |
| Early Adult (21-25yrs) | 0 | 0 | 0 | 0 | 0 |
| Young Adult (26-35yrs) | 3 (2.8%) | 5 (4.8%) | 0 | 0 | 8 (7.6%) |
| Middle Aged (36-50yrs) | 2 (1.9% | 0 | 0 | 1 (.9%) | 3 (2.8%) |
| Old Adult (50yrs+) | 3 (2.8%) | 0 | 0 | 0 | 3 (2.8%) |
| Unknown Adult | 8 (7.6%) | 14 (13.3%) | 0 | 50 (47.6%) | 72 (68.6%) |
| Total | 17 (16.2%) | 21 (20%) | 16 (15.2%) | 51 (48.6%) | 105 (100%) |
| **Early Monongahela** | **Male** | **Female** | **Subadult** | **Unknown** | **Total** |
| Fetus (<40 wks.) | 0 | 0 | 4 (8%) | 0 | 4 (8%) |
| Neonate (<6 mos.) | 0 | 0 | 2 (4%) | 0 | 2 (4%) |
| Toddler (6 mos-2yrs) | 0 | 0 | 2 (4%) | 0 | 2 (4%) |
| Early Child (3-6 yrs.) | 0 | 0 | 4 (8%) | 0 | 4 (8%) |
| Late Child (7-11yrs) | 0 | 0 | 3 (6%) | 0 | 3 (6%) |
| Adolescent (12-16yrs) | 0 | 0 | 3 (6%) | 0 | 3 (6%) |
| Unknown Subadult | 0 | 0 | 1 (2%) | 0 | 1 (2%) |
| Youth (17-20yrs) | 0 | 2 (4%) | 3 (6%) | 0 | 5 (10%) |
| Early Adult (21-25yrs) | 0 | 1 (2%) | 0 | 0 | 1 (2%) |
| Young Adult (26-35yrs) | 1 (2%) | 4 (8%) | 0 | 0 | 5 (10%) |
| Middle Aged (36-50yrs) | 4 (8%) | 2 (4%) | 0 | 0 | 6 (12%) |
| Old Adult (50yrs+) | 1 (2%) | 1 (2%) | 0 | 0 | 2 (4%) |
| Unknown Adult | 3 (6%) | 1 (2%) | 0 | 9 (18%) | 13 (26%) |
| Total | 9 (18%) | 11 (22%) | 21 (42%) | 9 (18%) | 50 (100%) |
| **Middle Monongahela** | **Male** | **Female** | **Subadult** | **Unknown** | **Total** |
| Fetus (<40 wks.) | 0 | 0 | 1 (1.3%) | 0 | 1 (1.3%) |
| Neonate (<6 mos.) | 0 | 0 | 8 (10.8%) | 0 | 8 (10.8%) |
| Toddler (6 mos-2yrs) | 0 | 0 | 4 (5.4%) | 0 | 4 (5.4%) |
| Early Child (3-6 yrs.) | 0 | 0 | 4 (5.4%) | 0 | 4 (5.4%) |
| Late Child (7-11yrs) | 0 | 0 | 6 (8.1%) | 0 | 6 (8.1%) |
| Adolescent (12-16yrs) | 0 | 0 | 1 (1.3%) | 0 | 1 (1.3%) |
| Unknown Subadult | 0 | 0 | 0 | 0 | 0 |
| Youth (17-20yrs) | 0 | 1 (1.3%) | 2 (2.7%) | 0 | 3 (4.1%) |
| Early Adult (21-25yrs) | 0 | 3 (4.1%) | 0 | 0 | 3 (4.1%) |
| Young Adult (26-35yrs) | 4 (5.4%) | 4 (5.4%) | 0 | 0 | 8 (10.8%) |
| Middle Aged (36-50yrs) | 6 (8.1%) | 5 (6.8%) | 0 | 1 (1.3%) | 12 (16.2%) |
| Old Adult (50yrs+) | 6 (8.1%) | 3 (4.1%) | 0 | 0 | 9 (12.2%) |
| Unknown Adult | 4 (5.4%) | 2 (2.7%) | 0 | 9 (12.2%) | 15 (20.3%) |
| Total | 20 (27.1%) | 18 (24.3%) | 26 (35.1%) | 10 (13.5%) | 74 (100%) |

*(N = number present)

**Table 9**: Number of individuals (N, %) per sample by age and sex group*

| Late Monongahela | Male | Female | Subadult | Unknown | Total |
|---|---|---|---|---|---|
| Fetus (<40 wks.) | 0 | 0 | 0 | 0 | 0 |
| Neonate (<6 mos.) | 0 | 0 | 4 (9.3%) | 0 | 4 (9.3%) |
| Toddler (6 mos-2yrs) | 0 | 0 | 4 (9.3%) | 0 | 4 (9.3%) |
| Early Child (3-6 yrs.) | 0 | 0 | 3 (6.9%) | 0 | 3 (6.9%) |
| Late Child (7-11yrs) | 0 | 0 | 0 | 0 | 0 |
| Adolescent (12-16yrs) | 0 | 0 | 1 (2.3%) | 0 | 1 (2.3%) |
| Unknown Subadult | 0 | 0 | 2 (4.7%) | 0 | 2 (4.7%) |
| Youth (17-20yrs) | 0 | 1 (2.3%) | 0 | 0 | 1 (2.3%) |
| Early Adult (21-25yrs) | 1 (2.3%) | 0 | 0 | 0 | 1 (2.3%) |
| Young Adult (26-35yrs) | 2 (4.7%) | 5 (11.5%) | 0 | 0 | 7 (16.3%) |
| Middle Aged (36-50yrs) | 2 (4.7%) | 3 (6.9%) | 0 | 0 | 5 (11.5%) |
| Old Adult (50yrs+) | 1 (2.3%) | 4 (9.3%) | 0 | 0 | 5 (11.5%) |
| Unknown Adult | 4 (9.3%) | 3 (6.9%) | 0 | 3 (6.9%) | 10 (23.3%) |
| Total | 10 (23.3%) | 16 (37.2%) | 14 (32.5%) | 3 (6.9%) | 43 (100%) |
| **Post-Contact** | **Male** | **Female** | **Subadult** | **Unknown** | **Total** |
| Fetus (<40 wks.) | 0 | 0 | 0 | 0 | 0 |
| Neonate (<6 mos.) | 0 | 0 | 0 | 0 | 0 |
| Toddler (6 mos-2yrs) | 0 | 0 | 3 (5.2%) | 0 | 3 (5.2%) |
| Early Child (3-6 yrs.) | 0 | 0 | 4 (6.9%) | 0 | 4 (6.9%) |
| Late Child (7-11yrs) | 0 | 0 | 2 (3.4%) | 0 | 2 (3.4%) |
| Adolescent (12-16yrs) | 0 | 0 | 4 (6.9%) | 0 | 4 (6.9%) |
| Unknown Subadult | 0 | 0 | 1 (1.7%) | 0 | 1 (1.7%) |
| Youth (17-20yrs) | 0 | 4 (6.9%) | 4 (6.9%) | 0 | 8 (13.8%) |
| Early Adult (21-25yrs) | 0 | 0 | 0 | 0 | 0 |
| Young Adult (26-35yrs) | 1 (1.7%) | 0 | 0 | 0 | 1 (1.7%) |
| Middle Aged (36-50yrs) | 3 (5.2%) | 4 (6.9%) | 0 | 0 | 7 (12.1%) |
| Old Adult (50yrs+) | 0 | 1 (1.7%) | 0 | 0 | 1 (1.7%) |
| Unknown Adult | 1 (1.7%) | 7 (12.1%) | 0 | 19 (32.8%) | 27 (46.6%) |
| Total | 5 (11.6%) | 16 (27.6%) | 18 (31.0%) | 19 (32.8%) | 58 (100%) |
| **Total Sample** | **Male** | **Female** | **Subadult** | **Unknown** | **Total** |
| Fetus (<40 wks.) | 0 | 0 | 5 (1.5%) | 0 | 5 (1.5%) |
| Neonate (<6 mos.) | 0 | 0 | 15 (4.5%) | 0 | 15 (4.5%) |
| Toddler (6 mos-2yrs) | 0 | 0 | 13 (3.9%) | 0 | 13 (3.9%) |
| Early Child (3-6 yrs.) | 0 | 0 | 19 (5.8%) | 0 | 19 (5.8%) |
| Late Child (7-11yrs) | 0 | 0 | 16 (4.8%) | 0 | 16 (4.8%) |
| Adolescent (12-16yrs) | 0 | 0 | 14 (4.2%) | 0 | 14 (4.2%) |
| Unknown Subadult | 0 | 0 | 5 (1.5%) | 0 | 1 (1.5%) |
| Youth (17-20yrs) | 0 | 11 (3.3%) | 11 (3.3%) | 0 | 22 (6.7%) |
| Early Adult (21-25yrs) | 1 (.3%) | 4 (1.2%) | 0 | 0 | 5 (1.5%) |
| Young Adult (26-35yrs) | 11 (3.3%) | 18 (5.4%) | 0 | 0 | 29 (8.8%) |
| Middle Aged (36-50yrs) | 16 (4.8%) | 14 (4.2%) | 0 | 0 | 30 (9.1%) |
| Old Adult (50yrs+) | 11 (3.3%) | 10 (3.0) | 0 | 0 | 21 (6.4%) |
| Unknown Adult | 20 (6.1%) | 27 (8.2%) | 0 | 90 (27.2%) | 137 (41.5%) |
| Total | 58 (17.9%) | 84 (25.5%) | 98 (29.7%) | 90 (27.2%) | 330 (100%) |

*(N = number present)

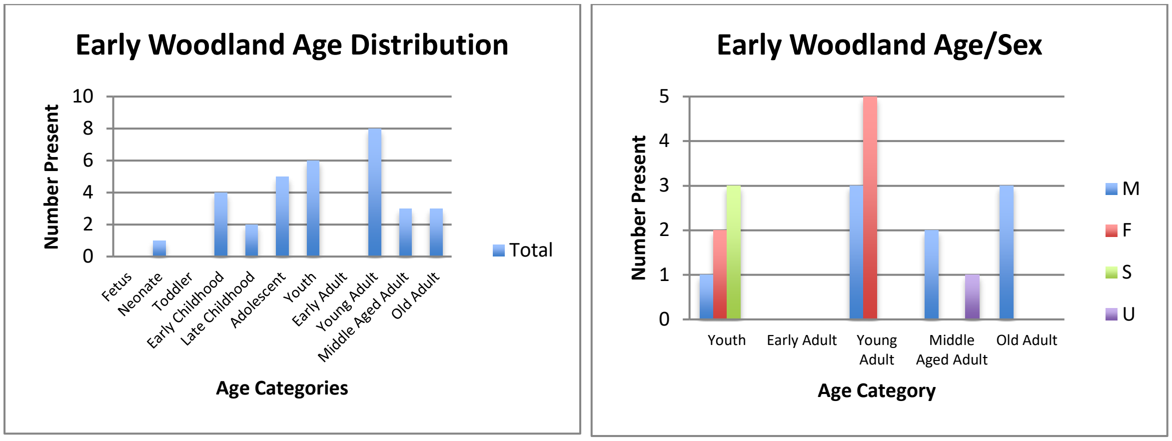



**Figure 20**: Bar graphs illustrating number of individuals by age and sex, Early Woodland sample

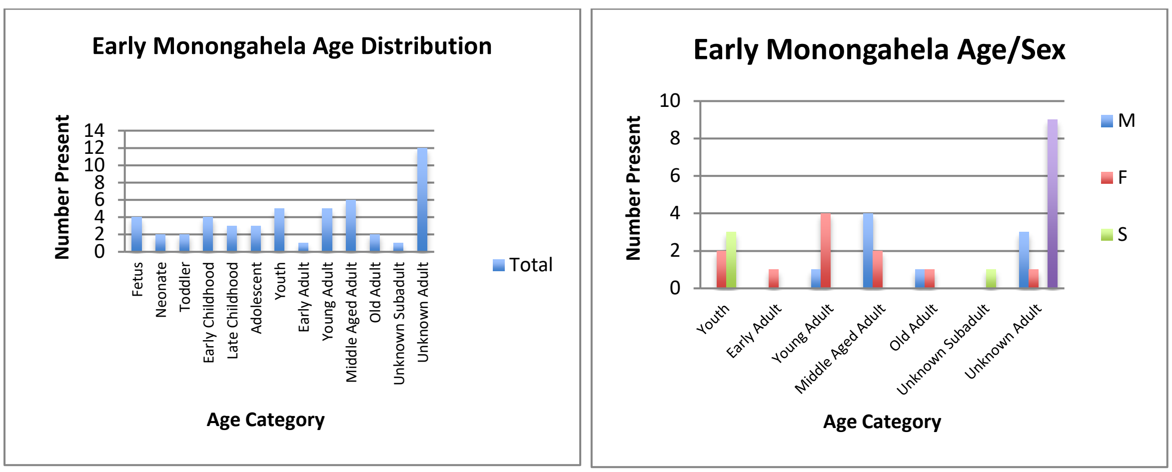



**Figure 21**: Bar graphs illustrating number of individuals by age/sex, Early Monongahela sample

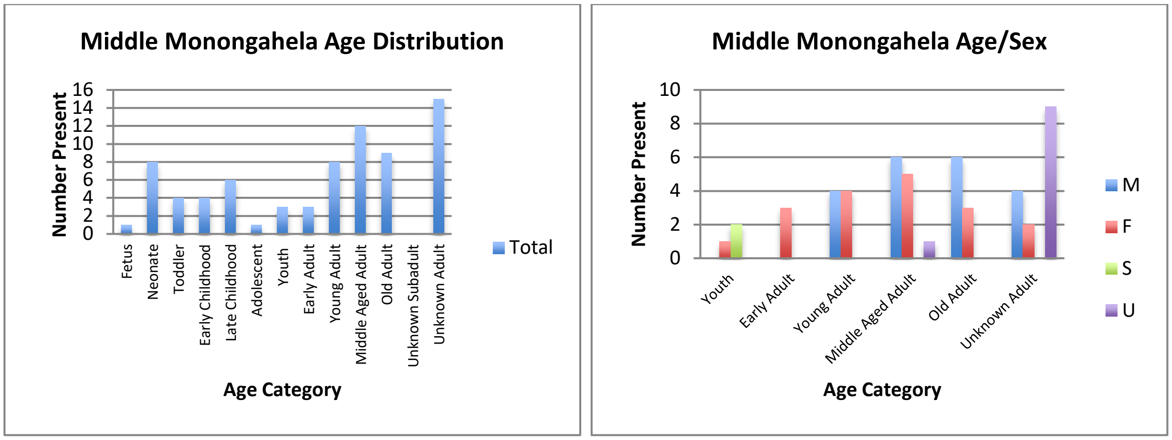



**Figure 22:** Bar graphs illustrating number of individuals by age/sex, Middle Monongahela sample

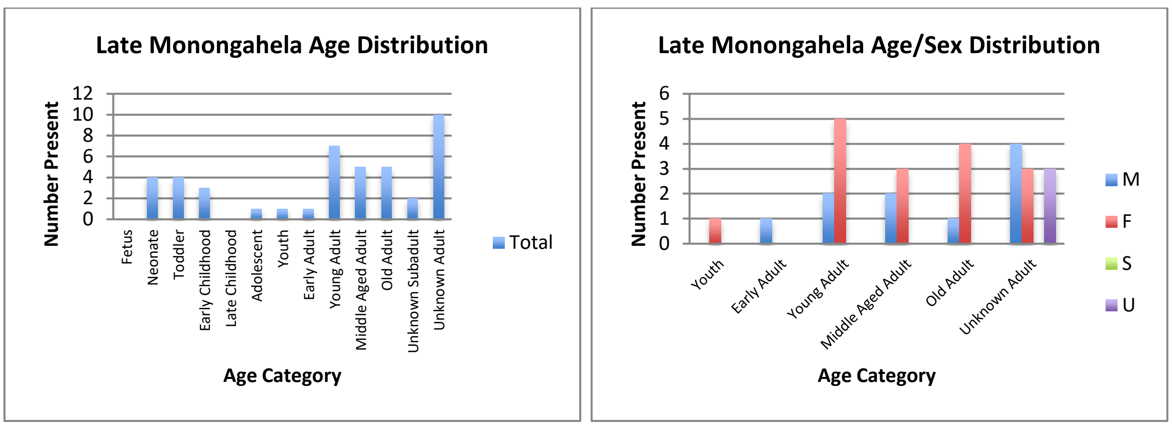
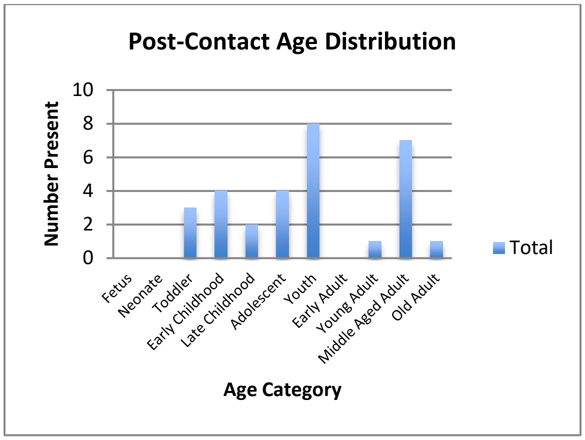



**Figure 23**: Bar graphs illustrating number of individuals by age/sex, Late Monongahela sample



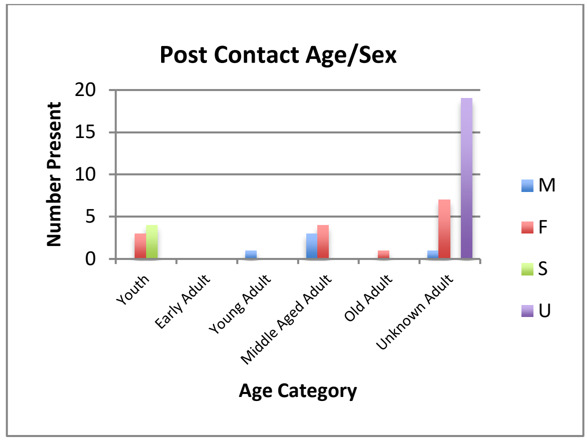




**Figure 24**: Bar graphs illustrating number of individuals by age/sex, Post-Contact sample

### 6.1.1 Paleodemography: Discussion

The Early Woodland period sample has a distinctive demographic pattern: a notable increase in the number of children in early childhood (n=4), and a marked increase of deaths amongst adolescents (n=5), youths (n=6), and young adults (n=8). This pattern typically indicates a catastrophic mortality profile (Gowland and Chamberlain 2004), but this conclusion should be interpreted carefully in light of two factors: skeletal preservation and sample representativeness. Sample preservation is of concern as most skeletal elements scored significantly lower in terms of preservation than in subsequent time periods (section 6.2 of this chapter), and many skeletal elements (e.g. crania and os coxae) were not preserved for analysis. Due to lack of preservation, sex and age could not be estimated for 72 skeletons, thus leaving only small sample sizes for each age category. The McKees Rocks Mound and Cresap Mound sample may also not be representative of the true age-at-death structure of the populations, as subadults were typically not present in Adena mound contexts (Milner 2004). Infant and neonate bones are more prone to damage from taphonomic processes, and therefore less likely to preserve (Lewis 2007). In examination of age/sex structure of the adult portion of the Early Woodland sample, it is observed that female mortality increased during youth and young adult ages. Some of these deaths may be attributed to maternal deaths, as childbirth is one of the leading causes of mortality in young females (Margerison and Knüsel 2002; Stone and Walrath 2006).

The Early Monongahela sample follows a pattern of attritional mortality. In this sample, the number of infant and early childhood deaths is higher than those of adolescents, though mortality increases amongst youths and young adults. Among young adults and youths, female deaths are markedly higher than for males, while male mortality increased among middle-aged adults. Mortality tapers in older adult age ranges, following both the attritional and catastrophic models (Gowland and Chamberlain 2004). Preservation is not as large of a confounding factor for the Early Monongahela sample as it was for the Early Woodland, though infant remains may not be as highly represented in any archaeological context due to taphonomic processes and differential burial practices of infants and young children (Baxter 2005; Lewis 2007).

The Middle Monongahela sample has a mortality profile highly indicative of attritional mortality. There are higher numbers of neonate (n=8), toddler (n=4), early childhood (n=4), and late childhood (n=6) deaths, with mortality tapering during adolescence (n=1). Youth (n=3) and early adult (n=3) deaths are also at low frequencies, whereas mortality increases markedly with young adults (n=8) and further with middle aged adults (n=12). When the adult age/sex structure is examined, it is evident that female mortality was not as marked in the Middle Monongahela sample as in previous periods, as the number of young adult deaths is equal for both males and females (n=4). Males outnumber female deaths among middle-aged and older adults, indicating that while male and female deaths were equal in younger ages, males were more likely to live to older age.

The mortality of profile of the Late Monongahela sample is similar to that of the Middle Monongahela sample and characteristic of attritional mortality: a higher number of neonate and childhood deaths, with mortality markedly decreasing at adolescence and increasing in young and middle aged adults. When the sex structure of adult age ranges is examined, it is observed that, unlike the Middle Monongahela sample, female deaths (n=5) are greater in number than those of males (n=2). This pattern is indicative of maternal mortality though this is a small sample size so chronic or acute disease cannot be ruled out (Margerison and Knüsel 2002).

The age structure of the Post-Contact sample is representative of a catastrophic mortality profile: a higher number of deaths in the toddler age (n=3), early (n=5) and late childhood (n=2), adolescence (n=4) and youth (n=8) than in an attritional pattern. Among adults, the middle-aged group has the greatest number of individuals in the sample (n=7). Given that this sample represents a population of Native Americans in the colonial era, it is likely that European diseases such as smallpox or measles may have caused higher mortality among adolescents and youths as such acute diseases had deleterious effects on indigenous populations (Silliman 2005; Ubelaker 1992).

Historical reports supported a catastrophic mortality pattern for this sample. British sources reported smallpox epidemics among indigenous communities in the Ohio country following raids from the British in 1756 and 1757AD (Heckewelder n.d: 38; Morris 1756). Upon examination of the age/sex structure, several mortality features of this sample emerge. First, the number of females (n=16) is much higher than the number of males (n=5). Historical documentation indicated that the Delaware were engaged in anti-British raiding as well as other conflicts such as Pontiac's Rebellion and the French and Indian War during the time of occupation at the towns associated with this cemetery sample, with males participating as guides and in war parties (LeRoy and Leininger n.d.: 407-420; M'Cullough n.d: 87-113). Additionally, there were not larger numbers of females in the younger age groups in the Post-Contact sample, indicating a reduction in maternal mortality from subsequent periods (Margerison and Knüsel 2002).

Comparing the catastrophic mortality profile from the Post-Contact sample with the profiles from earlier periods, notable differences emerge. The Early, Middle, and Late Monongahela periods were characterized by an attritional mortality profile, whereas the Early Woodland sample reflected an ambiguous profile due to preservation.

Attritional mortality was expected for these earlier time periods, as demonstrated by studies of other large pre-contact Native American assemblages in the Northeast (Herrmann and Konigsberg 2002). For example, the skeletal assemblage from Indian Knoll, Kentucky spanned from the Archaic Period until into the Mississippian era (5000BP-500BP). Herrmann and Konigsberg (2002) modeled mortality and survivorship in this assemblage and reported a characteristic attritional mortality profile. This comparison shows that after contact, biological agents transmitted from European groups into indigenous populations had a notable effect on mortality (Silliman 2005; Ubelaker 1992). Among Iroquoians, there was no recorded evidence of any significant outbreak of European disease prior to the mid-17th century when Huron populations experienced marked declines due to outbreaks of measles and smallpox (Warrick 2003). The Post-Contact sample aligns with this pattern and shows that well into the colonial era of the 18th century, both disease and conflict likely contributed to the decline of indigenous populations in the western Pennsylvania region (Ubelaker 1992). While demographic collapse is a significant facet of contact and colonialism in the Americas, the Post-Contact sample represents only a glimpse of one population at one moment in time. However, while communities may experience some re-growth after a period of decline, they were likely never able to recover pre-contact population size (Ubelaker 1992).

## 6.2 COMPLETENESS AND PRESERVATION

### 6.2.1 Completeness

Completeness score ranges and means by time period are tabulated (Table 10). P-values for statistical tests of completeness scores are listed by time period in Table 11 (See Appendix A, Tables 137-141 for bone counts and percentages by sex). When samples were compared by time period, the Early Woodland sample had the lowest mean; all of the Monongahela groups and the Post-Contact sample had significantly higher scores. The Monongahela samples also scored significantly higher than the Post-Contact sample. There was no significant difference between the Early, Middle, and Late Monongahela groups.

**Table 10:** Completeness score ranges and means by time period

| Time Period | Score Range | Mean |
|---|---|---|
| Early Woodland | 0.17 – 51.73 | 4.11 |
| Early Monongahela | 0.30 – 83.04 | 33.67 |
| Middle Monongahela | 0.23 – 83.08 | 37.14 |
| Late Monongahela | 0.51 – 81.27 | 35.82 |
| Post-Contact | 0.39 – 47.37 | 13.43 |

**Table 11**: P-values from Bonferroni post-hoc analysis of One-Way ANOVA, completeness scores by time period*

| Comparison of Time Periods by One Way ANOVA | P-value |
|---|---|
| Early Woodland vs. Early Monongahela | **.000** |
| Early Woodland vs. Middle Monongahela | **.000** |
| Early Woodland vs. Late Monongahela | **.000** |
| Early Woodland vs. Post-Contact | **.028** |
| Early Monongahela vs. Middle Monongahela | 1.000 |
| Early Monongahela vs. Late Monongahela | 1.000 |
| Early Monongahela vs. Post-Contact | **.000** |
| Middle Monongahela vs. Late Monongahela | 1.000 |
| Middle Monongahela vs. Post-Contact | **.000** |
| Late Monongahela vs. Post-Contact | **.000** |

*significant p-values bolded (p≤.05)

### 6.2.2 Preservation

Mean preservation scores and p-values for each anatomical region are presented in Tables 12-13. Mean asymmetry scores are listed in Table 14 by time period. Preservation scores were averaged per region (cranium, right and left upper limb, axial skeleton, right and left lower limb). When compared by time period and region, the Early Woodland had the highest scores for surface preservation (greatest surface erosion) with the Monongahela samples scoring the lowest (little surface erosion). The Early Woodland mean preservation scores were significantly higher than the Monongahela and Post-Contact groups. The Post-Contact group also scored significantly higher than the Monongahela samples for multiple regions. Asymmetry scores were calculated for the upper and lower limb (left – right = score). There was no significant difference in mean asymmetry score between samples.

**Table 12**: Mean preservation score by skeletal region and time period

| Time Period | Cranium | Upper Limb | | Axial | Lower Limb | |
|---|---|---|---|---|---|---|
| | | L | R | | L | R |
| Early Woodland | 2.56 | 3.02 | 2.93 | 3.00 | 3.14 | 3.24 |
| Early Monongahela | 1.90 | 2.00 | 2.05 | 2.19 | 2.18 | 2.12 |
| Middle Monongahela | 2.04 | 1.89 | 1.89 | 2.02 | 1.91 | 1.95 |
| Late Monongahela | 2.16 | 2.13 | 2.02 | 2.28 | 2.05 | 2.00 |
| Post-Contact | 2.04 | 2.44 | 2.64 | 2.33 | 2.94 | 2.92 |

**Table 13**: P-values of Kruskall Wallis post-hoc analysis - preservation by skeletal region and time period*

| Time Period | Cranium | Upper Limb | | Axial | Lower Limb | |
|---|---|---|---|---|---|---|
| | | L | R | | L | R |
| Early Woodland vs. Early Monongahela | **.000** | **.000** | **.000** | **.000** | **.000** | **.000** |
| Early Woodland vs. Middle Monongahela | **.000** | **.000** | **.000** | **.000** | **.000** | **.000** |
| Early Woodland vs. Late Monongahela | **.018** | **.000** | **.000** | **.000** | **.000** | **.000** |
| Early Woodland vs. Post-Contact | **.001** | **.002** | .176 | **.000** | .322 | .092 |
| Early Monongahela vs. Middle Monongahela | **.305** | .467 | .935 | .238 | .073 | .241 |
| Early Monongahela vs. Late Monongahela | .194 | .395 | .980 | .534 | .448 | .482 |
| Early Monongahela vs. Post-Contact | .440 | **.008** | **.001** | .293 | **.000** | **.000** |
| Middle Monongahela vs. Late Monongahela | .630 | .097 | .360 | .070 | .359 | .716 |
| Middle Monongahela vs. Post-Contact | .839 | **.000** | **.001** | **.019** | **.000** | **.000** |
| Late Monongahela vs. Post-Contact | .534 | .076 | **.001** | .698 | **.000** | **.000** |

*significant p-values bolded (p≤.05)

**Table 14:** Mean symmetry scores for the upper and lower limbs by time period*

| Time Period | Upper Limb | Lower Limb |
|---|---|---|
| Early Woodland | .0667 | -.1333 |
| Early Monongahela | -.0877 | .0000 |
| Middle Monongahela | -.0182 | -.0182 |
| Late Monongahela | .0938 | .0625 |
| Post-Contact | -.1379 | .1379 |

* negative scores indicate higher (poor) preservation score of the left limb, positive scores indicate higher score for the right limb

### 6.2.3 Discussion: Completeness and Preservation

Completeness scores show a preservation bias for several samples in this study. The Early Woodland sample had an average completeness score of only 4.11; skeletons ranged in completeness from comparatively complete (>50% complete) to only a few fragments. Completeness scores were expected to be low and preservation was expected to be poor for these burial mounds in comparison with later periods due to site antiquity and the fragmentary nature of the remains. Burials from this sample varied by type and location. Twenty-seven were secondary burials and the relatively poor preservation of the skeletons from these contexts supports this conclusion from the original excavation reports (Dragoo 1963). Secondary bundle burials are common in Adena contexts (Milner 2004). At the Cresap site, there were multiple secondary inhumations, including those from Feature 29 consisting of 6 crania arranged in a circle around a central cache of bone fragments and lithic points (Andrews and Bello 2006, Dragoo

1963). These 6 crania were poorly preserved (score of 4-5 on the Brickley and McKinley scale) and consisted only of several fragments and teeth. Primary inhumations from the Early Woodland sample generally had higher completeness and lower preservation scores, such as the primary log tomb burial from the Cresap site (Dragoo 1963). Asymmetry in surface preservation is also indicated for this sample by mean scores for the upper and lower limb; the right upper limb was generally more poorly preserved than the left, though the opposite pattern was observed for the lower limb. This likely has little to do with the position of the body for this sample as burial types were highly varied (Dragoo 1963).

The Monongahela samples were the most complete in this study, with no significant difference in completeness and preservation scores for Early, Middle, and Late periods. Mean asymmetry scores for limb preservation indicated asymmetry for these samples. The Early Monongahela score (-.0877) indicates that the upper left limb had more cortical damage than the right. Burial patterns for this sample reflect this observation for adults in flexed burials, a greater number were buried lying on the left side (n=14). This pattern is replicated for the Middle Monongahela sample, which has an asymmetry score of -.0182 for both the upper and lower limbs, with 8 right-sided burials and 7 left sided burials. However, the Late Monongahela sample shows the opposite pattern for positive asymmetry scores for the upper limb (.0938) and lower limb (.0625). Of the burials with recorded data on body position, the majority were flexed burials on the right side (n=7, left sided n=3). These patterns suggest that burial position affected cortical surface erosion, with flexed burials having higher preservation scores on the side the body was placed on during burial.

The Post-Contact sample was not as complete or well-preserved as the Monongahela samples, with a mean completeness score of 13.43, though there was a wide range of completeness. Preservation did not vary by burial type or body treatment, as these represented extended inhumations from the mid-18$^{th}$ century. The use of coffins was indicated by the presence of nails in each burial, plus archaeological documentation that the Delaware may have adopted European style mortuary treatments (Ferris 2009; McConnell 1992; Zakucia 1960). Preservation may also have been greatly affected by the post-excavation treatment of the remains, since these burials were stored in a garage facility for some time before being curated at the Carnegie Museum of Natural History (Verna Cowin, pers. comm).

## 6.3 DENTAL DISEASE

Dental disease and statistical results are discussed by individual and by tooth type. Pathology frequencies by tooth are presented in Appendix A (Tables 142-159).

### 6.3.1 Dental Inventory

Expected counts, observed number, and frequency of tooth presence are listed in Table 15 for adults. Deciduous dentition is inventoried in Table 16, and permanent tooth inventories of subadults with mixed dentitions are listed in Table 17. Overall, the best-represented sample for the dentition was the Early Monongahela, with Early Woodland having the lowest percentage of available teeth. For the adults, Early Monongahela females (64.5%) had the highest percentage of teeth present, followed by Post-Contact males (64.3%). The lowest frequency of tooth preservation was Middle Monongahela adults of unknown sex (7.8%).  For the deciduous dentition, the Middle and Late Monongahela samples were best represented, whereas mixed-dentition preservation was highest for Post-Contact subadults.

**Table 15:** Adult dental inventory by time period and sex*

| | Incisors | | | Canines | | | Premolars | | | Molars | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| EW Males | 136 | 25 | 18.3 | 68 | 21 | 30.8 | 136 | 45 | 33.1 | 204 | 55 | 26.9 | 544 | 146 | 26.8 |
| EW Females | 168 | 14 | 8.3 | 84 | 10 | 11.9 | 168 | 25 | 14.8 | 252 | 39 | 15.4 | 672 | 88 | 13.1 |
| EW Unkn | 408 | 15 | 3.7 | 204 | 17 | 8.3 | 408 | 44 | 10.7 | 612 | 113 | 18.4 | 1632 | 189 | 11.5 |
| **EW Total** | **712** | **54** | **7.6** | **356** | **48** | **13.4** | **712** | **114** | **16.0** | **1068** | **207** | **19.3** | **2848** | **423** | **14.9** |
| EM Males | 72 | 15 | 20.8 | 36 | 12 | 33.3 | 72 | 18 | 25 | 108 | 22 | 20.4 | 288 | 67 | 23.3 |
| EM Females | 88 | 50 | 56.8 | 44 | 31 | 70.4 | 88 | 59 | 67 | 132 | 74 | 56.1 | 352 | 227 | 64.5 |
| EM Unkn | 72 | 21 | 29.1 | 36 | 11 | 30.6 | 72 | 34 | 47.2 | 108 | 33 | 30.5 | 288 | 99 | 34.4 |
| **EM Total** | **232** | **86** | **37.1** | **116** | **54** | **46.6** | **232** | **111** | **47.3** | **348** | **129** | **37.1** | **928** | **393** | **42.3** |
| MM Males | 160 | 58 | 36.2 | 80 | 37 | 46.2 | 160 | 60 | 37.5 | 240 | 51 | 21.3 | 640 | 206 | 32.2 |
| MM Females | 144 | 49 | 34 | 72 | 30 | 41.7 | 144 | 53 | 36.8 | 216 | 51 | 23.6 | 576 | 183 | 31.7 |
| MM Unkn | 80 | 10 | 12.5 | 40 | 1 | 2.5 | 80 | 6 | 7.5 | 120 | 8 | 6.7 | 320 | 25 | 7.8 |
| **MM Total** | **384** | **117** | **30.4** | **192** | **68** | **35.4** | **384** | **119** | **40** | **576** | **110** | **19.1** | **1536** | **414** | **27** |
| LM Males | 80 | 33 | 41.3 | 40 | 20 | 50 | 80 | 75 | 93.7 | 120 | 30 | 25 | 320 | 158 | 49.3 |
| LM Females | 128 | 44 | 34.4 | 64 | 24 | 37.5 | 128 | 80 | 64 | 192 | 55 | 28.7 | 512 | 203 | 39.6 |
| LM Unkn | 24 | 3 | 12.5 | 12 | 2 | 16.6 | 24 | 1 | 4.2 | 36 | 6 | 16.6 | 96 | 12 | 12.5 |
| **LM Total** | **232** | **80** | **34.5** | **116** | **46** | **39.6** | **232** | **156** | **67.2** | **348** | **91** | **26.1** | **928** | **373** | **40.2** |
| PC Males | 40 | 23 | 57.5 | 20 | 13 | 65 | 40 | 28 | 70 | 60 | 39 | 65 | 160 | 103 | 64.3 |
| PC Females | 128 | 41 | 32 | 64 | 38 | 59.3 | 128 | 87 | 67.9 | 192 | 144 | 75 | 512 | 310 | 60.5 |
| PC Unkn | 152 | 17 | 8.9 | 76 | 12 | 15.8 | 152 | 26 | 17.1 | 228 | 49 | 21.5 | 608 | 75 | 12.3 |
| **PC Total** | **320** | **81** | **25.3** | **160** | **63** | **38.6** | **320** | **141** | **44.1** | **480** | **232** | **48.3** | **1280** | **488** | **38.1** |
| TOTAL Males | 488 | 154 | 31.5 | 244 | 103 | 42.2 | 488 | 226 | 46.3 | 732 | 197 | 26.9 | 1952 | 680 | 34.8 |
| TOTAL Females | 656 | 198 | 30.1 | 328 | 133 | 40.5 | 656 | 304 | 46.3 | 984 | 363 | 36.8 | 2624 | 1011 | 38.5 |
| TOTAL Unkn | 736 | 66 | 8.9 | 368 | 52 | 14.1 | 736 | 165 | 20.4 | 1104 | 209 | 18.8 | 2944 | 400 | 13.5 |
| **TOTAL Sample** | **1880** | **418** | **22.2** | **940** | **288** | **30.6** | **1880** | **695** | **36.9** | **2820** | **769** | **27.3** | **7520** | **2091** | **27.8** |

*(N = expected, n = present)

**Table 16:** Deciduous dental inventory by time period*

| | Incisors | | | Canines | | | Molars | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| EW Subadults | 128 | 0 | 0 | 64 | 3 | 4.7 | 128 | 10 | 7.8 | 320 | 13 | 4.1 |
| EM Subadults | 168 | 23 | 13.7 | 84 | 17 | 20.2 | 168 | 53 | 31.5 | 420 | 93 | 22.1 |
| MM Subadults | 208 | 61 | 29.3 | 104 | 42 | 40.4 | 208 | 89 | 42.8 | 520 | 192 | 36.9 |
| LM Subadults | 112 | 28 | 25 | 56 | 19 | 33.9 | 112 | 57 | 50.9 | 280 | 103 | 36.8 |
| PC Subadults | 144 | 10 | 6.9 | 72 | 9 | 12.5 | 144 | 57 | 39.6 | 360 | 76 | 21.1 |
| **TOTAL** | **760** | **122** | **16.1** | **380** | **90** | **23.7** | **760** | **266** | **35** | **1900** | **477** | **25.1** |

*(N = expected, n = present)

**Table 17:** Mixed dentition permanent tooth subadult inventory by time period*

| | Incisors | | | Canines | | | Premolars | | | Molars | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| EW Subadult | 128 | 9 | 7 | 64 | 6 | 9.3 | 128 | 19 | 14.8 | 192 | 36 | 18.7 | 384 | 70 | 18.2 |
| EM Subadult | 168 | 40 | 23.8 | 84 | 26 | 30.9 | 168 | 37 | 22 | 252 | 80 | 31.7 | 672 | 183 | 27.2 |
| MM Subadult | 208 | 68 | 32.7 | 104 | 38 | 36.5 | 208 | 60 | 28.8 | 312 | 87 | 27.8 | 832 | 253 | 30.4 |
| LM Subadult | 112 | 10 | 8.9 | 56 | 7 | 12.5 | 112 | 9 | 8 | 168 | 30 | 17.8 | 464 | 56 | 12.1 |
| PC Subadult | 144 | 50 | 34.7 | 72 | 26 | 36.1 | 144 | 95 | 65.9 | 216 | 84 | 38.9 | 576 | 255 | 44.2 |
| **TOTAL Sample** | **760** | **177** | **23.2** | **280** | **93** | **33.2** | **760** | **220** | **28.8** | **1140** | **317** | **27.8** | **2928** | **817** | **27.9** |

*(N = expected, n = present)

### 6.3.2 Dental Disease

Individual frequencies for dental disease are listed in Table 18 by time period and sex, and statistical results for individual frequencies by time period and sex are listed in Tables 19-20. Dental disease by tooth count is listed in Table 21 by time period and sex, followed by statistical analysis in Tables 22-24. Photographs of each condition follow the discussion in Figures 25-29. For individual frequencies, the Middle Monongahela had the highest rates of dental pathology. Early Monongahela females and Middle Monongahela males had the highest rates of dental disease when frequencies were compared by sex, specifically AMTL, caries, and periodontal disease. When using percentage of affected teeth as a comparative statistic, the Middle and Late Monongahela samples had the highest percentages of teeth affected by AMTL, caries and periodontal disease. In contrast, the Post-Contact sample had the highest rates of calculus when compared with both individual frequencies and percentage of affected teeth. Statistical analyses demonstrated that for individual frequency, the Middle Monongahela had the highest rates of dental disease except for calculus (Table 20). For tooth count, the Monongahela samples scored significantly higher than Early Woodland and Post-Contact groups (Tables 22-23); males had significantly higher rates of periodontitis (Table 24).

#### 6.3.2.1 Dental Disease Frequency by Individuals

**Table 18**: Individual dental disease rates by sex and time period*

| | **Antemortem Tooth Loss** | | | **Caries** | | | **Periodontal Disease** | | | **Calculus** | | | **Abscess** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| EW Males | 17 | 3 | 17.6 | 17 | 3 | 17.6 | 17 | 3 | 17.3 | 17 | 0 | 0 | 17 | 0 | 0 |
| EW Females | 21 | 2 | 9.5 | 21 | 8 | 38.1 | 21 | 3 | 14.3 | 21 | 2 | 9.5 | 21 | 3 | 14.2 |
| EW Subadults | 16 | 0 | 0 | 16 | 0 | 0 | 16 | 0 | 0 | 16 | 0 | 0 | 16 | 0 | 0 |
| EW Unknown | 51 | 1 | 1.9 | 51 | 1 | 1.9 | 51 | 1 | 1.9 | 51 | 1 | 1.9 | 51 | 0 | 0 |
| **EW Total** | **105** | **6** | **5.7** | **105** | **12** | **11.5** | **105** | **7** | **6.7** | **105** | **3** | **2.8** | **105** | **3** | **2.9** |
| EM Males | 9 | 6 | 66.6 | 9 | 3 | 33.3 | 9 | 5 | 55.6 | 9 | 2 | 22.2 | 9 | 1 | 11.1 |
| EM Females | 11 | 5 | 45.5 | 11 | 7 | 63.6 | 11 | 7 | 63.6 | 11 | 1 | 9.1 | 11 | 2 | 18.1 |
| EM Subadults | 21 | 0 | 0 | 21 | 3 | 14.3 | 21 | 0 | 0 | 21 | 0 | 0 | 21 | 0 | 0 |
| EM Unknown | 9 | 0 | 0 | 9 | 2 | 22.2 | 9 | 0 | 0 | 9 | 0 | 0 | 9 | 0 | 0 |
| **EM Total** | **50** | **11** | **22** | **50** | **15** | **30** | **50** | **12** | **24** | **50** | **3** | **6** | **50** | **3** | **6** |
| MM Males | 20 | 13 | 65 | 20 | 10 | 50 | 20 | 14 | 70 | 20 | 2 | 10 | 20 | 6 | 30 |
| MM Females | 18 | 10 | 55.5 | 18 | 9 | 50 | 18 | 11 | 61.1 | 18 | 2 | 11.1 | 18 | 3 | 15.7 |
| MM Subadults | 26 | 0 | 0 | 26 | 1 | 3.8 | 26 | 0 | 0 | 26 | 1 | 3.8 | 26 | 0 | 0 |
| MM Unknown | 10 | 2 | 20 | 10 | 1 | 10 | 10 | 1 | 10 | 10 | 1 | 10 | 10 | 0 | 0 |
| **MM Total** | **74** | **25** | **33.7** | **74** | **21** | **28.3** | **74** | **26** | **35.1** | **74** | **6** | **8.1** | **74** | **9** | **12.2** |
| LM Males | 10 | 7 | 70 | 10 | 6 | 60 | 10 | 7 | 70 | 10 | 1 | 10 | 10 | 1 | 10 |
| LM Females | 16 | 5 | 31.3 | 16 | 6 | 37.5 | 16 | 7 | 43.8 | 16 | 1 | 6.3 | 16 | 4 | 25 |
| LM Subadults | 14 | 0 | 0 | 14 | 1 | 7.1 | 14 | 0 | 0 | 14 | 1 | 7.1 | 14 | 0 | 0 |
| LM Unknown | 3 | 1 | 33.3 | 3 | 0 | 0 | 3 | 1 | 33.3 | 3 | 0 | 0 | 3 | 0 | 0 |
| **LM Total** | **43** | **13** | **30.2** | **43** | **13** | **30.2** | **43** | **15** | **34.9** | **43** | **3** | **6.9** | **43** | **5** | **11.6** |
| PC Males | 5 | 1 | 20 | 5 | 1 | 20 | 5 | 2 | 40 | 5 | 2 | 40 | 5 | 0 | 0 |
| PC Females | 16 | 6 | 37.5 | 16 | 8 | 50 | 16 | 10 | 62.5 | 16 | 10 | 62.5 | 16 | 0 | 0 |
| PC Subadults | 18 | 0 | 0 | 18 | 0 | 0 | 18 | 0 | 0 | 18 | 4 | 22.2 | 18 | 0 | 0 |
| PC Unknown | 19 | 1 | 5.2 | 19 | 4 | 21.1 | 19 | 2 | 10.5 | 19 | 5 | 26.3 | 19 | 0 | 9 |
| **PC Total** | **58** | **8** | **13.7** | **58** | **13** | **22.4** | **58** | **14** | **24.1** | **58** | **21** | **36.2** | **58** | **0** | **0** |
| TOTAL Males | 61 | 30 | 49.1 | 61 | 23 | 37.7 | 61 | 31 | 50.8 | 61 | 7 | 11.4 | 61 | 8 | 13.1 |
| TOTAL Females | 82 | 28 | 34.1 | 82 | 38 | 46.3 | 82 | 38 | 46.3 | 82 | 16 | 19.5 | 82 | 10 | 12.1 |
| TOTAL Subadults | 95 | 0 | 0 | 95 | 10 | 10.5 | 95 | 0 | 0 | 95 | 5 | 5.2 | 95 | 0 | 0 |
| TOTAL Unknown | 92 | 5 | 5.4 | 92 | 8 | 8.7 | 92 | 5 | 5.4 | 92 | 7 | 7.6 | 92 | 0 | 0 |
| **TOTAL Sample** | **330** | **63** | **19.1** | **330** | **79** | **23.9** | **330** | **74** | **22.4** | **330** | **80** | **24.2** | **330** | **18** | **5.4** |

*(N = number present, n = number affected)

**Table 19:** Comparison of individuals affected by dental disease by time period $X^2$ test*

| Time Period | EW | EM | MM | LM | PC | $X^2$ |
|---|---|---|---|---|---|---|
| AMTL | 6 | 11 | 25 | 13 | 8 | **.000** |
| Caries | 12 | 15 | 26 | 13 | 13 | **.003** |
| Periodontal Disease | 7 | 12 | 26 | 15 | 14 | **.000** |
| Calculus | 3 | 3 | 6 | 3 | 21 | **.000** |
| Abscess | 3 | 3 | 9 | 5 | 0 | **.012** |

*significant p-values bolded ($p \leq .05$)

**Table 20**: Comparison of individuals affected by dental disease by time period and sex, $X^2$ test*

| AMTL | | | |
|---|---|---|---|
| **Time Period** | **Male** | **Female** | **$X^2$** |
| Early Woodland | 3 | 2 | .461 |
| Early Monongahela | 6 | 5 | .342 |
| Middle Monongahela | 13 | 10 | .552 |
| Late Monongahela | 7 | 5 | .054 |
| Post-Contact | 1 | 6 | .772 |
| Total Sample | 30 | 28 | .070 |
| **CARIES** | | | |
| **Time Period** | **Male** | **Female** | **$X^2$** |
| Early Woodland | 3 | 8 | .445 |
| Early Monongahela | 3 | 7 | .177 |
| Middle Monongahela | 10 | 9 | .227 |
| Late Monongahela | 6 | 6 | .262 |
| Post Contact | 1 | 8 | .557 |
| Total Sample | 23 | 38 | .307 |
| **PERIODONTAL DISEASE** | | | |
| **Time Period** | **Male** | **Female** | **$X^2$** |
| Early Woodland | 3 | 3 | .778 |
| Early Monongahela | 5 | 7 | .713 |
| Middle Monongahela | 14 | 11 | .564 |
| Late Monongahela | 7 | 7 | .191 |
| Post-Contact | 2 | 10 | .374 |
| **Total Sample** | 31 | 38 | .596 |
| **CALCULUS** | | | |
| **Time Period** | **Male** | **Female** | **$X^2$** |
| Early Woodland | 0 | 2 | .191 |
| Early Monongahela | 2 | 1 | .413 |
| Middle Monongahela | 2 | 2 | .991 |
| Late Monongahela | 1 | 1 | .727 |
| Post-Contact | 2 | 10 | .374 |
| **Total Sample** | 7 | 16 | .191 |
| **ABSCESS** | | | |
| **Time Period** | **Male** | **Female** | **$X^2$** |
| Early Woodland | 0 | 3 | .104 |
| Early Monongahela | 1 | 2 | .659 |
| Middle Monongahela | 6 | 3 | .334 |
| Late Monongahela | 1 | 4 | .345 |
| Post-Contact | 0 | 0 | 1.00 |
| **Total Sample** | 8 | 10 | .869 |

*significant p-values bolded ($p \leq .05$)

#### 6.3.2.2 Dental Disease Frequencies by Tooth Count

**Table 21:** Dental disease rates by tooth count, time period and sex*

| | Antemortem Tooth Loss | | | Caries | | | Periodontal Disease | | | Calculus | | | Abscess | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| EW Males | 116 | 9 | 7.8 | 146 | 3 | 2.1 | 116 | 15 | 12.9 | 146 | 0 | 0 | 146 | 0 | 0 |
| EW Females | 192 | 11 | 5.7 | 88 | 8 | 9.1 | 192 | 15 | 7.8 | 88 | 20 | 22.7 | 88 | 3 | 3.4 |
| EW Subadults | 70 | 0 | 0 | 70 | 0 | 0 | 70 | 0 | 0 | 70 | 0 | 0 | 70 | 0 | 0 |
| EW Unknown | 239 | 7 | 2.9 | 189 | 1 | 1 | 239 | 7 | 2.9 | 189 | 4 | 2.1 | 189 | 0 | 0 |
| **EW Total** | **617** | **27** | **4.4** | **493** | **12** | **2.4** | **617** | **37** | **5.9** | **493** | **24** | **4.9** | **493** | **3** | **1** |
| EM Males | 149 | 49 | 32.9 | 67 | 28 | 41.7 | 149 | 93 | 62.4 | 67 | 3 | 44.8 | 67 | 2 | 3.5 |
| EM Females | 295 | 36 | 12.2 | 214 | 14 | 6.5 | 295 | 116 | 39.3 | 214 | 16 | 7.5 | 214 | 3 | 4.9 |
| EM Subadults | 183 | 0 | 0 | 183 | 3 | 1.6 | 183 | 0 | 0 | 183 | 0 | 0 | 183 | 0 | 0 |
| EM Unknown | 97 | 0 | 0 | 99 | 7 | 7.1 | 97 | 1 | 1 | 99 | 0 | 0 | 99 | 0 | 0 |
| **EM Total** | **724** | **85** | **11.7** | **563** | **52** | **9.2** | **724** | **210** | **29** | **563** | **19** | **3.4** | **563** | **5** | **1** |
| MM Males | 439 | 126 | 28.7 | 206 | 33 | 16 | 439 | 293 | 66.7 | 206 | 11 | 5.3 | 206 | 6 | 2.9 |
| MM Females | 441 | 119 | 26.5 | 183 | 26 | 14.2 | 441 | 145 | 32.9 | 183 | 6 | 3.3 | 183 | 5 | 2.7 |
| MM Subadults | 253 | 0 | 0 | 253 | 1 | 1 | 253 | 0 | 0 | 253 | 1 | 1 | 253 | 0 | 0 |
| MM Unknown | 67 | 5 | 7.5 | 19 | 1 | 5.3 | 67 | 11 | 16.4 | 19 | 1 | 5.2 | 19 | 0 | 0 |
| **MM Total** | **1200** | **250** | **20.8** | **661** | **63** | **9.5** | **1200** | **449** | **37.4** | **661** | **19** | **2.9** | **661** | **11** | **1.7** |
| LM Males | 212 | 56 | 26.4 | 158 | 13 | 8.2 | 212 | 104 | 49.1 | 158 | 8 | 5.1 | 158 | 5 | 3.2 |
| LM Females | 257 | 36 | 14 | 203 | 19 | 9.4 | 257 | 139 | 54.1 | 203 | 14 | 6.8 | 203 | 5 | 2.5 |
| LM Subadults | 56 | 0 | 0 | 56 | 1 | 1.7 | 96 | 0 | 0 | 56 | 1 | 1.8 | 56 | 0 | 0 |
| LM Unknown | 6 | 0 | 0 | 12 | 0 | 0 | 6 | 6 | 100 | 12 | 0 | 0 | 12 | 0 | 0 |
| **LM Total** | **531** | **92** | **17.3** | **429** | **33** | **7.7** | **531** | **249** | **46.9** | **429** | **23** | **5.4** | **429** | **10** | **2.3** |

*(N = number teeth present, n = number teeth affected)

**Table 21:** (continued)

| | Antemortem Tooth Loss | | | Caries | | | Periodontal Disease | | | Calculus | | | Abscess | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| PC Males | 128 | 1 | 1 | 103 | 3 | 2.9 | 128 | 22 | 17.2 | 103 | 54 | 52.4 | 103 | 0 | 0 |
| PC Females | 489 | 20 | 4.1 | 310 | 23 | 7.4 | 489 | 61 | 12.5 | 310 | 128 | 41.3 | 310 | 0 | 0 |
| PC Subadults | 255 | 0 | 0 | 255 | 0 | 0 | 255 | 0 | 0 | 255 | 5 | 1.9 | 255 | 0 | 0 |
| PC Unknown | 151 | 1 | 1 | 104 | 5 | 4.8 | 151 | 10 | 6.6 | 104 | 49 | 45 | 104 | 0 | 0 |
| **PC Total** | **1023** | **22** | **2.1** | **772** | **31** | **4** | **1023** | **93** | **9.1** | **772** | **236** | **30.6** | **772** | **0** | **0** |
| TOTAL Males | 1044 | 241 | 23.1 | 680 | 80 | 11.7 | 1044 | 527 | 50.5 | 680 | 76 | 11.1 | 1044 | 13 | 1.2 |
| TOTAL Females | 1674 | 222 | 13.3 | 998 | 90 | 9.1 | 1674 | 476 | 28.4 | 998 | 184 | 18.4 | 1674 | 16 | 0.9 |
| TOTAL Subadults | 817 | 0 | 0 | 817 | 5 | 0.6 | 817 | 0 | 0 | 817 | 7 | 0.8 | 817 | 0 | 0 |
| TOTAL Unknown | 560 | 13 | 2.3 | 423 | 14 | 3.3 | 560 | 35 | 6.3 | 423 | 54 | 12.7 | 560 | 0 | 0 |
| **TOTAL Sample** | **4095** | **476** | **11.6** | **2918** | **189** | **6.4** | **4095** | **1038** | **25.3** | **2918** | **321** | **11.0** | **4095** | **29** | **0.7** |

*(N = number teeth present, n = number teeth affected)

**Table 22**: Comparison of mean tooth count of pathology by time period, ANOVA*

| Condition | EW | EM | MM | LM | PC | ANOVA |
|---|---|---|---|---|---|---|
| AMTL | 0.28 | 1.93 | 3.93 | 2.62 | 0.41 | **.000** |
| Caries | 0.12 | 1.14 | 1.00 | 0.97 | 0.52 | **.002** |
| Periodontal Disease | 0.36 | 5.07 | 6.95 | 7.28 | 1.66 | **.000** |
| Calculus | 0.21 | 0.43 | 0.33 | 1.11 | 4.98 | **.000** |
| Abscess | 0.04 | 0.11 | 0.14 | 0.23 | 0.00 | .058 |

*significant p-values bolded (p≤.05)

**Table 23**: Significant p-values, Bonferroni post-hoc analysis of one-way ANOVA*

| Condition | Post-hoc Analysis – Significant Values |
|---|---|
| AMTL | MM > EW (p = **.000**), MM > PC (p = **.000**), LM > EW (p= **.048**) |
| Caries | EM > EW (p = **.021**), MM > EW (p = **.012**) |
| Periodontal Disease | EM > EW (p = **.004**), MM > EW (p = **.000**), MM > PC (p=**.000**), LM > EW (p = **.000**), LM > PC (p = **.001**) |
| Calculus | PC > EW, EM, MM, and PC (p = **.000**) |
| Abscess | NA |

*significant p-values bolded (p≤.05)

**Table 24:** Significant p-values, Bonferroni post-hoc analysis of one-way ANOVA*

| AMTL | | | |
|---|---|---|---|
| **Time Period** | **Male** | **Female** | **T-test** |
| Early Woodland | .53 | .52 | .992 |
| Early Monongahela | 5.44 | 3.27 | .399 |
| Middle Monongahela | 7.00 | 6.61 | .899 |
| Late Monongahela | 5.60 | 2.25 | .109 |
| Post-Contact | .20 | 1.18 | .437 |
| Total Sample | 4.08 | 2.67 | .174 |
| **CARIES** | | | |
| **Time Period** | **Male** | **Female** | **T-test** |
| Early Woodland | .18 | .38 | .374 |
| Early Monongahela | 3.11 | .91 | .299 |
| Middle Monongahela | 1.83 | 1.38 | .544 |
| Late Monongahela | 1.20 | 1.18 | .987 |
| Post Contact | .60 | 1.29 | .402 |
| Total Sample | 1.33 | 1.01 | .411 |
| **PERIODONTAL DISEASE** | | | |
| **Time Period** | **Male** | **Female** | **T-test** |
| Early Woodland | .82 | .67 | .837 |
| Early Monongahela | 10.00 | 10.72 | .879 |
| Middle Monongahela | **15.55** | 7.94 | **.041** |
| Late Monongahela | 14.1 | 6.5 | .063 |
| Post-Contact | 4.40 | 3.53 | .747 |
| **Total Sample** | **9.27** | 5.48 | **.013** |
| **CALCULUS** | | | |
| **Time Period** | **Male** | **Female** | **T-test** |
| Early Woodland | .00 | .85 | .213 |
| Early Monongahela | .33 | 1.45 | .500 |
| Middle Monongahela | .61 | .33 | .649 |
| Late Monongahela | .80 | .88 | .954 |
| Post-Contact | 10.80 | 7.47 | .538 |
| **Total Sample** | 1.28 | 2.18 | .331 |
| **ABSCESS** | | | |
| **Time Period** | **Male** | **Female** | **T-test** |
| Early Woodland | .00 | .19 | .135 |
| Early Monongahela | .22 | .27 | .866 |
| Middle Monongahela | .27 | .22 | .768 |
| Late Monongahela | .50 | .19 | .454 |
| Post-Contact | .00 | .00 | 1.00 |
| **Total Sample** | 0.20 | 0.17 | .737 |

*significant p-values bolded (p≤.05)

### 6.3.3 Discussion: Dental Disease

#### 6.3.3.1 Individual Frequency

Frequencies of dental disease among individuals varied across time periods. Rates of AMTL, caries, periodontal disease and abscess were statistically significant for the Middle Monongahela period, whereas calculus was highest for the Post-Contact sample (Table 19). Comparisons of percentages show that males had higher frequencies of AMTL than females in the Early Woodland (17.6 vs. %), Early Monongahela (66.6 vs. 45.5%, Middle Monongahela (65 vs. 55%), and Late Monongahela periods (70 vs. 31.3%). Males had higher rates of dental disease in all categories in Late Monongahela period except for abscesses: caries (60 vs. 37.5%), periodontal disease (70 vs. 43.8%), and calculus (10 vs. 6.3%). However, these differences in dental diseases between the sexes were not statistically significant (Table 20).

#### 6.3.3.2 Frequency by Tooth Count

Results of dental disease frequency by tooth count showed a slightly different pattern. Males had higher rates of AMTL for the Early Woodland, Early Monongahela, and Middle Monongahela periods. Males also had higher percentages of caries the Early Woodland period, and in all periods for periodontitis. Statistical evaluation of these frequencies demonstrated that the Early, Middle, and Late Monongahela periods had statistically significant levels of dental disease, except for abscesses (Table 23-Table 24). When compared by sex, mean tooth counts were only significant for periodontitis, with males scoring higher: Middle Monongahela ($p = .041$) and the entire study sample ($p = .013$).

#### 6.3.3.3 Discussion

These results demonstrate that even in agricultural societies that are heavily dependent upon maize, females are not necessarily more susceptible to dental disease. Several factors may have influenced these patterns. In the case of AMTL, risk for this condition increases with age due to longer periods of attrition and calculus buildup (Appleby 2010; Lukacs 2007). When the demographic profiles of the different samples were considered, it was observed that there were more old adult Monongahela males, while females tended to die at younger ages.

Another explanation for the markedly higher percentage of males with dental disease during the Late Monongahela period is possible differential access to maize between various social groups. Researchers suggested that increased resource stress brought about by the Little Ice Age may have led to the demise of the Monongahela group just before 1635AD. It is theorized that maize agriculture was strained by several severe droughts, leading to decreased territory, village numbers, and community consolidation in the Late Monongahela period (Richardson et al. 2002). Anderson (2002) hypothesized that dynamics of power and prestige among the Monongahela during the Late Prehistoric Period were notably altered compared to Late period sites. This is evidenced by the appearance of charnel house and central burial structures indicative of increased social differentiation due to community consolidation. One of the consequences of these alterations associated with emerging social hierarchies in Monongahela communities may have been gendered access to different foods. Emergent male elites, in turn, could have had preferential access to maize over others in the community as resource competition increased, thus explaining higher frequencies in AMTL, caries, and dental abscesses since maize is highly cariogenic (Sciulli 2002). While diets may have been supplemented by hunting, it is notable (later in this chapter) that rates of skeletal indicators of stress also increased during the Late Monongahela period.

Comparison of dental disease rates from the prehistoric period to the Post-Contact period, in contrast to the other research, shows several key differences: rates of caries and abscesses dropped, though frequencies of calculus increased (Table 18, Table 21). This may be due decreased reliance on maize following European contact. Historical documents describe the indigenous settlements of western Pennsylvania as mixed farming and trade communities, where European lifeways were partially adopted including keeping small numbers of livestock (pigs and cows) and the use of brass cookware (LeRoy and Leininger n.d; M'Cullough n.d). Protein rich diets may also influence calculus formation (Lieverse 1999); accounts by captives and travelers document a preference for butter and milk among indigenous communities in the Ohio country (LeRoy and Leininger n.d.). Conflict may have interrupted maize agriculture during this period. McConnell (1992) suggested that Pontiac's Rebellion and other indigenous conflicts during the mid-18$^{th}$ century might have interrupted subsistence strategies leading an increased reliance on hunting as a subsistence strategy in Delaware communities. For example, Gist (1759: 301) reported that the groups in Indian Towns had not planted corn and were starving. The observed increase in calculus rates for the Post-Contact sample may be confounded by the fact that remains from earlier Monongahela contexts were thoroughly washed and chemically treated with varnish, likely damaging preserved dental calculus (Verna Cowin pers. comm).

Comparison of caries and abscess rates with contemporaneous Iroquoian skeletal samples reveals that Ohio Valley groups were not as adversely affected by poor oral health (Table 25). Pfeiffer and Fairgrieve (1994) reported dental disease rates for both pre- and post-contact Iroquoian ossuaries. These data demonstrated a dramatic change in caries and alveolar abscess rates over time for the Iroquoians, ranging from 22-28% at pre-contact sites to over 40% at post-contact ossuaries. It was hypothesized that contact exacerbated resource stress and may have contributed to higher rates of dental disease among Iroquoians (Pfeiffer and Fairgrieve 1994). Data from other studies on Native American populations has also emphasized a trend of increasing amounts of dental disease, such as in populations in Spanish missions in Florida (Larsen et al. 2001). Dental disease rates among pre-contact Iroquoians, in contrast, were shown to be exceedingly high at some sites, such as the pre-contact Seneca cemetery at the Adams site where the caries rate was 84.2% (Wray et al. 1987). In comparison, the rates of caries and abscesses for the Ohio Valley samples are markedly lower. These disparities should be interpreted with caution for these samples, as the frequency of AMTL and periodontitis is high for the Ohio Valley samples. AMTL is caused by caries and other dental pathologies, so individuals with this condition likely did previously suffer from poor oral health in the form of caries and significantly high levels of periodontal disease that eventually results in tooth loss. For example, the Late Monongahela frequency of periodontal disease by tooth count was 46.9%. These data are meaningful in that indigenous groups varied in their biological responses to epidemiological transitions as well as European contact.

**Table 25:** Rates of dental conditions by percentage of affected teeth for all individuals, Ohio Valley samples. vs. Iroquoian samples

| Sample | Caries | Abscess | Study |
|---|---|---|---|
| Early Woodland | 2.4% | 1% | This study |
| Early Monongahela | 9.2% | 1% | This study |
| Middle Monongahela | 9.5% | 1.7% | This study |
| Late Monongahela | 7.7% | 2.3% | This study |
| Post-Contact | 4% | 0% | This study |
| Fairty (1400-1450AD) | 28% | Not recorded | Pfeiffer and Fairgrieve (1984) |
| Glen Williams (1400-1500AD) | 22.4% | 8.4% | Pfeiffer and Fairgrieve (1984) |
| Uxbridge (1490 +/- 80 AD) | 20.1% | 4.5% | Pfeiffer and Fairgrieve (1984) |
| Kleinberg (1585-1650) | 40.6% | 12.7% | Pfeiffer and Fairgrieve (1984) |
| Adams ($16^{th}$ century) | 84.2% | Not recorded | Wray et al. (1987) |

**Figure 25**: AMTL, FC#2050, middle-aged female, Middle Monongahela – Bunola site

**Figure 26:** Caries, tooth 14, FC#5163, middle aged male, Middle Monongahela – Bunola site

**Figure 27:** Periodontitis of mandible, FC#5159, old adult male, Middle Monongahela – Bunola site

**Figure 28:** Calculus, tooth 11, FC#2159, adolescent, Early Monongahela – Varner site

**Figure 29:** Abscess, right maxillary incisor, FC#5159, old adult male – Bunola site

## 6.4 SKELETAL INDICATORS OF STRESS

### 6.4.1 Cribra Orbitalia and Porotic Hyperostosis

Frequencies of individuals affected by cribra orbitalia and porotic hyperostosis are presented in Table 26. The Post-Contact sample had the highest frequencies of this lesion; subadults in this group had the highest rate when compared males and females (22.2%). The group with the lowest frequency was the Early Woodland sample. Statistical tests comparing rates of these conditions were not significant (Tables 27-28). Photographs depict both conditions in Figure 30.

**Table 26:** Individual frequencies of cribra orbitalia/porotic hyperostosis by time period and sex

| | Males | | | Females | | | Subadults | | | Unknown | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Early Woodland | 17 | 0 | 0 | 21 | 1 | 4.8 | 16 | 0 | 0 | 51 | 0 | 0 | 105 | 1 | 1 |
| Early Monongahela | 9 | 0 | 0 | 11 | 0 | 0 | 21 | 2 | 9.5 | 9 | 0 | 0 | 50 | 2 | 4 |
| Middle Monongahela | 20 | 0 | 0 | 18 | 2 | 11.1 | 26 | 3 | 11.5 | 10 | 1 | 10 | 74 | 6 | 8.1 |
| Late Monongahela | 10 | 0 | 0 | 16 | 0 | 0 | 14 | 3 | 21.4 | 3 | 0 | 0 | 43 | 3 | 6.9 |
| Post Contact | 5 | 1 | 20 | 16 | 1 | 6.3 | 18 | 4 | 22.2 | 19 | 0 | 0 | 58 | 6 | 10.3 |
| **TOTAL** | **61** | **1** | **1.6** | **82** | **4** | **4.8** | **95** | **12** | **12.6** | **93** | **1** | **1.1** | **330** | **18** | **5.4** |

**Table 27:** Comparison of mean presence/absence scores for cribra orbitalia/porotic hyperostosis by time period*

| Time Period | Mean | Kruskall-Wallis |
|---|---|---|
| Early Woodland | .01 | .085 |
| Early Monongahela | .04 | .085 |
| Middle Monongahela | .08 | .085 |
| Late Monongahela | .07 | .085 |
| Post-Contact | .10 | .085 |

*significant p-values bolded (p≤.05)

**Table 28:** Comparison of mean presence/absence scores for cribra orbitalia/porotic hyperostosis by time period and sex*

| Time Period | Male | Female | Subadult | Kruskall-Wallis |
|---|---|---|---|---|
| Early Woodland | .00 | .04 | .00 | .261 |
| Early Monongahela | .00 | .00 | .10 | .420 |
| Middle Monongahela | .00 | .11 | .12 | .515 |
| Late Monongahela | .00 | .00 | .21 | .089 |
| Post-Contact | .20 | .05 | .22 | .134 |

*significant p-values bolded (p≤.05)

### 6.4.2 Linear Enamel Hypoplasia

Frequencies of individuals with LEH are listed in Table 29 by sex and time period, with statistical analysis in Tables 30-31 (See Figure 31 for photograph). The Late Monongahela sample had the highest frequency of LEH. Males had the highest frequencies of LEH of the sex groups following individual frequencies, though this was not statistically significant (Table 30). The Early Woodland sample had the lowest frequency, and this was statistically significant at .010 (Table 30). When the tooth analysis was performed, males scored significantly higher than other groups for the Post-Contact period (Appendix A, Tables 160-163).

**Table 29:** Frequencies of LEH by time period and sex

| | Males | | | Females | | | Subadults | | | Unknown | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Early Woodland | 17 | 1 | 5.9 | 21 | 1 | 4.8 | 16 | 0 | 0 | 51 | 0 | 0 | 105 | 2 | 1.9 |
| Early Monongahela | 9 | 0 | 0 | 11 | 1 | 9.1 | 21 | 3 | 14.2 | 9 | 0 | 0 | 50 | 4 | 8 |
| Middle Monongahela | 20 | 5 | 25 | 18 | 2 | 11.1 | 26 | 3 | 11.5 | 10 | 0 | 0 | 74 | 10 | 13.5 |
| Late Monongahela | 10 | 3 | 30 | 16 | 2 | 12.5 | 14 | 3 | 21.4 | 3 | 1 | 33 | 43 | 9 | 20.9 |
| Post Contact | 5 | 2 | 40 | 16 | 3 | 18.8 | 18 | 2 | 11.1 | 19 | 0 | 0 | 58 | 7 | 12.1 |
| **TOTAL** | **61** | **11** | **18.0** | **82** | **9** | **10.9** | **95** | **11** | **11.6** | **92** | **1** | **1.1** | **330** | **32** | **9.6** |

**Table 30:** Comparison of mean presence/absence scores for LEH by time period*

| Time Period | Mean | Kruskall-Wallis |
|---|---|---|
| Early Woodland | .02 | **.010** |
| Early Monongahela | .08 | EM vs. EW - .225 |
| Middle Monongahela | .14 | MM > EW - **.009** |
| Late Monongahela | .19 | LM > EW - **.002** |
| Post-Contact | .12 | PC > EW - **.033** |

*significant p-values bolded (p≤.05)

**Table 31**: Comparison of mean presence/absence scores for LEH by time period and sex*

| Time Period | Male | Female | Subadult | Kruskall-Wallis |
|---|---|---|---|---|
| Early Woodland | .06 | .05 | .00 | .305 |
| Early Monongahela | .00 | .09 | .14 | .448 |
| Middle Monongahela | .28 | .11 | .12 | .156 |
| Late Monongahela | .30 | .13 | .14 | .613 |
| Post-Contact | .40 | .17 | .11 | .088 |

*significant p-values bolded (p≤.05)

### 6.4.3 Discussion: Stress Indicators

Rates of LEH in the Ohio Valley samples are highest in the Late Monongahela group, with an overall frequency of 20.9% (30% for males, 12.5% for females). These results coincide with other patterns of dental disease for this group; caries, periodontal disease, and AMTL are more prevalent among males in the Late Monongahela sample. However, LEH is an indicator of past stress as these form in childhood, though stress can result in caries and associated dental pathologies as well (Goodman and Rose 1990). Males may have had higher rates of dental pathologies due to the aging process, and during childhood from differential food allocation practices during times of resource scarcity. This pattern suggests increased resource stress during this period (Larsen et al. 2001) and supports the hypothesis that dental disease and physiological stress would increase during this period as a function of drought and resource depletion (Richardson et al. 2002). Other notable increases in stress indicators occurred with the Early and Middle Monongahela groups, demonstrating that the adoption of agriculture had a deleterious effect on the general health of Ohio Valley populations. These trends are cautiously interpreted as stress indicators due to the need for individuals to survive long enough for lesions to form (Wood et al. 1992). Conversely, individuals without lesions likely succumbed more quickly to disease, stress, and malnutrition.

Ohio Valley samples are not identical to contemporaneous groups in rates of stress indicators (Table 32). When compared to Iroquoian ossuary samples, the Monongahela and the Post-Contact groups had higher rates of LEH, despite these groups having a similar diet, and occupying a similar climate and neighboring geographic regions.

Iroquoians had higher rates of cribra orbitalia, indicating that the effects of stress may have manifested differently between these neighboring populations. Both Iroquoian ossuary samples and the Post-Contact sample from this study demonstrate that resource stress increased with contact. Cribra orbitalia rates increased after contact in the Ohio Valley, whereas LEH rates increased following contact for the Kleinberg people. This pattern of increasing stress with contact is also reflected in samples from Spanish missions (Table 32), indicating that contact as well as the adoption of agriculture had negative effects on the health of indigenous populations across Eastern North America.

**Table 32:** Rates of indicators of stress, Ohio Valley samples vs. Iroquoians vs. Spanish Florida

| Sample | Cribra Orbitalia | LEH | Study |
|---|---|---|---|
| Early Woodland | 1% | 1.9% | This study |
| Early Monongahela | 4% | 8% | This study |
| Middle Monongahela | 8.1% | 13.5% | This study |
| Late Monongahela | 6.9% | 20.9% | This study |
| Post-Contact | 10.3% | 12.1% | This study |
| Fairty (1400-1450AD) | 26% | NR | Pfeiffer and Fairgrieve (1994) |
| Glen Williams (1400-1500AD) | NR | 3.9% | Pfeiffer and Fairgrieve (1994) |
| Uxbridge (1490 +/- 80 AD) | NR | 2.5% | Pfeiffer and Fairgrieve (1994 |
| Kleinberg (1585-1650) | 24% | 10.6% | Pfeiffer and Fairgrieve (1994) |
| Late Prehistoric Georgia/Florida | 3.1% | 58% | Larsen et al. (2001) |
| Late Mission Florida | 22.9% | 59% | Larsen et al. (2001) |

**Figure 30:** Left - porotic hyperostosis, right parietal, FC#5700, early adult female, Middle Monongahela – Bunola site, Right - cribra orbitalia, right orbit, FC#1491, adult female, Middle Monongahela – Bunola site

**Figure 31:** LEH, erupting tooth 21, FC#7493, Late Child, Early Monongahela – Murphy Old House site

## 6.5 OSTEOARTHRITIS

### 6.5.1 Osteoarthritis

Frequencies of individuals with osteoarthritis are listed in Table 33 (See Figure 32 for photograph) by region, sex, and time period. The sample with the lowest frequency of osteoarthritis was the Early Woodland sample (See Table 34 for statistics). For the upper and lower limbs, and vertebral column, this sample has low rates of <10% for males, females, and adults of unknown sex. The highest rates occur in the Middle and Late Monongahela samples, though the Early Monongahela also scored significantly higher than the Early Woodland and Post-Contact groups (Table 34). When compared by sex, males had significantly higher rates of OA for the upper limb in the Early and Late Monongahela samples, for the lower limb in the Early Woodland sample, and for the vertebrae in the Post-Contact sample (See Table 35).

**Table 33:** Individual frequencies of osteoarthritis by time period and sex*

| | Upper Limb | | | Vertebral | | | Lower Limb | | |
|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| EW Males | 17 | 2 | 11.8 | 17 | 4 | 23.5 | 17 | 6 | 35.3 |
| EW Females | 21 | 2 | 9.5 | 21 | 2 | 9.5 | 21 | 1 | 4.8 |
| EW Subadults | 16 | 0 | 0 | 16 | 0 | 0 | 16 | 0 | 0 |
| EW Unknown | 51 | 2 | 3.9 | 51 | 1 | 1.9 | 51 | 1 | 1.9 |
| **EW Total** | **105** | **7** | **6.7** | **105** | **7** | **6.7** | **105** | **8** | **7.6** |
| EM Males | 9 | 6 | 66.7 | 9 | 6 | 66.7 | 9 | 7 | 77.8 |
| EM Females | 11 | 3 | 27.2 | 11 | 5 | 45.5 | 11 | 5 | 45.5 |
| EM Subadults | 21 | 0 | 0 | 21 | 0 | 0 | 21 | 0 | 0 |
| EM Unknown | 9 | 0 | 0 | 9 | 0 | 0 | 9 | 0 | 0 |
| **EM Total** | **50** | **9** | **18** | **50** | **11** | **22** | **50** | **12** | **24** |
| MM Males | 20 | 13 | 65% | 20 | 10 | 50% | 20 | 6 | 30% |
| MM Females | 18 | 10 | 55.6% | 18 | 11 | 61.1% | 18 | 12 | 66.7% |
| MM Subadults | 26 | 0 | 0 | 26 | 2 | 7.7% | 26 | 0 | 0 |
| MM Unknown | 10 | 0 | 0 | 10 | 4 | 40% | 10 | 0 | 0 |
| **MM Total** | **74** | **23** | **31.1** | **74** | **27** | **36.5** | **74** | **24** | **32.4** |
| LM Males | 10 | 8 | 80 | 10 | 6 | 60 | 10 | 6 | 60 |
| LM Females | 16 | 6 | 37.5 | 16 | 6 | 37.5 | 16 | 10 | 62.5 |
| LM Subadults | 14 | 0 | 0 | 14 | 3 | 21.4 | 14 | 0 | 0 |
| LM Unknown | 3 | 0 | 0 | 3 | 2 | 66.7 | 3 | 1 | 33.3 |
| **LM Total** | **43** | **14** | **32.6** | **43** | **17** | **39.5** | **43** | **17** | **39.5** |
| PC Males | 5 | 0 | 0 | 5 | 4 | 80 | 5 | 1 | 20 |
| PC Females | 16 | 0 | 0 | 16 | 5 | 31.2 | 16 | 1 | 6.3 |
| PC Subadults | 18 | 0 | 0 | 18 | 0 | 0 | 18 | 0 | 0 |
| PC Unknown | 19 | 0 | 0 | 19 | 0 | 0 | 19 | 1 | 5.3 |
| **PC Total** | **58** | **0** | **0** | **58** | **5** | **8.6** | **58** | **3** | **5.2** |

*(N = number present, n= number affected)

**Table 34:** Comparison of mean presence/absence of OA by region and time period*

| Upper Limb Osteoarthritis | | |
|---|---|---|
| **Time Period** | **Mean** | **Kruskall-Wallis** |
| Early Woodland | .06 | **.000** |
| Early Monongahela | .18 | EM > EW (p=**.000**), EM > PC (p=**.011**) |
| Middle Monongahela | .31 | MM > EW (p=**.000**), MM > PC (p = **.000**) |
| Late Monongahela | .33 | LM > EW (p=**.000**), LM > PC (p=**.000)** |
| Post-Contact | .00 | **.000** |
| **Lower Limb Osteoarthritis** | | |
| **Time Period** | **Mean** | **Kruskall-Wallis** |
| Early Woodland | .08 | **.000** |
| Early Monongahela | .24 | EM > EW (p=**.016**), EM > PC (p=**.014**) |
| Middle Monongahela | .32 | MM > EW (p=**.000**), MM > PC (p=**.000**) |
| Late Monongahela | .40 | LM > EW (p=**.000**), LM > PC (p=**.000**) |
| Post-Contact | .05 | **.000** |
| **Vertebral Osteoarthritis** | | |
| **Time Period** | **Mean** | **Kruskall-Wallis** |
| Early Woodland | .07 | **.000** |
| Early Monongahela | .22 | EM > EW (p=**.027**) |
| Middle Monongahela | .36 | MM > EW (p=**.000**), MM > PC (p=**.000**) |
| Late Monongahela | .40 | LM > EW (p=**.000**), LM>EM (p=**.036**), LM < MM (p=**.050**), LM> (p=**.000**), |
| Post-Contact | .09 | **.000** |

*significant p-values bolded (p≤.05)

**Table 35:** Comparison of mean OA presence/absence scores by region, time period, and sex*

| Upper Limb Osteoarthritis | | | |
|---|---|---|---|
| **Time Period** | **Male** | **Female** | **Kruskall-Wallis** |
| Early Woodland | .12 | .10 | .397 |
| Early Monongahela | .67 | .27 | **.027** |
| Middle Monongahela | .72 | .56 | .283 |
| Late Monongahela | .81 | .35 | **.012** |
| Post-Contact | .00 | .00 | 1.00 |
| **Lower Limb Osteoarthritis** | | | |
| **Time Period** | **Male** | **Female** | **Kruskall-Wallis** |
| Early Woodland | .35 | .05 | **.000** |
| Early Monongahela | .78 | .45 | .096 |
| Middle Monongahela | .67 | .67 | 1.00 |
| Late Monongahela | .55 | .64 | .596 |
| Post-Contact | .20 | .11 | .360 |
| **Vertebral Osteoarthritis** | | | |
| **Time Period** | **Male** | **Female** | **Kruskall-Wallis** |
| Early Woodland | .24 | .09 | .087 |
| Early Monongahela | .67 | .45 | .259 |
| Middle Monongahela | .55 | .61 | .731 |
| Late Monongahela | .64 | .35 | .139 |
| Post-Contact | .80 | .05 | **.000** |

*significant p-values bolded (p≤.05)

### 6.5.2 Discussion: Osteoarthritis

OA data from the Ohio Valley samples provides some insight into activity and labor based on general trends in frequencies between samples. Frequencies of OA among the Early Woodland people were low (<10%) across all age and sex categories, and there was little differentiation in rates between males and females. This is congruent with other studies that have shown that there are few sex differences among hunter-gatherer communities in Eastern North America prior to contact (Bridges 1992). It is a notable difference that compared to groups from the American Southeast, that Early Woodland groups in the Ohio Valley had lower frequencies of osteoarthritis, though it remains unclear whether or not these differences can be attributed to activity, genetics, or the age structure of the sample (Bridges 1992). There are fewer individuals in the older adult age range in the Early Woodland sample than in subsequent time periods, which may be a confounding factor in the interpretation of this data as the age structure of these groups is not comparable and age is a significant factor in osteoarthritis (Weiss 2005, 2006).

Several notable patterns emerge when examining frequencies of osteoarthritis among the Monongahela samples. Osteoarthritis frequencies steadily increase from the Early to Late Monongahela period. Females in the Middle Monongahela period had the highest frequencies of upper and lower limb arthritis, and vertebral arthritis, though these changes were not statistically significant. This loosely supports the hypothesis that Monongahela women were engaged in agricultural labor, following Sofaer Derevenski's (2000) research on the Ensay. During the Middle Monongahela period, communities in the Ohio Valley were intensively primarily in maize agriculture (Johnson 2001). While osteoarthritis rates may increase due to load bearing activity, MSMs are likely a better indicator of division of labor, as there are fewer confounding factors in interpretation (Hawkey and Merbs 1995; Weiss and Jurmain 2007). The pattern of osteoarthritis changed in the Late Monongahela samples. While rates of osteoarthritis remained at relatively high levels (>30%) throughout the skeleton, males (~60%) had higher frequencies than females (~30%). This is congruent with other trends in pathology for this sample: dental disease and stress are present in higher rates among males in the Late Monongahela. As this was a time of resource stress, greater competition for resources, and territory/community consolidation, it is likely that agriculture became more labor intensive due to drought conditions (Richardson et al. 2002). Providing agricultural yields large enough to sustain villages would have been increasingly difficult; carrying water longer distances to provide irrigation, plus the potential for having to clear new fields would have contributed to an increased labor load. While carrying water is traditionally an activity reserved for females and children (Murdock and Provost 1973), male labor may have been necessary to meet the demands of a difficult growing season.

Another feature of osteoarthritis for the Ohio Valley samples is the notable decrease in osteoarthritis frequencies during the Post-Contact period. In other areas of Eastern North America, contact exacerbated osteoarthritis levels due to colonial demands on indigenous labor. In Spanish Florida, during the Late Prehistoric Period lumbar vertebral osteoarthritis increased from 24.6% of individuals to 67.2% following contact (Larsen et al. 2001). In the Ohio Valley, indigenous communities through the $18^{th}$ century lived in ethnically diverse settlements, engaged in trade, and maintained local traditions while incorporating European goods and farming practices (Ferris 2009; Gist 1759; LeRoy and Leininger n.d.; McConnell 1992; M'Cullough n.d) The Delaware in western Pennsylvania were not incorporated into large-scale European farming efforts or missions, unlike the indigenous communities in Florida. The nature of the interaction between indigenous communities between these regions was markedly different and is reflected in patterns of pathology, especially osteoarthritis.

**Figure 32:** Severe spinal osteoarthritis with osteophytes and ankylosis of L4-L5 vertebrae, FC#7492, old adult male, Early Monongahela – Murphy Old House site

## 6.6 TRAUMA

### 6.6.1 Sharp Force Trauma

Cases of sharp force trauma were uncommon for the Ohio Valley samples. Frequencies of sharp force trauma (SFT) by sex are listed in Table 36 for only the Early Woodland and Middle Monongahela periods as these injuries were only observed for those samples (See Table 37 for features of SFT). Based on microscopic analysis, all instances SFT were determined to be perimortem. Three skeletons from the Early Woodland period were observed with SFT: a male of unknown age (FC#3207) with a cutmark on the right parietal (Figure 33), a female of unknown age (FC#3208) with 3 parallel cutmarks on the right anterior tibial diaphysis (Figure 34), and a male of unknown age (FC#3287) with a cutmark on the anterior proximal head of the humerus (Figure 35). For the Middle Monongahela period, one individual exhibited sharp force trauma. A stone projectile point was embedded in the superior surface of the left $12^{th}$ rib adjacent to the vertebral articulation of a female youth (FC#442) from the Shippenport site (Figures 36-37).

Statistical analysis by time period and sex revealed no significant differences in rates of SFT between samples (Tables 38-39).

**Table 36:** Frequencies of sharp force trauma by sex and time period*

| | Males | | | Females | | | Subadults | | | Unknown | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Early Woodland | 17 | 2 | 11.8 | 21 | 1 | 4.8 | 16 | 0 | 0 | 51 | 0 | 0 | 105 | 3 | 2.9 |
| Early Monongahela | 9 | 0 | 0 | 11 | 0 | 0 | 21 | 0 | 0 | 9 | 0 | 0 | 50 | 0 | 0 |
| Middle Monongahela | 20 | 0 | 0 | 18 | 1 | 5.6 | 26 | 0 | 0 | 10 | 0 | 0 | 74 | 1 | 1.4 |
| Late Monongahela | 10 | 0 | 0 | 16 | 0 | 0 | 14 | 0 | 0 | 3 | 0 | 0 | 43 | 0 | 0 |
| Post-Contact | 5 | 0 | 0 | 16 | 0 | 0 | 18 | 0 | 0 | 19 | 0 | 0 | 58 | 0 | 0 |
| **TOTAL** | **61** | **2** | **3.3** | **82** | **2** | **2.4** | **95** | **0** | **0** | **92** | **0** | **0** | **330** | **4** | **1.2** |

*(N = number present, n = number affected)

**Table 37:** Features of SFT

| Time Period | Context | Sex | Age | Bone | Side | Timing | Description |
|---|---|---|---|---|---|---|---|
| EW | 3208 | M | Adult | Parietal | R | Perimortem | Cutmark: 10.6x.8x.05mm |
| EW | 3287 | M | Adult | Humerus | R | Perimortem | Cutmark: 8.7x.7x.2mm |
| EW | 3207 | F | Adult | Tibia | R | Perimortem | Cutmark 1: 5.3x.6x.1mm<br>Cutmark 2: 2.6x.5x.1mm<br>Cutmark 3: 2.7x.5x.1mm |
| MM | 442 | F | Youth | 12$^{th}$ rib | L | Perimortem | Embedded projectile, superior rib surface, in shaft 1.7 cm from vertebral articulation, 8.28x1.8x.46mm |

**Table 38:** Comparison of mean presence/absence of SFT by time period*

| Time Period | Mean | Kruskall-Wallis |
|---|---|---|
| Early Woodland | .03 | .376 |
| Early Monongahela | .00 | .376 |
| Middle Monongahela | .01 | .376 |
| Late Monongahela | .00 | .376 |
| Post-Contact | .00 | .376 |

*significant p-values bolded (p≤.05)

**Table 39:** Comparison of mean presence/absence of SFT by time period and sex*

| Time Period | Male | Female | Subadult | Kruskall-Wallis |
|---|---|---|---|---|
| Early Woodland | .12 | .05 | .00 | .071 |
| Early Monongahela | .00 | .00 | .00 | NA |
| Middle Monongahela | .00 | .01 | .00 | 1.00 |
| Late Monongahela | .00 | .00 | .00 | NA |
| Post-Contact | .00 | .00 | .00 | NA |

*significant p-values bolded (p≤.05)

**Figure 33:** Cutmark on parietal of FC#3207 – adult male, Early Woodland, Cresap Mound

**Figure 34:** Cutmarks on anterior tibial shaft of FC# 3208 – adult female, Early Woodland, Cresap Mound

**Figure 35:** Cutmark on proximal humeral head of FC# 3287 – adult male, Early Woodland, Cresap Mound

**Figure 36:** Cutmark from embedded projectile of 12th rib, FC#442 – female youth, Middle Monongahela, Shippingport

**Figure 37:** Projectiles found in thoracic cage of FC#442 – 2nd from left embedded in left 12th rib.

### 6.6.2 Blunt Force Trauma

Frequencies of blunt force trauma (BFT) by sex and time period are listed in Table 40, whereas features are listed in Table 41. Statistical analyses showed significant differences between time periods. All trauma was antemortem. The Early Woodland group and Post-Contact samples had significantly fewer cases of BFT than the Monongahela groups (Table 42). In the Middle Monongahela sample, males had significantly higher presence of BFT than females (Table 43). Only one case of BFT was identified in the Early Woodland sample: an old adult male (FC# 1250, B20) sustained an oblique fracture of the right distal humerus.

In the Early Monongahela sample, 6 cases of BFT were observed. Among subadults, an antemortem depression fracture was identified on the left posterior parietal of an adolescent (FC#2159) (Figure 38). Three males and 2 females sustained fractures. One middle-aged male (FC#4561) had an antemortem facial fracture involving the nasals (Figure 39), an older adult male (FC#4691) had a transverse antemortem fracture of the distal 4$^{th}$ metatarsal, and an antemortem dislocation fracture was noted on the right proximal 2$^{nd}$ metatarsal of another middle aged individual (FC#2158). An early adult female (FC#2155) (Figure 40) had an antemortem depression fracture along the midline of the frontal of, and a middle-aged female (FC#4451) (Figure 41) had an avulsion fracture on the anterior body of the 5$^{th}$ lumbar vertebra.

Six individuals from the Middle Monongahela had antemortem BFT injuries, with 2 of these individuals exhibiting multiple injuries. FC#5072 was an adult male with an avulsion fracture on the posterior body of S1 and a crush fracture of an intermediate foot phalanx (Figure 42). An older adult male (FC# 5159) sustained a dislocation fracture of the right glenoid with associated traumatic myositis ossificans on the proximal articulation of the right humerus (Figures 43-45). Three additional males displayed BFT, including a young adult male (FC#C-475) with a comminuted fracture of the medial right clavicle, a young adult male (FC#5161) with an avulsion fracture on the right distal ramus of the mandible, and an old adult male (FC#5163) with an avulsion fracture of a proximal foot phalanx. One old adult female (FC#5070) suffered a transverse fracture on the left distal 3$^{rd}$ metatarsal.

In the Late Monongahela period, two females and one male had BFT. A young adult female (FC#4827) had a depression fracture on the left parietal, and an old adult female (FC#9635) had a healed parry fracture on the left ulna. One individual had multiple injuries. FC#E134 was an old adult male with a dislocated right mandibular condyle with associated osteoarthritis of the mandibular fossa, as well as a right parietal depression fracture (Figures 46-48).

**Table 40:** Frequencies of blunt force trauma by sex and time period

| | Males | | | Females | | | Subadults | | | Unknown | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Early Woodland | 17 | 1 | 5.8 | 21 | 0 | 0 | 16 | 0 | 0 | 51 | 0 | 0 | 105 | 1 | 1 |
| Early Monongahela | 9 | 3 | 33.3 | 11 | 2 | 18.1 | 21 | 1 | 4.7 | 9 | 0 | 0 | 50 | 6 | 12 |
| Middle Monongahela | 20 | 5 | 25 | 18 | 1 | 5.6 | 26 | 0 | 0 | 10 | 0 | 0 | 74 | 6 | 8.1 |
| Late Monongahela | 10 | 1 | 10 | 16 | 2 | 12.5 | 14 | 0 | 0 | 3 | 0 | 0 | 43 | 3 | 6.9 |
| Post-Contact | 5 | 0 | 16 | 16 | 0 | 0 | 18 | 0 | 0 | 19 | 0 | 0 | 58 | 0 | 0 |
| **TOTAL Sample** | **61** | **10** | **16.3** | **82** | **5** | **6.1** | **95** | **1** | **1.1** | **92** | **0** | **0** | **330** | **16** | **4.8** |

**Table 41:** Features of BFT

| Time Period | Context | Sex | Age | Bone | Side | Timing | Description |
|---|---|---|---|---|---|---|---|
| EW | 1250, B20 | M | Old Adult | Humerus | Right | Antemortem | Distal right humerus, oblique fracture, well-healed, no apposition, no angulation, no rotation |
| EM | 2159 | S | Adolescent | Parietal | Left | Antemortem | Depression fracture, posterior, 15.81 mm diameter |
| EM | 4561 | M | Middle-Aged | Nasals | Mid | Antemortem | Oblique fracture to distal nasals, causing a flattening of the nasal profile, well-healed |
| EM | 4691 | M | Old Adult | MT4 | Right | Antemortem | Transverse, distal, no apposition, no angulation, no rotation |
| EM | 2158 | M | Middle-Aged | MT2 | Right | Antemortem | Proximal surface, dislocation |
| EM | 2155 | F | Early Adult | Frontal | Mid | Antemortem | Depression fracture, 12.59mm diameter |
| EM | 4155 | F | Middle Aged | L5 | Mid | Antemortem | Avulsion fracture, anterior vertebral body |
| MM | 5072 | M | Adult | S1, Foot Phalanx | Mid | Antemortem | Avulsion fracture on S1, crush fracture intermediate foot phalanx |
| MM | 5159 | M | Old Adult | Scapula, Humerus | Right | Antemortem | Dislocation fracture with false joint surface and subsequent OA (32mm in height), traumatic myositis ossificans of teres major on proximal humerus (fibers severely ossified – 61mm in length) |
| MM | C-475 | M | Young Adult | Clavicle | Right | Antemortem | Comminuted fracture, medial clavicle, 13.48mm in length, 115 degree angulation |
| MM | 5161 | M | Young Adult | Mandible | Right | Antemortem | Avulsion of distal ramus, posterior |
| MM | 5163 | M | Old Adult | Foot Phalanx | Unknown | Antemortem | Avulsion, proximal foot phalanx, distal articulation |
| MM | 5070 | F | Old Adult | MT3 | Left | Antemortem | Distal portion, transverse fracture, no apposition, no angulation, no rotation |
| LM | 4827 | F | Young Adult | Parietal | Left | Antemortem | Mid-parietal, depression fracture, 27.23mm diameter |

**Table 41:** (continued)

| Time Period | Context | Sex | Age | Bone | Side | Timing | Description |
|---|---|---|---|---|---|---|---|
| LM | 9635 | F | Old Adult | Ulna | Left | Antemortem | Parry fracture, oblique, healed, no apposition, no angulation, no rotation |
| LM | E-134 | M | Old Adult | Mandible, Parietal | Right | Antemortem | Mandible – dislocation of right coronoid process, false joint surface and associated OA, Parietal – healed depression fracture, 14.92 mm in diameter |

**Table 42:** Comparison of mean BFT presence by time period*

| Time Period | Mean | Kruskall-Wallis |
|---|---|---|
| Early Woodland | .01 | **.007** |
| Early Monongahela | .12 | EM > EW (p=**.003**), EM > PC (p=**.004**) |
| Middle Monongahela | .08 | MM > EW (p=**.028**), MM > PC (p=**.032**) |
| Late Monongahela | .07 | .784 |
| Post-Contact | .00 | **.007** |

*significant p-values bolded (p≤.05)

**Table 43:** Comparison of mean BFT presence by time period and sex*

| Time Period | Male | Female | Subadult | Kruskall-Wallis |
|---|---|---|---|---|
| Early Woodland | .06 | .00 | .00 | NA |
| Early Monongahela | .33 | .18 | .00 | .093 |
| Middle Monongahela | .28 | .06 | .00 | **.001** |
| Late Monongahela | .10 | .13 | .00 | .548 |
| Post-Contact | .00 | .00 | .00 | NA |

*significant p-values bolded (p≤.05)

**Figure 38:** Depression fracture, antemortem, left parietal, posterior – FC# 2159, adolescent, Early Monongahela

**Figure 39:** Facial Fracture of nasals, antemortem – FC# 4561, middle-aged male, Early Monongahela

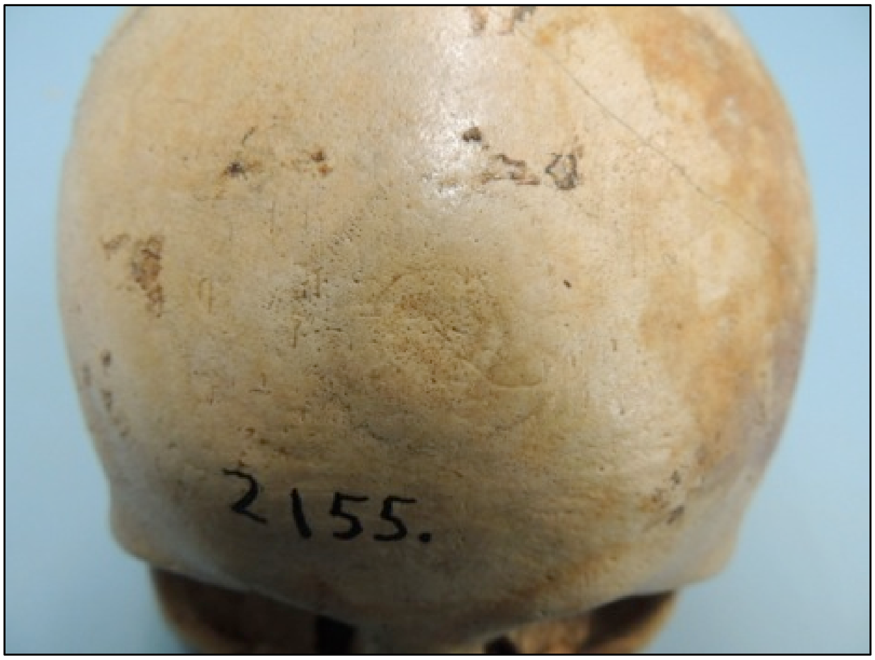



**Figure 40:** Depression fracture, antemortem, frontal – FC#2155, early adult female, Early Monongahela

**Figure 41:** Avulsion fracture, S1, antemortem – FC#5072, adult male, Middle Monongahela

**Figure 42:** Crush fracture, Intermediate foot phalanx – FC#5072, adult male, Middle Monongahela

**Figure 43:** Dislocation of glenoid, right affected, left normal, antemortem – FC#5159, old adult male, Middle Monongahela

**Figure 44:** Dislocation fracture, right humerus with associated traumatic myositis ossificans, left unaffected, antemortem – FC#5159, old adult male, Middle Monongahela

**Figure 45:** Glenoid dislocation fracture, articulation, right, antemortem – FC#5159, old adult male, Middle Monongahela

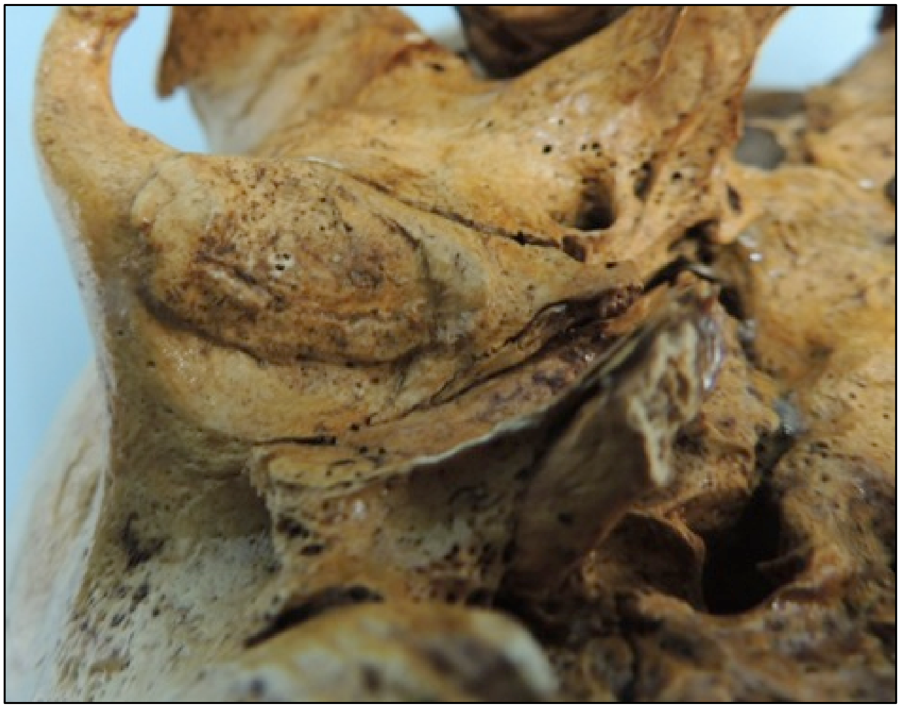


**Figure 46:** Dislocation of mandible, right mandibular fossa, false joint- FC#E-134, old adult male, Late Monongahela

**Figure 47:** Right condyle of mandible, dislocation, associated OA – FC#E-134, old adult male, Late Monongahela

**Figure 48:** Depression fracture, antemortem, right parietal, posterior – FC#E-134, old adult male, Late Monongahela

### 6.6.3 Discussion: Trauma

The nature of injury in the Ohio Valley samples is suggestive of interpersonal violence on a number of levels. Anterior skull trauma is often interpreted as evidence for interpersonal violence as these injuries can occur during face-to-face close-quarter combat (Torres-Rouff 2011). Clinical and forensic literature has assessed the location of cranial and facial fractures, applying the hat brim line rule to interpret the cause of cranial trauma (Guyomarc'h et al. 2010; Kremer et al. 2008). Kremer et al. (2008) stated that fractures occurring above the hat brim line were from of a violent blow, and these injuries were more likely to be sustained on the left side of the cranium, whereas right sided trauma was more likely to result from a fall. This established further criteria for the identification of cranial trauma from violent blows: location above the hat brim line and left sided lateralization (Kremer et al. 2008). Guyomarc'h et al. 2010 re-evaluated the utilization of the hat brim line as the primary criterion for the identification of cranial injury causation, and determined that the following features must be present to distinguish blows from falls in autopsy cases: lacerations to the scalp greater than 7cm, facial fractures or contusions, left sided lateralization of trauma, comminuted or depressed calvarium fractures, and presence of postcranial osseous or soft tissue trauma.

In this study, injuries occurred above the hat brim line and on both the right and left sides. In the cases of the adolescent (FC#2159) and the young adult female (FC#4827), the wounds were left sided and above the hat brim line, suggesting a violent blow. These types of fractures have been associated with violent death in other North American assemblages, such as the Late Woodland Oneota group in Illinois (Milner et al. 1991). In the case of FC# E-134, an old adult male from the Late Monongahela sample, the mandibular dislocation and cranial depression fracture were right sided, indicating a probable fall, though these injuries may have occurred on separate occasions.

Other injuries suggest of occupational or accidental trauma, such as the avulsion and dislocation fractures observed among the Monongahela groups. There was one parry fracture recorded for the entire collection (FC#9635). Parry fractures are commonly interpreted by bioarchaeologists as evidence of defensive wounds sustained when a person reacts to block a blow to the head. However, recent analyses have demonstrated that similar fractures to the ulna can be sustained from a chronic stress from habitual activity or sports (Judd 2008). The clearest evidence of interpersonal violence is the individual FC#442 from the Middle Monongahela period with an embedded projectile point in the 12$^{th}$ rib. Not only did this young female die a violent death, but also she was also buried in a unique context and represents an outlier in cluster analyses of regional burial patterns (See Chapter 8). Projectile injury may, however, be underrepresented in the Monongahela samples as analyses of projectile trauma from the 19$^{th}$ century demonstrate that approximately only 1 in 3 arrow wounds damaged bone (Milner 2005). In other cases, projectile points may have been narrow enough to go between ribs without damaging bone (Engelbrecht 2014). In his study of 19$^{th}$ century soldiers, Milner (2005) observed that the majority of wounds occurred in the thorax or abdomen and predominantly affected soft tissue (Milner 2005). In the present study, cutmarks were also observed on 3 individuals from the Early Woodland period. Based on their location, these perimortem cutmarks are most likely the result of post-funerary processing of remains for secondary burial in mounds than violent injury. The cutmarks, in these cases, were in areas of ligament attachment sites and dismembering bodies for secondary burial may have been necessary for relocation of the body or bundling (Dragoo 1963).

When compared with a violent death assemblage from Late Prehistoric Illinois, the nature of conflict among the Monongahela becomes more evident. Milner et al. (1991) identified 43 victims of violent death from a Late Prehistoric Illinois cemetery associated with the Oneota group (n=264). The most common injury was perimortem cranial blunt force trauma, along with perimortem mutilation such as decapitation and scalping; of these individuals, 41 were adults. Of the individuals that could be sexed, the distribution of males to females was relatively equal (35% vs. 29%). Only 5 Oneota individuals had healed injuries – all women with attempted scalp injuries (Milner et al. 1991). Milner et al. (1991) concluded that these injuries did not result from one mass violent event as the cemetery did not represent a single burial event, but rather from smaller scale raids that occurred over the span of time that the cemetery was in use by the Oneota.

The nature of violence for the Monongahela is heavily contrasted, as only 1 perimortem injury was recorded for of all cases of observed skeletal trauma. All other injuries, including blunt force cranial trauma, were well-healed at death. Frequencies of BFT were similar to those from Late Prehistoric Illinois for males: 33.3% of Middle Monongahela males had sustained BFT compared to 35% of males from the Oneota cemetery. However, the

Monongahela represents a longer time span, and thus this data suggests isolated events than intermittent raiding identified at the Oneota site (Milner et al. 1991). Middle Monongahela males were also more likely to sustain injury than females (Table 40). It has been proposed by archaeologists, such as Means (2007) and Johnson (2001), that the upland position of Monongahela heavily palisaded villages was a defensive strategy against raiding. While the evidence for violent cranial injuries is limited, it is important to note that the single case of projectile trauma suggests soft tissue (lethal and non-lethal) injuries from arrow wounds may have been more prevalent than can be estimated from the skeletal record (Milner 2005).

## 6.7 NON-SPECIFIC INFECTION

Frequencies of non-specific infection are listed in Table 44 by sex and time period. Twenty-three cases of non-specific infection were identified (See Figure 49). Periosteal reaction and osteomyelitic lesions occurred most commonly on the tibia as there is very little soft tissue covering the anterior portion (Weston 2012). The Middle Monongahela sample had the highest frequency overall of non-specific infection at 14.8% prevalence. The Early and Middle period samples scored significantly higher than Early Woodland and Post-Contact (Table 45). Early Monongahela males exhibited the highest frequency among biological sex groups with 22.2% prevalence. The Post-Contact sample represented the lowest frequency of lesions at 1.7%. No statistically significant differences were observed between the sexes (Table 46).

**Table 44:** Individual rates of non-specific infection by sex and time period*

| | Males | | | Females | | | Subadults | | | Unknown | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Early Woodland | 17 | 1 | 5.9 | 21 | 1 | 4.8 | 16 | 1 | 6.3 | 51 | 0 | 0 | 105 | 3 | 2.9 |
| Early Monongahela | 9 | 2 | 22.2 | 11 | 2 | 18.2 | 21 | 2 | 9.5 | 9 | 0 | 0 | 50 | 6 | 12 |
| Middle Monongahela | 20 | 3 | 15 | 18 | 3 | 16.7 | 26 | 2 | 7.7 | 10 | 3 | 30 | 74 | 11 | 14.8 |
| Late Monongahela | 10 | 1 | 10 | 16 | 1 | 6.2 | 14 | 0 | 0 | 3 | 0 | 0 | 43 | 2 | 4.7 |
| Post-Contact | 5 | 1 | 20 | 16 | 0 | 0 | 18 | 0 | 0 | 19 | 0 | 0 | 58 | 1 | 1.7 |

*(N = number present, n = number affected)

**Table 45:** Comparison of mean NSI presence by time period*

| Time Period | Mean | Kruskall-Wallis |
|---|---|---|
| Early Woodland | .03 | **.006** |
| Early Monongahela | .12 | EM > EW (p=**.002**), EM > PC (p=**.037**) |
| Middle Monongahela | .15 | MM > EW (p=**.002**), MM > EM (**.003**), MM > LM (p= **.041**). |
| Late Monongahela | .05 | .557 |
| Post-Contact | .02 | **.006** |

*significant p-values bolded (p≤.05)

**Table 46:** Comparison of mean NSI presence by time period and sex*

| Time Period | Male | Female | Subadult | Kruskall-Wallis |
|---|---|---|---|---|
| Early Woodland | .06 | .05 | .06 | .396 |
| Early Monongahela | .22 | .18 | .1 | .460 |
| Middle Monongahela | .17 | .17 | .08 | .639 |
| Late Monongahela | .11 | .06 | .00 | .640 |
| Post-Contact | .00 | .00 | .06 | .528 |

*significant p-values bolded (p≤.05)

### 6.7.1 Discussion: Non-Specific Infection

Rates of non-specific infection were low in comparison with contemporary indigenous groups for all the Ohio Valley samples. For example, rates of tibial periostitis for the Iroquoian ossuaries at Kleinberg and Fairty were 89% and 94.8% respectively (Pfeiffer and Fairgrieve 1994), whereas the highest rates of tibial periosteal reaction in the Ohio Valley samples only reached 22.2% (See Appendix for affected elements only, Tables 170 – 177). This pattern also contrasts with populations from Spanish Florida, in which case contact exacerbated existing patterns of periosteal reaction of the tibia (15.4% in early colonial periods, 59.3% in later colonial periods). In the Ohio Valley, frequencies of periostitis dropped following contact. This is an example of how patterns of health and disease varied following contact for various groups, and that interaction between Europeans and indigenous groups did not always result in negative health outcomes for the latter.

Severe tibial periostitis can be indicative of treponemal disease in the form of sabre shinning (Rothschild and Rothschild 1995). FC# E-72 was a young adult female with bilateral periosteal reaction with expansion of the tibial surface (Figure49). While this lesion is not pathognomonic, it is suggestive of treponemal disease. The skull did not have *caries sicca* or erosive changes to the joint surfaces associated with treponemal disease (Rothschild and Rothschild 1995; Waldron 2008). Since the tibia is a common site of osteomyelitis and periostitis that is not associated with treponemal disease, it is possible these lesions are the result of that condition in the absence of additional evidence (Larsen et al. 2001). A chronic infection of unknown origin is a differential diagnosis. As the lesions are bilateral and extensive, they are unlikely to have resulted from isolated trauma (Weston 2012).

**Figure 49:** Bilateral tibial periostitis – FC# E-72, young adult female, Middle Monongahela

### 6.8 OTHER PATHOLOGIES

In addition to non-specific infection, there are several cases of specific infectious diseases: tuberculosis (TB), blastomycosis, and maxillary sinusitis. There were 7 individuals in the collection with evidence of tuberculosis, all from the Middle Monongahela sample. FC#2051 was an old adult female with lesions on the spine and ribs. Krill and Siegel (1978) identified 90-degree angular kyphosis and fusion of thoracic vertebrae in this individual (Figure 50). This lesion is a case of Pott's deformity, which is pathognomonic for tuberculosis (Roberts et al. 1994; Santos and Roberts 2006; Waldron 2008). The individual also had plaque on the pleural surface of 3 ribs in the area adjacent to the vertebral column. Possible differential diagnoses for these lesions could be brucellosis and pulmonary disease (D'Anastasio et al. 2011). Brucellosis typically affects the lumbar vertebrae with lytic foci, though rib involvement is not common (D'Anastasio et al. 2011). Tuberculosis is a the most likely diagnosis for the vertebral pathology as brucellosis less commonly involves the thoracic region, and it does not commonly result in the collapse and ankylosis of vertebral bodies (D'Anastasio et al. 2011; Waldron 2008). Pulmonary infections such as pneumonia can cause periosteal reaction on the pleural surface of the ribs, though in cases of TB these lesions are likely to occur in the mid-thoracic cage on the pleural shaft adjacent to the vertebral end, such as in the case of FC#2051 (Santos and Roberts 2006).

Five individuals had rib lesions from the Middle Monongahela sample: FC# E-31 (youth, 5 affected ribs) (Figure 51), FC#6086 (unknown adult, 2 affected ribs), FC#5743 (middle-aged, 1 rib with lytic focus on pleural surface, sternal end), FC# KB1 (middle-aged female, 4 ribs with plaque on mid-shaft, pleural surface; Figure 52), and FC# 2159 (adolescent, 1 rib affected, periosteal reaction on pleural surface near vertebral end; Figure 53). Rib lesions are a possible indicator of tuberculosis, though are not pathognomonic as they can occur with other pulmonary conditions such as pneumonia (Roberts et al. 1998). According to Santos and Roberts (2006) rib lesions associated with pulmonary TB are likely to occur on the pleural surfaces of mid-thoracic ribs near the vertebral articulation, as in the case with FC#2159. Extrapulmonary TB more typically results in rib lesions in the lower ribs, with involvement on the sternal ends, and neoplastic conditions can cause "coral-like" periosteal lesion growth (Santos and Roberts 2006). The lesions in the Monongahela samples more closely resemble those described as resulting from pulmonary and extrapulmonary TB.

Another young adult female, FC# 5075, also exhibited lesions consistent with TB in the form of an osteomyelitic acetabular lesion in which there is extensive obliteration of the hip joint (Figure 54) as well as significant new bone expansion and vertebral fusion (C7 and T1). While this case is an atypical presentation of TB, it is a likely explanation due to the distribution of lesions. Ortner (2011) identified a case of hip TB in a prehistoric skeleton from Alaska with similar destruction of the acetabulum and proximal femur. Septic arthritis may also cause similar destruction of the hip joint, though it does not explain the involvement of C7 and T1 in the case of FC# 5075 (Ortner 2011; Waldron 2008).

**Figure 50:** Pott's deformity, T10 – T12, FC#2051, old adult female – Bunola site

**Figure 51:** Plaque on pleural surfaces of ribs – FC#E-31, youth, Middle Monongahela

**Figure 52:** Rib plaque, “coral-like” – FC#KB1, middle-aged female

**Figure 53:** Plaque on pleural surfaces of ribs – FC#2159, adolescent, Early Monongahela

**Figure 54:** TB of the hip joint – FC#5075, young adult female, Middle Monongahela

Two cases of probable blastomycosis are present in the sample. FC#3210 was an old adult male from the Early Woodland sample with small round lytic foci on the endocranial surface of the cranium (frontal and parietals). These lesions were surrounded by a slight lip of new bone formation (Figure 55). Hershkovitz et al. (1998) identified this pattern as the distinguishing signature of fungal infection in a skull and innominate from the Terry Collection. Tuberculosis and multiple myeloma can also cause small lytic foci, resulting in a moth-eaten appearance of the cranial vault. Neither condition results in new bone formation surrounding the lytic foci, thus mycotic infection is the most likely cause of the pathologies in FC#3210.

A Middle Monongahela female youth (FC#5741) had widespread lesions associated with both blastomycosis and congenital meningocele (Wakefield-Murphy 2016). Congenital meningoceles are developmental defects in which the laminae of the vertebrae fail to close, resulting in a gap or opening of the vertebral canal on the posterior portion of the vertebral column. This condition is most commonly associated with developmental neural tube anomalies such as spina bifida, and range from small lesions covered with soft tissue (spina bifida occulta) to severe defects in which the spinal cord protrudes through the lesion (spina bifida cystica) (Waldron 2008). Lytic lesions were recorded on the sacrum, right humerus, right ulna, right scapula, sternum, right ilium, and right femur. The sacrum had a large, symmetrical, midline lesion on the posterior side, measuring 34.23mm in diameter, resulting from the non-fusion of the laminae of S2-S4: a meningocele (Figure 57). On the anterior surface of the sacrum, another lytic lesion, measuring 31.69mm in diameter, was present ranging from S3-S5 (Figure 58). However, the anterior lesion was not on the mid-line, nor was it symmetrical, indicating it was not formed by non-union of sacral bodies and is likely the result of an infectious process due to extensive periosteal reaction (Hershkovitz et al. 1998). A 1.5 cm round lytic lesion was present on the iliac crest of the ilium, with a characteristic "punched out" appearance (Figure 59). Similar lytic foci were observed on the right scapular blade and through the sternum (Figures 60 and 61). The sternum was nearly completely obliterated by lytic processes surrounded by areas of new bone formation. The head of the right humerus was almost entirely obliterated (Figure 62), and the right ulna had a swollen appearance at the proximal end with lytic destruction measuring 4.2cm on the midshaft (Figure 63). Lytic foci were also present on the right femur with two 3mm "punched out" lesions surrounded by new bone formation posterior to the greater trochanter (Figure 64). The "punched out" appearance of the lytic lesions with surrounding new bone formation point to mycoses. Fungal infection is the most likely the cause of this lesion pattern, and blastomycosis is common in the Ohio Valley region (Aufderheide and Rodriguez-Martín 1998; Hershkovitz et al. 1998, Jain et al. 2014). The distribution and type of lesions does not fit with other possible conditions such as tuberculosis, actinomycosis, brucellosis, or multiple myeloma (Hershkovitz et al. 1998; Waldron 2008). Tuberculosis, actinomycosis, and brucellosis are not typically isolated to the sacrum in the vertebral column, nor is new bone formation a characteristic of the lytic processes of these diseases. Additionally, multiple myeloma rarely affects the sacrum, femur, humerus, and ulnae (Waldron 2008).

**Figure 55:** Blastomycosis, endocranial surface, left parietal – FC#3210, adult male, Early Woodland

**Figure 56:** Congenital meningocele, posterior sacrum – FC#5741, young adult female, Middle Monongahela

**Figure 57:** Large lytic lesion, blastomycosis, anterior sacrum – FC#5741, young adult female, Middle Monongahela

**Figure 58:** Lytic lesion, blastomycosis, right iliac crest – FC#5741, young adult female, Middle Monongahela

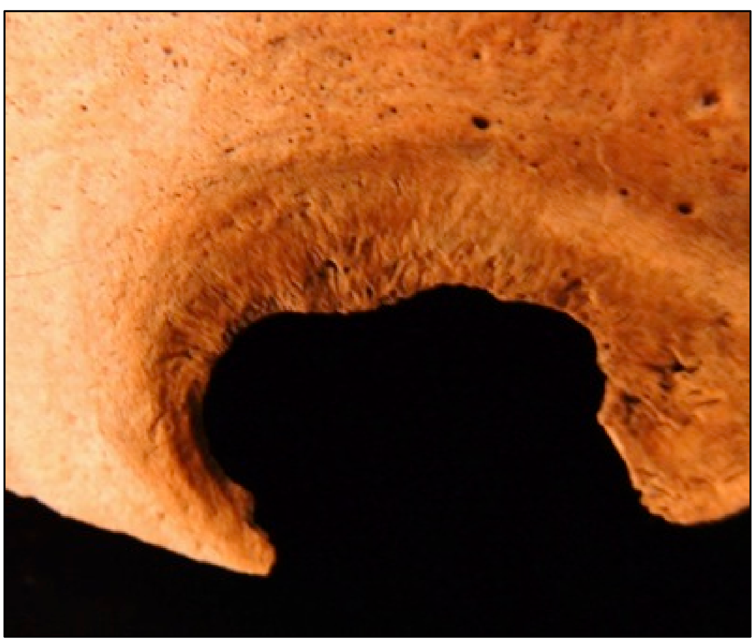


**Figure 59:** Lytic lesion, blastomycosis, right scapula – FC#5741, young adult female, Middle Monongahela

**Figure 60:** Lytic lesion, blastomycosis, sternum, lateral view – FC#5741, young adult female, Middle Monongahela

**Figure 61:** Lytic lesion, blastomycosis, right humerus – FC#5741, young adult female, Middle Monongahela


**Figure 62:** Lytic lesion and expansive changes, blastomycosis, right ulna – FC#5741, young adult female, Middle Monongahela

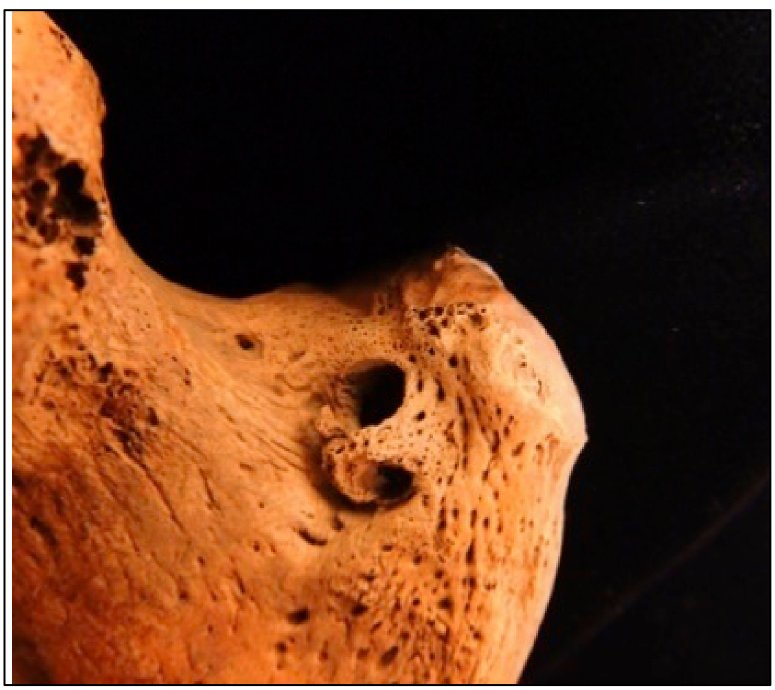


**Figure 63:** Lytic lesions, blastomycosis, right femur – FC#5741, young adult female, Middle Monongahela

Only two cases of maxillary sinusitis were observed, which was unexpected given the high prevalence of the condition in comparative ossuary samples (>40%) (Merrett and Pfeiffer 2000; Roberts 2007). FC#2158 (middle-aged male) and FC#5073 (young adult female) were part of the Middle Monongahela sample. Both skeletons exhibited the marked periosteal reaction associated with maxillary sinusitis. It is unlikely these were the only two cases of maxillary sinusitis in the Ohio Valley samples, but due to taphonomic damage and curation, the sinus areas of maxillae were not readily available for examination in a large proportion of skeletons.

Lastly, an isolated case of chondroblastoma was recorded for a female youth from the Middle Monongahela sample (FC#2155) (Figure 64). This consists of a large 2.12cm lytic lesion with smooth borders on the posterior portion of the distal left femur. This condition is a benign type of tumor that occurs most frequently in the metaphyses of the femur and tibia near the knee joint. The condition commonly affects teenage and young adult males, but can occur in females (Turcotte et al. 1993). Giant cell tumor is a possible differential diagnosis as these commonly occur in the distal femur in individuals younger than 20 years in 16% of cases (Pai et al. 2005).

**Figure 64:** Chondroblastoma, left femur – FC#2155, female youth, Middle Monongahela

# 7.0 RESULTS AND DISCUSSION: ACTIVITY

In this chapter, results for MSM robusticity and asymmetry are presented. These statistics are listed by time period, and results by sex and age are discussed. Statistical summaries of MSM robusticity and asymmetry between samples by sex, age, and age/sex are presented in Appendix B. Ethnographic studies provide key context to the interpretation of MSM patterning and culturally specific activities. To provide a basis for the interpretation of MSM patterning in each of the samples, Murdock and Provost's (1973) compilation of labor tasks compiled from ethnographic sources by sex was utilized. Each task likely to be a notable feature of labor and activity in the Ohio Valley throughout prehistory was summarized by percentage of participation by males in North American societies, such as the Pawnee and Creek, from Murdock and Provost (1973) and a list of associated muscle movements (Table 47).

**Table 47:** Activities expected for Ohio Valley samples with associated muscle actions by percentage of male participation*

| **Activity** | **% Male Participation*** | **Patterns of Muscle Action** |
|---|---|---|
| Hunting large land fauna | 98.7 | Bow loading: flexion, extension of elbow, extension of shoulder<br>Butchering: flexion, extension, medial and lateral rotation of shoulder, pronation, supination<br>Walking long distances: abduction of thigh, medial/lateral rotation of thigh, knee flexion/extension, |
| Trapping | 95.7 | Squatting/Rising: knee flexion/extension, thigh extension |
| Lumbering | 98.7 | Chopping: shoulder abduction, lateral rotation of shoulder, elbow flexion/extension, wrist flexion/extension/rotation<br>Load carrying: elbow flexion, shoulder abduction/extension/flexion, thigh extension |
| Stone Working | 92.9 | Flint knapping: pronation/supination of forearm, flexion/extension of forearm |
| Land clearance | 74.6 | Wood lumbering: shoulder abduction, lateral rotation of shoulder, elbow flexion/extension<br>Vegetation clearing: shoulder rotation, shoulder flexion/extension, shoulder abduction/adduction, thigh extension and knee flexion extension (from squatting/rising and pulling weedy plants)<br>Load carrying: elbow flexion/extension, shoulder abduction/extension/flexion, thigh extension |
| Fishing | 85.8 | Netmaking: flexion/extension of elbow and wrist, pronation/supination, rotation of wrist<br>Fishing with nets: thigh extension/flexion (from squatting/rising and bending), shoulder flexion, pronation/supination, elbow flexion/extension (from casting and setting nets)<br>Spearing: elbow flexion/extension, shoulder rotation/flexion, extension |
| Housebuilding | 67.9 | Wood and bark preparation: shoulder flexion/extension/abduction/adduction, elbow flexion/extension, pronation/supination<br>Digging post holes: thigh extension/flexion, knee flexion/extension, shoulder rotation/flexion/extension, pronation/supination, elbow flexion/extension |
| Soil preparation | 53.1 | Tilling/Hoeing: shoulder flexion/extension/rotation, elbow flexion/extension, pronation/supination |
| Preparation of skins | 30.7 | Using scraper: shoulder flexion/extension/rotation, pronation/supination, elbow flexion/extension |

*(Murdock and Provost 1973)

**Table 47:** (continued)

| Activity | % Male Participation* | Patterns of Muscle Action |
|---|---|---|
| Crop planting | 46.9 | Squatting/Rising: thigh flexion/extension, knee flexion/extension<br>Digging: elbow flexion/extension, pronation/supination |
| Harvesting | 35.4 | Shoulder flexion/extension, shoulder rotation, elbow flexion/extension, pronation/supination<br>Squatting/Rising: thigh flexion/extension, knee flexion/extension<br>Load carrying: shoulder and elbow flexion/extension, shoulder abduction/adduction |
| Pottery and Clothing Manufacture | 13.8, 14.3 | Pottery: shoulder rotation, elbow flexion/extension, pronation supination, squatting: thigh flexion/extension, knee flexion/extension<br>Clothing: elbow flexion/extension, pronation/supination, wrist flexion/extension/rotation |
| Gathering Wild Foods | 12.3 | Walking/Running: thigh adduction, thigh flexion/extension, knee flexion/extension<br>Bending/Squatting: thigh flexion/extension, knee flexion/extension<br>Gathering: elbow flexion/extension, pronation/supination, shoulder flexion/extension |
| Preparation of maize | 0.6 | Grinding with stone: shoulder flexion/extension/rotation, elbow flexion/extension, pronation/supination, wrist flexion/extension/rotation |

*(Murdock and Provost 1973)

## 7.1 EARLY WOODLAND ACTIVITY

### 7.1.1 Early Woodland Activity: Discussion

#### 7.1.1.1 Early Woodland Results

Means and p-values from Kruskall-Wallis and Spearman's correlation are listed for MSM for upper limb by sex (Table 48) and for the lower limb (Table 49). These values for MSM scores by adult age category are listed in Tables 50 and 51. Asymmetry score means by sex (Tables 52-53) and age (Tables 54-55) are also presented. Statistical tests revealed no significant differences between the sexes or adult age ranges for MSM robusticity. No significant difference was found from Mann-Whitney U tests or Kruskall-Wallis H tests when MSM asymmetry scores were compared by sex and age.

#### 7.1.1.2 Early Woodland Discussion

The interpretation of the MSM analysis results from the Early Woodland is complicated by the fact that preservation was a confounding factor for this sample. Few anatomical markers for activity were preserved for males and females, between age groups, or between left and right sides. MSM scores were moderate for muscles of the shoulder (rotators, flexors, extensors, adductors). The common wrist flexors and extensors had low scores, whereas main elbow flexors/extensors scored moderate to high. Few asymmetry scores were obtained for the upper limb. Those from the clavicle either showed symmetry or increased use of the left side. It is important to note that there were no significant differences in upper limb MSM scores and asymmetry scores between the sexes or adult age groups. The patterning of MSMs for the upper limb is suggestive of heavier shoulder involvement and elbow flexion/extension than pronation/supination activities.

Shuler et al. (2012) noted that increased robusticity in muscles of arm flexion and extension (brachialis, biceps, and triceps) can be associated with hunting activities such as bow hunting, as these muscle groups have actions that respond to biomechanical loading of bow use. Bridges (1991) proposed that for hunter-gatherers in the eastern North America, activity patterns included hunting, skinning of hides, chopping and gathering wood, gathering food, food processing, pottery production, and lithic production. For the Early Woodland sample, activities such as stone tool and pottery production, hunting, wood chopping, hide preparation, and small load carrying are indicated by increased muscle robusticity in the shoulder and in elbow flexion/extension. Wood chopping, food processing, and load bearing are reflected in the moderate robusticity in shoulder flexors (pectoralis major, deltoid, and teres major). Bow hunting is also indicated by moderate to high robusticity scores for elbow flexors and extensors. Similar patterns of use of upper limb muscles were observed in Natufian hunter-gatherer societies, with greater robusticity in the latissimus, pectoralis, deltoid and brachialis (Eshed et al. 2004). According to Eshed et al. (2004) food processing activities such as grinding are inferred by this patterning.

Lower thigh extensors, knee flexors and extensors, and hip adductors scored moderately. Hip flexors scored low to moderate. As with the upper limb, MSMs of the lower limb did not have any significant differences between sexes or adult age groups in terms of mean score or asymmetry. This arrangement is indicative of activities such as squatting/rising and walking/running associated with hunting, gathering, load carrying, and wood lumbering.

Taken as a whole, the patterning of robusticity in this sample leads to several models regarding the nature of activity in the Early Woodland Period. It is unlikely that the groups using the Cresap and McKees Rocks burial mounds in the Early Woodland were engaged in intensive agriculture, as these samples exhibit significantly lower MSM robusticity than the Monongahela groups across ages and sexes (See Appendix B), who were intensive maize agriculturists. Little subsistence and settlement data is available for the Adena complex, though it has been hypothesized that indigenous groups in the American Northeast during Early Woodland engaged in small-scale weedy crop cultivation in the form of small plot seasonal propagation (Asch-Sidell 2002; Hart and Asch-Sidell 1997). There was preference for terrace zones in the Early Woodland, which would have afforded populations access to wild and garden plants from the Eastern Agricultural Complex, such as sumpweed and chenopodium (Crowell et al.

2005; Keener and Nye 2007). Activities such as habitual squatting, distance walking, small load carrying are supportive of seasonal movement and small-plot weedy plant cultivation. Significant or strict division of labor is not supported by MSM results, as there are no significant differences between demographic groups.

This pattern is different from those observed from similar groups elsewhere in the American Northeast. Rodrigues (2006) observed notable differences in MSM robusticity between males and females among the Turner Mound group in southeastern Ohio (AD 250-400). These mounds and earthworks were associated with the Hopewell Interaction Sphere. These groups were likely engaged in seasonal movements with a subsistence strategy of hunting and gathering with small-scale non-maize cultivation (Wymer 1997). Given this pattern of settlement/subsistence, the Turner Mound group represents a close approximation to Early Woodland populations living in the Ohio Valley region.

Among the Turner Mound groups, ranked differences between sexes emphasized muscles of the upper limb among females (59%) and lower limb muscles among males (60%). Females were more likely to exhibit greater robusticity in the muscles that flex and extend the hand, elbow and arms well as those that rotate and abduct the thigh and flex the knee (gastrocnemius). Males among the Turner group were more likely to have higher MSM scores for rotators, flexors, and adductors of the arm at the shoulder, thigh flexors and knee extension (Rodrigues 2006). It was hypothesized that a sex based division of labor was suggested by these differences; females were associated with muscle use patterns indicative of food grinding and running, whereas males MSM patterning was associated with food grinding and hide processing (Rodrigues 2006).

The Early Woodland sample had similar activities to the Turner Mound group but without associations with sex: the patterning of greater MSM robusticity in muscle groups of the shoulder associated with rotation, adduction and flexion/extension of the arm at the shoulder, as well as squatting activities as supported by greater robusticity scores in the gluteal muscles and knee flexion/extension. This supports the hypothesis that Early Woodland groups in the Ohio Valley were engaged in seasonal movement, hunting and gathering, and small-scale cultivation.

**Table 48**: Early Woodland - comparison of mean scores by sex for upper limb MSMs*

| | **Male** | | **Female** | | **Kruskall-Wallis*** | | **Spearman*** | |
|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | NA | NA | 2.5 | 2 | NA | NA | NA | NA |
| Subclavius | NA | NA | 1.5 | 1.5 | NA | NA | NA | NA |
| Trapezoid ligament | NA | NA | 3 | 2 | NA | NA | NA | NA |
| Conoid ligament | NA | NA | 3 | 3 | NA | NA | NA | NA |
| Deltoid | NA | NA | 1 | 1.5 | NA | NA | NA | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | 2 | NA | NA | NA | NA | NA | NA | NA |
| Pectoralis minor | NA | NA | NA | NA | NA | NA | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 1 | NA | NA | NA | NA | NA | NA | NA |
| Infraspinatus | 1 | NA | NA | NA | NA | NA | NA | NA |
| Teres minor | 1 | NA | NA | NA | NA | NA | NA | NA |
| Pectoralis major | 3 | 2 | 2 | NA | .083 | NA | NA | NA |
| Latissimus dorsi | 3 | 2 | 2 | NA | .083 | NA | NA | NA |
| Teres major | 2 | 1 | 1.3 | NA | .317 | NA | NA | NA |
| Deltoid | 3 | 2 | 2.5 | NA | .264 | NA | NA | NA |
| Coracobrachialis | 2 | 1 | 1.25 | NA | .114 | NA | NA | NA |
| Common extensors | 2 | 1 | 1.33 | NA | .127 | NA | NA | NA |
| Common flexors | 1.5 | 1 | 1 | NA | .114 | NA | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 3 | NA | 1.5 | 2 | .221 | NA | NA | NA |
| Anconeus | 2 | NA | 1 | 1 | .157 | NA | NA | NA |
| Triceps | 1 | NA | 2 | 1 | .317 | NA | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | NA | NA | 3 | NA | NA | NA | NA | NA |
| Pronator teres | NA | NA | 1.5 | NA | NA | NA | NA | NA |
| Supinator | NA | NA | 1 | 1 | NA | NA | NA | NA |
| Pronator quadratus | NA | NA | 1 | 1 | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 49:** Early Woodland - comparison of mean scores by sex for lower limb MSMs*

| ATTACHMENT | Male | | Female | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | NA | NA | 2 | 2 | NA | NA | NA | NA |
| Gluteus minimus | NA | NA | 1 | 1 | NA | NA | NA | NA |
| Gluteus medius | NA | NA | 1 | 1 | NA | NA | NA | NA |
| Tensor fascia latae | NA | NA | 2 | 2 | NA | NA | NA | NA |
| Adductor brevis | NA | NA | NA | NA | NA | NA | NA | NA |
| Adductor longus | NA | NA | NA | NA | NA | NA | NA | NA |
| Adductor magnus | NA | NA | 2 | 2 | NA | NA | NA | NA |
| Pectineus | NA | NA | NA | NA | NA | NA | NA | NA |
| Gracilis | NA | NA | NA | NA | NA | NA | NA | NA |
| Iliacus | 2 | 1 | 1.3 | 1.3 | .317 | .564 | NA | NA |
| Obturator externus | NA | NA | NA | NA | NA | NA | NA | NA |
| Obturator internus | NA | NA | NA | NA | NA | NA | NA | NA |
| Piriformis | NA | NA | 2 | 2 | NA | NA | NA | NA |
| Superior gemelli | NA | NA | NA | NA | NA | NA | NA | NA |
| Inferior gemelli | NA | NA | NA | NA | NA | NA | NA | NA |
| Quadratus femoris | NA | NA | NA | NA | NA | NA | NA | NA |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 3 | 3 | 2.33 | 2.33 | .114 | .237 | NA | NA |
| Gluteus medius | 1 | 1 | NA | NA | NA | NA | NA | NA |
| Gluteus minimus | 1 | 1 | NA | NA | NA | NA | NA | NA |
| Adductor magnus | 2.5 | 2.5 | 2.33 | 2.33 | .456 | .462 | NA | NA |
| Vastus intermedius | 2 | 2 | 2 | 2 | 1.00 | 1.00 | NA | NA |
| Vastus medialis | 2 | 2 | 2 | 2 | 1.00 | 1.00 | NA | NA |
| Vastus lateralis | 2 | 2 | 2 | 2 | 1.00 | 1.00 | NA | NA |
| Piriformis | 1 | 1 | NA | NA | NA | NA | NA | NA |
| Obturator externus | 1 | 1 | NA | NA | NA | NA | NA | NA |
| Obturator internus | 1 | 1 | NA | NA | NA | NA | NA | NA |
| Quadratus femoris | 1 | 1 | NA | NA | NA | NA | NA | NA |
| Popliteus | 1 | 1 | NA | NA | NA | NA | NA | NA |
| Gastrocnemius | 2 | 2 | 2 | 1 | 1.00 | .564 | NA | NA |
| Iliacus | 2 | 2 | 2 | 1 | 1.00 | 1.00 | NA | NA |
| Pectineus | 2 | 2 | 1 | 1.5 | .083 | .480 | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | 1 | 1 | 1.5 | 2.5 | .564 | .167 | NA | NA |
| Popliteus | NA | NA | 1 | 1 | NA | NA | NA | NA |
| Semimembranosus | NA | NA | 1 | 1 | NA | NA | NA | NA |
| Tibialis posterior | NA | NA | 1 | 1.5 | NA | NA | NA | NA |
| Tibialis anterior | NA | NA | 1 | 1.5 | NA | NA | NA | NA |
| Flexor digitorum | NA | NA | 1 | 1.5 | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 50:** Early Woodland - comparison of mean scores by adult age category for upper limb MSMs*

| | **Young Adult** | | **Middle-Aged Adult** | | **Old Adult** | | **Kruskall-Wallis*** | | **Spearman*** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | 3 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Subclavius | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Trapezoid ligament | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Conoid ligament | 3 | 3 | NA | NA | NA | NA | NA | NA | NA | NA |
| Deltoid | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Pectoralis minor | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Infraspinatus | 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Teres minor | 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Pectoralis major | 2.3 | NA | NA | 2 | NA | NA | NA | NA | NA | NA |
| Latissimus dorsi | 2.3 | NA | NA | 2 | NA | NA | NA | NA | NA | NA |
| Teres major | 2 | NA | NA | 1 | NA | NA | NA | NA | NA | NA |
| Deltoid | 3 | NA | NA | 2 | NA | NA | NA | NA | NA | NA |
| Coracobrachialis | 1.5 | NA | NA | 1 | NA | NA | NA | NA | NA | NA |
| Common extensors | 2 | NA | NA | 1 | NA | NA | NA | NA | NA | NA |
| Common flexors | 1.5 | NA | NA | 1 | NA | NA | NA | NA | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 2.5 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Anconeus | 1.5 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Triceps | 2 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | NA | NA | 3 | NA | NA | NA | NA | NA | NA | NA |
| Pronator teres | 1 | NA | 2 | NA | NA | NA | .317 | NA | NA | NA |
| Supinator | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Pronator quadratus | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 51:** Early Woodland - comparison of mean scores by adult age category for lower limb MSMs*

| ATTACHMENT | Young Adult | | Middle-Aged Adult | | Old Adult | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Gluteus minimus | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Gluteus medius | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Tensor fascia latae | 2 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Adductor brevis | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Adductor longus | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Adductor magnus | 2 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Pectineus | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Gracilis | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Iliacus | 1.6 | 1.5 | NA | 1 | NA | NA | .480 | .564 | NA | NA |
| Obturator externus | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Obturator internus | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Piriformis | 2 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Superior gemelli | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Inferior gemelli | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Quadratus femoris | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.75 | 2.6 | 3 | 3 | NA | NA | .617 | .564 | NA | NA |
| Gluteus medius | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Gluteus minimus | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Adductor magnus | 2.75 | 2.6 | 2 | 2 | NA | NA | .221 | .317 | NA | NA |
| Vastus intermedius | 2 | 2 | 2 | 2 | NA | NA | 1.00 | 1.00 | NA | NA |
| Vastus medialis | 2 | 2 | 2 | 2 | NA | NA | 1.00 | 1.00 | NA | NA |
| Vastus lateralis | 2 | 2 | 2 | 2 | NA | NA | 1.00 | 1.00 | NA | NA |
| Piriformis | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Obturator externus | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Obturator internus | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Quadratus femoris | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Popliteus | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Gastrocnemius | 2 | 1.5 | NA | NA | NA | NA | NA | NA | NA | NA |
| Iliacus | 2 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Pectineus | 1.6 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | 2 | 3 | 1 | 1 | NA | NA | .317 | .317 | NA | NA |
| Popliteus | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Semimembranosus | 1 | 1 | NA | NA | NA | NA | NA | NA | NA | NA |
| Tibialis posterior | 1 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Tibialis anterior | 1 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
| Flexor digitorum | 1 | 2 | NA | NA | NA | NA | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 52:** Early Woodland - comparison of asymmetry score means by sex for upper limb MSMs*

| CLAVICLE | Male | Female | Kruskall-Wallis* | Spearman * |
|---|---|---|---|---|
| Costoclavicular ligament | NA | 125.00 | NA | NA |
| Subclavius | NA | 100.00 | NA | NA |
| Trapezoid ligament | NA | 150.00 | NA | NA |
| Conoid ligament | NA | 100.00 | NA | NA |
| Deltoid | NA | 100.00 | NA | NA |
| **SCAPULA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | NA | NA | NA | NA |
| Pectoralis minor | NA | NA | NA | NA |
| **HUMERUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | NA | NA | NA | NA |
| Infraspinatus | NA | NA | NA | NA |
| Teres minor | NA | NA | NA | NA |
| Pectoralis major | NA | NA | NA | NA |
| Latissimus dorsi | NA | NA | NA | NA |
| Teres major | NA | NA | NA | NA |
| Deltoid | NA | NA | NA | NA |
| Coracobrachialis | NA | NA | NA | NA |
| Common extensors | NA | NA | NA | NA |
| Common flexors | NA | NA | NA | NA |
| **ULNA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | NA | 100.00 | NA | NA |
| Anconeus | NA | NA | NA | NA |
| Triceps | NA | NA | NA | NA |
| **RADIUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | NA | NA | NA | NA |
| Pronator teres | NA | NA | NA | NA |
| Supinator | NA | NA | NA | NA |
| Pronator quadratus | NA | 100.00 | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 53:** Early Woodland - comparison of symmetry mean scores by sex for lower limb MSMs*

| INNOMINATE | Male | Female | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|
| Gluteus maximus | NA | 100.00 | NA | NA |
| Gluteus minimus | NA | 100.00 | NA | NA |
| Gluteus medius | NA | 100.00 | NA | NA |
| Tensor fascia latae | NA | 100.00 | NA | NA |
| Adductor brevis | NA | NA | NA | NA |
| Adductor longus | NA | NA | NA | NA |
| Adductor magnus | NA | 100.00 | NA | NA |
| Pectineus | NA | NA | NA | NA |
| Gracilis | NA | NA | NA | NA |
| Iliacus | NA | 100.00 | NA | NA |
| Obturator externus | NA | NA | NA | NA |
| Obturator internus | NA | NA | NA | NA |
| Piriformis | NA | 100.00 | NA | NA |
| Superior gemelli | NA | NA | NA | NA |
| Inferior gemelli | NA | NA | NA | NA |
| Quadratus femoris | NA | NA | NA | NA |
| **FEMUR** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | 100.00 | 100.00 | 1.00 | NA |
| Gluteus medius | 100.00 | NA | NA | NA |
| Gluteus minimus | NA | NA | NA | NA |
| Adductor magnus | 100.00 | 100.00 | 1.00 | NA |
| Vastus intermedius | 100.00 | 100.00 | 1.00 | NA |
| Vastus medialis | 100.00 | 100.00 | 1.00 | NA |
| Vastus lateralis | 100.00 | 100.00 | 1.00 | NA |
| Piriformis | 100.00 | NA | NA | NA |
| Obturator externus | 100.00 | NA | NA | NA |
| Obturator internus | 100.00 | NA | NA | NA |
| Quadratus femoris | 100.00 | NA | NA | NA |
| Popliteus | 100.00 | NA | NA | NA |
| Gastrocnemius | 100.00 | 133.00 | .667 | NA |
| Iliacus | 100.00 | 100.00 | 1.00 | NA |
| Pectineus | 100.00 | 75.00 | .667 | NA |
| **TIBIA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 100.00 | 58.33 | .667 | NA |
| Popliteus | NA | 100.00 | NA | NA |
| Semimembranosus | NA | 100.00 | NA | NA |
| Tibialis posterior | NA | 75.00 | NA | NA |
| Tibialis anterior | NA | 75.00 | NA | NA |
| Flexor digitorum | NA | 75.00 | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 54:** Early Woodland - comparison of mean asymmetry scores by adult age category for upper limb MSMs*

| CLAVICLE | Young Adult | Middle-Aged Adult | Old Adult | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|---|
| Costoclavicular ligament | 150.00 | NA | NA | NA | NA |
| Subclavius | 100.00 | NA | NA | NA | NA |
| Trapezoid ligament | 150.00 | NA | NA | NA | NA |
| Conoid ligament | 100.00 | NA | NA | NA | NA |
| Deltoid | 100.00 | NA | NA | NA | NA |
| **SCAPULA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | NA | NA | NA | NA | NA |
| Pectoralis minor | NA | NA | NA | NA | NA |
| **HUMERUS** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | NA | NA | NA | NA | NA |
| Infraspinatus | NA | NA | NA | NA | NA |
| Teres minor | NA | NA | NA | NA | NA |
| Pectoralis major | NA | NA | NA | NA | NA |
| Latissimus dorsi | NA | NA | NA | NA | NA |
| Teres major | NA | NA | NA | NA | NA |
| Deltoid | NA | NA | NA | NA | NA |
| Coracobrachialis | NA | NA | NA | NA | NA |
| Common extensors | NA | NA | NA | NA | NA |
| Common flexors | NA | NA | NA | NA | NA |
| **ULNA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 100.00 | NA | NA | NA | NA |
| Anconeus | NA | NA | NA | NA | NA |
| Triceps | NA | NA | NA | NA | NA |
| **RADIUS** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | NA | NA | NA | NA | NA |
| Pronator teres | NA | NA | NA | NA | NA |
| Supinator | NA | NA | NA | NA | NA |
| Pronator quadratus | 100.00 | NA | NA | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 55:** Early Woodland - comparison of mean asymmetry scores by adult age category for lower limb MSMs*

| INNOMINATE | Young Adult | Middle-Aged Adult | Old Adult | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|---|
| Gluteus maximus | 100.00 | NA | NA | NA | NA |
| Gluteus minimus | 100.00 | NA | NA | NA | NA |
| Gluteus medius | 100.00 | NA | NA | NA | NA |
| Tensor fascia latae | 100.00 | NA | NA | NA | NA |
| Adductor brevis | NA | NA | NA | NA | NA |
| Adductor longus | NA | NA | NA | NA | NA |
| Adductor magnus | 100.00 | NA | NA | NA | NA |
| Pectineus | NA | NA | NA | NA | NA |
| Gracilis | NA | NA | NA | NA | NA |
| Iliacus | 100.00 | NA | NA | NA | NA |
| Obturator externus | NA | NA | NA | NA | NA |
| Obturator internus | NA | NA | NA | NA | NA |
| Piriformis | 100.00 | NA | NA | NA | NA |
| Superior gemelli | NA | NA | NA | NA | NA |
| Inferior gemelli | NA | NA | NA | NA | NA |
| Quadratus femoris | NA | NA | NA | NA | NA |
| **FEMUR** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | 100.00 | 100.00 | NA | 1.00 | NA |
| Gluteus medius | 100.00 | NA | NA | NA | NA |
| Gluteus minimus | NA | NA | NA | NA | NA |
| Adductor magnus | 100.00 | 100.00 | NA | 1.00 | NA |
| Vastus intermedius | 100.00 | 100.00 | NA | 1.00 | NA |
| Vastus medialis | 100.00 | 100.00 | NA | 1.00 | NA |
| Vastus lateralis | 100.00 | 100.00 | NA | 1.00 | NA |
| Piriformis | 100.00 | NA | NA | NA | NA |
| Obturator externus | 100.00 | NA | NA | NA | NA |
| Obturator internus | 100.00 | NA | NA | NA | NA |
| Quadratus femoris | 100.00 | NA | NA | NA | NA |
| Popliteus | 100.00 | NA | NA | NA | NA |
| Gastrocnemius | 150.00 | NA | NA | NA | NA |
| Iliacus | 100.00 | NA | NA | NA | NA |
| Pectineus | 75.00 | NA | NA | NA | NA |
| **TIBIA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 66.66 | 100.00 | NA | .317 | NA |
| Popliteus | 100.00 | NA | NA | NA | NA |
| Semimembranosus | 100.00 | NA | NA | NA | NA |
| Tibialis posterior | 50.00 | NA | NA | NA | NA |
| Tibialis anterior | 50.00 | NA | NA | NA | NA |
| Flexor digitorum | 50.00 | NA | NA | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

## 7.2 THE MONONGAHELA SAMPLES

### 7.2.1 Early Monongahela Activity: Discussion

#### 7.2.1.1 Early Monongahela Results

Means and p-values from statistical procedures are listed for MSM robusticity of the upper limb of the upper limb by sex in Table 56 and for the lower limb in Table 57. These values for MSM scores by adult age category are listed in Tables 58 and 59. Asymmetry score means by sex (Tables 60-61) and age (Tables 62-63) are also presented. Males had significantly higher MSM scores for the following markers: left deltoid, right coracobrachialis, left triceps, left bicep, left supinator, left tensor fascia latae, and right vastus medialis. Old adults scored significantly higher than younger adults for the right pectoralis major and left biceps, and higher than middle-aged adults for the right adductor magnus. Middle-aged adults scored significantly higher than young adults for the left biceps, and left and right vastus intermedius. Age was significantly correlated with MSM score for the right pectoralis major, left biceps, and right vastus intermedius. No significant differences were revealed from statistical procedures for MSM asymmetry by sex or adult age.

#### 7.2.1.2 Early Monongahela Discussion

A distinctive pattern of activity for upper limb MSMs from the Early Monongahela can be deduced from mean values and statistical results. Major flexors, extensors and rotators of the arm at the shoulder had moderate to high MSM scores. Stabilizing ligaments of the clavicle with high robusticity scores support heavy use of shoulder musculature. Flexors and extensors of the elbow also had moderate to high scores and pronation and supination actions were also indicated at a moderate level. Males in generally had higher mean scores in upper limb MSMs than females. MSM scores for these attachments were correlated with biological sex. While no significant differences were found in asymmetry scores for the upper limb, mean scores indicate that males tended to have more robusticity for the left limb, whereas females had higher robusticity scores for the right limb. The reason for this difference could have been that males were more heavily engaged in activities requiring extensive left handed activities such as rowing/paddling, or left handed bow use. In terms of age, old adults had higher MSM scores than middle-aged and young adults. MSM scores were significantly correlated with age. Age is a suspected confounding factor in the interpretation of activity patterns, as MSM robusticity increases with age as muscle use occurs over a longer period. However, entheseal changes may also decrease over the lifespan if muscle use decreases with age (Niinimäki 2011; Stefanovic and Porcic 2013). In this sample, there are more old adult males than females; one possibility for increased muscle robusticity among males in this sample is this age factor (Stefanovic and Porcic 2013). This is also evidence that older Monongahelans were still actively participating in activity relating to agricultural subsistence (Shuler et al. 2012).

Heavy shoulder muscle use supports an intensive agricultural economy, as activities such as digging, soil preparation and heavy load lifting (Shuler et al. 2012). While males had higher scores for several shoulder MSMs, females still had moderate to high scores indicating they were also participating in these or similar activities. Moderately robust markers for pronation and supination also indicate that both males and females performed craft production activities, such as pottery and lithic preparation, hide preparation and making basketry/nets. Hunting was still a subsistence mechanism indicated by patterning of flexion and extension of the arm, with high scores for the brachialis, biceps, and triceps. The biomechanical loading of bow use puts markedly increased strain on elbow flexors and extensors (Shuler et al. 2012). It is important to note that males had significantly higher robusticity in the biceps and triceps than females for this sample, thus it is possible that males were primarily responsible for bow hunting (Shuler et al. 2012). Faunal evidence from Monongahela sites indicates that deer were supplemental to the diet, even though maize was the primary source of nutrition (Johnson 2001; Means 2007a). Maize grinding and production is indicated by MSMs as well, as grinding actions produce upper limb robusticity in shoulder attachments for medial and lateral rotators (Eshed et al. 2004).

For the lower limb, The Early Monongahela sample exhibited moderate to high robusticity in the gluteus maximus, adductor magnus, iliacus, quadriceps, gastrocnemius and soleus. Males scored significantly higher than females for the tensor fascia latae (p=.044) and vastus medialis (p=.047) attachments; these results were correlated with biological sex. Age was also correlated with several muscle attachments in the lower limb as older adults scored significantly higher for the adductor magnus (p=.018), and left/right vastus intermedius (p=.017, p=.002). Demographics also play a role in this interpretation as with the upper limb, as there are more males in the old adult cohort for this sample (Stefanovic and Porcic 2013). In terms of between sample comparisons, the Early Monongahela sample scored significantly higher than the Early Woodland sample for several muscle markings in the lower limb involved with of thigh extension, knee extension and flexion. All of these actions are associated with squatting, running/walking, and rising from a squatted position as these actions are performed during planting, harvesting, and soil clearing. Adductor magnus robusticity is indicative of frequent walking/running. It is possible that agricultural activity was delineated strictly by sex during the Early Monongahela period, but several other activities such as lumbering and house building can use similar muscle groups to those associated with soil clearing, harvesting, and planting, though these building projects are not every day labor activities. While sex differences were observed, only two variables were significant for the lower limb. Thus, the patterning of MSM robusticity indicates that both males and females were heavily engaged in activities with similar biomechanical stresses such as agricultural activities and lumbering.

Several key differences emerge when Early Monongahela upper limb activity patterns are compared with those of Mississippian maize agriculturalists from the American Southeast. Shuler et al. (2012) examined upper limb MSMs among Mississippian agriculturalists from the Moundville site and sites from central Tombigbee River Valley in Mississippi and Alabama. The MSM patterning indicated that males were performing hunting activities, as marked by increased use of arm flexors and extensors. Shoulder entheses also indicated that males were participating in agricultural subsistence. Female activity patterning was unlike than that of males, with greater use of the biceps and common extensors of the humeri (Shuler et al. 2016). Ethnohistorical accounts of indigenous groups in the American Southeast suggest that these societies were matrilineal and matrilocal, with women engaged in various agricultural and household productive activities by age (Shuler et al. 2016). Age was a significant factor in the expression and severity of entheseal changes for the Mississippian samples; younger individuals exhibited more changes than middle aged or older adults. It was hypothesized that intensive activity and labor were performed by the younger individuals in these societies (Shuler et al 2016). This is suggestive that productive roles were delineated by age among Mississippians. As age is an important factor in gendered identity, these patterns indicated that gendered social categories had an influence on labor and status among Mississippians (Shuler et al. 2012; Sofaer 2006b).

While the subsistence strategies between Mississippians and Monongahelans were similar, age and sex differences in MSM changes are evident and in turn, the way in which gender, age, and labor intersected among these societies is dissimilar. Only males exhibited significantly high robusticity in upper limb muscle attachments, especially in the arm flexors and shoulder. This patterning is similar to that of the Mississippian males, indicating that hunting was still practiced by males among both of these societies. Early Monongahela males and females exhibited moderate to high robusticity in shoulder muscles such as pectoralis major, deltoid, and teres major as well as the arm flexors. The interpretation of the use of these muscles is tenuous, as multiple activities can caused increased robusticity for these markers (Shuler et al. 2012). Bow use is indicated in individuals with higher scores for arm flexors/extensor MSMs, but activities such as load lifting, grain grinding, and soil preparation could also have caused these alterations (Shuler et al. 2012). In tandem with faunal evidence from sites, it is supported that the Early Monongahela were using deer at least as a supplemental nutritional source (Johnson 2001; Means 2007a). It is suggested that labor was delineated for hunting along gendered lines, given that associated muscle changes are more robust among males. The key difference between Early Monongahela and the Mississippian groups is the expression of activity in terms of age. Early Monongahela old adults scored significantly higher for attachments in both the upper and lower limb than younger age categories. This suggests that Monongahelan adults were active in the agricultural labor structure into older adulthood, whereas among Mississippians entheseal changes declined with age.

There are no ethnohistorical accounts for the Monongahela as there are for groups in the Southeast, though Johnson (2001) has made a case for an Iroquoian connection. Ethnohistorical Iroquoian gender, status, and labor models follow the notion of separate spaces and tasks for men and women; men were engaged in hunting, trade, and travel to outside communities whereas women were responsible for agricultural production, gathering, and household production of pottery (Allen 2010; Sagard 1636; Venables 2010). While separate spaces and activities were delineated by sex, indigenous scholarship stresses that the value of labor was viewed as equal across genders (Venables 2010). MSM patterning of the upper limb is suggests that Monongahela males engaged in bow hunting, whereas this is not indicated among females. Shoulder robusticity indicates that males were still likely engaged in agricultural production or lumbering, however, as high MSM scores indicate heavy shoulder flexion/extension associated with load bearing, chopping, and land clearing activities. The patterning of lower limb robusticity is also indicative that males may have engaged more in long distance walking than females, but were still likely engaged in agricultural or craft activities such as squatting and rising during planting or lithic production, so the division of labor was not as clearly delineated for the Monongahela as ethnohistorical models for the Iroquoians report (Sagard 1636; Venables 2010).

**Table 56:** Early Monongahela - comparison of mean values for MSMs of the upper limb by sex*

| | Male | | Female | | Kruskall-Wallis* | | Spearman * | |
|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | 2.40 | 2.00 | 2.44 | 2.44 | .653 | .308 | NA | NA |
| Subclavius | 1.17 | 1.17 | 1.33 | 1.44 | .496 | .286 | NA | NA |
| Trapezoid ligament | 2.60 | 2.40 | 2.00 | 2.22 | .496 | .286 | NA | NA |
| Conoid ligament | 2.40 | 2.80 | 2.22 | 2.22 | .649 | .071 | NA | NA |
| Deltoid | 2.75 | 2.75 | 2.75 | 2.75 | .925 | .873 | NA | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | 1.25 | 1.25 | 1.25 | 1.25 | .690 | .447 | NA | NA |
| Pectoralis minor | 1.00 | 1.00 | .88 | .88 | .505 | .765 | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 1.00 | .75 | 1.17 | 1.17 | .480 | .080 | NA | NA |
| Infraspinatus | 1.00 | .75 | 1.17 | 1.17 | .480 | .080 | NA | NA |
| Teres minor | 1.25 | 1.00 | 1.00 | 1.00 | .157 | .484 | NA | NA |
| Pectoralis major | 2.25 | 2.75 | 1.83 | 2.00 | .170 | 133 | NA | NA |
| Latissimus dorsi | 2.00 | 2.25 | 1.50 | 1.5 | .034 | .291 | .023 | NA |
| Teres major | 2.00 | 2.50 | 1.83 | 1.83 | .241 | .349 | NA | NA |
| Deltoid | 2.50 | 2.75 | 2.00 | 1.83 | **.022** | .058 | **.016** | NA |
| Coracobrachialis | 1.25 | 1.50 | 1.00 | 1.17 | .238 | **.028** | NA | **.021** |
| Common extensors | 1.00 | 1.00 | 1.17 | 1.17 | .690 | 736 | NA | NA |
| Common flexors | 1.25 | 1.00 | 1.17 | 1.17 | .765 | .231 | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 2.50 | 2.50 | 2.13 | 2.38 | .182 | .356 | NA | NA |
| Anconeus | 1.50 | 1.50 | 1.13 | 1.13 | .225 | .166 | NA | NA |
| Triceps | 2.00 | 1.33 | 1.25 | 1.38 | **.033** | .698 | **.027** | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | 2.80 | 2.60 | 2.22 | 2.11 | **.022** | .149 | **.016** | NA |
| Pronator teres | 2.40 | 2.00 | 1.56 | 1.44 | .051 | .136 | NA | NA |
| Supinator | 1.60 | 1.80 | 1.00 | 1.11 | **.006** | .053 | **.002** | NA |
| Pronator quadratus | 1.00 | 1.00 | .89 | 1.00 | .324 | 1.00 | NA | NA |

*significant p-values bolded (p≤.05)

**Table 57:** Early Monongahela - comparison of mean MSM scores for the lower limb by sex*

| ATTACHMENT | Male | | Female | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 1.67 | 2.67 | 2.40 | 2.40 | .857 | .407 | NA | NA |
| Gluteus minimus | 1.00 | 1.00 | 1.20 | 1.00 | 1.00 | 1.00 | NA | NA |
| Gluteus medius | 1.33 | 1.33 | 1.4 | 1.2 | .254 | .726 | NA | NA |
| Tensor fascia latae | 2.33 | 2.33 | 1.8 | 1.8 | **.044** | .754 | **.038** | NA |
| Adductor brevis | 1.00 | 1.00 | 1.14 | 1.00 | .513 | 1.00 | NA | NA |
| Adductor longus | 2.00 | 2.00 | 1.00 | 1.00 | .183 | .317 | NA | NA |
| Adductor magnus | 2.75 | 2.50 | 2.11 | 2.11 | .149 | .386 | NA | NA |
| Pectineus | 2.00 | 2.50 | 1.25 | 1.25 | .327 | .056 | NA | NA |
| Gracilis | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Iliacus | 2.25 | 2.25 | 1.78 | 1.78 | .312 | .310 | NA | NA |
| Obturator externus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Obturator internus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Piriformis | 1.25 | 1.25 | 1.63 | 1.63 | .077 | .151 | NA | NA |
| Superior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Inferior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Quadratus femoris | 1.75 | 2.00 | 1.67 | 1.67 | .610 | .344 | NA | NA |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 3.00 | 3.00 | 2.89 | 2.78 | .480 | .299 | NA | NA |
| Gluteus medius | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Gluteus minimus | 1.33 | 1.33 | 1.00 | 1.00 | .157 | .157 | NA | NA |
| Adductor magnus | 2.25 | 2.00 | 1.67 | 1.67 | .069 | .131 | NA | NA |
| Vastus intermedius | 2.50 | 2.75 | 2.11 | 2.22 | .703 | .071 | NA | NA |
| Vastus medialis | 2.25 | 2.50 | 1.89 | 1.89 | .219 | **.047** | NA | **.042** |
| Vastus lateralis | 2.44 | 2.44 | 2.00 | 2.00 | .061 | .061 | NA | NA |
| Piriformis | 1.33 | 1.33 | 1.00 | 1.00 | .157 | .157 | NA | NA |
| Obturator externus | 1.33 | 1.33 | 1.00 | 1.00 | .157 | .157 | NA | NA |
| Obturator internus | 1.33 | 1.33 | 1.00 | 1.00 | .157 | .157 | NA | NA |
| Quadratus femoris | 2.00 | 2.00 | 1.80 | 1.80 | .569 | .835 | NA | NA |
| Popliteus | 1.00 | 1.00 | 1.40 | 1.40 | .221 | .325 | NA | NA |
| Gastrocnemius | 2.33 | 2.33 | 1.40 | 1.60 | .076 | .090 | NA | NA |
| Iliacus | 2.00 | 2.00 | 1.60 | 1.40 | .633 | .103 | NA | NA |
| Pectineus | 2.00 | 2.00 | 1.60 | 1.40 | .233 | .286 | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | 2.50 | 2.50 | 1.34 | 2.00 | .566 | .754 | NA | NA |
| Popliteus | 1.50 | 1.50 | 1.17 | 1.00 | .673 | .224 | NA | NA |
| Semimembranosus | .50 | .50 | .83 | .83 | .312 | .176 | NA | NA |
| Tibialis posterior | 1.00 | 1.00 | 1.00 | 1.00 | .600 | .456 | NA | NA |
| Tibialis anterior | 1.00 | 1.00 | 1.00 | 1.00 | .600 | 1.00 | NA | NA |
| Flexor digitorum | 1.50 | 1.50 | 1.67 | 1.33 | .692 | .937 | NA | NA |

*significant p-values bolded (p≤.05)

**Table 58:** Early Monongahela - comparison of mean MSM scores by age for the upper limb*

| | Young Adult | | Middle-Aged Adult | | Old Adult | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | 2.25 | 2.25 | 2.67 | 2.67 | 2.50 | 2.50 | .399 | .678 | NA | NA |
| Subclavius | 1.00 | 1.25 | 1.33 | 1.33 | 1.50 | 1.50 | .556 | .890 | NA | NA |
| Trapezoid ligament | 2.00 | 2.25 | 2.67 | 2.33 | 2.50 | 2.50 | .345 | .709 | NA | NA |
| Conoid ligament | 2.50 | 2.25 | 2.67 | 2.33 | 2.00 | 2.50 | .377 | .456 | NA | NA |
| Deltoid | 2.75 | 2.75 | 3.00 | 3.00 | 3.00 | 3.00 | .214 | .214 | NA | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | 1.25 | 1.25 | 1.00 | 1.00 | 1.50 | 1.50 | .261 | .307 | NA | NA |
| Pectoralis minor | .75 | .75 | 1.00 | 1.00 | 1.00 | 1.00 | .472 | .417 | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 1.00 | 1.00 | 1.00 | 1.00 | 1.25 | 1.00 | .135 | 1.00 | NA | NA |
| Infraspinatus | 1.00 | 1.00 | 1.00 | 1.00 | 1.50 | 1.00 | .135 | 1.00 | NA | NA |
| Teres minor | 1.00 | 1.00 | 1.33 | 1.33 | 1.00 | .50 | .311 | .233 | NA | NA |
| Pectoralis major | 2.00 | 2.00 | 2.67 | 2.00 | 3.00 | 3.00 | .159 | **.020** | NA | **.004** |
| Latissimus dorsi | 1.67 | 1.67 | 2.00 | 1.67 | 2.00 | 3.00 | .593 | .374 | NA | NA |
| Teres major | 1.67 | 1.33 | 2.00 | 2.67 | 3.00 | 3.00 | .143 | .098 | NA | NA |
| Deltoid | 2.00 | 1.67 | 2.67 | 2.67 | 2.00 | 3.00 | .155 | .140 | NA | NA |
| Coracobrachialis | 1.00 | 1.00 | 1.00 | 1.33 | 1.50 | 2.00 | .724 | .076 | NA | NA |
| Common extensors | 1.33 | 1.33 | 1.00 | 1.00 | 1.00 | 1.00 | .821 | .797 | NA | NA |
| Common flexors | 1.33 | 1.33 | 1.33 | 1.00 | 1.00 | 1.00 | .811 | .214 | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 2.50 | 2.25 | 2.50 | 2.50 | 2.00 | 3.00 | .480 | .178 | NA | NA |
| Anconeus | 1.00 | 1.00 | 1.67 | 1.67 | 1.00 | 1.00 | .159 | .159 | NA | NA |
| Triceps | 1.25 | 1.25 | 1.67 | 1.5 | 2.50 | 1.50 | .155 | .688 | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | 2.00 | 2.00 | 2.67 | 2.50 | 3.00 | 3.00 | **.048, .027** | .105 | **.006** | NA |
| Pronator teres | 1.33 | 1.00 | 2.17 | 2.00 | 2.50 | 2.00 | .217 | .055 | NA | NA |
| Supinator | 1.00 | 1.00 | 1.33 | 1.50 | 1.50 | 1.50 | .361 | .484 | NA | NA |
| Pronator quadratus | 1.00 | 1.00 | .83 | 1.00 | 1.00 | 1.00 | .607 | 1.00 | NA | NA |

*significant p-values bolded (p≤.05)

**Table 59:** Early Monongahela - comparison of mean MSM scores by age for lower limb*

| ATTACHMENT | Young Adult | | Middle-Aged Adult | | Old Adult | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.00 | 3.00 | 2.00 | 2.67 | 3.00 | 3.00 | .439 | .527 | NA | NA |
| Gluteus minimus | 1.00 | 1.00 | 2.00 | 2.00 | 1.00 | 1.00 | .693 | 1.00 | NA | NA |
| Gluteus medius | 1.33 | 1.33 | 1.00 | 1.00 | 1.50 | 1.50 | .527 | .296 | NA | NA |
| Tensor fascia latae | 1.75 | 2.00 | 2.33 | 2.33 | 2.33 | 2.00 | .226 | 1.00 | NA | NA |
| Adductor brevis | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .513 | 1.00 | NA | NA |
| Adductor longus | 1.50 | 1.50 | 2.00 | NA | NA | NA | .317 | NA | NA | NA |
| Adductor magnus | 2.50 | 2.50 | 2.20 | 2.00 | 3.00 | 3.00 | .183 | **.018** | NA | .706 |
| Pectineus | 2.00 | 2.00 | 1.00 | 2.00 | NA | NA | .543 | 1.00 | NA | NA |
| Gracilis | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Iliacus | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 1.00 | 1.00 | NA | NA |
| Obturator externus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| \Obturator internus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .368 | NA | NA |
| Piriformis | 1.75 | 1.75 | 1.33 | 1.33 | 1.50 | 1.50 | .457 | .407 | NA | NA |
| Superior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Inferior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Quadratus femoris | 1.75 | 1.75 | 1.75 | 2.00 | 2.00 | 2.00 | .768 | .769 | NA | NA |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.80 | 2.60 | 3.00 | 3.00 | 3.00 | 3.00 | .264 | 1.00 | NA | NA |
| Gluteus medius | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Gluteus minimus | 1.00 | 1.00 | 1.33 | 1.33 | 1.00 | 1.00 | .368 | .535 | NA | NA |
| Adductor magnus | 1.60 | 1.60 | 2.50 | 2.25 | 3.00 | 2.00 | .106 | .135 | NA | NA |
| Vastus intermedius | 2.00 | 2.00 | 2.75 | 3.00 | 2.00 | 2.00 | **.017** | **.002** | .348 | **.035** |
| Vastus medialis | 2.00 | 1.80 | 2.25 | 2.50 | 3.00 | 3.00 | .161 | .180 | NA | NA |
| Vastus lateralis | 2.60 | 2.60 | 2.75 | 2.75 | 3.00 | 3.00 | .588 | .659 | NA | NA |
| Piriformis | 1.00 | 1.00 | 1.33 | 1.33 | 1.00 | 1.00 | .368 | .535 | NA | NA |
| Obturator externus | 1.00 | 1.00 | 1.33 | 1.33 | 1.00 | 1.00 | .368 | .535 | NA | NA |
| Obturator internus | 1.00 | 1.00 | 1.33 | 1.33 | 1.00 | 1.00 | .368 | .535 | NA | NA |
| Quadratus femoris | 1.33 | 1.33 | 2.33 | 2.33 | 2.00 | 2.00 | .205 | .424 | NA | NA |
| Popliteus | 1.33 | 1.33 | 1.33 | 1.33 | 1.00 | 1.00 | .678 | .869 | NA | NA |
| Gastrocnemius | 1.33 | 1.33 | 2.25 | 2.25 | 2.00 | 2.00 | .121 | .098 | NA | NA |
| Iliacus | 1.50 | 1.50 | 2.00 | 2.00 | 2.00 | 2.00 | .264 | .185 | NA | NA |
| Pectineus | 1.50 | 1.50 | 2.00 | 2.00 | 3.00 | 2.00 | .303 | .474 | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | 1.67 | 1.67 | 2.00 | 2.00 | 2.00 | 2.50 | 1.00 | .660 | NA | NA |
| Popliteus | 1.00 | 1.00 | 1.33 | 1.33 | 1.00 | 1.00 | .535 | .739 | NA | NA |
| Semimembranosus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .407 | .368 | NA | NA |
| Tibialis posterior | 1.00 | 1.00 | 1.25 | 1.00 | 1.00 | 1.00 | .869 | .417 | NA | NA |
| Tibialis anterior | 1.00 | 1.00 | 1.25 | 1.00 | 1.00 | 1.00 | .869 | 1.00 | NA | NA |
| Flexor digitorum | 1.33 | 1.33 | 1.75 | 1.75 | 2.00 | 2.00 | .687 | .852 | NA | NA |

*significant p-values bolded (p≤.05)

**Table 60:** Early Monongahela - comparison of mean asymmetry scores for upper limb by sex*

| CLAVICLE | Male | Female | Kruskall-Wallis* | Spearman * |
|---|---|---|---|---|
| Costoclavicular ligament | 100.00 | 100.00 | 1.00 | NA |
| Subclavius | 125.00 | 93.75 | .429 | NA |
| Trapezoid ligament | 125.00 | 97.92 | .212 | NA |
| Conoid ligament | 102.08 | 83.33 | .372 | NA |
| Deltoid | 100.00 | 100.00 | 1.00 | NA |
| **SCAPULA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | 100.00 | 100.00 | 1.00 | NA |
| Pectoralis minor | 100.00 | 100.00 | 1.00 | NA |
| **HUMERUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | 100.00 | 100.00 | 1.00 | NA |
| Infraspinatus | NA | NA | NA | NA |
| Teres minor | 100. | 100.00 | 1.00 | NA |
| Pectoralis major | 100.00 | 93.33 | .516 | NA |
| Latissimus dorsi | 100.00 | 103.33 | 1.00 | NA |
| Teres major | 106.25 | 86.66 | .428 | NA |
| Deltoid | 120.37 | 103.33 | .667 | NA |
| Coracobrachialis | 105.55 | 90.00 | .457 | NA |
| Common extensors | 100.00 | 100.00 | 1.00 | NA |
| Common flexors | 94.44 | 90.00 | .661 | NA |
| **ULNA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 91.66 | 106.66 | .492 | NA |
| Anconeus | 100.00 | 100.00 | 1.00 | NA |
| Triceps | 100.00 | 86.66 | .720 | NA |
| **RADIUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | 112.50 | 110.00 | .743 | NA |
| Pronator teres | 112.50 | 120.00 | .307 | NA |
| Supinator | 93.75 | 93.33 | .743 | NA |
| Pronator quadratus | 100.00 | 100.00 | 1.00 | NA |

*(>100 indicates left dominance), *significant p-values bolded (p≤.05)

**Table 61:** Early Monongahela - comparison of mean asymmetry scores for lower limb by sex*

| INNOMINATE | Male | Female | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|
| Gluteus maximus | 100.00 | 120.00 | .127 | NA |
| Gluteus minimus | 83.33 | 100.00 | .294 | NA |
| Gluteus medius | 110.00 | 100.00 | .480 | NA |
| Tensor fascia latae | 100.00 | 100.00 | .513 | NA |
| Adductor brevis | 100.00 | 100.00 | 1.00 | NA |
| Adductor longus | 100.00 | 100.00 | 1.00 | NA |
| Adductor magnus | 100.00 | 100.00 | .134 | NA |
| Pectineus | 100.00 | 75.00 | .157 | NA |
| Gracilis | 100.00 | 100.00 | 1.00 | NA |
| Iliacus | 100.00 | 100.00 | 1.00 | NA |
| Obturator externus | 100.00 | 100.00 | 1.00 | NA |
| Obturator internus | 100.00 | 100.00 | 1.00 | NA |
| Piriformis | 100.00 | 100.00 | 1.00 | NA |
| Superior gemelli | 100.00 | 100.00 | 1.00 | NA |
| Inferior gemelli | 100.00 | 100.00 | 1.00 | NA |
| Quadratus femoris | 100.00 | 91.66 | .134 | NA |
| **FEMUR** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | 108.33 | 100.00 | .505 | NA |
| Gluteus medius | 100.00 | 100.00 | 1.00 | NA |
| Gluteus minimus | 100.00 | 100.00 | 1.00 | NA |
| Adductor magnus | 100.00 | 112.50 | .180 | NA |
| Vastus intermedius | 94.44 | 91.66 | .743 | NA |
| Vastus medialis | 105.55 | 91.66 | .516 | NA |
| Vastus lateralis | 100.00 | 100.00 | 1.00 | NA |
| Piriformis | 100.00 | 100.00 | 1.00 | NA |
| Obturator externus | 100.00 | 100.00 | 1.00 | NA |
| Obturator internus | 100.00 | 100.00 | 1.00 | NA |
| Quadratus femoris | 100.00 | 100.00 | 1.00 | NA |
| Popliteus | 100.00 | 100.00 | 1.00 | NA |
| Gastrocnemius | 90.00 | 100.00 | .513 | NA |
| Iliacus | 120.00 | 100.00 | .398 | NA |
| Pectineus | 120.00 | 100.00 | .429 | NA |
| **TIBIA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 103.33 | 100.00 | .248 | NA |
| Popliteus | 120.00 | 100.00 | .480 | NA |
| Semimembranosus | 100.00 | 100.00 | 1.00 | NA |
| Tibialis posterior | 100.00 | 133.33 | .127 | NA |
| Tibialis anterior | 100.00 | 133.33 | .127 | NA |
| Flexor digitorum | 128.57 | 133.33 | .886 | NA |

*(>100 indicates left dominance), *significant p-values bolded (p≤.05)

**Table 62:** Early Monongahela - comparison of mean asymmetry scores for upper limb by age*

| **CLAVICLE** | **Young Adult** | **Middle-Aged** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
|---|---|---|---|---|---|
| Costoclavicular ligament | 100.00 | 100.00 | 100.00 | NA | NA |
| Subclavius | 87.50 | 100.00 | 100.00 | .463 | NA |
| Trapezoid ligament | 104.1650 | 110.00 | 100.00 | .682 | NA |
| Conoid ligament | 112.50 | 103.33 | 83.33 | .500 | NA |
| Deltoid | 100.00 | 100.00 | 100.00 | NA | NA |
| **SCAPULA** | **Young Adult** | **Middle-Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | 100.00 | 100.00 | 100.00 | NA | NA |
| Pectoralis minor | 100.00 | 100.00 | 100.00 | NA | NA |
| **HUMERUS** | **Young Adult** | **Middle-Aged** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | 100.00 | 100.00 | 100.00 | NA | NA |
| Infraspinatus | NA | NA | NA | NA | NA |
| Teres minor | 100.00 | 100.00 | 100.00 | NA | NA |
| Pectoralis major | 110.00 | 91.00 | 100.00 | .377 | NA |
| Latissimus dorsi | 100.00 | 112.50 | 83.33 | .211 | NA |
| Teres major | 120.00 | 83.33 | 100.00 | .390 | NA |
| Deltoid | 123.33 | 112.50 | 100.00 | .252 | NA |
| Coracobrachialis | 120.00 | 90.00 | 75.00 | .274 | NA |
| Common extensors | 100.00 | 100.00 | 100.00 | NA | NA |
| Common flexors | 90.00 | 90.00 | 100.00 | .832 | NA |
| **ULNA** | **Young Adult** | **Middle-Aged** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 112.50 | 106.66 | 100.00 | .250 | NA |
| Anconeus | 100.00 | 100.00 | 100.00 | NA | NA |
| Triceps | 112.50 | 90.00 | 66.66 | .511 | NA |
| **RADIUS** | **Young Adult** | **Middle-Aged** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | 100.00 | 110.00 | 100.00 | .716 | NA |
| Pronator teres | 133.33 | 110.00 | 125.00 | .600 | NA |
| Supinator | 100.00 | 100.00 | 93.33 | .706 | NA |
| Pronator quadratus | 100.00 | 100.00 | 100.00 | NA | NA |

*(>100 indicates left dominance), *significant p-values bolded (p≤.05)

**Table 63:** Early Monongahela - comparison of mean asymmetry scores for upper limb by age*

| INNOMINATE | Young Adult | Middle-Aged Adult | Old Adult | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|---|
| Gluteus maximus | 100.00 | 100.00 | 100.00 | ,977 | NA |
| Gluteus minimus | 100.00 | 100.00 | 100.00 | .422 | NA |
| Gluteus medius | 100.00 | 100.00 | 100.00 | .178 | NA |
| Tensor fascia latae | 100.00 | 100.00 | 100.00 | .605 | NA |
| Adductor brevis | 100.00 | 100.00 | 100.00 | NA | NA |
| Adductor longus | 100.00 | 100.00 | 100.00 | NA | NA |
| Adductor magnus | 100.00 | 100.00 | 100.00 | .528 | NA |
| Pectineus | 100.00 | 100.00 | 100.00 | NA | NA |
| Gracilis | 100.00 | 100.00 | 100.00 | NA | NA |
| Iliacus | 100.00 | 100.00 | 100.00 | NA | NA |
| Obturator externus | 100.00 | 100.00 | 100.00 | NA | NA |
| Obturator internus | 100.00 | 100.00 | 100.00 | NA | NA |
| Piriformis | 100.00 | 100.00 | 100.00 | NA | NA |
| Superior gemelli | 100.00 | 100.00 | 100.00 | NA | NA |
| Inferior gemelli | 100.00 | 100.00 | 100.00 | NA | NA |
| Quadratus femoris | 100.00 | 100.00 | 100.00 | .528 | NA |
| **FEMUR** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | 116.66 | 100.00 | 100.00 | .662 | NA |
| Gluteus medius | 100.00 | 100.00 | 100.00 | NA | NA |
| Gluteus minimus | 100.00 | 100.00 | 100.00 | NA | NA |
| Adductor magnus | 100.00 | 112.50 | 100.00 | .528 | NA |
| Vastus intermedius | 100.00 | 91.66 | 100.00 | .528 | NA |
| Vastus medialis | 120.00 | 91.66 | 100.00 | .517 | NA |
| Vastus lateralis | 100.00 | 100.00 | 100.00 | NA | NA |
| Piriformis | 100.00 | 100.00 | 100.00 | NA | NA |
| Obturator externus | 100.00 | 100.00 | 100.00 | NA | NA |
| Obturator internus | 100.00 | 100.00 | 100.00 | NA | NA |
| Quadratus femoris | 100.00 | 100.00 | 100.00 | NA | NA |
| Popliteus | 100.00 | 100.00 | 100.00 | NA | NA |
| Gastrocnemius | 100.00 | 100.00 | 100.00 | NA | NA |
| Iliacus | 100.00 | 100.00 | 100.00 | NA | NA |
| Pectineus | 100.00 | 100.00 | 100.00 | NA | NA |
| **TIBIA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 100.00 | 112.50 | 100.00 | .715 | NA |
| Popliteus | 100.00 | 100.00 | 100.00 | NA | NA |
| Semimembranosus | 100.00 | 100.00 | 100.00 | NA | NA |
| Tibialis posterior | 100.00 | 125.00 | 100.00 | .680 | NA |
| Tibialis anterior | 100.00 | 125.00 | 100.00 | .680 | NA |
| Flexor digitorum | 100.00 | 125.00 | 100.00 | .177 | NA |

*(>100 indicates left dominance), *significant p-values bolded (p≤.05)

### 7.2.2 Middle Monongahela Activity: Discussion

#### 7.2.2.1 Middle Monongahela Results

Means and p-values from statistical tests are listed for MSM robusticity by sex are presented in Tables 64-65. These statistics are listed for MSM score by age in Tables 66-67. Asymmetry score means by sex (Tables 68-69) and age (Tables 70-71) are also included. Males had significantly higher MSM scores for the left deltoid, left pectoralis major, left latissimus dorsi, left teres major, right deltoid, left anconeus, left biceps, right pectineus, left gluteus maximus, left adductor magnus, vastus intermedius, vastus medialis, and quadratus femoris. These results were significantly correlated with sex following Spearman's correlation. Old adults scored significantly higher for the right brachialis, left and right vastus intermedius, right quadratus femoris, and left soleus. Age was significantly correlated with MSM score for the right and left brachialis, and left and right vastus medialis only. No significant differences were revealed when asymmetry scores were compared by adult age, but males scored higher than females for the femoral gluteus maximus attachment, indicating increased use of the left side in thigh extension.

#### 7.2.2.2 Middle Monongahela Discussion

The patterning of MSM robusticity is not significantly different than that of the Early Monongahela Period, with the exception of the right brachialis (Middle Monongahela Old Adults > Early Monongahela Young Adults, p=.037, Appendix B). In the upper limb, only the deltoid, pectoralis major, brachialis, and biceps had high mean MSM scores, with the supporting shoulder ligaments scoring moderate to high. The pronator and supinator had low-moderate mean scores, and the common flexors/extensors had low MSM scores. Significant differences between the sexes were observed with males scoring significantly higher than females for both upper and lower limb MSMs and biological sex significantly correlated for each of these activity markers. Age was also significantly correlated with MSM score, with old adults scoring significantly higher than younger age cohorts for the right brachialis (p=.020, p=.028). As with the Early Monongahela sample, there were more old adult males, making age demographics a contributing factor to sex differences in MSM robusticity (Stefanovic and Porcic 2013).

Despite these differences, it is clear that males and females, as well as individuals of all age groups participated in similar activities. Asymmetry scores varied between left and right dominance for MSMs of the upper limb between the sexes and age cohorts, though no significant differences were observed. As with the Early Monongahela sample, heavy shoulder musculature involvement along with evidence of heavy use of the major arm flexors and extensors indicates that this group was engaged in intensive maize agriculture. These patterns are indicative of activities that require increased upper body strength such as digging, tilling soil, heavy load carrying, and grain grinding (Shuler et al. 2012). A difference that is evident between the Middle and Early Monongahela samples is in the muscles that involve flexion and extension of the elbow. Early Monongahela males scored significantly higher than females for robusticity in these muscle groups, indicating that males participated in hunting, particularly with a bow, whereas females were more specifically engaged in agricultural labor or gathering (Shuler et al. 2012). This division is not suggested for the Middle Monongahela period as no significant differences emerge between the sexes for these muscle groups.

Middle Monongahela patterning of the lower limb was similar to the Early Monongahela, as mean scores for the thigh extensors, hip flexors, knee extensors, and thigh adductors were moderate to high. The knee flexor attachments had moderate mean scores, indicating decreased though frequent knee flexion/extension compared with the Early Monongahela, though these differences were not significant across age and sex groups between these samples. Within the Middle Monongahela sample, significant differences in robusticity score by sex were observed as males scored higher than females for the right pectineus (p=.041), left gluteus maximus (p=.001), left adductor magnus (p=.023), left vastus intermedius (p=.009), left vastus medialis (p=.027), and left quadratus femoris (p=.026). Age was also a significant factor in MSM robusticity, as older adults scored significantly higher than middle aged or young adults for three markers: left vastus intermedius (p=.013, p=.005), right vastus intermedius (p=.039, p=.020). This lower limb patterning is similar to the Early Monongahela in terms of squatting, rising from a squatted position, walking, and running. These activities are associated with agricultural practices craft production, and food preparation though for the differences in MSMs between sexes is salient. Males had higher scores in muscles associated with running/walking such as adductor magnus and the quadriceps group, indicating that males performed sustained activities that involved these actions such as trade, hunting, and trapping, as these would have required travel on foot. Faunal assemblages from Monongahela sites do indicate that deer and small game supplemented an agricultural diet (Means 2007a).

The Middle Monongahela sample is comparable to contemporary Fort Ancient groups from the Ohio region in chronology, geography, and subsistence strategy (Johnson 2011; Sciulli 2002). The Madisonville site is a large occupation site in southern Ohio, with intensive occupation dating roughly from 1400-1650 (Drooker 1997). The Fort Ancient complex consisted of large villages with central plazas. The subsistence economy was based upon maize agriculture, though there is evidence of small-scale cultivation of beans, squash, and chenopodium (Drooker 1997). Rodrigues (2006) studied activity patterns from the Madisonville site as a comparative sample to the earlier Turner Mound group. Patterns of muscle use were similar between the Turner Mound and Madisonville samples; females placed greater stress on muscles that flex and extend the forearm and hand, pronation and supination, thigh rotation. Males placed greater stress on flexion and rotation of the arm, flexion of the elbow, leg adduction, thigh flexion and extension, and knee flexion and extension. Females were more likely doing activities such as hide processing, using grindstones, and cultivation whereas males had greater use of the lower limb in activities such squatting and shoulder musculature for activities such as load lifting.

In comparison with Madisonville, the gendered division of activity is not as clear for the Middle Monongahela, though males did exhibit greater robusticity in the shoulder musculature, as did males from Madisonville. This indicates that males from both groups may have engaged in more load bearing activities from agricultural labor than did females. Age was not explored in the Turner Mound and Madisonville samples (Rodrigues

2006), though Monongahela old adults scored higher than younger ages for the brachialis, indicating older adults were engaged in activities involving elbow flexion such as grinding, soil preparation, and lifting into old age.

**Table 64:** Middle Monongahela - comparison of mean MSM scores by sex for upper limb*

| | Male | | Female | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | 2.25 | 2.08 | 2.0 | 1.82 | .578 | .665 | NA | NA |
| Subclavius | 1.14 | .87 | 1.17 | 1.00 | .770 | .452 | NA | NA |
| Trapezoid ligament | 2.42 | 2.08 | 1.92 | 1.92 | .102 | .248 | NA | NA |
| Conoid ligament | 2.50 | 2.00 | 1.92 | 2.00 | .141 | .517 | NA | NA |
| Deltoid | 2.77 | 2.46 | 2.33 | 2.33 | **.025** | .091 | **.022** | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | 2.00 | 1.67 | 1.17 | 1.00 | .197 | .376 | NA | NA |
| Pectoralis minor | 1.38 | 1.38 | 1.25 | 1.50 | .877 | .367 | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 1.09 | 1.18 | 1.14 | 1.14 | .355 | .468 | NA | NA |
| Infraspinatus | 1.00 | 1.09 | 1.29 | 1.00 | 1.00 | .448 | NA | NA |
| Teres minor | 1.27 | 1.45 | 1.00 | .86 | .344 | .081 | NA | NA |
| Pectoralis major | 2.64 | 2.43 | 2.10 | 2.20 | **.038** | .371 | **.035** | NA |
| Latissimus dorsi | 1.93 | 2.00 | 1.40 | 1.80 | **.044** | .335 | **.042** | NA |
| Teres major | 1.71 | 1.79 | .80 | 1.40 | **.007** | .196 | **.004** | NA |
| Deltoid | 2.43 | 2.50 | 2.00 | 1.80 | .059 | **.039** | NA | **.036** |
| Coracobrachialis | .88 | 1.21 | .89 | 1.00 | .191 | .080 | NA | NA |
| Common extensors | 1.00 | 1.14 | 1.00 | 1.22 | 1.00 | .598 | NA | NA |
| Common flexors | 1.00 | 1.00 | .89 | 1.00 | .619 | .464 | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 2.73 | 2.64 | 2.20 | 2.20 | .059 | .143 | NA | NA |
| Anconeus | 1.36 | 1.27 | .90 | .90 | **.018** | .069 | **.014** | NA |
| Triceps | 1.82 | 1.45 | 1.50 | 1.30 | .256 | .933 | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | 2.67 | 2.67 | 2.30 | 2.20 | **.031** | .106 | **.028** | NA |
| Pronator teres | 2.00 | 1.92 | 1.60 | 1.50 | .072 | .331 | NA | NA |
| Supinator | 1.17 | 1.33 | 1.00 | 1.10 | .326 | .619 | NA | NA |
| Pronator quadratus | .75 | .67 | .60 | .80 | .702 | .686 | NA | NA |

*significant p-values bolded (p≤.05)

**Table 65:** Middle Monongahela – comparison of mean MSM scores by sex for lower limb*

| ATTACHMENT | Male | | Female | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.50 | 2.40 | 1.91 | 2.00 | .226 | .535 | NA | NA |
| Gluteus minimus | 1.10 | 1.10 | .91 | 1.00 | .166 | .580 | NA | NA |
| Gluteus medius | 1.20 | 1.27 | 1.09 | 1.20 | .586 | .904 | NA | NA |
| Tensor fascia latae | 1.38 | 1.13 | 1.00 | 1.00 | .104 | .161 | NA | NA |
| Adductor brevis | .75 | .75 | .50 | .75 | .161 | .477 | NA | NA |
| Adductor longus | 1.00 | 1.00 | 1.25 | 1.00 | .817 | 1.00 | NA | NA |
| Adductor magnus | 2.00 | 2.00 | 2.00 | 1.75 | .166 | .166 | NA | NA |
| Pectineus | 1.71 | 1.86 | 1.25 | 1.25 | .061 | **.041** | NA | **.037** |
| Gracilis | 1.86 | 1.57 | 1.00 | 1.00 | .214 | .389 | NA | NA |
| Iliacus | 1.60 | 1.60 | 1.43 | 1.43 | .896 | 1.00 | NA | NA |
| Obturator externus | 1.10 | 1.10 | .86 | .86 | .607 | .167 | NA | NA |
| Obturator internus | 1.20 | 1.20 | 1.00 | 1.14 | .371 | .732 | NA | NA |
| Piriformis | 1.33 | 1.33 | 1.20 | 1.20 | .820 | .893 | NA | NA |
| Superior gemelli | .89 | .89 | .80 | .80 | .705 | .661 | NA | NA |
| Inferior gemelli | .89 | .89 | .80 | .80 | .939 | .871 | NA | NA |
| Quadratus femoris | 1.44 | 1.33 | 1.80 | 1.60 | .720 | .805 | NA | NA |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.88 | 2.50 | 2.11 | 2.22 | **.001** | .713 | **.000** | NA |
| Gluteus medius | 1.00 | .88 | 1.00 | 1.11 | .170 | .102 | NA | NA |
| Gluteus minimus | .88 | .75 | .89 | .89 | .070 | .253 | NA | NA |
| Adductor magnus | 1.88 | 2.13 | 1.50 | 1.57 | **.023** | .146 | **.020** | NA |
| Vastus intermedius | 2.50 | 2.50 | 1.93 | 1.93 | **.009** | .066 | **.007** | NA |
| Vastus medialis | 2.26 | 2.25 | 1.86 | 1.71 | **.027** | .081 | **.025** | NA |
| Vastus lateralis | 2.63 | 2.63 | 2.43 | 2.43 | .122 | .185 | NA | NA |
| Piriformis | .88 | .75 | .78 | .89 | .186 | .200 | NA | NA |
| Obturator externus | .88 | .88 | 1.11 | 1.11 | .704 | .739 | NA | NA |
| Obturator internus | 1.00 | .88 | 1.11 | 1.11 | .424 | .106 | NA | NA |
| Quadratus femoris | 1.63 | 1.25 | 1.22 | 1.22 | **.026** | .834 | **.022** | NA |
| Popliteus | .88 | .88 | .89 | .89 | 1.00 | .237 | NA | NA |
| Gastrocnemius | 1.75 | 1.33 | 1.44 | 1.75 | .237 | .223 | NA | NA |
| Iliacus | 1.63 | 1.63 | 1.44 | 1.44 | .053 | .418 | NA | NA |
| Pectineus | 1.38 | 1.50 | 1.44 | 1.33 | .101 | .834 | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | 2.70 | 1.10 | 2.20 | 1.00 | .104 | .472 | NA | NA |
| Popliteus | 1.10 | .80 | 1.00 | .60 | .198 | .686 | NA | NA |
| Semimembranosus | .80 | 1.40 | .60 | 1.20 | .686 | .383 | NA | NA |
| Tibialis posterior | 1.10 | 1.10 | 1.31 | 1.15 | .902 | 1.00 | NA | NA |
| Tibialis anterior | 1.10 | 1.30 | 1.23 | 1.38 | .554 | .752 | NA | NA |
| Flexor digitorum | NA | NA | NA | NA | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 66:** Middle Monongahela - comparison of mean MSM scores by age for upper limb*

| | Young Adult | | Middle-Aged Adult | | Old Adult | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | 3 | 3 | 2.00 | 2.00 | 2.57 | 2.14 | .923 | .907 | NA | NA |
| Subclavius | 1.50 | 1.50 | .85 | .86 | 1.43 | 1.00 | .571 | .527 | NA | NA |
| Trapezoid ligament | 2.50 | 2.50 | 2.14 | 2.29 | 2.43 | 2.00 | .200 | .273 | NA | NA |
| Conoid ligament | 2.50 | 2.50 | 2.43 | 2.43 | 2.14 | 1.57 | .137 | .178 | NA | NA |
| Deltoid | 2.50 | 2.50 | 2.71 | 2.71 | 2.86 | 2.43 | .082 | .155 | NA | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | 3.00 | 2.50 | 2.00 | .67 | 1.00 | 1.50 | .104 | .835 | NA | NA |
| Pectoralis minor | 1.50 | 1.50 | 1.67 | 1.67 | 1.25 | 1.50 | .267 | .763 | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 1.00 | 1.00 | 1.17 | 1.17 | 1.25 | 1.38 | .868 | .591 | NA | NA |
| Infraspinatus | 1.00 | .50 | 1.17 | 1.17 | 1.25 | 1.38 | .868 | .203 | NA | NA |
| Teres minor | 1.00 | 1.00 | 1.50 | 1.50 | 1.13 | 1.38 | .119 | .450 | NA | NA |
| Pectoralis major | 2.50 | 3.00 | 2.67 | 2.50 | 2.63 | 2.19 | .703 | .226 | NA | NA |
| Latissimus dorsi | 1.67 | 1.67 | 1.83 | 2.00 | 1.88 | 2.13 | .553 | .295 | NA | NA |
| Teres major | 1.67 | 1.67 | 1.83 | 2.00 | 1.13 | 1.38 | .279 | .525 | NA | NA |
| Deltoid | 2.17 | 2.33 | 2.83 | 2.17 | 2.13 | 2.33 | .922 | .870 | NA | NA |
| Coracobrachialis | 1.17 | 1.33 | 1.17 | 1.00 | 1.13 | 1.25 | .870 | .910 | NA | NA |
| Common extensors | 1.00 | 1.17 | .83 | 1.17 | 1.00 | 1.13 | .277 | .875 | NA | NA |
| Common flexors | 1.00 | 1.00 | .83 | 1.00 | 1.00 | 1.00 | .794 | .740 | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 2.40 | 2.40 | 2.67 | 2.50 | 3.00 | 3.00 | .051 | **.020, .028** | NA | **.013** |
| Anconeus | 1.20 | 1.00 | 1.17 | 1.17 | 1.33 | 1.33 | .553 | .270 | NA | NA |
| Triceps | 1.40 | 1.00 | 1.67 | 1.33 | 1.83 | 1.83 | .506 | .155 | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | 2.33 | 2.00 | 2.57 | 2.71 | 3.00 | 3.00 | .253 | .066 | NA | NA |
| Pronator teres | 1.83 | 1.83 | 1.86 | 1.57 | 2.00 | 2.00 | .949 | .746 | NA | NA |
| Supinator | 1.00 | 1.17 | 1.14 | 1.43 | 1.17 | 1.17 | .355 | .341 | NA | NA |
| Pronator quadratus | .83 | .67 | .43 | .83 | .83 | .67 | .244 | .343 | NA | NA |

*significant p-values bolded (p≤.05)

**Table 67:** Middle Monongahela - comparison of mean MSM scores by age for lower limb*

| ATTACHMENT | Young Adult | | Middle-Aged Adult | | Old Adults | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.40 | 2.00 | 2.43 | 2.71 | 2.20 | 2.00 | .743 | .221 | NA | NA |
| Gluteus minimus | 1.20 | 1.20 | 1.00 | 1.14 | 1.00 | 1.00 | .343 | .699 | NA | NA |
| Gluteus medius | 1.40 | 1.40 | 1.14 | 1.14 | 1.20 | 1.20 | .933 | .751 | NA | NA |
| Tensor fascia latae | 1.00 | 1.00 | 1.00 | .80 | 1.50 | 1.50 | .958 | .944 | NA | NA |
| Adductor brevis | .50 | .50 | .80 | 1.00 | 1.00 | 1.00 | .769 | .546 | NA | NA |
| Adductor longus | .50 | .50 | 1.40 | 1.20 | 1.50 | 1.50 | .267 | .328 | NA | NA |
| Adductor magnus | 1.50 | 1.50 | 2.40 | 2.20 | 1.50 | 1.50 | .082 | .416 | NA | NA |
| Pectineus | 2.00 | 1.50 | 1.67 | 2.00 | 1.00 | 1.00 | .491 | .111 | NA | NA |
| Gracilis | 1.50 | 1.00 | 1.56 | 1.50 | 2.00 | 2.00 | .788 | .542 | NA | NA |
| Iliacus | 2.00 | 2.00 | 1.17 | 1.33 | 1.00 | 1.00 | .918 | .907 | NA | NA |
| Obturator externus | 1.00 | 1.00 | 1.17 | 1.17 | 1.00 | 1.00 | .252 | .472 | NA | NA |
| Obturator internus | 1.00 | 1.00 | 1.50 | 1.50 | 1.00 | 1.20 | .081 | .278 | NA | NA |
| Piriformis | 1.00 | 1.00 | 1.33 | 1.33 | 1.40 | 1.40 | .426 | .775 | NA | NA |
| Superior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | .75 | .75 | .368 | .435 | NA | NA |
| Inferior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | .75 | .75 | .435 | .368 | NA | NA |
| Quadratus femoris | 1.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .099 | **.015** | NA | .689 |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.17 | 2.00 | 2.71 | 2.29 | 3.00 | 3.00 | .108 | .185 | NA | NA |
| Gluteus medius | 1.00 | 1.00 | 1.00 | .86 | 1.33 | 1.33 | .280 | .568 | NA | NA |
| Gluteus minimus | 1.00 | 1.00 | .71 | .71 | 1.00 | 1.00 | .243 | .791 | NA | NA |
| Adductor magnus | 1.50 | 1.50 | 1.75 | 2.13 | 1.80 | 1.80 | .571 | .275 | NA | NA |
| Vastus intermedius | 1.67 | 1.67 | 2.38 | 2.38 | 2.60 | 2.60 | **.013, .005** | **.039, .020** | **.003** | **.012** |
| Vastus medialis | 1.83 | 1.83 | 2.38 | 2.13 | 1.80 | 1.80 | .147 | .747 | NA | NA |
| Vastus lateralis | 2.17 | 2.17 | 2.75 | 2.75 | 2.8 | 2.8 | .056 | .219 | NA | NA |
| Piriformis | .80 | .80 | .86 | .86 | 1.00 | 1.00 | .577 | .793 | NA | NA |
| Obturator externus | 1.20 | 1.20 | .86 | .86 | 1.00 | 1.00 | .848 | .499 | NA | NA |
| Obturator internus | 1.20 | 1.20 | 1.00 | .86 | 1.00 | 1.00 | .995 | .751 | NA | NA |
| Quadratus femoris | 1.60 | 1.40 | 1.29 | 1.00 | 1.67 | 1.67 | .375 | **.008** | NA | .537 |
| Popliteus | .60 | .60 | 1.00 | 1.00 | 1.25 | 1.25 | .075 | .216 | NA | NA |
| Gastrocnemius | 1.80 | 1.80 | 1.33 | 1.33 | 1.75 | 1.75 | .216 | .401 | NA | NA |
| Iliacus | 1.60 | 1.60 | 1.50 | 1.50 | 1.75 | 1.75 | .452 | .695 | NA | NA |
| Pectineus | .80 | 1.00 | 1.67 | 1.67 | 1.00 | 1.75 | .055 | **.015** | NA | .057 |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | 2.00 | 1.00 | 2.83 | 1.33 | 2.67 | 1.00 | **.011** | .831 | .057 | NA |
| Popliteus | 1.00 | .60 | 1.33 | .83 | 1.00 | 1.00 | .450 | .690 | NA | NA |
| Semimembranosus | .60 | 1.00 | .83 | 1.40 | 1.00 | 1.67 | .796 | .316 | NA | NA |
| Tibialis posterior | 1.14 | 1.14 | 1.43 | 1.14 | 1.17 | 1.17 | .816 | .874 | NA | NA |
| Tibialis anterior | 1.14 | 1.57 | 1.29 | 1.29 | 1.17 | 1.33 | .725 | .343 | NA | NA |
| Flexor digitorum | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 68:** Middle Monongahela - comparison of mean MSM asymmetry scores by sex for upper limb*

| CLAVICLE | Male | Female | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|
| Costoclavicular ligament | 95.23 | 112.5 | .354 | NA |
| Subclavius | 100.00 | 112.5 | 1.00 | NA |
| Trapezoid ligament | 107.14 | 93.75 | .472 | NA |
| Conoid ligament | 114.29 | 104.17 | .111 | NA |
| Deltoid | 100.00 | 100.00 | .338 | NA |
| **SCAPULA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | 126.66 | 100.00 | .651 | NA |
| Pectoralis minor | 90.00 | 83.33 | .673 | NA |
| **HUMERUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | 100.00 | 100.00 | .460 | NA |
| Infraspinatus | NA | NA | NA | NA |
| Teres minor | 93.93 | 100.00 | .500 | NA |
| Pectoralis major | 110.60 | 103.33 | .350 | NA |
| Latissimus dorsi | 96.96 | 83.33 | .112 | NA |
| Teres major | 96.42 | 90.00 | .197 | NA |
| Deltoid | 86.90 | 86.66 | .443 | NA |
| Coracobrachialis | 88.09 | 100.00 | .198 | NA |
| Common extensors | 92.85 | 90.00 | .876 | NA |
| Common flexors | 100.00 | 100.00 | 1.00 | NA |
| **ULNA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 108.33 | 98.14 | .096 | NA |
| Anconeus | 93.74 | 100.00 | .599 | NA |
| Triceps | 100.00 | 92.59 | .343 | NA |
| **RADIUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | 95.23 | 100.00 | .639 | NA |
| Pronator teres | 100.00 | 125.00 | .895 | NA |
| Supinator | 92.85 | 100.00 | .546 | NA |
| Pronator quadratus | 100.00 | 100.00 | .347 | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 69:** Middle Monongahela - comparison of mean MSM asymmetry scores by sex for lower limb*

| INNOMINATE | Male | Female | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|
| Gluteus maximus | 111.11 | 114.81 | .232 | NA |
| Gluteus minimus | 100.00 | 94.44 | .296 | NA |
| Gluteus medius | 100.00 | 100.00 | 1.00 | NA |
| Tensor fascia latae | 100.00 | 100.00 | .186 | NA |
| Adductor brevis | 100.00 | 100.00 | 1.00 | NA |
| Adductor longus | 100.00 | 100.00 | .364 | NA |
| Adductor magnus | 100.00 | 100.00 | .296 | NA |
| Pectineus | 100.00 | 83.25 | 1.00 | NA |
| Gracilis | 112.50 | 100.00 | .450 | NA |
| Iliacus | 100.00 | 100.00 | .116 | NA |
| Obturator externus | 100.00 | 100.00 | 1.00 | NA |
| Obturator internus | 100.00 | 100.00 | .248 | NA |
| Piriformis | 100.00 | 100.00 | .337 | NA |
| Superior gemelli | 100.00 | 100.00 | 1.00 | NA |
| Inferior gemelli | 100.00 | 100.00 | 1.00 | NA |
| Quadratus femoris | 100.00 | 100.00 | .340 | NA |
| **FEMUR** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | 110.00 | 98.14 | **.015** | **.012** |
| Gluteus medius | 100.00 | 100.00 | 1.00 | NA |
| Gluteus minimus | 100.00 | 100.00 | 1.00 | NA |
| Adductor magnus | 90.00 | 100.00 | .282 | NA |
| Vastus intermedius | 100.00 | 100.00 | 1.00 | NA |
| Vastus medialis | 100.00 | 100.00 | .380 | NA |
| Vastus lateralis | 100.00 | 100.00 | 1.00 | NA |
| Piriformis | 100.00 | 100.00 | 1.00 | NA |
| Obturator externus | 100.00 | 125.00 | .456 | NA |
| Obturator internus | 100.00 | 125.00 | .350 | NA |
| Quadratus femoris | 87.50 | 125.00 | .590 | NA |
| Popliteus | 100.00 | 100.00 | 1.00 | NA |
| Gastrocnemius | 100.00 | 125.00 | .317 | NA |
| Iliacus | 100.00 | 100.00 | 1.00 | NA |
| Pectineus | 100.00 | 125.00 | .502 | NA |
| **TIBIA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 250.00 | 220.00 | .146 | NA |
| Popliteus | 120.00 | 140.00 | .486 | NA |
| Semimembranosus | 80.00 | 90.00 | .523 | NA |
| Tibialis posterior | 100.00 | 90.00 | .380 | NA |
| Tibialis anterior | 90.00 | 90.00 | .777 | NA |
| Flexor digitorum | NA | NA | .NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 70:** Middle Monongahela - comparison of mean MSM asymmetry scores by age for upper limb*

| **CLAVICLE** | **Young Adults** | **Middle-Aged Adults** | **Old Adults** | **Kruskall-Wallis*** | **Spearman*** |
|---|---|---|---|---|---|
| Costoclavicular ligament | 100.00 | 100.00 | 133.33 | .854 | NA |
| Subclavius | 100.00 | 100.00 | 133.33 | .535 | NA |
| Trapezoid ligament | 100.00 | 100.00 | 100.00 | .518 | NA |
| Conoid ligament | 100.00 | 100.00 | 150.00 | .334 | NA |
| Deltoid | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| **SCAPULA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | 100.00 | 100.00 | 61.11 | .503 | NA |
| Pectoralis minor | 100.00 | 100.00 | 66.66 | .240 | NA |
| **HUMERUS** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | 100.00 | 100.00 | 100.00 | .607 | NA |
| Infraspinatus | NA | NA | NA | NA | NA |
| Teres minor | 100.00 | 100.00 | 77.77 | .607 | NA |
| Pectoralis major | 100.00 | 100.00 | 94.44 | .564 | NA |
| Latissimus dorsi | 100.00 | 100.00 | 77.77 | .569 | NA |
| Teres major | 100.00 | 100.00 | 83.33 | .108 | NA |
| Deltoid | 100.00 | 100.00 | 100.00 | .258 | NA |
| Coracobrachialis | 100.00 | 66.66 | 83.33 | .854 | NA |
| Common extensors | 100.00 | 100.00 | 83.33 | .906 | NA |
| Common flexors | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| **ULNA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 100.00 | 100.00 | 100.00 | .208 | NA |
| Anconeus | 100.00 | 75.00 | 100.00 | .580 | NA |
| Triceps | 100.00 | 100.00 | 100.00 | .300 | NA |
| **RADIUS** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | 100.00 | 83.33 | 100.00 | .497 | NA |
| Pronator teres | 100.00 | 125.00 | 133.33 | .200 | NA |
| Supinator | 100.00 | 100.00 | 100.00 | .472 | NA |
| Pronator quadratus | 100.00 | 100.00 | 100.00 | 1.00 | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 71:** Middle Monongahela - comparison of mean MSM asymmetry scores by age for lower limb*

| INNOMINATE | Young Adult | Middle-Aged Adult | Old Adult | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|---|
| Gluteus maximus | NA | 100.00 | 100.00 | .200 | NA |
| Gluteus minimus | NA | 100.00 | 100.00 | .472 | NA |
| Gluteus medius | NA | 100.00 | 100.00 | 1.00 | NA |
| Tensor fascia latae | NA | 100.00 | 100.00 | .479 | NA |
| Adductor brevis | NA | 100.00 | 100.00 | 1.00 | NA |
| Adductor longus | NA | 100.00 | 100.00 | .329 | NA |
| Adductor magnus | NA | 100.00 | 100.00 | .503 | NA |
| Pectineus | NA | 100.00 | 100.00 | .189 | NA |
| Gracilis | NA | 100.00 | 100.00 | .717 | NA |
| Iliacus | NA | 100.00 | 100.00 | .395 | NA |
| Obturator externus | NA | 100.00 | 100.00 | 1.00 | NA |
| Obturator internus | NA | 100.00 | 100.00 | .368 | NA |
| Piriformis | NA | 100.00 | 100.00 | .368 | NA |
| Superior gemelli | NA | 100.00 | 100.00 | 1.00 | NA |
| Inferior gemelli | NA | 100.00 | 100.00 | .301 | NA |
| Quadratus femoris | NA | 100.00 | 100.00 | .832 | NA |
| **FEMUR** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | 100.00 | 116.66 | 100.00 | 1.00 | NA |
| Gluteus medius | 100.00 | 83.33 | 100.00 | 1.00 | NA |
| Gluteus minimus | 100.00 | 100.00 | 100.00 | .082 | NA |
| Adductor magnus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Vastus intermedius | 100.00 | 100.00 | 100.00 | .472 | NA |
| Vastus medialis | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Vastus lateralis | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Piriformis | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Obturator externus | 100.00 | 133.33 | 100.00 | .221 | NA |
| Obturator internus | 100.00 | 133.33 | 100.00 | .449 | NA |
| Quadratus femoris | 100.00 | 116.66 | 100.00 | .861 | NA |
| Popliteus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Gastrocnemius | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Iliacus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Pectineus | 100.00 | 100.00 | 100.00 | .271 | NA |
| **TIBIA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 200.00 | 260.00 | 225.00 | .145 | NA |
| Popliteus | 100.00 | 140.00 | 160.00 | .785 | NA |
| Semimembranosus | 83.33 | 100.00 | 100.00 | .240 | NA |
| Tibialis posterior | 100.00 | 90.00 | 100.00 | .395 | NA |
| Tibialis anterior | 66.66 | 100.00 | 100.00 | .144 | NA |
| Flexor digitorum | NA | NA | NA | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

### 7.2.3 Late Monongahela Activity: Discussion

#### 7.2.3.1 Late Monongahela Results

Means and p-values from statistical procedures are listed for MSM robusticity by sex are presented in Tables 72-73. Results are listed for MSM score by age in Tables 74-75. Tables 76-77 and 78-79 list results from MSM asymmetry by sex and age respectively. Males had significantly higher MSM scores for the following markers: right costoclavicular ligament, right supinator, right gluteus maximus, left gluteus minimus and gluteus medius. Females scored significantly higher for the left deltoid and right coracobrachialis. Sex was correlated with MSM score for all of the significant variables from Kruskall-Wallis H-tests. Old adults scored significantly higher for the right costoclavicular ligament, left subclavius, left teres minor and left/right quadratus femoris (innominate); age was significantly correlated with these MSM scores only. No significant differences were revealed when asymmetry scores were compared by sex or adult age.

#### 7.2.3.2 Late Monongahela Discussion

Muscle use intensified during the late Monongahela period. This group scored significantly higher in sex and age categories than the Early and Middle Monongahela categories, as well as the Early Woodland and Post-Contact samples (See Appendix B). Upper limb robusticity for this sample was comparatively high: the deltoid, pectoralis manor, latissimus dorsi, teres major, teres minor, coracobrachialis, brachialis, anconeus, triceps, biceps, and pronator teres all scored high or moderate-high, generally. These patterns are similar to those from the Middle Monongahela period in terms of sex and age differences, with greater overall robusticity. Specifically, hunting is indicated as a subsistence strategy based on the higher robusticity of forearm flexors and extensors, especially brachialis, biceps, and triceps (Shuler et al. 2012). There are no differences between sex and age for these muscle groups, so both males and females across age classes were likely participating in these activities. Agricultural labor is also still indicated based on the heavy musculature of the shoulder joint, indicating heavy load lifting, soil preparation, and grain grinding. Because this sample scored significantly higher in most of the MSMs of the upper limb, it is indicated that agricultural labor may have been intensified in the period before the demise of the Monongahela, as well as a return to hunting and gathering as a subsistence strategy with both sexes participating in all subsistence activities.

For the lower limb, the Late Monongahela sample also scored higher for nearly all MSMs in sex and age categories than all other samples in this study (See Appendix B, Tables 198-220). High or moderate MSM scores are observed in nearly all the major muscle groups of the lower limb: gluteals, quadriceps, adductors, hip flexors, knee extensors, and knee flexors. The robust nature of lower limb activity markers indicates an increased effort in agriculture, hunting, and long distance gathering or trade as the patterning of activity indicates increased levels of squatting, walking, and running than in previous Monongahela periods.

The intensification of agricultural labor, as well as the return to hunting and gathering as a supplement to maize as indicated by the significantly increased robusticity compared to past periods supports they hypothesis of Richardson et al. (2002) that the disappearance of the Monongahela can be partially attributed to climate change. Site aggregation and movement into a smaller territory occurred in this time period, and it is likely that due to drought conditions, maize agriculture became more difficult and increased labor demands (Richardson et al. 2002). Activities such as water carrying, land clearing for new fields, and foraging and hunting further afield may have attributed to MSM patterning. According to Richardson et al. (2002), Late Monongahela site structure indicates community consolidation, suggesting population movement and aggregation into smaller territory (Richardson et al. 2002). At the beginning of the Monongahela complex, the Medieval Warming Period (900-1300AD) introduced the ideal climate for maize agriculture. Cooling temperatures brought about by the Little Ice Age (1400-1900AD) decreased the number of frost free days in the region as well as increased drought conditions that would have made maize agriculture difficult to sustain (Richardson et al. 2002). These factors, combined with other climactic events such as El Niño and volcanic eruptions, may have "pushed the Monongahela over the edge" leading to decreasing territory after 1580AD and ultimate disappearance from the regional landscape of the Ohio Valley just before 1635AD (Richardson et al. 2002:89). Other factors such as the spread of European disease through indirect contact and raiding by the Seneca also contributed to the Monongahela disappearance (Richardson et al. 2002). With drought conditions and cooler climate, subsistence strategies would have necessarily been altered or intensified, and the significant increase in MSM robusticity from previous period is one more line of evidence to this effect. Paleopathological evidence from this study supports increased resource stress or disease; rates of stress indicators increased in the Late Monongahela sample from the Middle Monongahela. For example, between these periods rates of cribra orbitalia and linear enamel hypoplasia among subadults increased from 11.4% to 21.4% and 11.5% to 21.4% respectively. The paleopathological evidence in conjunction with increased activity marker robusticity indicates that the Late Monongahela was a time of increased stress from disease, resource depletion, and increasing labor demands. These patterns support the hypothesis of Richardson et al. (2002).

**Table 72:** Late Monongahela - comparison of mean MSM scores by sex for upper limb*

| | **Male** | | **Female** | | **Kruskall-Wallis*** | | **Spearman*** | |
|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | 2.50 | 2.75 | 2.14 | 2.14 | .246 | **.047** | NA | **.041** |
| Subclavius | 1.50 | 1.50 | 1.14 | 1.00 | .297 | .262 | NA | NA |
| Trapezoid ligament | 2.00 | 2.00 | 2.00 | 2.14 | .754 | .724 | NA | NA |
| Conoid ligament | 2.25 | 2.00 | 2.43 | 2.43 | .875 | .327 | NA | NA |
| Deltoid | 1.75 | 2.25 | 2.57 | 2.57 | **.049** | .414 | **.040** | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | 1.33 | 1.33 | 1.00 | 1.00 | .237 | .392 | NA | NA |
| Pectoralis minor | 1.33 | 1.33 | 1.00 | 1.00 | .237 | .083 | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Infraspinatus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Teres minor | 1.50 | 1.00 | 1.00 | 1.00 | .221 | 1.00 | NA | NA |
| Pectoralis major | 2.50 | 2.00 | 2.40 | 2.40 | .916 | .332 | NA | NA |
| Latissimus dorsi | 2.00 | 2.50 | 2.40 | 2.20 | .325 | .392 | NA | NA |
| Teres major | 2.50 | 2.50 | 2.14 | 2.00 | .538 | .118 | NA | NA |
| Deltoid | 2.00 | 2.00 | 2.57 | 2.57 | .799 | .556 | NA | NA |
| Coracobrachialis | 1.00 | 1.00 | 1.29 | 1.14 | .436 | **.014** | NA | **.008** |
| Common extensors | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .071 | NA | NA |
| Common flexors | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .071 | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 3.00 | 3.00 | 2.78 | 2.67 | .303 | .564 | NA | NA |
| Anconeus | 2.00 | 2.00 | 2.00 | 1.78 | 1.00 | .720 | NA | NA |
| Triceps | 2.00 | 2.00 | 1.56 | 1.67 | .148 | .093 | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | 3.00 | 2.75 | 2.50 | 2.75 | .061 | .526 | NA | NA |
| Pronator teres | 1.75 | 1.50 | 1.88 | 2.00 | .835 | .118 | NA | NA |
| Supinator | 1.25 | 1.25 | 1.13 | 1.00 | .661 | **.038** | NA | **.032** |
| Pronator quadratus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |

*significant p-values bolded ($p \leq .05$)

**Table 73:** Late Monongahela - comparison of mean MSM scores by sex for lower limb*

| ATTACHMENT | Male | | Female | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.50 | 3.00 | 2.00 | 2.00 | .540 | **.010** | NA | **.003** |
| Gluteus minimus | 2.00 | 1.00 | 1.00 | 1.00 | **.015** | .102 | **.006** | NA |
| Gluteus medius | 2.00 | 1.00 | 1.00 | 1.00 | **.015** | .102 | **.006** | NA |
| Tensor fascia latae | 1.50 | 2.50 | 1.75 | 1.50 | 1.00 | .471 | NA | NA |
| Adductor brevis | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Adductor longus | 1.50 | 1.50 | 1.50 | 1.50 | .823 | .683 | NA | NA |
| Adductor magnus | 2.50 | 2.00 | 2.50 | 2.00 | .661 | .112 | NA | NA |
| Pectineus | 1.25 | 1.50 | 1.00 | 1.75 | .112 | .870 | NA | NA |
| Gracilis | 1.50 | 1.50 | 1.00 | 1.00 | .157 | .248 | NA | NA |
| Iliacus | 2.00 | 2.50 | 2.25 | 2.00 | .331 | .801 | NA | NA |
| Obturator externus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Obturator internus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Piriformis | 2.00 | 2.00 | 1.87 | 1.87 | .788 | .771 | NA | NA |
| Superior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Inferior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Quadratus femoris | 1.00 | 1.00 | 1.00 | 1.00 | .712 | .392 | NA | NA |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.67 | 2.67 | 2.80 | 2.80 | .409 | .690 | NA | NA |
| Gluteus medius | 1.33 | 1.33 | 1.20 | 1.20 | .600 | .903 | NA | NA |
| Gluteus minimus | 1.33 | 1.33 | 1.40 | 1.40 | 1.00 | .572 | NA | NA |
| Adductor magnus | 2.40 | 2.60 | 2.67 | 2.56 | .924 | .724 | NA | NA |
| Vastus intermedius | 2.20 | 2.20 | 2.56 | 2.40 | .130 | .494 | NA | NA |
| Vastus medialis | 2.20 | 2.20 | 2.56 | 2.44 | .228 | .454 | NA | NA |
| Vastus lateralis | 2.20 | 2.20 | 2.56 | 2.44 | .228 | .454 | NA | NA |
| Piriformis | 1.67 | 1.33 | 1.20 | 1.20 | .176 | .673 | NA | NA |
| Obturator externus | 1.33 | 1.33 | 1.20 | 1.20 | .600 | .673 | NA | NA |
| Obturator internus | 1.33 | 1.20 | 1.33 | 1.20 | .600 | .673 | NA | NA |
| Quadratus femoris | 1.33 | 1.33 | 1.40 | 1.20 | .903 | .759 | NA | NA |
| Popliteus | 1.33 | 1.33 | 1.33 | 1.33 | .746 | .866 | NA | NA |
| Gastrocnemius | 2.33 | 2.00 | 2.00 | 1.67 | .742 | .655 | NA | NA |
| Iliacus | 2.00 | 2.00 | 1.67 | 1.67 | .269 | .678 | NA | NA |
| Pectineus | 1.67 | 2.00 | 2.00 | 2.00 | .712 | .506 | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Popliteus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Semimembranosus | 1.50 | 1.50 | 1.14 | 1.14 | .112 | .091 | NA | NA |
| Tibialis posterior | 1.75 | 1.75 | 1.25 | 1.25 | .062 | .062 | NA | NA |
| Tibialis anterior | 1.75 | 1.75 | 1.25 | 1.25 | .062 | .062 | NA | NA |
| Flexor digitorum | NA | NA | NA | NA | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 74:** Late Monongahela - comparison of mean MSM scores by age for upper limb*

| | **Young Adult** | | **Middle-Aged Adult** | | **Old Adult** | | **Kruskall-Wallis*** | | **Spearman*** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | 2.17 | 2.17 | 2.00 | 2.00 | 3.00 | 2.50 | .130 | .773 | NA | NA |
| Subclavius | 1.17 | 1.17 | 1.00 | 1.00 | 1.00 | 1.50 | **.006, .014** | .100 | **.050** | NA |
| Trapezoid ligament | 2.17 | 2.17 | 2.00 | 2.50 | 2.00 | 2.00 | .535 | .741 | NA | NA |
| Conoid ligament | 2.50 | 2.33 | 2.00 | 2.50 | 2.50 | 2.50 | .156 | 1.00 | NA | NA |
| Deltoid | 2.33 | 2.50 | 3.00 | 3.00 | 2.00 | 2.00 | .389 | .206 | NA | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | 1.00 | 1.00 | 1.00 | 1.00 | 1.50 | 1.50 | .135 | .238 | NA | NA |
| Pectoralis minor | 1.00 | 1.00 | 1.00 | 1.00 | 1.50 | 1.50 | .135 | .264 | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Infraspinatus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Teres minor | 1.00 | 1.00 | 1.00 | 1.00 | 2.00 | 1.00 | **.018, .031** | 1.00 | .091 | NA |
| Pectoralis major | 2.33 | 2.67 | 2.50 | 2.00 | 3.00 | 3.00 | .565 | .549 | NA | NA |
| Latissimus dorsi | 2.33 | 2.67 | 2.50 | 3.00 | 3.00 | 3.00 | .472 | .401 | NA | NA |
| Teres major | 2.00 | 2.25 | 2.50 | 2.00 | 2.00 | 2.00 | .185 | 1.00 | NA | NA |
| Deltoid | 2.75 | 2.50 | 3.00 | 2.50 | 3.00 | 3.00 | .713 | .676 | NA | NA |
| Coracobrachialis | 1.50 | 1.25 | 1.50 | 1.00 | 2.00 | 2.00 | .947 | .517 | NA | NA |
| Common extensors | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .287 | NA | NA |
| Common flexors | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .287 | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 2.00 | 2.00 | 2.50 | 2.50 | 3.00 | 3.00 | .529 | .167 | NA | NA |
| Anconeus | 1.67 | 1.50 | 1.50 | 2.00 | 2.00 | 2.00 | .449 | .449 | NA | NA |
| Triceps | 1.67 | 2.00 | 1.50 | 1.50 | 1.67 | 1.67 | .624 | .697 | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | 2.80 | 2.80 | 2.50 | 3.00 | 3.00 | 3.00 | .450 | .558 | NA | NA |
| Pronator teres | 1.60 | 1.80 | 2.00 | 2.00 | 1.50 | 2.00 | 1.00 | .170 | NA | NA |
| Supinator | 1.00 | 1.00 | 1.50 | 1.00 | 1.50 | 1.50 | .185 | .333 | NA | NA |
| Pronator quadratus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |

*significant p-values bolded ($p \leq .05$)

**Table 75:** Late Monongahela - comparison of mean MSM scores by age for lower limb*

| ATTACHMENT | Young Adult | | Middle-Aged Adult | | Old Adult | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.33 | 2.00 | 2.50 | 2.00 | 2.00 | 2.33 | .369 | .965 | NA | NA |
| Gluteus minimus | 1.20 | 1.20 | 1.50 | 1.50 | 2.00 | 2.00 | .659 | .430 | NA | NA |
| Gluteus medius | 1.20 | 1.20 | 1.00 | 1.00 | 1.50 | 1.50 | .659 | .430 | NA | NA |
| Tensor fascia latae | 1.60 | 1.60 | 2.00 | 2.00 | 2.50 | 2.50 | .384 | .140 | NA | NA |
| Adductor brevis | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Adductor longus | 1.50 | 1.50 | 1.00 | 1.00 | 2.00 | 2.00 | .687 | .407 | NA | NA |
| Adductor magnus | 2.00 | 2.00 | 2.33 | 2.33 | 2.33 | 2.33 | .438 | .376 | NA | NA |
| Pectineus | 1.60 | 1.80 | 1.00 | 1.00 | 2.00 | 2.00 | .284 | .466 | NA | NA |
| Gracilis | 1.00 | 1.00 | 1.00 | 1.00 | 2.00 | 2.00 | .082 | .052 | NA | NA |
| Iliacus | 2.33 | 2.17 | 2.33 | 2.33 | 2.50 | 2.00 | 1.00 | .861 | NA | NA |
| Obturator externus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Obturator internus | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Piriformis | 1.83 | 1.67 | 1.67 | 1.67 | 2.00 | 2.00 | .825 | .443 | NA | NA |
| Superior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Inferior gemelli | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Quadratus femoris | 1.00 | 1.00 | 1.00 | 1.00 | 2.00 | 2.00 | **.010** | **.013** | **.007** | **.020** |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 2.80 | 2.80 | 2.50 | 2.50 | 2.33 | 2.67 | .855 | .922 | NA | NA |
| Gluteus medius | 1.20 | 1.20 | 1.00 | 1.00 | 2.00 | 2.00 | .472 | .670 | NA | NA |
| Gluteus minimus | 1.20 | 1.20 | 1.00 | 1.00 | 2.00 | 2.00 | .472 | .670 | NA | NA |
| Adductor magnus | 2.40 | 2.60 | 2.50 | 2.50 | 2.75 | 2.75 | .648 | .568 | NA | NA |
| Vastus intermedius | 2.20 | 2.40 | 2.50 | 2.50 | 2.75 | 2.50 | .353 | .910 | NA | NA |
| Vastus medialis | 2.20 | 2.40 | 2.50 | 2.50 | 2.75 | 2.50 | .353 | .910 | NA | NA |
| Vastus lateralis | 2.20 | 2.40 | 2.50 | 2.50 | 2.75 | 2.50 | .353 | .910 | NA | NA |
| Piriformis | 1.40 | 1.20 | 1.00 | 1.00 | 2.00 | 2.00 | .565 | .518 | NA | NA |
| Obturator externus | 1.20 | 1.20 | 1.00 | 1.00 | 2.00 | 2.00 | .472 | .518 | NA | NA |
| Obturator internus | 1.20 | 1.20 | 1.00 | 1.00 | 2.00 | 2.00 | .472 | .518 | NA | NA |
| Quadratus femoris | 1.20 | 1.20 | 2.00 | 1.00 | 2.00 | 2.00 | .264 | .195 | NA | NA |
| Popliteus | 1.20 | 1.20 | NA | NA | 2.00 | 2.00 | .264 | .267 | NA | NA |
| Gastrocnemius | 1.80 | 1.80 | NA | NA | 2.00 | 2.00 | **.018** | .819 | .683 | NA |
| Iliacus | 1.80 | 1.80 | 1.00 | 1.00 | 2.00 | 2.00 | .066 | .852 | NA | NA |
| Pectineus | 1.75 | 2.00 | 1.00 | 1.00 | 2.00 | 2.00 | .751 | .683 | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | 1.00 | 1.00 | NA | NA | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Popliteus | 1.00 | 1.00 | NA | NA | 1.00 | 1.00 | 1.00 | 1.00 | NA | NA |
| Semimembranosus | 1.20 | 1.20 | NA | NA | 1.25 | 1.25 | .892 | .680 | NA | NA |
| Tibialis posterior | 1.60 | 1.60 | NA | NA | 1.25 | 1.25 | .326 | .310 | NA | NA |
| Tibialis anterior | 1.60 | 1.60 | NA | NA | 1.25 | 1.25 | .326 | .310 | NA | NA |
| Flexor digitorum | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 76:** Late Monongahela - comparison of mean MSM asymmetry scores by sex for upper limb*

| CLAVICLE | Male | Female | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|
| Costoclavicular ligament | 88.88 | 125.00 | .683 | NA |
| Subclavius | 100.00 | 100.00 | .776 | NA |
| Trapezoid ligament | 100.00 | 100.00 | 1.00 | NA |
| Conoid ligament | 100.00 | 125.00 | .414 | NA |
| Deltoid | 88.88 | 104.16 | .181 | NA |
| **SCAPULA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | 100.00 | 100.00 | 1.000 | NA |
| Pectoralis minor | 100.00 | 100.00 | 1.00 | NA |
| **HUMERUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | 100.00 | 100.00 | 1.00 | NA |
| Infraspinatus | NA | NA | NA | NA |
| Teres minor | 133.00 | 100.00 | .571 | NA |
| Pectoralis major | 88.88 | 103.33 | .833 | NA |
| Latissimus dorsi | 88.88 | 110.00 | .383 | NA |
| Teres major | 105.55 | 110.00 | .833 | NA |
| Deltoid | 100.00 | 113.33 | .839 | NA |
| Coracobrachialis | 100.00 | 130.00 | .440 | NA |
| Common extensors | 100.00 | 100.00 | 1.00 | NA |
| Common flexors | 100.00 | 100.00 | 1.00 | NA |
| **ULNA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 125.00 | 102.38 | 1.00 | NA |
| Anconeus | 100.00 | 107.49 | 1.00 | NA |
| Triceps | 100.00 | 92.85 | .909 | NA |
| **RADIUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | 100.00 | 95.23 | .284 | NA |
| Pronator teres | 75.00 | 92.85 | .364 | NA |
| Supinator | 100.00 | 100.00 | .724 | NA |
| Pronator quadratus | 100.00 | 100.00 | 1.00 | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 77:** Late Monongahela - comparison of mean MSM asymmetry scores by sex for lower limb*

| INNOMINATE | Male | Female | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|
| Gluteus maximus | 100.00 | 116.66 | 1.00 | NA |
| Gluteus minimus | 100.00 | 133.33 | 1.00 | NA |
| Gluteus medius | 100.00 | 100.00 | 1.00 | NA |
| Tensor fascia latae | 100.00 | 100.00 | .755 | NA |
| Adductor brevis | 100.00 | 100.00 | 1.00 | NA |
| Adductor longus | 100.00 | 100.00 | 1.00 | NA |
| Adductor magnus | 100.00 | 100.00 | 1.00 | NA |
| Pectineus | 100.00 | 83.33 | .400 | NA |
| Gracilis | 100.00 | 100.00 | 1.00 | NA |
| Iliacus | 100.00 | 125.00 | .943 | NA |
| Obturator externus | 100.00 | 100.00 | 1.00 | NA |
| Obturator internus | 100.00 | 100.00 | 1.00 | NA |
| Piriformis | 100.00 | 100.00 | .797 | NA |
| Superior gemelli | 100.00 | 100.00 | 1.00 | NA |
| Inferior gemelli | 100.00 | 100.00 | 1.00 | NA |
| Quadratus femoris | 100.00 | 100.00 | 1.00 | NA |
| **FEMUR** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | 104.86 | 120.00 | .607 | NA |
| Gluteus medius | 100.00 | 100.00 | 1.00 | NA |
| Gluteus minimus | 100.00 | 100.00 | 1.00 | NA |
| Adductor magnus | 91.66 | 110.00 | .428 | NA |
| Vastus intermedius | 100.00 | 103.33 | .792 | NA |
| Vastus medialis | 100.00 | 103.33 | .792 | NA |
| Vastus lateralis | 100.00 | 103.33 | .792 | NA |
| Piriformis | 125.00 | 100.00 | .556 | NA |
| Obturator externus | 100.00 | 100.00 | 1.00 | NA |
| Obturator internus | 100.00 | 100.00 | .730 | NA |
| Quadratus femoris | 100.00 | 100.00 | 1.00 | NA |
| Popliteus | 100.00 | 100.00 | 1.00 | NA |
| Gastrocnemius | 112.50 | 133.33 | 1.00 | NA |
| Iliacus | 100.00 | 100.00 | 1.00 | NA |
| Pectineus | 91.66 | 100.00 | .610 | NA |
| **TIBIA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 100.00 | 100.00 | 1.00 | NA |
| Popliteus | 100.00 | 100.00 | 1.00 | NA |
| Semimembranosus | 100.00 | 100.00 | 1.00 | NA |
| Tibialis posterior | 100.00 | 100.00 | 1.00 | NA |
| Tibialis anterior | 100.00 | 100.00 | 1.00 | NA |
| Flexor digitorum | 100.00 | 100.00 | N/A | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 78:** Late Monongahela - comparison of mean MSM asymmetry scores by age for upper limb*

| CLAVICLE | Young Adult | Middle-Aged Adult | Old Adult | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|---|
| Costoclavicular ligament | 111.11 | NA | 100.00 | .187 | NA |
| Subclavius | 100.00 | NA | 100.00 | .160 | NA |
| Trapezoid ligament | 100.00 | NA | 100.00 | .086 | NA |
| Conoid ligament | 116.667 | NA | 100.00 | .796 | NA |
| Deltoid | 97.22 | NA | 100.00 | .812 | NA |
| **SCAPULA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | 100.00 | NA | 100.00 | 1.00 | NA |
| Pectoralis minor | 100.00 | NA | 100.00 | 1.00 | NA |
| **HUMERUS** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Infraspinatus | NA | NA | NA | NA | NA |
| Teres minor | 100.00 | 100.00 | 100.00 | .052 | NA |
| Pectoralis major | 88.88 | 116.66 | 100.00 | .360 | NA |
| Latissimus dorsi | 88.88 | 116.66 | 100.00 | .360 | NA |
| Teres major | 88.88 | 116.66 | 100.00 | .158 | NA |
| Deltoid | 116.66 | 116.66 | 100.00 | .455 | NA |
| Coracobrachialis | 133.33 | 133.33 | 100.00 | .680 | NA |
| Common extensors | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Common flexors | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| **ULNA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 100.00 | 100.00 | 100.00 | .266 | NA |
| Anconeus | 83.33 | 100.00 | 100.00 | .417 | NA |
| Triceps | 83.33 | 100.00 | 100.00 | .368 | NA |
| **RADIUS** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | 100.00 | 100.00 | 100.00 | .311 | NA |
| Pronator teres | 83.33 | 100.00 | 75.00 | .595 | NA |
| Supinator | 100.00 | 100.00 | 100.00 | .311 | NA |
| Pronator quadratus | 100.00 | 100.00 | 100.00 | 1.00 | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 79:** Late Monongahela – comparison of mean MSM asymmetry scores by age for lower limb*

| INNOMINATE | Young Adult | Middle-Aged Adult | Old Adult | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|---|
| Gluteus maximus | 116.66 | NA | 100.00 | .304 | NA |
| Gluteus minimus | 100.00 | NA | 100.00 | 1.00 | NA |
| Gluteus medius | 100.00 | NA | 100.00 | 1.00 | NA |
| Tensor fascia latae | 133.33 | NA | 100.00 | .831 | NA |
| Adductor brevis | 100.00 | NA | 100.00 | 1.00 | NA |
| Adductor longus | 100.00 | NA | 100.00 | 1.00 | NA |
| Adductor magnus | 100.00 | NA | 100.00 | 1.00 | NA |
| Pectineus | 77.77 | NA | 100.00 | 1.00 | NA |
| Gracilis | 100.00 | NA | 100.00 | 1.00 | NA |
| Iliacus | 133.33 | NA | 100.00 | .397 | NA |
| Obturator externus | 100.00 | NA | 100.00 | 1.00 | NA |
| Obturator internus | 100.00 | NA | 100.00 | 1.00 | NA |
| Piriformis | 100.00 | NA | 100.00 | .558 | NA |
| Superior gemelli | 100.00 | NA | 100.00 | 1.00 | NA |
| Inferior gemelli | 100.00 | NA | 100.00 | 1.00 | NA |
| Quadratus femoris | 100.00 | NA | 100.00 | 1.00 | NA |
| **FEMUR** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | 112.50 | 100.00 | 100.00 | .169 | NA |
| Gluteus medius | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Gluteus minimus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Adductor magnus | 91.66 | 100.00 | 100.00 | .497 | NA |
| Vastus intermedius | 100.00 | 100.00 | 100.00 | .290 | NA |
| Vastus medialis | 100.00 | 100.00 | 100.00 | .290 | NA |
| Vastus lateralis | 100.00 | 100.00 | 100.00 | .290 | NA |
| Piriformis | 125.00 | 100.00 | 100.00 | .741 | NA |
| Obturator externus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Obturator internus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Quadratus femoris | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Popliteus | 100.00 | 100.00 | 100.00 | .223 | NA |
| Gastrocnemius | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Iliacus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Pectineus | 91.66 | 100.00 | 100.00 | .607 | NA |
| **TIBIA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Popliteus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Semimembranosus | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Tibialis posterior | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Tibialis anterior | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Flexor digitorum | NA | NA | NA | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

# 7.3 THE POST-CONTACT PERIOD

## 7.3.1 Post-Contact Activity: Discussion

### 7.3.1.1 Post-Contact Results

Means and p-values from statistical procedures are listed for MSM robusticity by sex are presented in Tables 80-81. Results are listed for MSM score by age in Tables 82-83. Tables 84-85 and 86-87 list results from MSM asymmetry by sex and age respectively. For this sample, no significant differences by age and sex were observed for robusticity or asymmetry. Few MSM sites had enough comparative data for tests to be run due to sample preservation. Of the MSMs observed, mean scores were low: 0 to 1 on the Hawkey and Merbs (1995) scale.

### 7.3.1.2 Post-Contact Discussion

In comparison to all earlier samples, the Post-Contact group is comparatively gracile. This sample scored significantly lower for nearly all MSMs than the Early Woodland and Monongahela samples, including sex and age cohorts (Appendix B, all tables). All of the MSMs ranged from not visible to barely visible, with few exceptions and many skeletons did not have adequate surface preservation to score all activity markers. These observations represent a notable shift from high muscle use in pre-contact periods to extremely low muscle robusticity following European contact and colonialism in the Ohio Valley. For the Post-Contact sample, muscles of shoulder rotation, flexion and extension scored the highest in the upper limb with mean scores between .5 and 1.00. In the lower limb, quadriceps, adductor magnus, and gluteus maximus scored the highest with mean MSM scores at approximately 1.00. Given the poorer sample preservation and younger age structure than previous periods, MSM scores may be lower due to these factors (Stefanovic and Porcic 2013).

Another factor that influences labor and activity patterns is alterations in the subsistence strategy. Sciulli (1993) noted in a preliminary analysis of the Chamber's site collection that rates of dental disease were lower than expected for a population that consumed primarily maize (<10%). Historical reports from the mid-18$^{th}$ century by the British indicate that indigenous subsistence on the western frontier of the colonies was interrupted due to warfare (Gist 1759). Cornfields may have been destroyed as a warfare tactic during the French and Indian War (1754-1763) and Pontiac's Rebellion (1763-1766AD); traveler's through the Ohio Country reported disease and famine in the indigenous towns during this period of turmoil (Gist 1759; McConnell 1992). As a result, it is suggested that indigenous groups settled in the Ohio Valley region had to resort to hunting and gathering, though it may not have been an adequate food source (Sciulli 1993). Historical documents describing life in the Kuskuskies Towns in the mid-18$^{th}$ century add to this picture; McConnell (1992) stated that the Delaware and other tribes settled in towns in the Ohio Valley had partially adopted European style lifeways such as keeping small numbers of livestock (pigs and chickens). It is important to note that the age structure of this assemblage indicates a catastrophic mortality assemblage; the MSM patterning and pathology are only a glimpse at one moment in time following a mass mortality event, likely an epidemic of smallpox (Gist 1759). It may have been possible that due to disease outbreaks, these people were not able to engage in intensive labor. Once the Delaware migrated to Michigan and the Great Lakes following the 1770's (Obermeyer 2009), Ferris (2009) reported that they were engaged in trade, European style farming, and Christian mission life, where the subsistence, labor, and health patterns were further altered, though traditional dress and gendered status divisions continued.

**Table 80:** Post-Contact - comparison of mean MSM scores by sex for upper limb*

| | **Male** | | **Female** | | **Kruskall-Wallis*** | | **Spearman*** | |
|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | 1.00 | 1.00 | .50 | 1.50 | .317 | .665 | NA | NA |
| Subclavius | 0.00 | 0.00 | .50 | .50 | 1.00 | .414 | NA | NA |
| Trapezoid ligament | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | .617 | NA | NA |
| Conoid ligament | 1.00 | 1.00 | 0.00 | 0.00 | .157 | .317 | NA | NA |
| Deltoid | 1.00 | 1.00 | 1.00 | 1.00 | .480 | .564 | NA | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | .50 | .50 | 1.00 | 1.00 | .480 | .480 | NA | NA |
| Pectoralis minor | .50 | .50 | 0.00 | 0.00 | .480 | .480 | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | NA | NA |
| Infraspinatus | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | .317 | NA | NA |
| Teres minor | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | NA | NA |
| Pectoralis major | 0.00 | 1.00 | 0.00 | 0.00 | .414 | .317 | NA | NA |
| Latissimus dorsi | 0.00 | .50 | 0.00 | 0.00 | 1.00 | 1.00 | NA | NA |
| Teres major | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | .317 | NA | NA |
| Deltoid | .50 | 1.00 | 0.00 | 0.00 | .637 | .576 | NA | NA |
| Coracobrachialis | .50 | 1.00 | 0.00 | 0.00 | .317 | .317 | NA | NA |
| Common extensors | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | .414 | NA | NA |
| Common flexors | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | .414 | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 | .617 | NA | NA |
| Anconeus | .33 | .33 | .50 | .50 | .739 | .576 | NA | NA |
| Triceps | .50 | .50 | .67 | .67 | .739 | 1.00 | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | .67 | .67 | .67 | 1.33 | .814 | .343 | NA | NA |
| Pronator teres | .50 | .50 | 0.00 | 0.00 | .480 | .739 | NA | NA |
| Supinator | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | NA | NA |
| Pronator quadratus | 0.00 | 0.00 | 0.00 | .50 | 1.00 | .317 | NA | NA |

*significant p-values bolded (p≤.05)

**Table 81:** Post-Contact - comparison of mean MSM scores by sex for lower limb*

| ATTACHMENT | Male | | Female | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 0.00 | 0.00 | .67 | .67 | .317 | .317 | NA | NA |
| Gluteus minimus | .50 | .50 | .33 | .33 | .739 | .683 | NA | NA |
| Gluteus medius | .67 | .67 | .33 | .33 | .456 | .683 | NA | NA |
| Tensor fascia latae | .50 | .50 | .67 | .67 | 1.00 | 1.00 | NA | NA |
| Adductor brevis | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Adductor longus | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Adductor magnus | 0.00 | 0.00 | 1.33 | 1.33 | .068 | .361 | NA | NA |
| Pectineus | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Gracilis | 0.00 | 0.00 | 1.00 | 1.00 | .317 | .317 | NA | NA |
| Iliacus | .67 | .67 | 1.00 | 1.00 | .637 | .637 | NA | NA |
| Obturator externus | 0.00 | 0.00 | .50 | .50 | .480 | .480 | NA | NA |
| Obturator internus | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | NA | NA |
| Piriformis | 0.00 | 0.00 | 1.00 | 1.00 | .197 | .197 | NA | NA |
| Superior gemelli | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | NA | NA |
| Inferior gemelli | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | NA | NA |
| Quadratus femoris | 0.00 | 0.00 | .33 | .33 | .564 | .564 | NA | NA |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | 0.00 | 0.00 | 1.00 | 1.00 | .606 | .606 | NA | NA |
| Gluteus medius | 0.00 | 0.00 | .25 | .25 | .480 | .383 | NA | NA |
| Gluteus minimus | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | .423 | NA | NA |
| Adductor magnus | 0.00 | 1.00 | 1.00 | 1.00 | .091 | .460 | NA | NA |
| Vastus intermedius | 0.00 | 0.00 | .83 | 1.00 | .144 | .805 | NA | NA |
| Vastus medialis | 0.00 | 0.00 | .67 | .67 | .248 | .897 | NA | NA |
| Vastus lateralis | 0.00 | 0.00 | .67 | .83 | .091 | .826 | NA | NA |
| Piriformis | 0.00 | .50 | .25 | .25 | .334 | .847 | NA | NA |
| Obturator externus | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | .564 | NA | NA |
| Obturator internus | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | .564 | NA | NA |
| Quadratus femoris | 0.00 | 0.00 | 0.00 | 0.00 | .527 | .419 | NA | NA |
| Popliteus | 0.00 | 0.00 | .25 | .25 | .480 | .378 | NA | NA |
| Gastrocnemius | 0.00 | 0.00 | .20 | .20 | .383 | .423 | NA | NA |
| Iliacus | 0.00 | 0.00 | .60 | .60 | .180 | .900 | NA | NA |
| Pectineus | .50 | 0.00 | .20 | .20 | .564 | .175 | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | .33 | .33 | .67 | .67 | .252 | .414 | NA | NA |
| Popliteus | .33 | .33 | .33 | .33 | 1.00 | .823 | NA | NA |
| Semimembranosus | .67 | .67 | 1.00 | .67 | .248 | .860 | NA | NA |
| Tibialis posterior | 1.00 | .33 | .33 | .33 | .346 | .823 | NA | NA |
| Tibialis anterior | .33 | .33 | .33 | .33 | 1.00 | .823 | NA | NA |
| Flexor digitorum | NA | NA | NA | NA | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 82:** Post-Contact - comparison of mean MSM scores by age for upper limb*

| | Young Adult | | Middle-Aged Adult | | Old Adult | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLAVICLE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Costoclavicular ligament | NA | NA | 1.00 | 1.00 | 1.00 | 3.00 | 1.00 | .317 | NA | NA |
| Subclavius | NA | NA | 0.00 | 0.00 | 1.00 | 1.00 | .480 | .317 | NA | NA |
| Trapezoid ligament | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Conoid ligament | NA | NA | 1.00 | 1.00 | NA | NA | NA | NA | NA | NA |
| Deltoid | NA | NA | 1.00 | 1.00 | NA | NA | NA | NA | NA | NA |
| **SCAPULA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Trapezius | NA | NA | .50 | .50 | NA | NA | NA | NA | NA | NA |
| Pectoralis minor | NA | NA | .50 | .50 | NA | NA | NA | NA | NA | NA |
| **HUMERUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Supraspinatus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Infraspinatus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Teres minor | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Pectoralis major | NA | NA | 0.00 | .67 | NA | NA | NA | NA | NA | NA |
| Latissimus dorsi | NA | NA | 0.00 | .33 | NA | NA | NA | NA | NA | NA |
| Teres major | NA | NA | 0.00 | .67 | NA | NA | NA | NA | NA | NA |
| Deltoid | NA | NA | .33 | .67 | NA | NA | NA | NA | NA | NA |
| Coracobrachialis | NA | NA | .33 | .67 | NA | NA | NA | NA | NA | NA |
| Common extensors | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Common flexors | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| **ULNA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Brachialis | 1.00 | 1.00 | .75 | .75 | 1.00 | 1.00 | .779 | 1.00 | NA | NA |
| Anconeus | 0.00 | 0.00 | .50 | .50 | NA | NA | .414 | .480 | NA | NA |
| Triceps | 1.00 | 1.00 | .33 | .33 | NA | NA | .317 | .414 | NA | NA |
| **RADIUS** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Biceps | 1.00 | 1.00 | .33 | .33 | 1.00 | 2.00 | .411 | .210 | NA | NA |
| Pronator teres | 1.00 | 1.00 | 0.00 | 0.00 | NA | NA | .157 | .221 | NA | NA |
| Supinator | 0.00 | 0.00 | 0.00 | 0.00 | NA | NA | 1.00 | 1.00 | NA | NA |
| Pronator quadratus | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | .082 | NA | NA |

*significant p-values bolded (p≤.05)

**Table 83:** Post-Contact - comparison of mean MSM scores by age for lower limb*

| ATTACHMENT | Young Adult | | Middle-Aged Adult | | Old Adult | | Kruskall-Wallis* | | Spearman* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **INNOMINATE** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | NA | NA | .50 | .50 | 0.00 | 0.00 | .480 | .480 | NA | NA |
| Gluteus minimus | NA | NA | .33 | .33 | 1.00 | 1.00 | .317 | .480 | NA | NA |
| Gluteus medius | NA | NA | .50 | .50 | 1.00 | 1.00 | .414 | .480 | NA | NA |
| Tensor fascia latae | NA | NA | .33 | .33 | 2.00 | 2.00 | .157 | .114 | NA | NA |
| Adductor brevis | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Adductor longus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Adductor magnus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Pectineus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Gracilis | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Iliacus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Obturator externus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Obturator internus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Piriformis | NA | NA | .50 | .50 | NA | NA | NA | NA | NA | NA |
| Superior gemelli | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Inferior gemelli | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Quadratus femoris | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| **FEMUR** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Gluteus maximus | NA | NA | .50 | .50 | NA | NA | NA | NA | NA | NA |
| Gluteus medius | NA | NA | .50 | .50 | NA | NA | NA | NA | NA | NA |
| Gluteus minimus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Adductor magnus | NA | NA | .33 | 1.00 | 2.00 | 2.00 | .157 | .446 | NA | NA |
| Vastus intermedius | NA | NA | .33 | .33 | 2.00 | 3.00 | .157 | .206 | NA | NA |
| Vastus medialis | NA | NA | .33 | .33 | 2.00 | 1.00 | .157 | .351 | NA | NA |
| Vastus lateralis | NA | NA | .33 | .33 | 2.00 | 1.00 | .317 | .351 | NA | NA |
| Piriformis | NA | NA | .33 | .67 | NA | NA | NA | NA | NA | NA |
| Obturator externus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Obturator internus | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Quadratus femoris | NA | NA | 0.00 | 0.00 | NA | NA | NA | NA | NA | NA |
| Popliteus | NA | NA | .33 | .33 | NA | NA | NA | NA | NA | NA |
| Gastrocnemius | NA | NA | .33 | .33 | NA | NA | NA | NA | NA | NA |
| Iliacus | NA | NA | .33 | .33 | NA | NA | NA | NA | NA | NA |
| Pectineus | NA | NA | .67 | 1.00 | NA | NA | NA | NA | NA | NA |
| **TIBIA** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** | **L** | **R** |
| Soleus | NA | NA | .33 | .33 | 1.00 | 1.00 | .317 | .221 | NA | NA |
| Popliteus | NA | NA | .33 | .33 | 1.00 | 1.00 | .317 | .221 | NA | NA |
| Semimembranosus | NA | NA | .67 | .67 | 1.00 | 1.00 | .564 | .414 | NA | NA |
| Tibialis posterior | NA | NA | 1.00 | .33 | 1.00 | 1.00 | 1.00 | .221 | NA | NA |
| Tibialis anterior | NA | NA | .50 | .50 | 1.00 | 1.00 | .317 | .221 | NA | NA |
| Flexor digitorum | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

*significant p-values bolded (p≤.05)

**Table 84:** Post-Contact - comparison of mean MSM asymmetry scores by sex for upper limb*

| **CLAVICLE** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
|---|---|---|---|---|
| Costoclavicular ligament | NA | 33.33 | NA | NA |
| Subclavius | NA | 100.00 | NA | BA |
| Trapezoid ligament | NA | NA | NA | NA |
| Conoid ligament | 100.00 | NA | NA | NA |
| Deltoid | 100.00 | 100.00 | 1.00 | NA |
| **SCAPULA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | 100.00 | NA | NA | NA |
| Pectoralis minor | 100.00 | NA | NA | NA |
| **HUMERUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | NA | NA | NA | NA |
| Infraspinatus | NA | NA | NA | NA |
| Teres minor | NA | NA | NA | NA |
| Pectoralis major | NA | NA | NA | NA |
| Latissimus dorsi | NA | NA | NA | NA |
| Teres major | NA | NA | NA | NA |
| Deltoid | 50.00 | NA | NA | NA |
| Coracobrachialis | 50.00 | NA | NA | NA |
| Common extensors | NA | NA | NA | NA |
| Common flexors | NA | NA | NA | NA |
| **ULNA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 100.00 | 100.00 | 1.00 | NA |
| Anconeus | 100.00 | 100.00 | 1.00 | NA |
| Triceps | 100.00 | 100.00 | 1.00 | NA |
| **RADIUS** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | 100.00 | 100.00 | 1.00 | NA |
| Pronator teres | NA | 100.00 | NA | NA |
| Supinator | NA | NA | NA | NA |
| Pronator quadratus | NA | NA | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 85:** Post-Contact - comparison of mean MSM asymmetry scores by sex for lower limb*

| INNOMINATE | Male | Female | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|
| Gluteus maximus | 100.00 | 100.00 | 1.00 | NA |
| Gluteus minimus | 100.00 | 100.00 | 1.00 | NA |
| Gluteus medius | 100.00 | 100.00 | 1.00 | NA |
| Tensor fascia latae | 100.00 | 100.00 | 1.00 | NA |
| Adductor brevis | NA | NA | NA | NA |
| Adductor longus | NA | NA | NA | NA |
| Adductor magnus | NA | 100.00 | NA | NA |
| Pectineus | NA | NA | NA | NA |
| Gracilis | 50.00 | NA | NA | NA |
| Iliacus | 100.00 | 100.00 | 1.00 | NA |
| Obturator externus | NA | 100.00 | NA | NA |
| Obturator internus | NA | NA | NA | NA |
| Piriformis | NA | 100.00 | NA | NA |
| Superior gemelli | NA | NA | NA | NA |
| Inferior gemelli | NA | NA | NA | NA |
| Quadratus femoris | NA | 100.00 | NA | NA |
| **FEMUR** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | NA | 100.00 | NA | NA |
| Gluteus medius | NA | 100.00 | NA | NA |
| Gluteus minimus | NA | 100.00 | NA | NA |
| Adductor magnus | NA | 100.00 | NA | NA |
| Vastus intermedius | NA | 100.00 | NA | NA |
| Vastus medialis | NA | 100.00 | NA | NA |
| Vastus lateralis | NA | 91.53 | NA | NA |
| Piriformis | NA | 83.33 | NA | NA |
| Obturator externus | NA | NA | NA | NA |
| Obturator internus | NA | NA | NA | NA |
| Quadratus femoris | NA | 100.00 | NA | NA |
| Popliteus | NA | 100.00 | NA | NA |
| Gastrocnemius | NA | 100.00 | NA | NA |
| Iliacus | NA | 100.00 | NA | NA |
| Pectineus | 100.00 | 100.00 | 1.00 | NA |
| **TIBIA** | **Male** | **Female** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | 100.00 | 100.00 | 1.00 | NA |
| Popliteus | 100.00 | 100.00 | 1.00 | NA |
| Semimembranosus | 100.00 | 100.00 | 1.00 | NA |
| Tibialis posterior | 100.00 | 100.00 | 1.00 | NA |
| Tibialis anterior | 100.00 | 100.00 | 1.00 | NA |
| Flexor digitorum | NA | NA | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 86:** Post-Contact - comparison of mean MSM asymmetry scores by age for upper limb*

| CLAVICLE | Young Adult | Middle-Aged Adult | Old Adult | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|---|
| Costoclavicular ligament | NA | 100.00 | 33.00 | .317 | |
| Subclavius | NA | NA | 100.00 | NA | NA |
| Trapezoid ligament | NA | NA | NA | NA | NA |
| Conoid ligament | NA | 100.00 | NA | NA | NA |
| Deltoid | NA | 100.00 | NA | NA | NA |
| **SCAPULA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Trapezius | NA | 100.00 | NA | NA | NA |
| Pectoralis minor | NA | 100.00 | NA | NA | NA |
| **HUMERUS** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Supraspinatus | NA | NA | NA | NA | NA |
| Infraspinatus | NA | NA | NA | NA | NA |
| Teres minor | NA | NA | NA | NA | NA |
| Pectoralis major | NA | NA | NA | NA | NA |
| Latissimus dorsi | NA | NA | NA | NA | NA |
| Teres major | NA | NA | NA | NA | NA |
| Deltoid | NA | 50.00 | NA | NA | NA |
| Coracobrachialis | NA | 50.00 | NA | NA | NA |
| Common extensors | NA | NA | NA | NA | NA |
| Common flexors | NA | NA | NA | NA | NA |
| **ULNA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Brachialis | 100.00 | 100.00 | 100.00 | 1.00 | NA |
| Anconeus | NA | 100.00 | NA | NA | NA |
| Triceps | 100.00 | 100.00 | NA | NA | NA |
| **RADIUS** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Biceps | 100.00 | 100.00 | NA | 1.00 | NA |
| Pronator teres | NA | NA | 100.00 | NA | NA |
| Supinator | NA | NA | NA | NA | NA |
| Pronator quadratus | NA | NA | NA | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

**Table 87:** Post-Contact - comparison of mean MSM asymmetry scores by age for lower limb*

| INNOMINATE | Young Adult | Middle-Aged Adult | Old Adult | Kruskall-Wallis* | Spearman* |
|---|---|---|---|---|---|
| Gluteus maximus | NA | 100.00 | NA | NA | NA |
| Gluteus minimus | NA | 100.00 | 100.00 | 1.00 | NA |
| Gluteus medius | NA | 100.00 | 100.00 | 1.00 | NA |
| Tensor fascia latae | NA | 100.00 | 100.00 | 1.00 | NA |
| Adductor brevis | NA | NA | NA | NA | NA |
| Adductor longus | NA | NA | NA | NA | NA |
| Adductor magnus | NA | NA | 100.00 | NA | NA |
| Pectineus | NA | NA | NA | NA | NA |
| Gracilis | NA | 50.00 | NA | NA | NA |
| Iliacus | NA | 100.00 | 100.00 | 1.00 | NA |
| Obturator externus | NA | NA | 100.00 | NA | NA |
| Obturator internus | NA | NA | NA | NA | NA |
| Piriformis | NA | 100.00 | 100.00 | 1.00 | NA |
| Superior gemelli | NA | NA | NA | NA | NA |
| Inferior gemelli | NA | NA | NA | NA | NA |
| Quadratus femoris | NA | NA | 100.00 | NA | NA |
| **FEMUR** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Gluteus maximus | NA | 100.00 | NA | NA | NA |
| Gluteus medius | NA | 100.00 | NA | NA | NA |
| Gluteus minimus | NA | NA | NA | NA | NA |
| Adductor magnus | NA | 100.00 | 100.00 | 1.00 | NA |
| Vastus intermedius | NA | 66.66 | 100.00 | .317 | |
| Vastus medialis | NA | 100.00 | 100.00 | NA | NA |
| Vastus lateralis | NA | 50.00 | 100.00 | .317 | |
| Piriformis | NA | 66.66 | 100.00 | .317 | |
| Obturator externus | NA | NA | NA | NA | NA |
| Obturator internus | NA | NA | NA | NA | NA |
| Quadratus femoris | NA | NA | NA | NA | NA |
| Popliteus | NA | 100.00 | NA | NA | NA |
| Gastrocnemius | NA | 100.00 | 100.00 | 1.00 | NA |
| Iliacus | NA | 100.00 | NA | NA | NA |
| Pectineus | NA | 100.00 | NA | NA | NA |
| **TIBIA** | **Young Adult** | **Middle-Aged Adult** | **Old Adult** | **Kruskall-Wallis*** | **Spearman*** |
| Soleus | NA | 100.00 | 100.00 | 1.00 | NA |
| Popliteus | NA | 100.00 | 100.00 | 1.00 | NA |
| Semimembranosus | NA | 100.00 | 100.00 | 1.00 | NA |
| Tibialis posterior | NA | 100.00 | 100.00 | 1.00 | NA |
| Tibialis anterior | NA | 100.00 | 100.00 | 1.00 | NA |
| Flexor digitorum | NA | NA | NA | NA | NA |

*(>100 indicates left dominance) *significant p-values bolded (p≤.05)

# 8.0 MULTIVARIATE ANALYSIS: "SOCIAL STATUS", "BIOLOGICAL STATUS", AND GENDER

This chapter investigates the intersection of group and individual identity in regards to status and gendered social processes via multivariate statistical analyses for each time period. Multivariate analyses are an appropriate means to elucidate patterns of interaction between "social status" and "biological status" (Robb et al. 2001). Two levels of analysis were performed for each time period for the present study. First, a traditional mortuary analysis of binary sex and age categories in conjunction with burial treatment and grave goods was performed to elucidate basic patterns of social differentiation as reflected in burials following O'Shea (1984). A second, biosocial cluster analysis was then performed that added biological variables observed from the activity and pathology analyses, along with new demographic profiles of each cluster according to nuanced age/sex categories following theoretical frameworks by Sofaer (2006 a,b). The variables used for interpretation were highly dependent upon the results of initial PCA/MCA tests, which determined which variables had significant relationships to determine data groupings. For example, only MSMs were significant in PCA analysis for biological features of burials in the Early Woodland sample, whereas dental disease and trauma were significant for later periods. For each time period, the PCA/MCA results are presented, followed by cluster analysis results, demographic charts, and dendograms. This is followed by a discussion of background research on status and an interpretation of the results for social status, biological status, and specialized burials. Appendix C presents follow up ANOVA and chi-square tests of homogeneity regarding grave goods and burial attributes.

## 8.1 THE EARLY WOODLAND PERIOD

### 8.1.1 PCA/MCA Analysis

PCA/MCA analysis produced three principal components per data category: grave attributes, grave goods, and biological attributes. PCA/MCA results are listed in Tables 88-90, and components included in the cluster analyses for each data category are listed in Table 91.

**Table 88:** PCA Scores for grave attributes, Early Woodland sample

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Body Location | 0.023594417 | **0.810782961** | 0.083038965 |
| Mound Burial | 0.211127454 | **0.689909658** | 0.028173459 |
| Head Orientation | **0.579205459** | 0.238982637 | 0.292639489 |
| Leg Flexure | **0.758768655** | 0.086511479 | **0.6970964** |
| Body Position | **0.761715049** | 0.070064523 | **0.683158484** |
| Treatment of Body | **0.587777184** | 0.013431027 | 0.366930905 |

**Table 89:** PCA Scores for grave goods, Early Woodland sample

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Stone | **0.544783684** | 0.128496727 | 0.104066101 |
| Bone | **0.718076258** | 0.02389549 | 0.07172377 |
| Lithics | **0.594812122** | 0.058887014 | 0.125172013 |
| Ceramics | **0.473405041** | 0.115594602 | 0.064770829 |
| Copper | 0.752845623 | 0.057307939 | 0.047120938 |
| Shell | 0.007497332 | 0.000363546 | 0.028530352 |
| Total Items | **0.796112819** | 0.078127002 | 0.049127559 |
| Metal Beads | 0.174219005 | **0.66503592** | 0.121071914 |
| Shell Beads | **0.597876174** | 0.293491428 | 0.022726238 |
| Metal Bead Location | 0.085607882 | **0.577114501** | **0.726635136** |
| Shell Bead Location | **0.834791132** | 0.888014916 | 0.117996661 |

**Table 90:** PCA Scores for biological attributes, Early Woodland

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Left Deltoid – Clavicle | 0.01742811 | 0.005721907 | 0.622759384 |
| Right Deltoid – Clavicle | 0.053711225 | 0.013876056 | 0.353313229 |
| Left Pectoralis – Humerus | 0.202621123 | **0.367561636** | 0.110921635 |
| Left Latissimus Dorsi | 0.202621123 | **0.367561636** | 0.110921635 |
| Left Deltoid – Humerus | 0.264496826 | 0.204324625 | **0.077011665** |
| Right Deltoid – Humerus | 0.000618322 | 0.001135061 | **0.002457113** |
| Left Extensors | **0.418595482** | 0.171799631 | 0.054740114 |
| Left Flexors | 0.278103628 | 0.305621527 | 0.12347621 |
| Left Brachialis | 0.122036117 | **0.451386434** | 0.05372583 |
| Right Brachialis | 0.007798048 | 0.072628745 | 0.071055 |
| Left Anconeus | 0.180889775 | 0.41944434 | 0.039848932 |
| Right Anconeus | 0.001617864 | 0.00229091 | 0.12671626 |
| Left Triceps | 0.142187035 | **0.418236856** | 0.059708436 |
| Left Biceps | 0.004025098 | 0.012891675 | 0.009292093 |
| Left Pronator Teres | 0.007448373 | 0.014969007 | **0.468215284** |
| Left Gluteus Maximus – Femur | **0.441070936** | 0.000788269 | 0.030246669 |
| Right Gluteus Maximus – Femur | **0.439078879** | 0.001318397 | 0.01352388 |
| Left Adductor Magnus – Femur | **0.610616383** | 0.006673593 | 0.052758988 |
| Right Adductor Magnus – Femur | **0.633043057** | 0.023647021 | 0.02367886 |
| Left Vastus Intermedius | **0.535459189** | **0.321290888** | 0.017651266 |
| Right Vastus Intermedius | **0.496721789** | **0.339428511** | 0.031297709 |
| Left Vastus Medialis | **0.429074904** | **0.301036299** | 0.022838696 |
| Right Vastus Medialis | 0.396006599 | 0.315373149 | 0.038597672 |
| Left Vastus Lateralis | **0.535459189** | **0.321290888** | 0.017651266 |
| Right Vastus Lateralis | **0.495661287** | **0.339351328** | 0.031446171 |
| Left Gastrocnemius | 0.132083178 | 0.082655288 | 0.038524495 |
| Right Gastrocnemius | 0.00960368 | 0.006744715 | **0.687089398** |
| Left Pectineus | 0.180417033 | 0.045875784 | 0.197864458 |
| Right Pectineus | 0.333309089 | 0.000157312 | 0.00397659 |
| Left Soleus | 0.01174968 | 0.006494762 | 0.001080747 |
| Right Soleus | 0.022645592 | 0.00296892 | **0.572237803** |
| Sharp Force Trauma | 0.00012293 | 0.002204771 | 0.000340102 |
| Blunt Force Trauma | 0.092785756 | 0.037227966 | 0.005885546 |
| Cribra Orbitalia/Porotic Hyperostosis | 0.014098489 | 0.108696249 | 0.017702122 |
| Linear Enamel Hypoplasia | 0.057676151 | 0.046735842 | 0.001307062 |
| Upper Limb Osteoarthritis | 0.117049381 | 0.117902936 | 0.132641359 |
| Lower Limb Osteoarthritis | 0.106316829 | 0.013860828 | 0.06623235 |
| Vertebral Osteoarthritis | 0.002818441 | 0.005708023 | 0.009981139 |
| Antemortem Tooth Loss | 0.055591392 | 0.040714487 | 0.000043363 |
| Caries | 0.006296347 | 0.182538386 | 0.002281813 |
| Periodontitis | 0.043873573 | 0.053115013 | 0.000010669 |
| Dental Calculus | 0.005672907 | 0.065478709 | 0.009814557 |
| Dental Abscess | 0.000132027 | 0.000128508 | 0.003031393 |
| Non-specific Infection | 0.006349509 | 0.046559838 | 0.007717421 |

**Table 91:** Woodland PCA components for grave attributes, grave goods, and biological attributes

| PCA | Grave Attributes | Grave Goods | Biological Attributes |
|---|---|---|---|
| PCA1 | Head orientation, leg flexure, body position, treatment of body | Stone, bone, lithics, ceramics, total items, shell beads, shell bead location | Left extensors, left and right gluteus maximus, left and right adductor magnus, left and right vastus intermedius, left vastus medialis, left and right vastus lateralis |
| PCA2 | Body location, mound burial type | metal beads, metal bead location | Left pectoralis major, left latissimus dorsi, left flexors, left brachialis, left triceps, left and right vastus intermedialis, right vastus medialis, left and right vastus lateralis |
| PCA3 | Leg flexure, body position | Metal beads | Left and right deltoid (clavicle attachment), left pronator teres, right gastrocnemius, and right soleus |

### 8.1.2 Mortuary Cluster Analysis Results

The features of each of the four clusters that were generated are listed in Table 92. The demographic distribution for each cluster is presented in Figure 65, and the dendogram for cluster structure by burial is presented in Figure 66. In summary, Cluster 1 is representative of both adults of both sexes and subadults with extended burials and a moderate number of grave goods, whereas Cluster 2 represents a large number of undifferentiated adult and subadult primary and secondary multiple inhumations of south and southwest orientations with few grave good inclusions. Individuals in Cluster 3 were adults of both sexes and subadults in single inhumations with few grave goods. It is hypothesized that Clusters 1-3 represent lay people in this group. Cluster 4 includes adults of both sexes interred in wooden tombs in a north or northeast orientation, with a high number of grave goods; they are hypothesized to be a high status or ritual class.

**Table 92:** Early Woodland - traditional demographic-mortuary cluster analysis

| Cluster | Demography | Grave Attributes | Grave Goods |
|---|---|---|---|
| 1 | 1 Male, 3 Females, 4 Subadults, 18 Unknown Adults | Extended burials, 3 burials in wooden structures (2 subadults, 1 unknown) all others in mound fill, no orientation pattern (multiple N, NE, NW, SE burials) | Moderate Grave Goods: <15 Stone items, <14 lithics, <24 total Items.<br>Low numbers metal beads (<150) in wrist or pelvic area |
| 2 | 12 Males, 14 Females, 9 Subadults, 23 Unknown | Primary and secondary multiple inhumations, SE/SW orientation, 3 burials in wooden structures (1 subadult, 1 male, 1 unknown), burials in mound fill | Few grave goods: <5 total items; <3 stone items, <2 lithics. Very low numbers of metal beads in grave fill of 2 burials (<43) |
| 3 | 3 Males, 2 Females, 3 Subadults, 9 Unknown | 4 single Inhumations (3 subadults, 1 male), multiple primary inhumations, 1 burial in wooden structure (subadult), S/SW orientation | Few grave goods: <3 stone items, <3 total items.<br>Low numbers of metal and shell beads in neck area in subadult burials (<43 metal beads, 1 shell bead) |
| 4 | 1 Male, 1 Female, 1 Unknown | Single inhumations, N/NW orientation, wooden log tomb burials | High number of grave goods: <20 stone items, <9 bone items, <22 lithics, <5 ceramic items, <58 total items. Large counts of beads: <357 metal beads in neck area, <160 shell beads (pelvis or grave fill) |

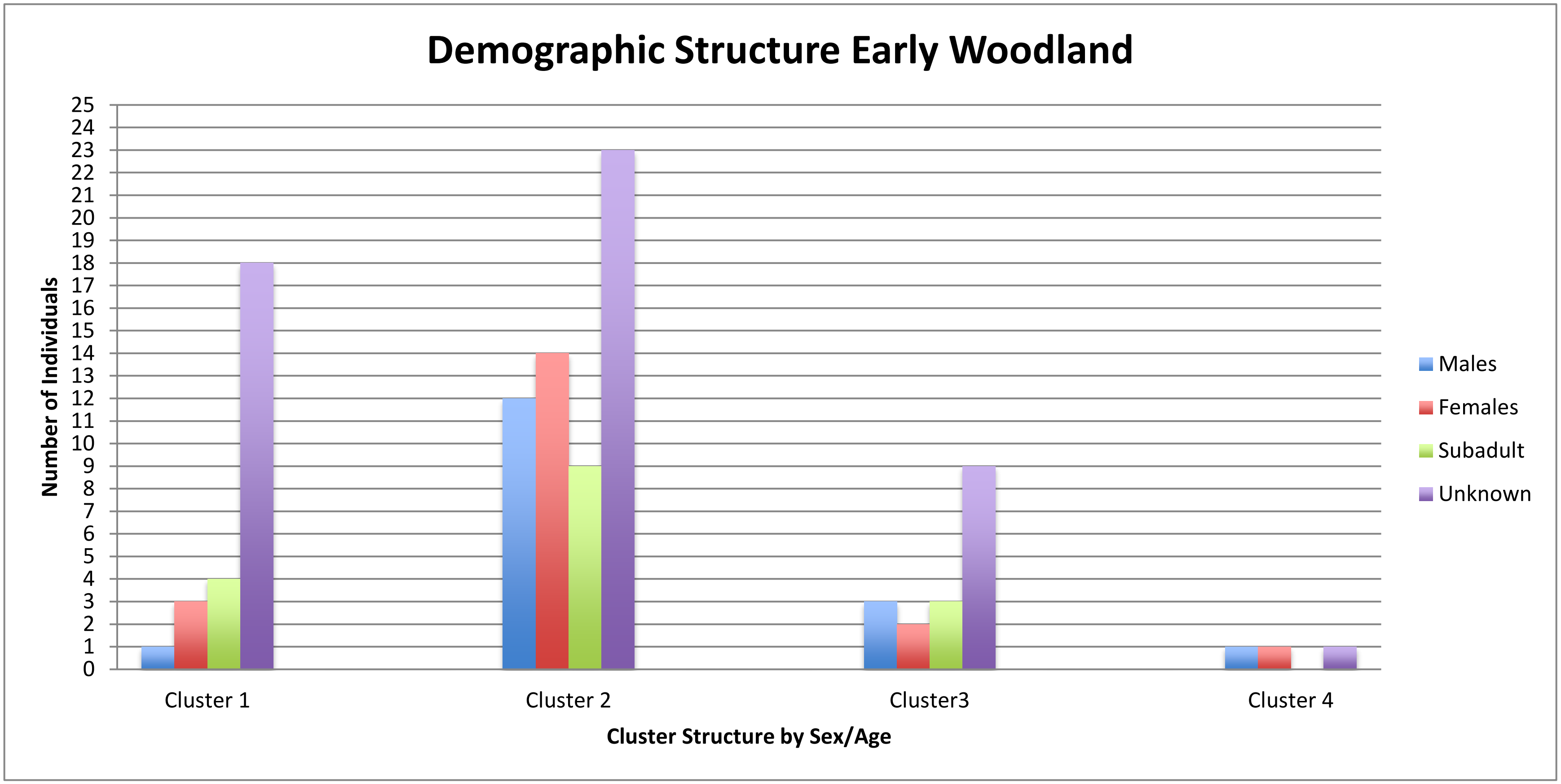



**Figure 65:** Early Woodland - traditional demographic-mortuary structure cluster analysis by age/sex

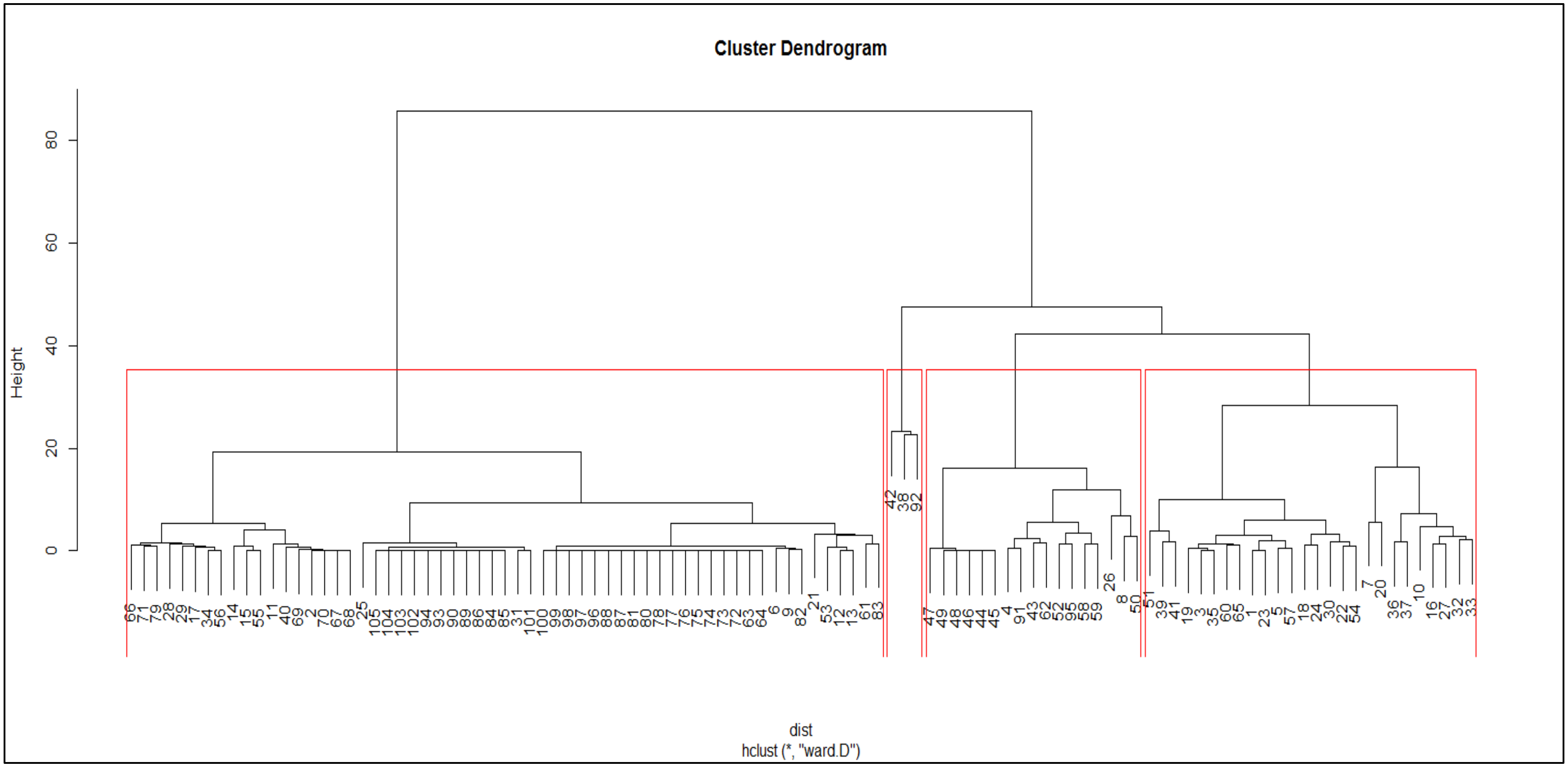



**Figure 66:** Cluster dendogram for Early Woodland mortuary cluster analysis
Left to right – Cluster 2, Cluster 4, Cluster 3, Cluster 1

### 8.1.3 Biosocial Cluster Analysis Results

Descriptions of each cluster by demography, grave attributes, grave goods, and biological features (activity) are listed in Table 93. The demographic structure of each cluster is illustrated in Figure 67, and the structure of each cluster by burial is illustrated in a dendogram in Figure 68. In this analysis, Cluster 1 represents adults and subadults ranging from early child to old adult, the majority of which are single inhumations with moderate grave good counts; these burials had low to moderate/high upper limb MSMs and moderate to high lower limb MSMs. Individuals in Cluster 2 consisted of neonates to young adults in primary and secondary single inhumations with low grave goods and moderate MSMs. There were a range of ages in Cluster 3 from adolescent to old adults of both sexes in secondary inhumations in the mound fill associated with low grave good counts and high MSMs, although this cluster was associated with missing MSM data values. Cluster 4 was comprised of young to old adults of both sexes in single inhumations with high grave good counts; these individuals had high and moderate-high MSM scores. Cluster 4 in this analysis includes all of the individuals from Cluster 4 in the traditional analysis, which is hypothesized to represent a high status or ritual class; it is important to note that MSMs for this group are high and comparable to the lay population.

**Table 93:** Early Woodland: biosocial cluster analysis demographic, mortuary, and biological features

| Cluster | Demography | Grave Attributes | Grave Goods | Biological Features |
|---|---|---|---|---|
| 1 | 1 Early Child, 2 Adolescents, 1 Youth Subadult, 2 Unknown Adult Males, 1 Male Youth, 1 Middle Aged Male, 1 Old Adult Male, 5 Adult Unknown Females, 2 Young Adult Females 17 Adults of Unknown Age/Sex | Majority single inhumations, 6 multiple burials (1 male youth, 1 middle aged male, 1 old adult male, 1 young adult female, 2 female unknowns), 4 burials in wooden structures (1 early child, 1 adolescent, 2 unknown males) | Moderate numbers of grave goods: <9 stone items, <14 lithics, <24 total items), high number of beads in pelvis or wrist location (~130-150 beads, 1 youth burial and 2 unknown adult burials) | Upper Limb MSMs: high-moderate deltoid and pronator teres, moderate pectoralis and latissimus, low extensors, brachialis, and triceps<br><br>Lower Limb: High gluteus maximus, moderate adductor and quadriceps, moderate soleus and gastrocnemius |
| 2 | 1 neonate, 2 early child, 1 late child, 2 Adolescents, 2 Youth Subadults, 1 Unknown Subadult, 5 Unknown Adult Males, 1 Young Adult Male, 7 Unknown Adult Females, 2 Female Youths, 1 Young Adult Female, 25 Adults of Unknown Age/Sex | Primary and secondary single inhumations, 2 in wood structures (1 early child, 1 unknown adult) | Low grave goods: <3 stone items, <3 lithics, <5 total items<br><br>Low to moderate bead count: <50 metal beads in grave fill, wrist, neck area (1 neonate, 1 unknown subadult, 1 adult unknown) | Upper Limb MSMs: High deltoid, moderate pectoralis and latissimus, low flexors, low brachialis, low pronator<br><br>Lower Limb MSMs: High gluteus maximus and adductors, moderate quadriceps, moderate soleus/gastrocnemius |
| 3 | 1 Adolescent, 1 Young Adult Male, 1 Unknown Adult Female, 1 Old Adult Female, 7 Adults Unknown Age/Sex | Multiple secondary inhumations in mound fill, S/SW orientation | Low grave goods: <3 stone items, <3 lithics, <4 total items<br><br>No beads | MSMs: Missing data, high gluteus maximums, adductors, and quadriceps |
| 4 | 1 Unknown Adult Male, 1 Young Adult Male, 1 Middle Aged Male, 1 Old Adult Male, 1 Unknown Adult Female, 1 Young Adult Female, 1 Unknown Adult | Multiple and single primary inhumations in mound fill, 3 in wooden structures (1 Old Adult Male, 1 Young Adult Female, 1 Adult Unknown) | Higher grave good count: <20 stone, <9 bone items, <22 lithics, <58 total items<br>Beads: high counts (160 shell beads and 357 metal beads with young adult female, 97 shell beads with old adult male) | Upper Limb MSMs: High pectoralis and latissimus, moderate-high flexors, moderate extensors, brachialis, and triceps, low pronator<br><br>Lower Limb MSMs: High gluteus, adductor, and quadriceps, moderate-high soleus/gastrocnemius |

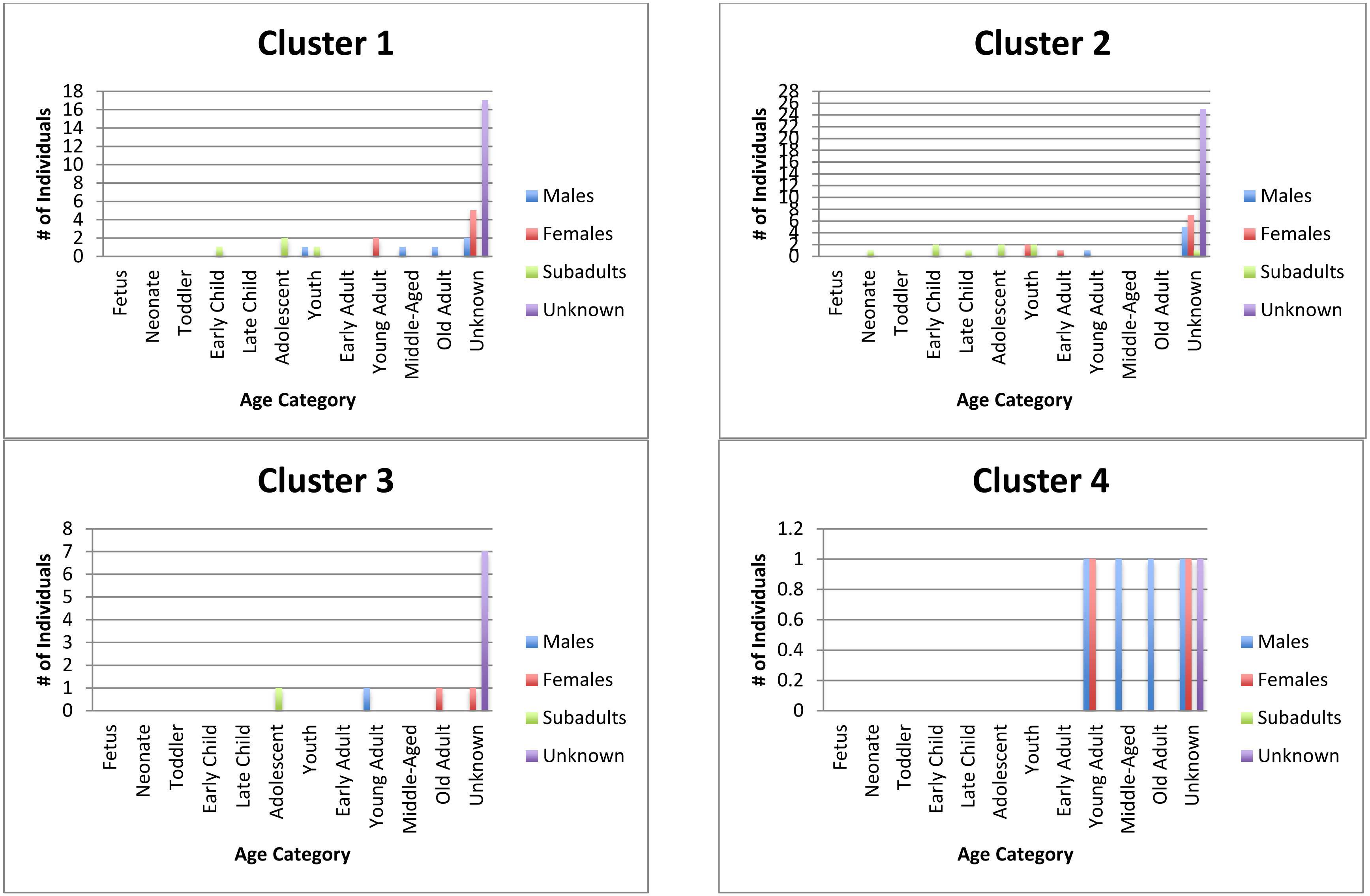



**Figure 67:** Early Woodland: biosocial demographic structure by cluster

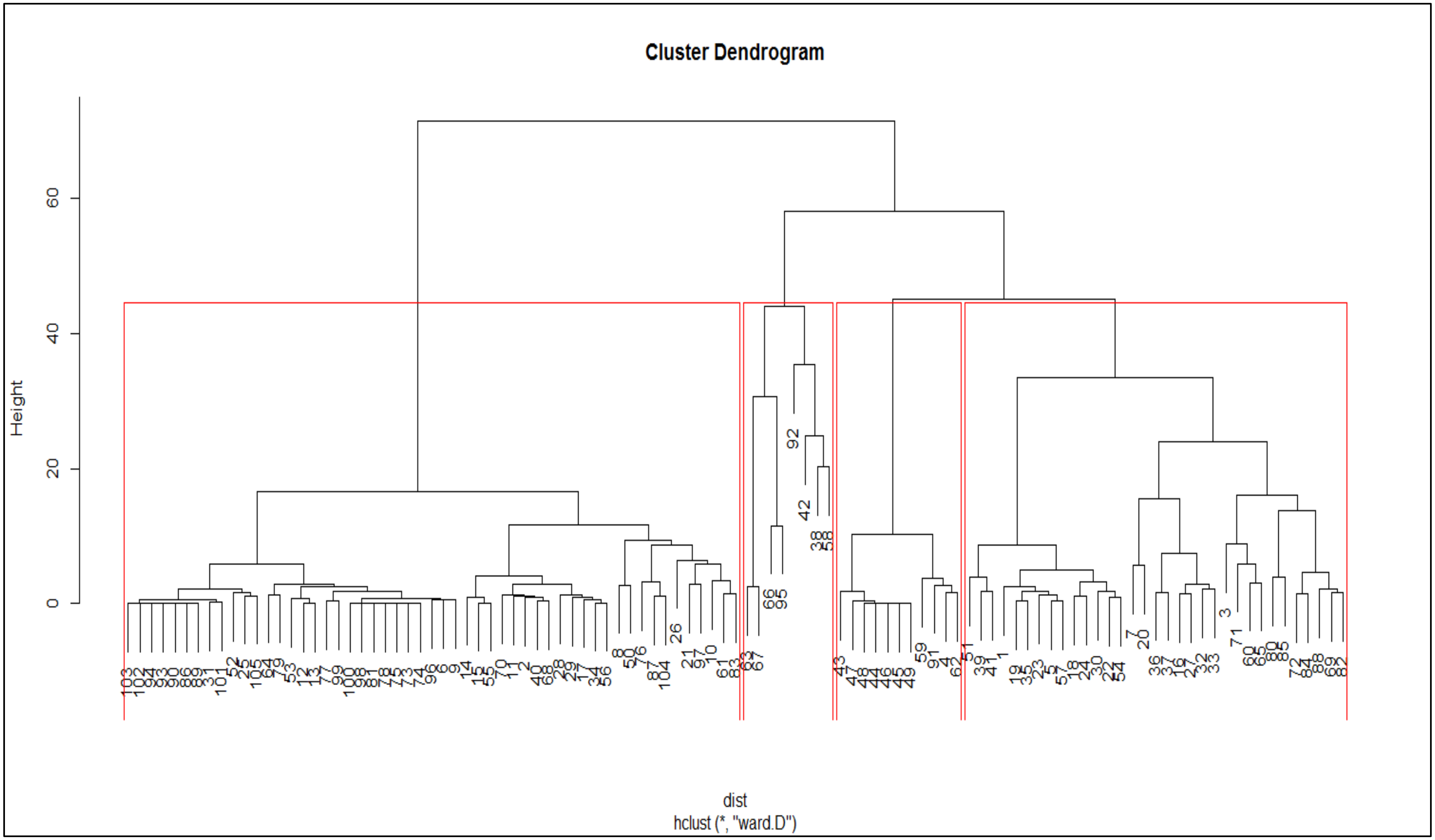



**Figure 68:** Dendogram of burials from biosocial cluster analysis for Early Woodland sample
Left to right – Cluster 2, Cluster 4, Cluster 3, Cluster 1

### 8.1.4 Early Woodland Burials: Social "Status" and Ritual

Little information is known about the subsistence and settlement strategy of the Adena-Hopewell people of the Early and Middle Woodland periods, though the nature of Adena mound burials provides some clues as to the organization of these societies (Milner 2004). Most of the burial mounds likely did not hold a large proportion of the local group. Both sexes are generally represented in Adena contexts but subadults are rarely recovered (Milner 2004). At Cresap Mound and McKees Rocks Mound, several burial types were discovered: single inhumations in log tombs, single inhumations in burial pits, secondary bundle burials, and cremations. These contexts are commonly found across the Adena complex. Grave goods inventoried included stone celts and groundstones, Adena points, Adena pottery, copper and slate gorgets, stone concretions, animal carvings, and copper and shell beads (Dragoo 1963).

One of the main features of Adena-Hopewell complex burials is the inclusion of fine items made from rare, non-local materials, such as obsidian, copper, shell, and chert (Milner 2004). According to Milner (2004:92) "the people who received special treatment upon their deaths must have held positions of great respect and influence in their lineages or communities." It is suggested that such burials represented local leaders who would have played a key role in organizing trade and contact with neighboring communities, as acquiring such prestige items would have required ties with trade routes (Milner 2004). Community leaders and members of these high status kin groups were most likely the persons who organized the constructions of mounds; these activities were part of the enhancement of the prestige of individuals or kin groups as mounds were marked alterations to the physical landscape (Milner 2004). Mounds and widely distributed artifact types and symbolism represented a shared *communitas* among mobile hunting and gathering groups occupying areas of the American Midwest into the Mid-Atlantic region. Construction would have been a labor-intensive activity requiring the collection of resources and people; elite kin groups would likely have had available resources to orchestrate mound building events and associated feasts (Milner 2004).

Milner (2004) emphasized that the most elaborate forms of Adena mortuary treatment were log tombs with larger grave good caches of non-local material, used by such higher ranking individuals from single families or extended kin groups. Burial in these structures served to reinforce prestige and lineage within local communities. Despite this apparent social ranking, Milner (2004) stressed the idea that based on other aspects of the burials, such as health and disease indicators, elites did not live differently than the rest of their community. Studies of activity markers on Hopewell remains echo this assertion, as individuals in elaborate ritualized burials did not have significantly different MSM patterning than the lay people (Rodriguez 2006).

In addition to social ranking, elaborate burials among the Adena suggest that elite identities were tied to ritual. Fragments of ceremonial costuming have been identified in Adena contexts such as wolf palates used in masks, cut maxillae and mandibles from animals attached to masks or other ritual costume, human trophy skulls, and reindeer headdresses made from deer antler or copper; and an elk antler headdress from Cresap Mound (Dragoo 1963; Milner 2004). Ritual dress and other items depicting animal effigy would have been "widely recognized symbols that underscored connections between different groups of people and their relations with the supernatural" (Milner 2004: 93).

The presence of a ritual or shamanic class has been suggested among later, Middle Woodland Hopewell burials (see below). Brown (2006) theorized that there was a shamanistic element to Hopewell ritual, and burial artifacts such zoomorphic and anthropomorphic effigy pipes and ceramic figurines, quartz and other mineral hemispheres, and animal effigy headdresses indicate ritually important individuals or shamans in Hopewell societies. Field et al. (2006) studied the distributions of ritually important "prestige" items in Ohio Hopewell burials, with both sexes represented in this social grouping. They concluded that women were both socially and ritually important in this region. Carr and Case (2006) argued that shamans likely played multiple roles in Middle Woodland societies ranging from elite leadership to ritual functions. Rodriguez (2006) demonstrated that there was no significant difference in MSM activity patterns between individuals of different ranking (shamanic elites vs. laypeople) among the Ohio Hopewell, thus high-status individuals with emergent ritual roles participated in everyday activities. These models can be applied to the Adena, as similar artifact classes have been discovered at multiple Adena sites, including Cresap Mound and McKees Rocks mound (stone hemispheres, shell and metal beads, copper gorgets, elk headdress, animal totems), in elite graves.

### 8.1.5 Social "Status" vs. "Biological" Status in the Early Woodland Sample

#### 8.1.5.1 "Social Status"

The traditional cluster analysis for the Early Woodland sample demonstrates a model of social status defined by sex and grave goods similar to that described above by Milner (2004) for the Adena-Hopewell complex. There was a wide range of burial types for this time period, as reflected in the cluster structure, and two salient groupings appear: elites vs. non-elites. Clusters 1-3, consisting of primary and secondary inhumations of males, females, and subadults with moderate (Cluster 1) to few grave items (Clusters 2 and 3) likely represent non-elite burial classes. Cluster 4 is representative of high social status based upon the fact that these individuals were buried in log tombs in either the subfloor or mound fill areas of the burial mounds, with large caches of grave goods consisting of artifact types, such as stone concretions and hemispheres, blades, and metal objects, similar to those of the "shamanic practitioner" class proposed by Carr and Case (2006) for the Hopewell.

Burial typology is one avenue through which status can be interpreted (O'Shea 1984). In the case of the Early Woodland sample, three main burial types were revealed through the cluster analysis: primary inhumations (single and multiple), secondary inhumations/cremations (single and multiple) and log tomb burials (single). Marked patterns were noted for Clusters 2 and 4. Cluster 2 was predominantly secondary inhumations and cremations. These burials were classified as secondary inhumations based on preservation, arrangement in the burial pit, and missing elements. A large proportion of these burials consisted only of a few fragments of long bones, teeth, and skull fragments; some of the bones had traces of red ochre. It has been demonstrated in mortuary studies that in cases of secondary burial, smaller elements such as the bones of the hands, feet, and patella are often lost during transport from the primary burial location to the secondary location. Secondary burial may also be delayed for ceremonial or ritualistic reasons, in which case the body is exposed and elements are lost due to taphonomic processes such as decay and animal interference (Bello and Andrews 2006). Dragoo (1963) described similar cases in which Adena skeletons were found to be directly painted with red ochre and other pigments, indicating that the body had been left to decay at the site or in another location before being buried. Excavation reports form Cresap Mound described most of the secondary inhumations as collections of long bones or fragments in a collected heap; Dragoo (1963) identified these as “bundle burials”. Several of these fragmentary burials (Burial 2 and remains in Feature 29) were described as “trophies”, as they were represented by disembodied skulls included in extended primary burials (Burial 1) or buried collectively in larger features (Feature 29). What is evident from the grave good distributions in these secondary burial contexts is that according to number and type, the grave good assemblages in Cluster 2 were similar to the single, primary inhumations in Cluster 3. Few significant differences in grave good distributions were found in ANOVA tests but young adult females from this time period had significantly higher numbers of metal and shell beads than early children, adolescents, and young adult males (See Appendix C, Table 244).

Based on grave good assemblages, clusters 1-3 represent the lay population or non-elites. A key feature of these clusters was the presence of subadults. According to Milner (2004) subadults are rare in Adena burial contexts, though this may be due to differential burial practices or poor preservation of subadult remains (Lewis 2007). The social role of Adena children is an important question in this bioarchaeological investigation of gendered social roles. While childhood is often treated by bioarchaeologists in terms of age stages and the timing of biological events, many societies divide their social identities in to “people” and “non-people” (Thompson et al. 2014). The incorporation of subadults into mortuary ritual is then a marker of personhood, though the social role of children at various stages of the life course may vary from culture to culture (Thompson et al. 2014). Children in the past have generally received varied types of mortuary treatment ranging from burial in specialized contexts to unritualized deposition (Lewis 2007; Thompson et al. 2014). Among the Adena, as evidenced by the presence of subadults in Clusters 1-3, at least some children received similar body treatment and grave goods as adults in the Cresap and McKees Rocks mounds; they appear in both primary and secondary burial contexts and with the same types of grave goods found in adult burials such as lithics, ceramic fragments, stone items, and metal/shell beads.

An elite class of burials is evident in Cluster 4. While only consisting of three adults, there were several commonalities evident following cluster analysis. This group consisted of one male, one female, and one adult of unknown sex. These burials were in subfloor log burial tombs and the grave good assemblages were large and highly varied, consisting of multiple items of personal adornment, utilitarian items such as lithics and groundstones, and items of rare, non-local materials such as hematite, copper and marine shell. FC#1250, Burial 26 from the McKees Rocks site, was an adult female buried in the extended position in a wooden tomb with 1 tomahawk, 4 bone pointers, 2 bone flakes, a slate gorget, a stone scraper, a fashioned bear tooth from copper, 2 flints, 160 shell beads, and 357 bone beads (Swauger 1940). The adult male, Burial 54 (FC#3238) from the Cresap Mound Site, was buried in a subfloor log tomb with a large cache of grave goods: 7 stemmed blades, 2 stemmed projectiles, 1 large blade, 11 stone scrapers, 1 pole celt, 1 deer scapula awl, 1 bone awl, 5 pieces of worked deer bone, 1 piece of obsidian, 3 fragments of Fayette thick pottery, a hematite concretion (Figure 69), 7 pieces/hemispheres of worked hematite (Figure 70), 6 marine shells, 2 sandstone tablets, 1 graphite concretion, 1 clump of red ochre, 1 turtle shell cup or rattle, 43 small shell beads, 44 marginella shell beads, and 10 large conch shell beads (Figure 71). Another elite burial at the Cresap site consisted of an unknown adult (FC#3281, Burial 45) in a log tomb with 2 stemmed blades, 6 stemmed points, 2 stone scrapers, 1 drill, 1 piece of flint, 2 pieces of irregularly shaped sandstone, 1 sandstone tablet, 4 pieces of worked hematite hemispheres (Figure 72), 1 slate gorget (Figure 73), and 128 copper beads (Figure 74). These prestige items, such as large caches of shell and metal beads, obsidian, and hematite do not appear in large quantities in other clusters. Coupled with the fact that these were subfloor log tombs, this leads to the conclusion that this cluster represents an elite class. Following Milner (2004), this cluster represents those emergent leaders among mobile communities who likely organized mound building events, mortuary rituals, and feasting events associated with both practices.

The grave good assemblages in Cluster 4 are similar to the artifact assemblages for shaman burials among the Hopewell as described by Carr and Case (2006). The role of shamanic practitioners in societies is varied, as they have ritualistic, political, and economic roles (Carr and Case 2006). These functions range from acting as healers, diviners, political leaders, war leaders, trade mediators, keepers of cultural mythology, and communicators between worlds. Carr and Case (2006) described these practitioners as emergent leaders and elites among the Ohio Hopewell, identified from grave good assemblages. Of the artifacts listed for these practitioners, commonalities exist between these and those found in Early Woodland Cluster 4, including copper effigies of animal teeth, hemispheres of non-local stones such as quartz and hematite, reel shaped gorgets, turtle shell cups and rattles, stone concretions, bone awls, worked animal bone, and pieces of obsidian. Carved animal effigies were found in other burials; Burial 25 contained a carving of a turtle (Figure 75). It is suggested that these items make up a form of ritual dress and toolkit (Case and Carr 2006). It was hypothesized that ritual practitioners represented their own gendered social class among the Hopewell (Field et al. 2006; Rodriguez 2006). Membership to this specialized elite class was not dependent upon sex, as both males and females were well represented among the Ohio Hopewell. Cluster 4 for the Early Woodland represents a comparable high status class, with ritualized connotations in the form of animal effigy and non-local prestige burial items reserved for this group.

Gendered identity, role, and social status are not easily inferred from the traditional cluster analysis results. Demographic profiles for each cluster show the presence of both males and females, so from these results it is clear that “social status” was not dependent upon biological sex as even in the elite group among the Early Woodland Adena, as both sexes are represented fairly equally.  Subadults are present in all clusters except for cluster 4, indicating that ritual importance and social status were likely achieved after adulthood.


**Figure 69:** Hematite concretion, burial 54, Cresap Mound


**Figure 70:** Worked hematite hemisphere, burial 54, Cresap Mound

**Figure 71:** Conch beads, burial 54, Cresap Mound

**Figure 72:** Hematite concretions, burial 54, Cresap Mound


**Figure 73:** Slate gorget, burial 45, Cresap Mound


**Figure 74:** Metal beads, burial 45, Cresap Mound


**Figure 75:** Turtle effigy carving, burial 25, Cresap Mound

**8.1.5.2 "Biological" Status**

A biosocial view of gendered social processes may emerge when biological attributes of human burials are integrated into cluster analyses. As the body is a site of gendered cultural performance, skeletal markers such as MSMs, dental disease, and rates of osteoarthritis can be the result of habitual activity and the interaction between social role and biology (Sofaer 2006). In the case of the Early Woodland period, similar groupings emerged from cluster analysis that integrated biological variables as in the traditional burial analysis. Groupings were revealed based upon similar burial types, grave good caches, and MSM patterning; no pathological conditions were significant in PCA/MCA analysis and were therefore not a factor in clustering. Clusters 1-3 included only burials from the layperson classes as revealed in the traditional cluster analysis. These clusters had similar MSM patterning: moderate-high use of the muscles of the shoulder and low robusticity of forearm flexors/extensors, with moderate to high robusticity of the muscles of the lower limb associated with thigh extension and adduction and leg flexion/extension. Cluster 4 in biosocial analysis included the three elite burials from Cluster 4 in the traditional analysis. The MSM patterning for Cluster 4 was similar to that of Clusters 1-3, with higher robusticity in the muscles of forearm flexion/extension.

The age/sex structure of each cluster was varied. Subadults as young as neonates and early children were included in Clusters 1 and 2, whereas adolescents and adults represented Cluster 3. Cluster 4 consisted only of adults ranging from young to old. Males and females were represented in all the clusters. The differences in MSM patterning may be related to these profiles. Higher MSM robusticity is often correlated with age (Stefanovic and

Porcic 2013). From activity analysis results in Chapter 7, it was revealed that males had generally higher robusticity scores for flexion/extension muscles of the elbow and forearm. These attachments had higher robusticity scores in Cluster 4 in the biosocial analysis, and there were more adult males of middle age and old age in this group than in Clusters 1-3. What is also demonstrated by these results is that the elite or ritualized class did not have markedly different MSM patterning than that of the laypeople, as Cluster 4 in this analysis included members of the lay community and there were few differences in MSM robusticity between the clusters. This concurs with the results of Rodriguez (2006); where the distribution of MSM robusticity was not significantly different among the Ohio Hopewell between female elite class burials and those of laypeople. These results, and those from this analysis, suggest that some ritual practitioners or emergent leaders did not have a significantly different productive role than that of the laypeople, and they likely participated in the same types of subsistence related activities such as hunting, small-crop cultivation, and food preparation (Rodriguez 2006).

Gendered identity thus does not appear to be tied to division of labor when MSM patterning and burial attributes are taken into consideration together. It is also important to note that biological age was not linked to social status, as both old and young adults are represented in elite and lay burials, as are both biological sexes. Following the model by Milner (2004) for Early/Middle Woodland social organization and these cluster analyses, it is likely that status was correlated to the ability of an individual to organize trade and mound building, with ritual connections to the animal-totemic world (Case and Carr 2006), and that status and gendered identity were not inexorably tied to biological sex, biological age, or productive role among the Early Woodland Adena.

### 8.1.6 Early Woodland Sample: Specialized Contexts

#### 8.1.6.1 Early Woodland Sample: Specialized Contexts

Several burials in the Cresap Mound group were labeled as “human trophies” by Dragoo (1963). Six skulls were found in Feature 29, a clay lined basin (5.2x3x.05 ft.); three of these skulls (FC#3219, FC#3218, FC#3217) were clustered at the southwestern end of the basin, two skulls were at the northeast end (FC#3226, FC#3227), and one skull was along the SE side of the basin (FC#3225). The skulls were determined to be male at the time of excavation, though the current condition of the remains was too poor to allow for sex estimation. Fragments of vertebrae and long bones were discovered in the center of the feature (FC#3239-3245). Reports from the excavation state these fragments and one of the skulls in the pit likely belonged to this individual who was decapitated and buried in the center of the feature (Dragoo 1963). The remains in this feature were badly crushed and highly fragmentary, though this damage was postmortem. Burial #2 (FC#3208) consisted of a male skull that was badly damaged, and placed between the legs of Burial #1, an adult female (FC#3207). Analyses of these burials did not reveal any hallmarks of other burials labeled as trophy skulls by Seeman (1988, 2007) or Chacon and Dye (2007). No cutmarks or alterations such as red ochre paint, polishing, or pigmentation were visible.

The presence of human trophy skulls in Hopewell contexts has been debated. Seeman (2007) emphasized that while some researchers (Milner 1995, 1999; Carr 2006) demonstrated that very few cases of violent injury such as embedded projectiles or blunt trauma to the skull are found in Hopewell contexts, some Hopewell burials across the American Midwest and Southeast contained modified human remains that were indicative of trophy taking. These indicators include drilling, polishing, cutting, and painting of skulls and mandibles (Seeman 1988, 2007). It was argued that these represented trophies similar to that of predator jaws and skulls as they were given similar treatment and context in Hopewell burials (Seeman 2007). Alternative explanations for the presence of modified remains in Hopewell contexts have stressed that ancestor veneration rather than trophy taking was the purpose of modified human remains in burials as both sexes are represented and there is little evidence for warfare (Johnson 2002). This hypothesis fits with other research that emphasizes strong kinship and ritual ties to status among the Hopewell (Carr and Case 2006, Field et al. 2006).

Based upon the current analysis of cutmarks and injury timing, it is concluded that the burials labeled as trophies from the Cresap Mound site are not likely to be the result of warfare-related trophy taking, as there was no evidence of modification: no cutmarks or perimortem damage. The ritualized connection of the Adena burial cult and the similarity between high status burials and those of the later Ohio Hopewell point to secondary burial practices or ancestor veneration. Bundle burials and secondary burials are common in Adena contexts (Dragoo 1963; Milner 2004). The skulls in Feature 29 and that of Burial #2 from Cresap are representative of secondary burials that may have had kinship or ritual associations between the individuals in these contexts.

#### 8.1.6.2 The McKees Rocks "Warrior" Burial

The McKees Rocks mound site was excavated in the 1890's and several published sources have compiled original notes (Mayer-Oaks 1955; Swauger 1940). Swauger (1940) stated that Burial 26 (FC#1250) was the grave of a male warrior over 6ft tall; the burial contained 1 tomahawk, 4 bone pointers, 2 bone flakers, a slate amulet, a scraper, a copper bear canine effigy, 2 flints, 160 shell beads, and 357 bone beads. The current study assessed the skeleton to be that of a young adult female with a stature estimate of 162.81cm (5ft, 4 inches). Anthropological and archaeological literature has emphasized the presence of female warriors in human prehistory as actors of human agency (Davis-Kimball 1998; Hanks 2008; Rubinson 2008). Scholarship regarding the fluidity of gender identity among Native American groups has also emphasized the presence of third gender warriors among the Navajo and Plains groups, and cross-gender "berdaches" – women or men who took part in the identity and productive role of the opposite sex. Women held positions of leadership such as chief or "queen" among groups in the American Northeast such as the Narragansett, or as warriors who accompanied men into battle and in warfare rituals among groups in the Plains (Roscoe 1998).

Warriorhood itself is a social process connected with social memory and symbolic contexts rather than merely a status within ranked societies, in which mortuary contexts are embodied with the meaning of warfare as a social practice (Hanks 2010). In conventional models, warriorhood is presented as a process of emergence into high status or elite ranking within chiefdoms, whereas current anthropological theory places an emphasis on individual agency and how this operates within larger institutions of social ranking and power (Hanks 2008). Following Treherne (1995), the mortuary context is one element in which warriorhood is constituted, as the mortuary treatment of the dead warrior is imbued with social meaning, with masculinity and visual reinforcement of this identity are constituted (Hanks 2010). Archaeologists have conventionally interpreted placement of weaponry or iconography in burials as a sign of the "warrior toolkit", but these items may often serve a symbolic rather than a functional meaning (Härke 1997). Härke (1997) suggested that weaponry was an important symbolic affirmation of existing power structures and social agency rather than a direct sign of a warrior burial. Forty-eight percent of the male adult Anglo-Saxon burials from his study contained weaponry; Härke (1997) concluded that weapons were not associated with high status or elite warrior connotations. Age categories such as puberty and old age are also of importance in the iteration of identity through material culture and bodily modifications, so bioarchaeological analysis is crucial to the interpretation of warrior identities (Hanks 2010).

Among the Ohio Hopewell and the Adena, weaponry such as axes and celts were common grave goods and receive considerable ritual attention (Seeman 2007). These items appeared in the graves of adults across the lifespan and biological sex (Carr and Case 2006, Field et al. 2006; Milner 2004). War paraphernalia, including weapons, is part of the grave good "toolkit" associated with shamanistic ritual burials among the Hopewell (Carr and Case 2006). Taken together, the cache in Burial 26 is representative of a large portion of the shamanistic toolkit as described above (Carr and Case 2006). The role of shaman in many societies has association with symbolic warfare with unseen, supernatural forces. Weaponry such as celts, stemmed points, and knives thus may have played a symbolic role in the burials of shamanistic practitioners of the Hopewell Adena complex as part of the identity and social agency of these individuals as spiritual interventionists (Carr and Case 2006). In the case of Burial 26, a shamanic role is suggested rather than that of an individual participating in physical warfare, despite evidence from North America that women participated in violent conflict (Hollimon 2001a). This young female did not exhibit signs of physical injury and was buried with other items aside from weaponry that have shamanic symbolism. It is likely that the role of this individual, as a shamanic practitioner, was seen as important within the existing power structure of the Adena. This is further evidence that power, agency, and status were not inexorably tied to age and biological sex and these ritual practitioners can be interpreted as their own gendered class.

## 8.2 THE EARLY MONONGAHELA SAMPLE

### 8.2.1 PCA/MCA Analysis

PCA/MCA results are presented in Tables 94-97, with a list of features for each category in Table 98.

**Table 94:** Early Monongahela grave attributes PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Depth | 0.007055527 | **0.577341962** | 0.090500633 |
| Width | 0.007055527 | **0.489049904** | 0.009361077 |
| Length | 0.007055527 | **0.543387542** | 0.00009469 |
| Body Location | **0.319145111** | 0.002538214 | 0.022209125 |
| Head Orientation | **0.858379939** | 0.639410403 | 0.177695292 |
| Leg Flexure | **0.867485681** | 0.403356217 | 0.218689788 |
| Body Position | **0.888016185** | 0.412680141 | **0.854963956** |
| Treatment of Body | **0.419743481** | 0.024074478 | **0.853579083** |

**Table 95:** Early Monongahela grave good PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Stone | 0.112224235 | 0.026542232 | 0.008139036 |
| Bone | **0.629281205** | 0.04203878 | 0.005213527 |
| Lithics | 0.010379638 | 0.024408003 | 0.0607114 |
| Ceramics | **0.811866193** | 0.020759807 | 0.000453464 |
| Shell | 0.140940552 | 0.056445117 | 0.000785369 |
| Total Items | **0.926270935** | 0.05863414 | 0.000030216 |
| Shell Beads | 0.00640861 | **0.456859625** | 0.232751602 |
| Bone Beads | 0.038282958 | **0.468658789** | 0.238679746 |
| Shell Bead Location | 0.013578928 | **0.73961778** | 0.194174696 |
| Bone Bead Location | 0.345125829 | **0.544811088** | **0.502088636** |

**Table 96:** Early Monongahela biological attributes (MSMs) PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Left Deltoid - Clavicle | **0.471692843** | 0.011559268 | 0.024875515 |
| Right Deltoid – Clavicle | **0.404939802** | 0.009729207 | 0.027964625 |
| Left Trapezius | 0.211081412 | 0.060033684 | 0.080065006 |
| Right Trapezius | 0.160414554 | 0.107110456 | 0.135928898 |
| Left Pectoralis Major - Scapula | **0.523205036** | 0.029826053 | 0.058209127 |
| Right Pectoralis Major – Scapula | **0.390581978** | 0.074782161 | 0.041556516 |
| Left Pectoralis – Humerus | **0.307453112** | 0.000363095 | 0.000231021 |
| Right  Pectoralis – Humerus | 0.265072603 | 0.017085474 | 0.015058831 |
| Left Latissimus Dorsi | 0.258560002 | 0.127955946 | **0.204489376** |
| Right Latissimus Dorsi | 0.212387383 | 0.128838444 | **0.115387406** |
| Left Deltoid – Humerus | 0.230035475 | 0.015713432 | 0.074700861 |
| Right Deltoid – Humerus | **0.323556769** | 0.102167054 | 0.182629337 |
| Left Extensors | **0.138858336** | **0.322837429** | 0.077371605 |
| Right Extensors | **0.125050705** | **0.388563062** | 0.068583276 |
| Left Flexors | 0.382378554 | 0.181272124 | 0.021830834 |
| Right Flexors | 0.038468838 | 0.190897977 | **0.295318129** |
| Left Brachialis | 0.076711966 | 0.032383216 | 0.006277051 |
| Right Brachialis | 0.123480009 | 0.317272454 | 0.055894419 |
| Left Anconeus | **0.397349825** | 0.107743484 | 0.004160388 |
| Right Anconeus | **0.360540134** | 0.061923799 | 0.002486559 |
| Left Triceps | **0.391085853** | 0.014884136 | 0.000135736 |
| Right Triceps | 0.075271984 | 0.009852402 | **0.352889547** |
| Left Biceps | 0.111053142 | **0.450808715** | **0.10488585** |
| Right Biceps | 0.219196258 | **0.367334781** | 0.015699265 |
| Left Pronator Teres | **0.537024308** | 0.000316976 | **0.166108995** |
| Right Pronator Teres | 0.236543676 | 0.007393047 | **0.168346773** |
| Left Adductor Magnus – Innominate | **0.486195363** | 0.000880278 | 0.285841585 |
| Right Adductor Magnus – Innominate | **0.485968322** | 0.032124047 | 0.221434076 |
| Left Gluteus Maximus – Femur | **0.534819849** | 0.022661485 | 0.034847756 |
| Right Gluteus Maximus – Femur | **0.598605435** | 0.016942471 | 0.010247551 |
| Left Adductor Magnus – Femur | **0.543313388** | 0.179786728 | **0.001163667** |
| Right Adductor Magnus – Femur | 0.571368519 | 0.078809226 | **0.000760339** |
| Left Vastus Intermedius | **0.08575051** | 0.089563803 | 0.019601926 |
| Right Vastus Intermedius | **0.215012324** | **0.251510309** | 0.021926077 |
| Left Vastus Medialis | 0.30591844 | 0.024004019 | 0.010722015 |
| Right Vastus Medialis | 0.236003251 | 0.120175127 | **0.119915839** |
| Left Vastus Lateralis | 0.577587905 | 0.034626978 | 0.000560547 |
| Right Vastus Lateralis | 0.570071526 | 0.025766186 | 0.000620053 |
| Left Gastrocnemius | **0.786743449** | 0.002793415 | 0.00001556 |
| Right Gastrocnemius | **0.568531546** | 0.011262091 | 0.01470540 |
| Left Iliacus | **0.337284667** | 0.051639524 | 0.011789598 |
| Right Iliacus | 0.695313928 | 0.022318814 | 0.005129002 |
| Left Pectineus | **0.493998533** | 0.050252669 | **0.15238022** |
| Right Pectineus | **0.541680518** | 0.015930346 | **0.147790255** |
| Left Soleus | 0.04316674 | 0.0985916 | **0.33077979** |
| Right Soleus | 0.136834108 | 0.125406163 | **0.151833183** |

**Table 97:** Early Monongahela biological attributes (Pathology) PCA scores

| Variable | PCA1 | PCA2 | PC3 |
|---|---|---|---|
| Blunt Force Trauma | 0.012923828 | 0.084032667 | 0.010931637 |
| Cribra Orbitalia/Porotic Hyperostosis | 0.000574636 | 0.001004625 | 0.00242401 |
| Linear Enamel Hypoplasia | 0.076230871 | 0.035683733 | 0.14881451 |
| Upper Limb Osteoarthritis | **0.324267653** | 0.158886994 | 0.023728121 |
| Lower Limb Osteoarthritis | 0.196405034 | **0.260469481** | 0.013925653 |
| Vertebral Osteoarthritis | 0.262516607 | 0.086411607 | 0.010818954 |
| Antemortem Tooth Loss | 0.149063672 | 0.243186403 | **0.121624636** |
| Caries | 0.012350084 | 0.026831396 | 0.003851903 |
| Periodontitis | 0.039607564 | 0.188779736 | **0.1799885** |
| Dental Calculus | 0.027466419 | 0.197133279 | **0.112885863** |
| Dental Abscess | 0.195144699 | 0.011414436 | 0.002130012 |
| Non-specific Infection | 0.030623642 | 0.048729698 | 0.055459763 |

**Table 98:** Early Monongahela PCA components for grave attributes, grave goods, and biological attributes

| PCA | Grave Attributes | Grave Goods | Biological Attributes |
|---|---|---|---|
| PCA1 | Body location, head orientation, leg flexure, body position, treatment of body | Bone, ceramics, total items | Left/right deltoid (clavicle), left/right pectoralis major (scapula), left pectoralis major (humerus), left/right flexors, left/right anconeus, left pronator teres, left triceps, left/right adductor magnus (innominate), left/right gluteus maximus, left adductor magnus (femur), left/right vastus lateralis, left/right gastrocnemius, right iliacus, left/right pectineus, upper limb osteoarthritis |
| PCA2 | Grave depth, width, and length | Shell beads, bone beads, shell bead location, bone bead location | Left/right extensors, left/right biceps, right vastus intermedius, lower limb osteoarthritis |
| PCA3 | Body position, treatment of body | Bone bead location | Left/right latissimus dorsi, right flexors, right triceps, left biceps, left/right pronator teres, left/right adductor magnus (innominate), right vastus medialis, left/right pectineus, left/right soleus, AMTL, periodontitis, calculus |

### 8.2.2 Mortuary Cluster Analysis

Full results and cluster descriptions are listed in Table 99. Demographic profiles and dendograms are pictured in Figures 76-77. Cluster 1 contained both subadults and adults buried in the flexed position with few grave inclusions (<5 bone, stone, ceramic, lithic, and beads). The general pattern for Cluster 2 is similar, but these graves did not contain beads. Cluster 3 included males, females, and subadults with no grave goods and unknown burial contexts. House floor burials of subadults and one adult male comprised Cluster 4; these burials contained more grave goods (>10 items) and beads (>25) than other clusters.

**Table 99:** Early Monongahela - traditional demographic-mortuary cluster analysis

| Cluster | Demography | Grave Attributes | Grave Goods |
|---|---|---|---|
| 1 | 5 Males, 8 Females, 8 Subadults, 2 Unknown Adults | Village burials, single primary inhumations, E/NE orientation.<br>Adults = left sided flexed burials (2 right sided)<br>Subadults = extended | Low to High grave good counts: 1-64 total items.<br>1-39 bone items, 1-10 ceramic items,<br>Beads: <10 shell or bone beads in head, neck, and torso regions |
| 2 | 1 Male, 1 Female, 6 Subadults, 1 Unknown Adult | Village burials, single primary inhumations, East orientation.<br>Adults = left sided flexed burials<br>Subadults = extended (1 in household) | Low to Moderate grave good counts: 1-17 bone items, 1-22 ceramic items, 1-42 total items<br>No beads |
| 3 | 2 Males, 2 Females, 4 Subadults, 6 Unknown Adults | Village burials, single inhumations, unknown orientation.<br>Adults = in village<br>Subadults = in household, | Low grave good counts: 1 bone item, 1-7 ceramic items, 1-9 total items<br>No beads |
| 4 | 1 Male, 3 Subadults | Village burials, East orientation.<br>Adult: village, tightly flexed, left side<br>Subadults: in household, extended or left sided, flexed burials | Male – high grave good count: 34 bone items, 118 ceramic fragments, 168 total items, 2 bone beads in head region<br>Subadults – 1 bone item, 1 ceramic item, moderate bead count (~22 bone beads or shell beads in head region) |

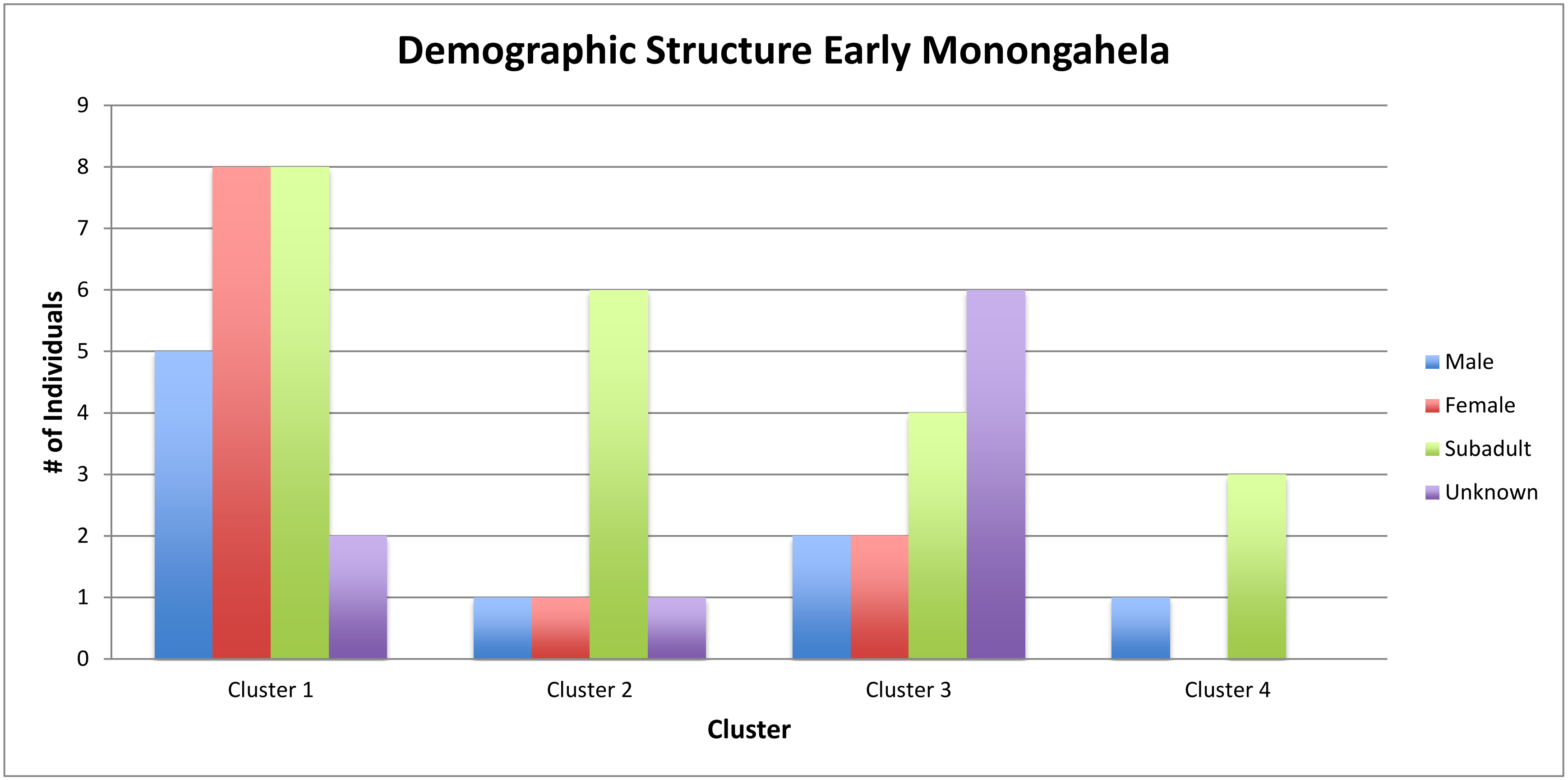



**Figure 76:** Early Monongahela - traditional demographic-mortuary structure cluster analysis by age/sex

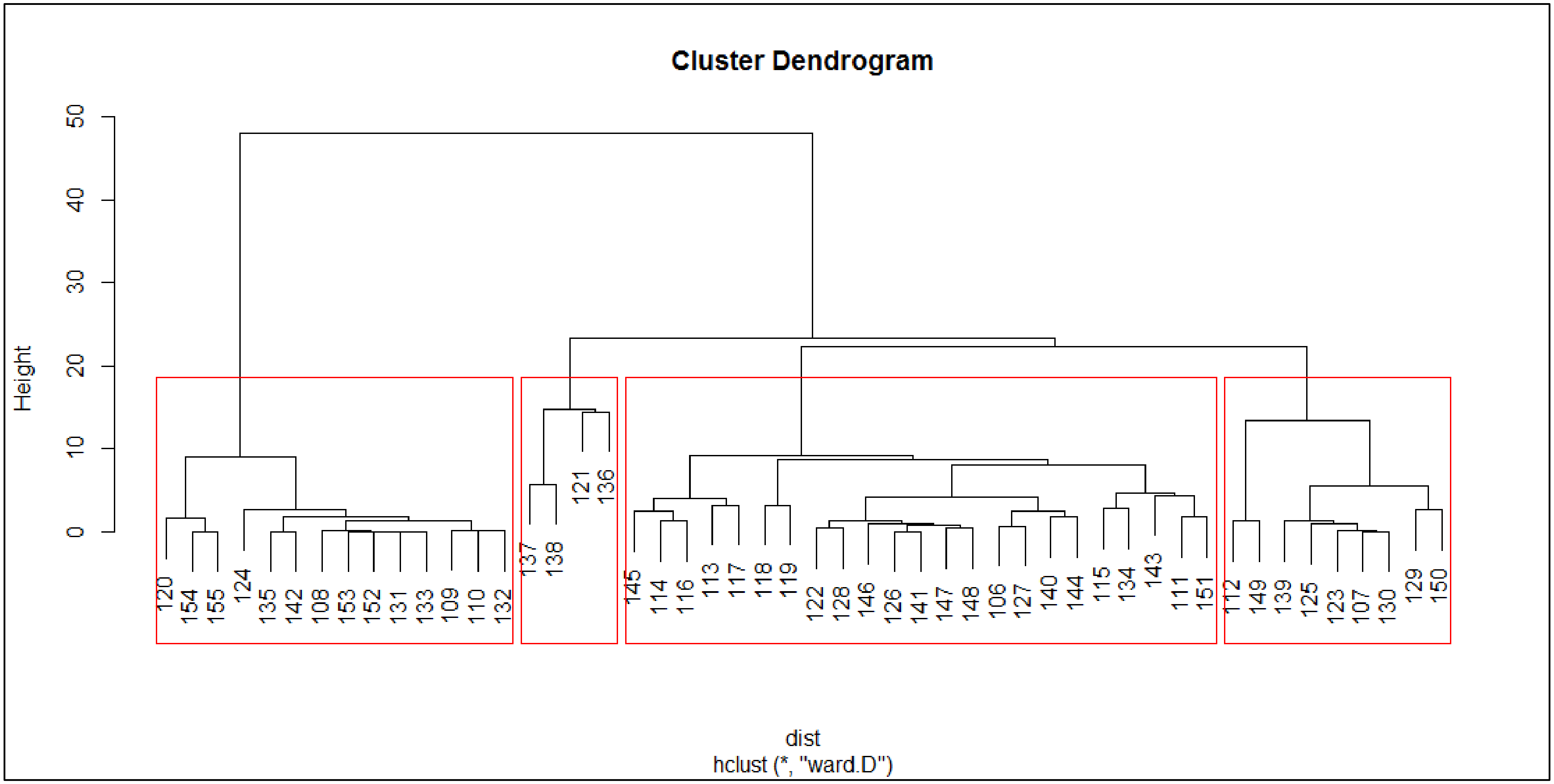



**Figure 77:** Cluster dendogram for Early Monongahela mortuary cluster analysis
Left to right – Cluster 3, Cluster 4, Cluster 1, Cluster 2

### 8.2.3 Biosocial Cluster Analysis Results

Descriptions of each cluster by demography, grave attributes, grave goods, and biological features (activity/pathology) are listed in Table 100. The demographic structure of each cluster is illustrated in Figure 78, and the structure of each cluster by burial is illustrated in a dendogram in Figure 79. In this analysis, Cluster 1 included young females and an adolescent in village burials with low grave good counts (<10 items, no beads), dental disease, and low to moderate MSMs. Cluster 2 is represented by subadults and adults, children in house floors and adults in village burials. There were no to low counts of grave goods (<10 items); adults were associated with moderate to high MSMs, but had no evidence of dental disease or osteoarthritis. There were only middle-aged to older adults in Cluster 3, who were buried in villages, in a tightly flexed position with moderate grave good inclusions (9-30 total items). These adults exhibited high shoulder and low elbow MSM attachments and moderate to high attachments in the lower limb; there was evidence of dental disease and upper/lower limb osteoarthritis. Cluster 4 included adults and subadults of a wide span of ages. Adults in this cluster were buried in the flexed position in villages with a moderate number of grave goods (<64 total items, no beads), and had moderate to high MSMs; several individuals had dental disease and osteoarthritis. Subadults were buried in house floors; there were low numbers of grave goods and a moderate number of beads (<10 items, <25 beads).

**Table 100:** Early Monongahela - biosocial cluster analysis demographic, mortuary, and biological features

| Cluster | Demography | Grave Attributes | Grave Goods | Biological Features |
|---|---|---|---|---|
| 1 | 1 Adolescent, 1 Early Adult Female, 2 Young Adult Females | Village burials: left sided flexed burials, east orientation (1 early adult female, 1 young adult female), 1 unknown context (1 young adult female), 1 extended burial (adolescent) | Low grave good counts: <10 bone items, <5 ceramics, no beads | Upper Limb MSMs: Moderate to high deltoid, low pectoralis, low to moderate elbow flexors, low elbow extensors<br>Lower Limb MSMs: low thigh adductors, low to moderate thigh extensors, moderate leg extensors, low to moderate leg flexors, moderate hip flexors<br>Dental: Periodontitis and abscess |
| 2 | 1 Fetus, 1 Early Child, 1 Late Child, 1 Unknown subadult, 6 Unknown Adults 1 Adult Male, 1 Young Adult Female, | Single Inhumations, unknown orientation, extended position<br>Adults= in village<br>Subadults = in household | Low grave good counts: <10 total items, no beads | Upper Limb MSMs: high deltoid, moderate to high pectoralis, low elbow flexors/extensors, low pronators<br>Lower Limb MSMs: high thigh extensor, moderate to high thigh adductors, moderate-high knee extensors/flexors, moderate hip flexors |
| 3 | 3 Middle Aged Males, 1 Old Adult Male, 1 Middle Aged Female, 1 Old Adult Female | Village Burials, single inhumations, left sided tightly flexed burials, E/NE orientation | Moderate grave good count: 9-30 total items, <5 beads<br>Outlier: Middle Aged Male – FC#5899 (34 bone items, 118 ceramic fragments, 168 total items, 2 bone beads in neck area) | Upper Limb MSMs: high deltoid and pectoralis, low elbow flexors, low to moderate anconeus, moderate pronator<br>Lower Limb MSMs: high thigh extensor, moderate to high adductor, high knee extensor, moderate to high knee flexor<br>Dental: AMTL, Caries, Periodontitis<br>OA: Upper and Lower Limb |

**Table 100:** (continued)

| Cluster | Demography | Grave Attributes | Grave Goods | Biological Features |
|---|---|---|---|---|
| 4 | 3 Fetuses, 2 Neonates, 3 Toddlers, 2 Early Children, 2 Late Children, 2 Adolescents, 2 Youths, 3 Unknown Adults, 2 Adult Males, 1 Young Adult Male, 1 Middle Aged Male, 1 Adult Female, 2 Female Youths, 1 Young Adult Female, 1 Middle Aged Female | Adults: Village burials, single inhumations, flexed, left sided (2 right sided)<br>Subadults: Household burials, extended position | Adult Grave Goods: <38 bone items, <17 ceramic, <64 total items, no beads<br><br>Subadult Grave goods: <5 bone or ceramic items, <10 total items, <23 shell or bone beads in head, neck or torso region | Upper Limb MSM: high deltoid and pectoralis, low to moderate flexors and anconeus, moderate triceps and biceps, high pronators<br>Lower Limb MSM: High adductors and thigh extensors, moderate to high knee flexors/extensors<br>Dental: AMTL, Caries, and Periodontitis<br>OA: 1 Upper Limb, 2 Lower limb |

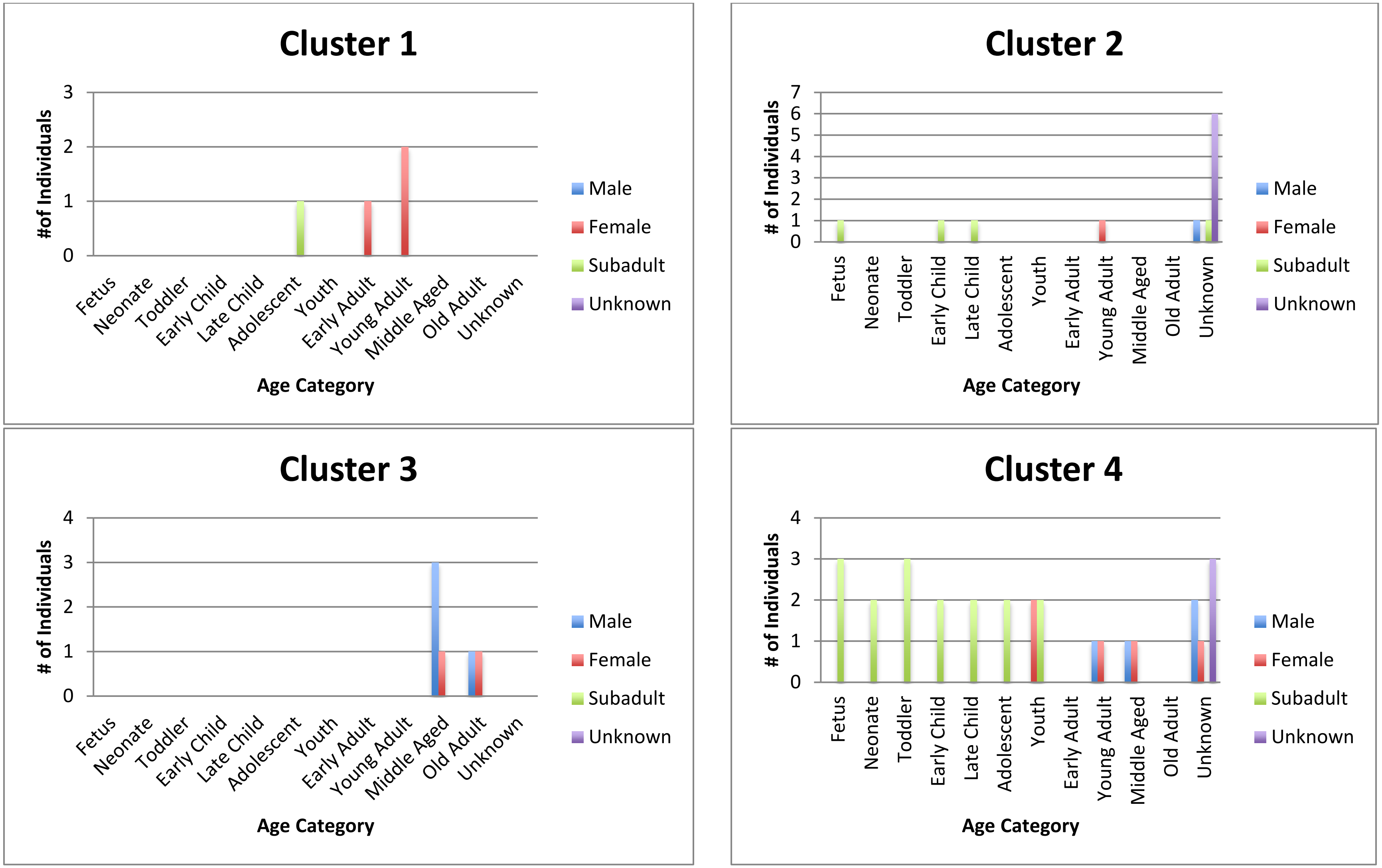



**Figure 78:** Early Monongahela - biosocial demographic structure by cluster

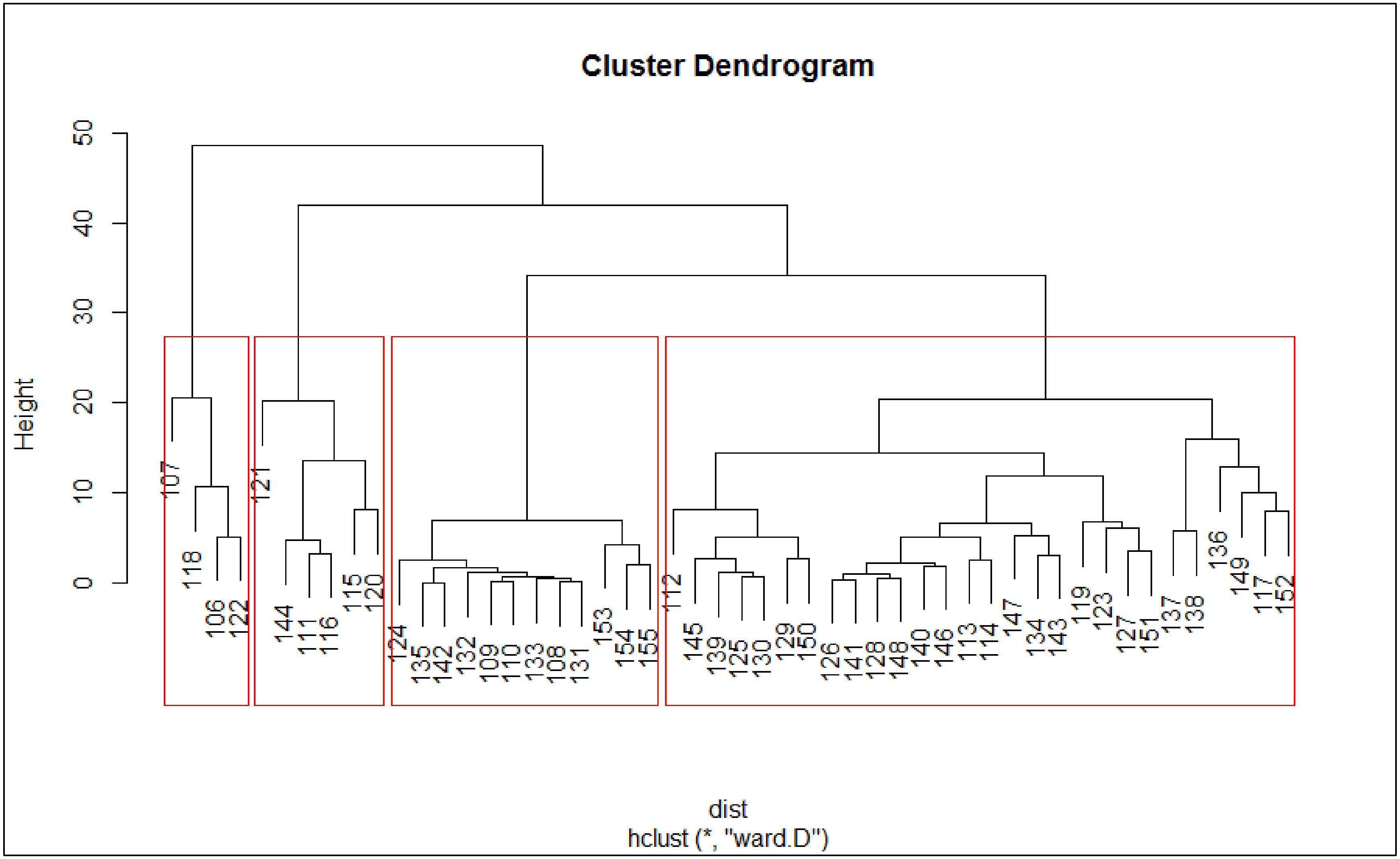



**Figure 79:** Cluster dendogram for Early Monongahela biosocial cluster analysis
Left to right – Cluster 1, Cluster 3, Cluster 2, Cluster 4

## 8.3 THE MIDDLE MONONGAHELA SAMPLE

### 8.3.1 PCA/MCA Analysis Results

PCA results for grave attributes, grave goods and biological attributes are listed in Tables 101-104, with features of each category presented in Table 105.

**Table 101:** Middle Monongahela grave attributes PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Depth | 0.11670257 | 0.093408982 | 0.004782873 |
| Width | 0.40981152 | 0.176080988 | 0.087311228 |
| Length | 0.388983371 | 0.162761164 | 0.129472183 |
| Body Location | 0.271608147 | **0.413341954** | 0.209456877 |
| Head Orientation | **0.865198166** | 0.337731933 | **0.497329838** |
| Leg Flexure | **0.853733983** | **0.728703249** | 0.15524998 |
| Body Position | **0.858198067** | **0.743887937** | **0.429052638** |
| Treatment of Body | 0.054762047 | 0.014109608 | **0.389826435** |

**Table 102:** Middle Monongahela grave good PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Stone | 0.009317122 | **0.584077724** | 0.052451005 |
| Bone | 0.001196547 | 0.18700994 | 0.001448958 |
| Lithics | 0.197429008 | 0.132612201 | 0.005084809 |
| Ceramics | 0.009531653 | **0.47051264** | 0.11616936 |
| Shell | 0.000115936 | 0.217319659 | **0.549273642** |
| Total Items | 0.005364989 | **0.658934369** | **0.259154172** |
| Metal Beads | 0.002795009 | 0.009110059 | 0.066254812 |
| Shell Beads | **0.849551152** | 0.033540733 | 0.017072182 |
| Bone Beads | **0.230060194** | 0.000367897 | 0.115021403 |
| Metal Bead Location | 0.002076769 | 0.003204636 | 0.004042541 |
| Shell Bead Location | **0.929870105** | 0.048142465 | 0.127712286 |
| Bone Bead Location | **0.933619279** | 0.306518904 | 0.294239366 |

**Table 103:** Middle Monongahela biological attributes (MSMs) PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Left Deltoid - Clavicle | 0.299974664 | **0.2641405** | 0.011810391 |
| Right Deltoid – Clavicle | 0.118579355 | **0.229206832** | 0.09223018 |
| Left Trapezius | 0.172845127 | 0.084456974 | 0.004104998 |
| Right Trapezius | 0.054871817 | **0.269032959** | 0.127128305 |
| Left Pectoralis Major - Scapula | 0.027456444 | 0.181897127 | 0.00000059 |
| Right Pectoralis Major – Scapula | 0.143195103 | 0.059324345 | 0.039597517 |
| Left Pectoralis – Humerus | **0.191338977** | 0.002631994 | 0.00039887 |
| Right Pectoralis – Humerus | 0.336008354 | 0.001841347 | 0.00000587 |
| Left Latissimus Dorsi | **0.423707881** | 0.137392444 | 0.126325584 |
| Right Latissimus Dorsi | **0.336423138** | 0.086481874 | 0.102708682 |
| Left Deltoid – Humerus | 0.142989125 | 0.033755872 | 0.003881182 |
| Right Deltoid – Humerus | 0.149670349 | 0.010492458 | 0.046045751 |
| Left Extensors | 0.126040616 | **0.286906078** | 0.181670781 |
| Right Extensors | 0.184863669 | 0.174677593 | 0.072391421 |
| Left Flexors | 0.15873167 | **0.221685391** | 0.103249411 |
| Right Flexors | 0.176985104 | 0.15111948 | 0.133492973 |
| Left Brachialis | 0.168836536 | 0.000303949 | 0.036853015 |
| Right Brachialis | **0.46573017** | 0.004541332 | 0.000597831 |
| Left Anconeus | 0.07076148 | 0.027652316 | 0.014194695 |
| Right Anconeus | **0.393728581** | 0.007586935 | 0.000300315 |
| Left Triceps | 0.276053238 | 0.012013016 | 0.071682957 |
| Right Triceps | 0.270999896 | 0.0000625 | 0.092971099 |
| Left Biceps | 0.09185243 | 0.012581683 | 0.019771896 |
| Right Biceps | **0.384153464** | 0.015658789 | 0.004659683 |
| Left Pronator Teres | 0.1371138 | 0.024800187 | 0.074339788 |
| Right Pronator Teres | 0.188039695 | 0.003787754 | 0.023913183 |
| Left Adductor Magnus – Innominate | **0.348823748** | 0.018039822 | 0.000145771 |
| Right Adductor Magnus – Innominate | 0.282828811 | 0.000002963 | 0.000162759 |
| Left Gluteus Maximus – Femur | **0.547421382** | 0.010833561 | 0.030818785 |
| Right Gluteus Maximus – Femur | **0.397926664** | 0.017224479 | 0.004218059 |
| Left Adductor Magnus – Femur | 0.251273723 | 0.018319411 | 0.03186125 |
| Right Adductor Magnus – Femur | 0.232859591 | 0.002356284 | 0.020214835 |
| Left Vastus Intermedius | **0.500294993** | 0.000648747 | 0.059935319 |
| Right Vastus Intermedius | **0.453386478** | 0.009507452 | 0.01621982 |
| Left Vastus Medialis | **0.495769005** | 0.000206004 | 0.024758591 |
| Right Vastus Medialis | **0.384036164** | 0.020694985 | 0.004172451 |
| Left Vastus Lateralis | **0.45697654** | 0.059005761 | 0.019240308 |
| Right Vastus Lateralis | **0.356171702** | 0.047689386 | 0.00292456 |
| Left Gastrocnemius | 0.261127727 | 0.026538319 | 0.00140486 |
| Right Gastrocnemius | 0.218899328 | 0.013449987 | 0.002442174 |
| Left Iliacus | 0.273698919 | 0.060636905 | 0.010130357 |
| Right Iliacus | 0.267793571 | 0.049093573 | 0.031918993 |
| Left Pectineus | 0.12790487 | 0.020598602 | 0.076957101 |
| Right Pectineus | 0.135688703 | 0.06964009 | 0.036089768 |
| Left Soleus | **0.404683632** | 0.016540559 | 0.028252912 |
| Right Soleus | **0.418756653** | 0.123583544 | 0.032244992 |

**Table 104:** Middle Monongahela biological attributes (Pathology) PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Sharp Force Trauma | 0.047356814 | **0.221994196** | 0.002070456 |
| Blunt Force Trauma | 0.23318444 | 0.004652296 | **0.288341332** |
| Schmorl's Nodes | 0.045867223 | 0.010439892 | 0.001597282 |
| Cribra Orbitalia/Porotic Hyperostosis | 0.036340728 | 0.074343661 | 0.000768499 |
| Linear Enamel Hypoplasia | 0.002315759 | 0.14262364 | 0.089374356 |
| Upper Limb Osteoarthritis | 0.274606283 | 0.149362907 | **0.245439933** |
| Lower Limb Osteoarthritis | 0.20520254 | 0.094855944 | **0.289496404** |
| Vertebral Osteoarthritis | 0.071552295 | 0.046724959 | 0.086711482 |
| Antemortem Tooth Loss | 0.087064786 | 0.180571804 | **0.307116507** |
| Caries | 0.041135732 | **0.324720742** | **0.21186633** |
| Periodontitis | 0.056698288 | **0.247938988** | **0.356533135** |
| Dental Calculus | 0.024852042 | 0.025393715 | 0.018492192 |
| Dental Abscess | 0.27445848 | 0.004931424 | **0.385348205** |
| Non-specific Infection | 0.013399261 | 0.001812889 | 0.072355984 |

**Table 105:** Middle Monongahela PCA components for grave attributes, grave goods, and biological attributes

| PCA | Grave Attributes | Grave Goods | Biological Attributes |
|---|---|---|---|
| PCA1 | Head orientation, leg flexure, and body position | Shell beads, bone beads, shell bead location, bone bead location | Left pectoralis major (humerus), left/right latissimus dorsi, right brachialis, right anconeus, right biceps, left adductor magnus, left/right gluteus maximus, left/right vastus intermedius, left/right vastus medialis, left/right vastus lateralis, left/right soleus |
| PCA2 | Burial location, leg flexure, body position | Stone, ceramics, total items | Left/right deltoid (clavicle), right trapezius, left extensors, left flexors, SFT, caries, periodontitis |
| PCA3 | Head orientation, body position, treatment of body | Shell, total items | BFT, upper limb osteoarthritis, lower limb osteoarthritis, AMTL, caries, periodontitis, dental abscess |

### 8.3.2 Mortuary Cluster Analysis Results

Cluster descriptions are listed in Table 106. The demographic structure of each cluster is illustrated in Figure 80 and the dendogram for cluster structure is presented in Figure 81. Subadults and adults of both sexes were present in Cluster 1, which consisted primarily of flexed village burials with few grave items (<6 total). Cluster 2 was also comprised of subadult and adult village burials, with unknown grave attributes and low grave good counts (<12 items). Cluster 3 was mixed in burial type; it consisted of an adult male buried in the village, one adult female buried outside the village, and seven subadults buried in house floors. These individuals, with the exception of the female, had few grave goods (<10 items) and subadults were associated with moderate counts of beads (0-78 total beads). The female burial outside the village is an outlier from all of the Monongahela burials. Cluster 4 included males, females, and subadults in village burials with unknown orientations. Grave good counts for this cluster were high, ranging from 0-50 stone items, 0-28 ceramic items, and 0-166 shell items.

**Table 106:** Middle Monongahela - traditional demographic-mortuary cluster analysis

| Cluster | Demography | Grave Attributes | Grave Goods |
|---|---|---|---|
| 1 | 5 Males, 7 Females, 4 Subadults, 3 Unknown Adults | Village Burials, left or right sided flexed burials, single inhumation | Low grave good counts: <6 stone, <5 ceramic items, <5 shell items, <11 total items<br>2 subadults individuals with shell beads (<3) in knee area |
| 2 | 8 Males, 11 Females, 10 Subadults, 7 Unknown Adults | Village Burials, Unknown Orientation, Unknown Position | Low grave good counts: 0-1 stone items, 0-5 ceramic items, 0-12 total items<br>No beads |
| 3 | 1 Male, 1 Female, 7 Subadults | Male in village, tightly flexed, left side, east orientation, subadults in households, extended, east orientation<br><br>Outlier: Female with subadult outside village (FC#442) | 0-5 stone items, 0-5 ceramic items, 0-1 shell, 0-6 Total Items<br>Beads: Subadults (0-78 shell beads, 0-10 bone beads)<br>Outlier: Female with 44 shell beads in head/neck region, 30 bone beads in pelvic region |
| 4 | 4 Males, 3 Subadults, 3 Unknown Adults | Village Burials, Unknown Orientation, Unknown Position | Moderate to high grave goods: 0-50 stone items, 0-28 ceramic items, 0-166 shell items, 0-166 total items |

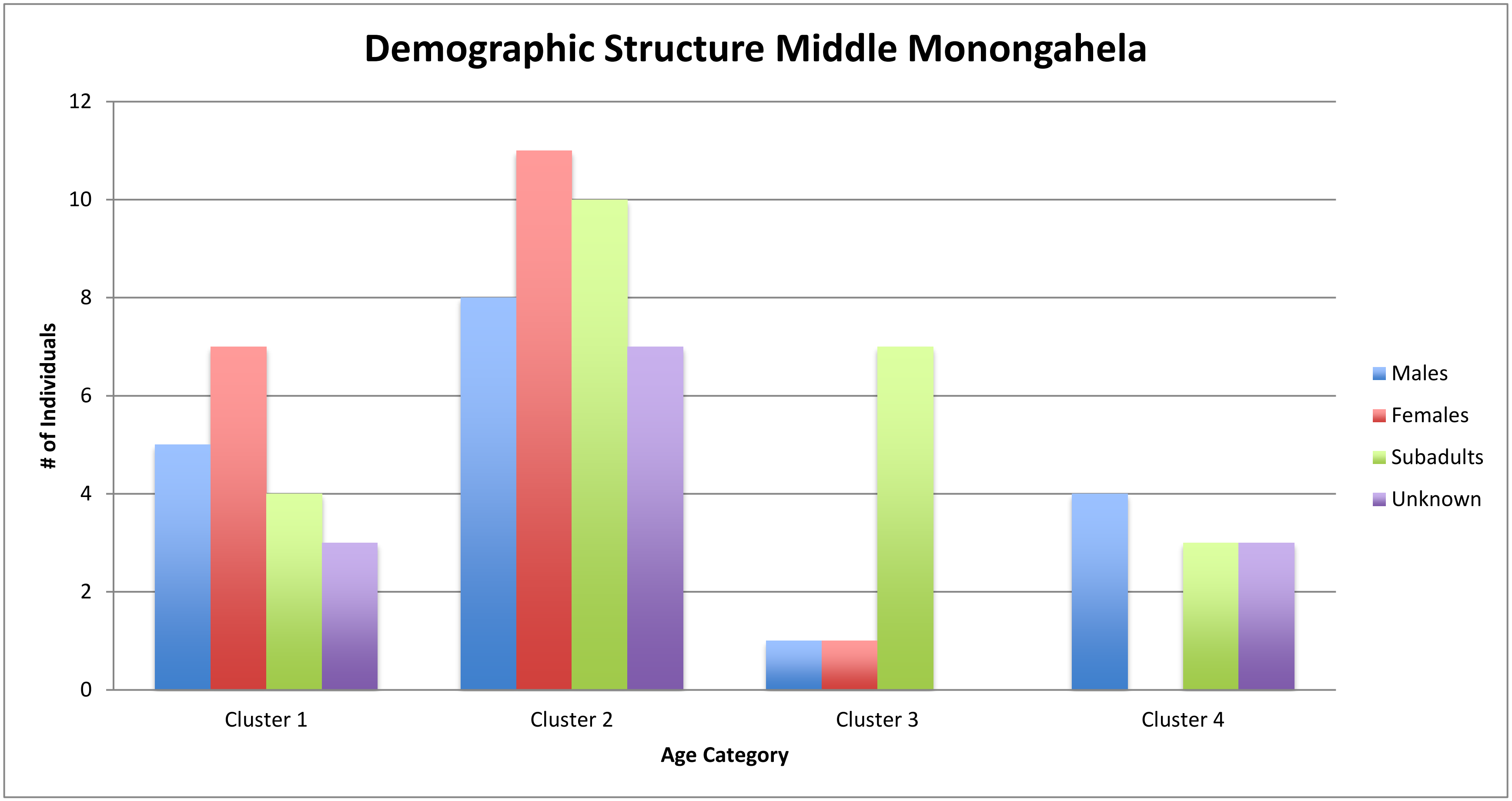



**Figure 80:** Middle Monongahela - traditional demographic-mortuary structure cluster analysis by age/sex

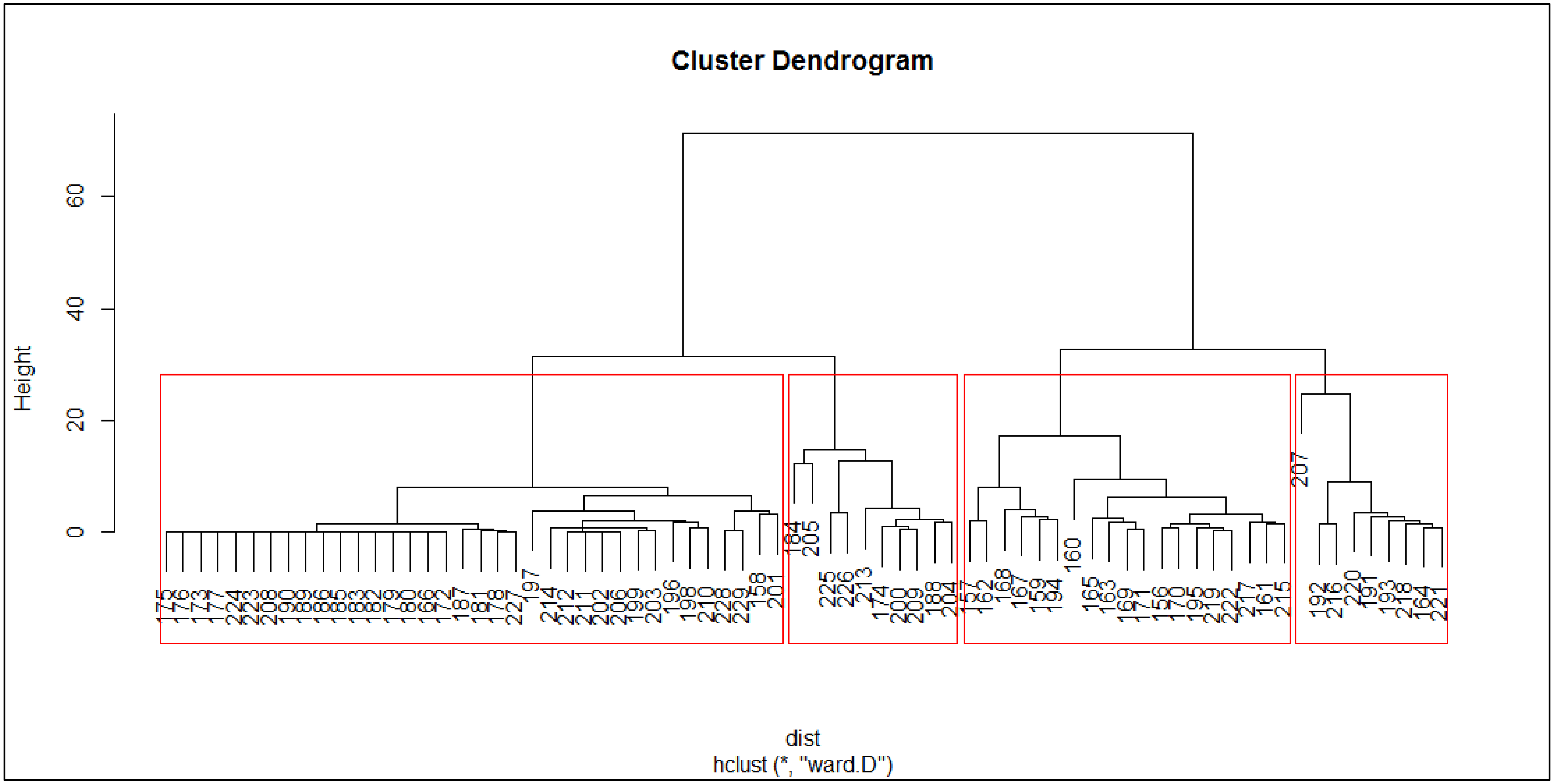



**Figure 81:** Cluster dendogram for mortuary cluster analysis of Middle Monongahela
Left to right – Cluster 2, Cluster 4, Cluster 1, Cluster 3

### 8.3.3 Biosocial Cluster Analysis Results

Cluster descriptions are listed in Table 107 and demographic structure by age/sex is presented in Figure 82. The cluster structure by burial is depicted in a dendogram (Figure 83). Cluster 1 was comprised of flexed adolescents and adults in village burials, and subadults in house floors; grave good counts were low for adults and subadults (<10 items) but subadults were associated with moderate counts of shell beads (<78 beads). Only young adults and youths were present in Cluster 2. These village burials were tightly flexed and placed on the right side with few grave goods (<6 total items). One female burial was an outlier, as this individual and her fetus were buried outside the village with a larger cache of beads. Cluster 3 included adults of various ages and both sexes in village burials and subadults in house floor burials, all with moderate numbers of grave goods (<86 total items). One outlier, an old adult male with 166 shells was included in this cluster. In Cluster 4, there were only tightly flexed adults in village burials, placed on the right side with a moderate number of grave goods (<50 items).

The biological features of these burials are varied. All clusters contained individuals with dental disease and osteoarthritis. The MSM and injury patterning was heterogeneous between clusters. Cluster 1 had low to moderate MSM scores for the upper limb and moderate scores for the lower limb, but Cluster 2 ranged from low to moderate in both the upper and lower limbs. MSM scores were moderate to high in the upper and lower limbs in Cluster 3, whereas Cluster 4 MSM scores were high. Only Clusters 1 and 4 had cases of BFT, and Cluster 3 had one case of SFT.

**Table 107:** Middle Monongahela - biosocial cluster analysis demographic, mortuary, and biological features

| Cluster | Demography | Grave Attributes | Grave Goods | Biological Features |
|---|---|---|---|---|
| 1 | 1 Fetus, 1 Toddler, 2 Early Children, 3 Late Children, 1 Adolescent, 1 Unknown Adult, 1 Middle Aged Unknown Adult, 2 Adult Males, 1 Young Adult Male, | Adolescents and adults: flexed burials in village. Subadults: extended burials in household | Grave goods: 0-1 stone item, 0-2 ceramic items, 0-10 shell items, 0-11 total items<br><br>Beads: subadults only – 2-78 shell beads, 0-10 bone beads | Upper Limb MSMs: moderate pectoralis, deltoid and latissimus, low forearm flexors and extensors<br>Lower Limb MSMs: moderate thigh extensor, adductors, knee flexors/extensors<br>Dental: Male and Unknown with AMTL and Periodontitis<br>OA: Upper/Lower Limb in 1 Adult<br>BFT: One Unknown Adult |
| 2 | 1 Fetus, 2 Youths, 1 Young Adult Male, 3 Early Adult Females, 3 Young Adult Females | Village Burials: Tightly Flexed, Right side<br><br>*Outlier – young adult female buried outside village with fetus | Grave goods: 0-5 ceramic, 0-3 shell, 0-6 total items<br><br>Outlier: young adult female (FC#442) 44 shell beads in neck area, 30 bone beads in pelvic area | Upper Limb MSMs: low to moderate pectoralis and latissimus, low flexors/extensors<br>Lower Limb MSMs: low to moderate thigh extensor, adductors, knee extensors, moderate knee flexors<br>Dental: Caries, Periodontitis, AMTL<br>OA: Upper and Lower Limb<br>SFT: Outlier (young adult female) |
| 3 | 5 Neonates, 3 Toddlers, 2 Early Children, 3 Late Children, 1 Youth, 9 Unknown Adults, 1 Young Adult Male, 1 Middle Aged Male, 2 Old Adult Males, 2 Adult Females, 4 Middle Aged Females, 1 Old Adult Female | Adults: Village burials, single inhumations, unknown orientations and positions<br><br>Subadults: Household burials, unknown orientation and position | Grave goods: 0-50 stone items, 0-28 ceramic items, 0-17 shell items, 0-86 total items*<br><br>Subadults: <10 shell or bone beads<br>Outlier: Old Adult Male (FC#5074) with 166 shells | Upper Limb MSMs: moderate to high pectoralis and latissimus, moderate brachialis, anconeus, low flexors/extensors<br>Lower Limb: moderate to high MSMs<br>Dental: AMTL, Caries, Periodontitis<br>Osteoarthritis: Upper and Lower limb |

**Table 107:** (continued)

| Cluster | Demography | Grave Attributes | Grave Goods | Biological Features |
|---|---|---|---|---|
| 4 | 1 Young Adult Male, 5 Middle Aged Males, 3 Old Adult Males, 1 Young Adult Female, 1 Middle Aged Female, 2 Old Adult Females | Village burials: tightly flexed, left or right side, E/NE orientation | Grave goods: 0-6 stone, 0-42 shell, 0-45 total items<br>Beads: 9 shell in middle aged female, 19 bone in middle aged male<br>*42 shell in middle aged male burial | Upper Limb MSMs: high deltoid, pectoralis, latissimus, biceps, moderate anconeus<br>Lower Limb MSMs: high thigh extensors, adductors, knee flexors/extensors<br>Dental: AMTL, Caries, Periodontitis, and Abscess (severe)<br>Upper/Lower Limb OA, BFT |

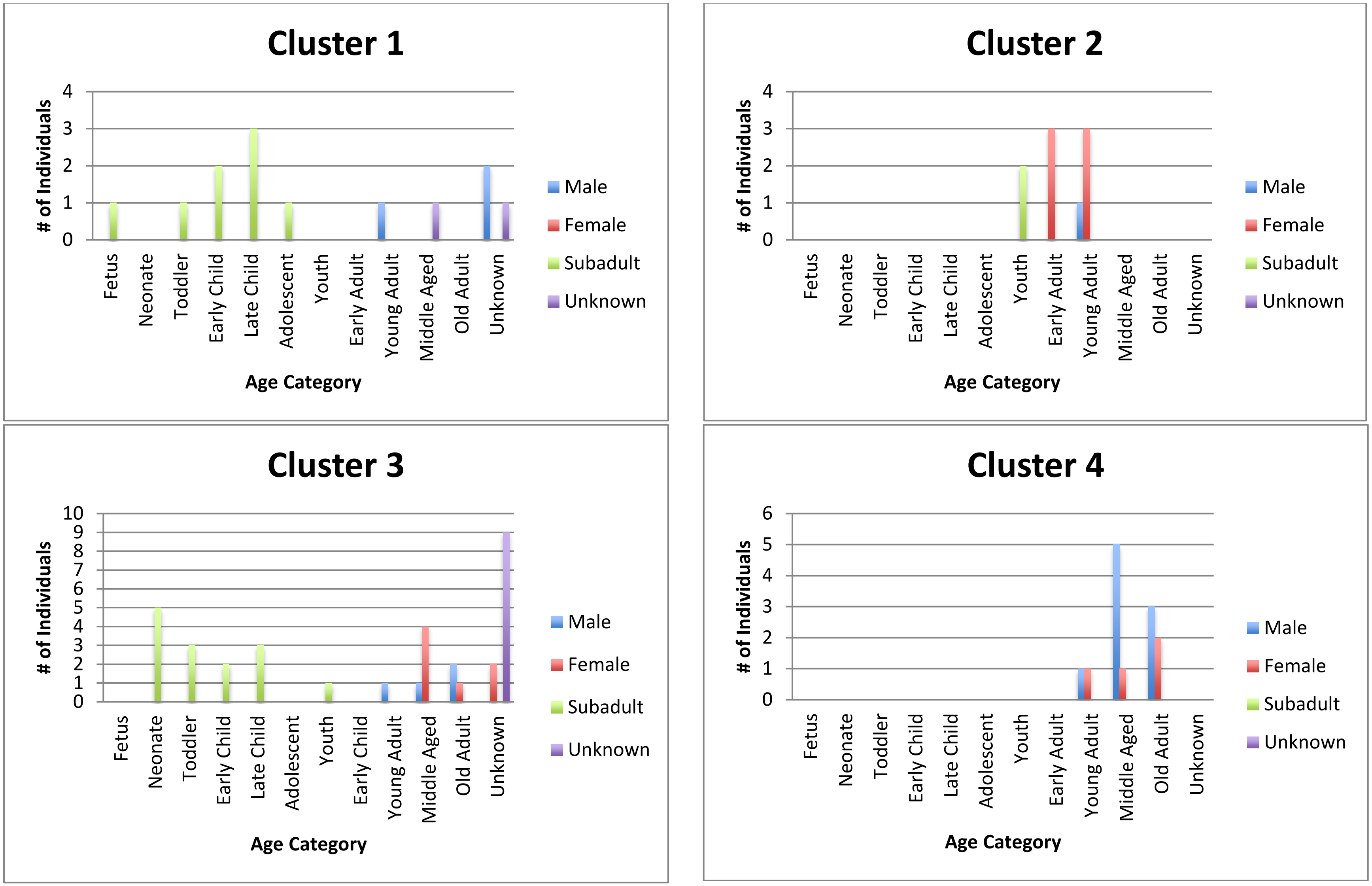



**Figure 82:** Middle Monongahela - biosocial demographic structure by cluster

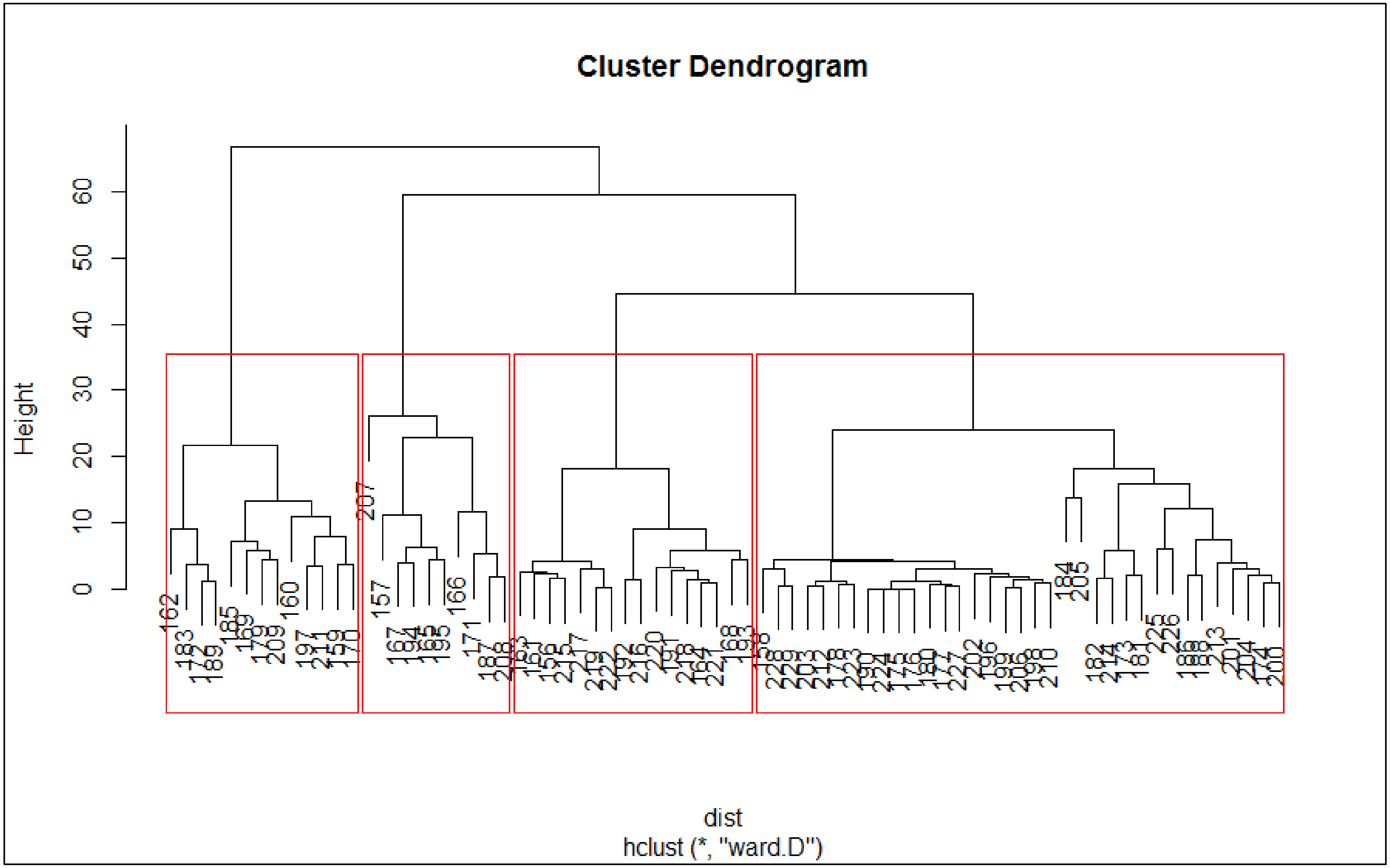



**Figure 83:** Cluster dendogram by burial for Middle Monongahela sample, biosocial cluster analysis
Left to right – Cluster 4, Cluster 2, Cluster 1, Cluster 3

## 8.4 THE LATE MONONGAHELA SAMPLE

### 8.4.1 PCA/MCA Analysis Results

PCA results for grave attributes, grave goods and biological features of burials are listed in Tables 108-111, with features of these categories in Table 112.

**Table 108:** Late Monongahela grave attribute PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Body Location | **0.827047707** | **0.635343836** | 0.249458215 |
| Head Orientation | 0.183916883 | 0.003960131 | **0.775816463** |
| Leg Flexure | **0.905705674** | **0.949409049** | **0.991726978** |
| Body Position | **0.895530999** | **0.87250894** | 0.127863836 |
| Treatment of Body | **0.675421745** | 0.035083076 | 0.011966421 |

**Table 109:** Late Monongahela grave good PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Stone | 0.268600328 | **0.561038301** | 0.06693445 |
| Bone | 0.230215423 | **0.552433337** | 0.062913614 |
| Lithics | 0.233793944 | **0.432389275** | 0.045352971 |
| Ceramics | **0.929829584** | 0.045531718 | 0.004754817 |
| Shell | **0.770221674** | 0.103560201 | 0.014524853 |
| Total Items | **0.928168153** | 0.043434989 | 0.005665451 |
| Shell Beads | 0.000244382 | 0.14124218 | **0.856886572** |
| Bone Beads | 0.503772553 | 0.397266637 | **0.901643354** |

**Table 110:** Late Monongahela biological attributes (MSMs) PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Left Deltoid - Clavicle | 0.012428329 | 0.179826837 | 0.006818887 |
| Right Deltoid – Clavicle | 0.030984633 | 0.029760958 | 0.000436246 |
| Left Trapezius | 0.271293669 | 0.060685201 | 0.166957213 |
| Right Trapezius | 0.164553757 | 0.017676818 | 0.145584248 |
| Left Pectoralis Major - Scapula | 0.271293669 | 0.060685201 | 0.166957213 |
| Right Pectoralis Major – Scapula | 0.238612088 | 0.005027163 | 0.333605415 |
| Left Pectoralis – Humerus | 0.498646469 | 0.173835253 | 0.005087126 |
| Right Pectoralis – Humerus | 0.271694565 | 0.007434375 | 0.09852482 |
| Left Latissimus Dorsi | 0.148795905 | **0.235410738** | 0.066468462 |
| Right Latissimus Dorsi | 0.09739037 | 0.000046822 | 0.330059216 |
| Left Deltoid – Humerus | 0.254109647 | 0.013410059 | 0.049489857 |
| Right Deltoid – Humerus | 0.199590199 | 0.162473631 | 0.033049565 |
| Right Extensors | 0.005478754 | 0.000427027 | 0.066169491 |
| Right Flexors | 0.005478754 | 0.000427027 | 0.066169491 |
| Left Brachialis | 0.233967951 | 0.008280157 | 0.026506105 |
| Right Brachialis | 0.047176702 | 0.047390118 | 0.311716567 |
| Left Anconeus | 0.298596892 | 0.019105071 | 0.039724295 |
| Right Anconeus | 0.306656749 | 0.001321775 | 0.0354268 |
| Left Triceps | 0.054267635 | 0.007003176 | 0.022539007 |
| Right Triceps | 0.026161161 | 0.000104517 | 0.037775653 |
| Left Biceps | 0.078311694 | 0.176743493 | 0.005590389 |
| Right Biceps | 0.205594279 | 0.001238622 | 0.001238622 |
| Left Pronator Teres | 0.20880066 | 0.000989439 | 0.213729026 |
| Right Pronator Teres | 0.295348431 | 0.048677755 | 0.120324292 |
| Left Adductor Magnus – Innominate | **0.610661698** | 0.047594951 | 0.003449308 |
| Right Adductor Magnus – Innominate | **0.628729807** | 0.046016375 | 0.004953661 |
| Left Gluteus Maximus – Femur | 0.108904752 | 0.106717742 | 0.164887064 |
| Right Gluteus Maximus – Femur | **0.494210599** | 0.0087093 | 0.06964506 |
| Left Adductor Magnus – Femur | 0.263391288 | 0.029581548 | 0.034860129 |
| Right Adductor Magnus – Femur | **0.467791604** | 0.004515049 | 0.001210162 |
| Left Vastus Intermedius | **0.456190541** | 0.021598444 | 0.116848652 |
| Right Vastus Intermedius | **0.490145103** | **0.219006081** | 0.03055452 |
| Left Vastus Medialis | **0.474804058** | 0.037133259 | 0.118980929 |
| Right Vastus Medialis | **0.490145103** | **0.219006081** | 0.03055452 |
| Left Vastus Lateralis | **0.474804058** | 0.037133259 | 0.118980929 |
| Right Vastus Lateralis | **0.490145103** | **0.219006081** | 0.03055452 |
| Left Gastrocnemius | 0.229406829 | 0.115710589 | 0.052833404 |
| Right Gastrocnemius | 0.199561477 | 0.052221809 | 0.000225284 |
| Left Iliacus | 0.276581541 | 0.140696182 | 0.042822658 |
| Right Iliacus | 0.359954757 | 0.064872057 | 0.0278941 |
| Left Pectineus | **0.654920521** | 0.003938069 | 0.113616712 |
| Right Pectineus | 0.460134549 | 0.072618059 | 0.237574349 |
| Left Soleus | 0.010175589 | **0.324452705** | 0.03632882 |
| Right Soleus | 0.09226853 | 0.000498882 | 0.095093402 |

**Table 111:** Late Monongahela biological attributes (pathology) PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Blunt Force Trauma | 0.13903317 | 0.065191646 | **0.333683672** |
| Schmorl's Nodes | 0.004356306 | 0.008690877 | 0.008690877 |
| Cribra Orbitalia/Porotic Hyperostosis | 0.008690877 | 0.012200855 | 0.003928034 |
| Linear Enamel Hypoplasia | 0.06832843 | **0.244957526** | 0.000589105 |
| Upper Limb Osteoarthritis | 0.146331307 | **0.36167391** | 0.000687607 |
| Lower Limb Osteoarthritis | 0.19837482 | 0.061610973 | 0.043322135 |
| Vertebral Osteoarthritis | 0.005065938 | 0.11351237 | 0.01345108 |
| Antemortem Tooth Loss | 0.186706583 | **0.314203428** | 0.026829664 |
| Caries | 0.016750186 | **0.386808082** | 0.062924199 |
| Periodontitis | 0.153272001 | **0.337626943** | 0.037103202 |
| Dental Calculus | 0.146118636 | 0.140898273 | 0.070882628 |
| Dental Abscess | 0.171954379 | 0.00857244 | **0.298747053** |
| Non-specific Infection | 0.006183385 | 0.145513046 | 0.190141289 |

**Table 112:** Late Monongahela PCA components for grave attributes, grave goods, and biological attributes

| PCA | Grave Attributes | Grave Goods | Biological Attributes |
|---|---|---|---|
| PCA1 | Body location, leg flexure, body position, treatment of the body | Ceramic, shell, total items | Left/right adductor magnus (innominate), left/right gluteus maximus (femur), right adductor magnus (femur), left/right vastus intermedius, left/right vastus medialis, left/right vastus lateralis, left pectineus |
| PCA2 | Body location, leg flexure, body position | Stone, bone, lithics | Left latissimus dorsi, right vastus intermedius, right vastus medialis, right vastus lateralis, left soleus, LEH, upper limb osteoarthritis, AMTL, caries, periodontitis |
| PCA3 | Head orientation, leg flexure | Shell beads, bone beads | Right pectoralis major, right latissimus dorsi, right brachialis, left pronator teres, right pectineus, BFT, dental abscess |

### 8.4.2 Mortuary Cluster Analysis Results

Cluster analysis results are listed in Table 113, and the demographic structure of each cluster is depicted in Figure 84. A dendogram of cluster structure by burial is presented in Figure 85. Cluster 1 primarily consisted of adult village burials in the flexed position with a moderate to high number of grave inclusions (1-120). One outlier was present: a subadult was buried with a large cache of marine shells in a burial structure from the Household site. Adults in flexed village burials and subadult burials in household floors comprised Cluster 2; these burials did not contain grave goods. Cluster 3 included adult and subadult burials from the burial structure at the Household site as well as village burials from several Late period sites. The burials in the structure for this cluster did not have associated grave goods, but the adults in the village burials were associated with few items (<17 total items). Only subadults are included in Cluster 4, and the characteristic pattern for these cases was house floor burial with no associated grave goods.

**Table 113:** Late Monongahela - traditional demographic-mortuary cluster analysis

| Cluster | Demography | Grave Attributes | Grave Goods |
|---|---|---|---|
| 1 | 2 Males, 1 Female, 1 Subadult, 1 Unknown | Village burials: flexed, left side, unknown orientation<br><br>Outlier: subadult in burial structure (FC#9746) | Grave goods: 5-43 ceramic fragments, 1-59 shell items, 1-102 total items<br>Beads: 6 shell, 1 bone bead in female burial (59 shell beads in subadult burial FC#9746) in structure) |
| 2 | 2 Males, 4 Females, 2 Subadults, 1 Unknown | Adult burials: village, left sided flexed burials<br>Subadults: extended household burials | Grave goods: No grave goods, 1 burial with 1 ceramic and 1 shell item (subadult)<br>Beads: 1 subadult with 1 shell, 1 female with 1 bone |
| 3 | 6 Males, 11 Females, 3 Subadults, 1 Unknown | Burial Structure: secondary and primary inhumations (6 Males, 8 Females, 1 Subadult, 1 Unknown)<br>Village Burials: Unknown position and orientation (3 females, 2 subadults) | Burial Structure: No grave goods<br>Village Burials: 0-17 ceramic items, 0-1 shell item, 0-17 total items<br>Beads: 3 bone in female burial |
| 4 | 8 Subadults | Household burials, 1 village burial (left sided, flexed), east orientation | No grave goods |

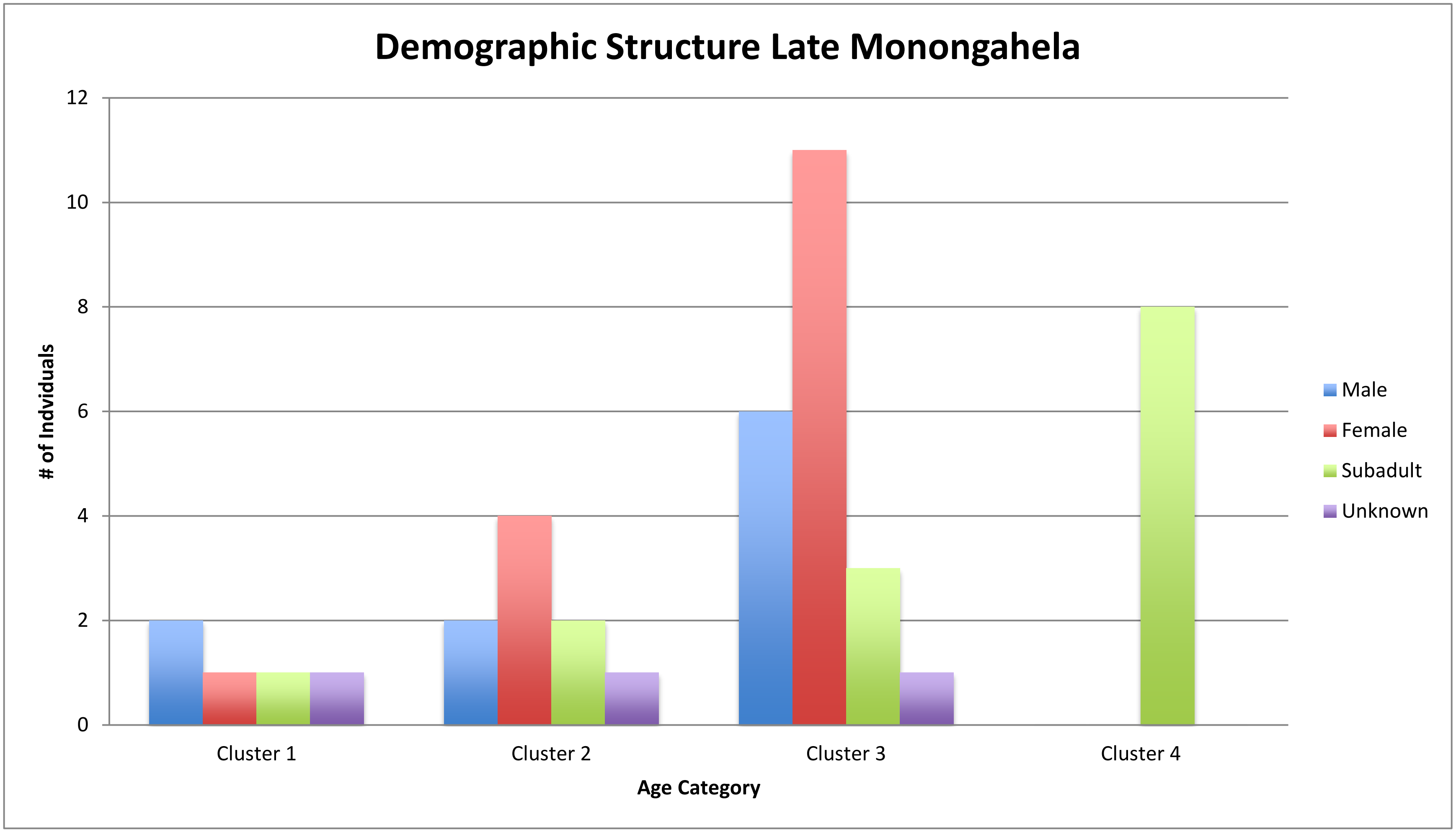



**Figure 84:** Late Monongahela - traditional demographic-mortuary structure cluster analysis by age/sex

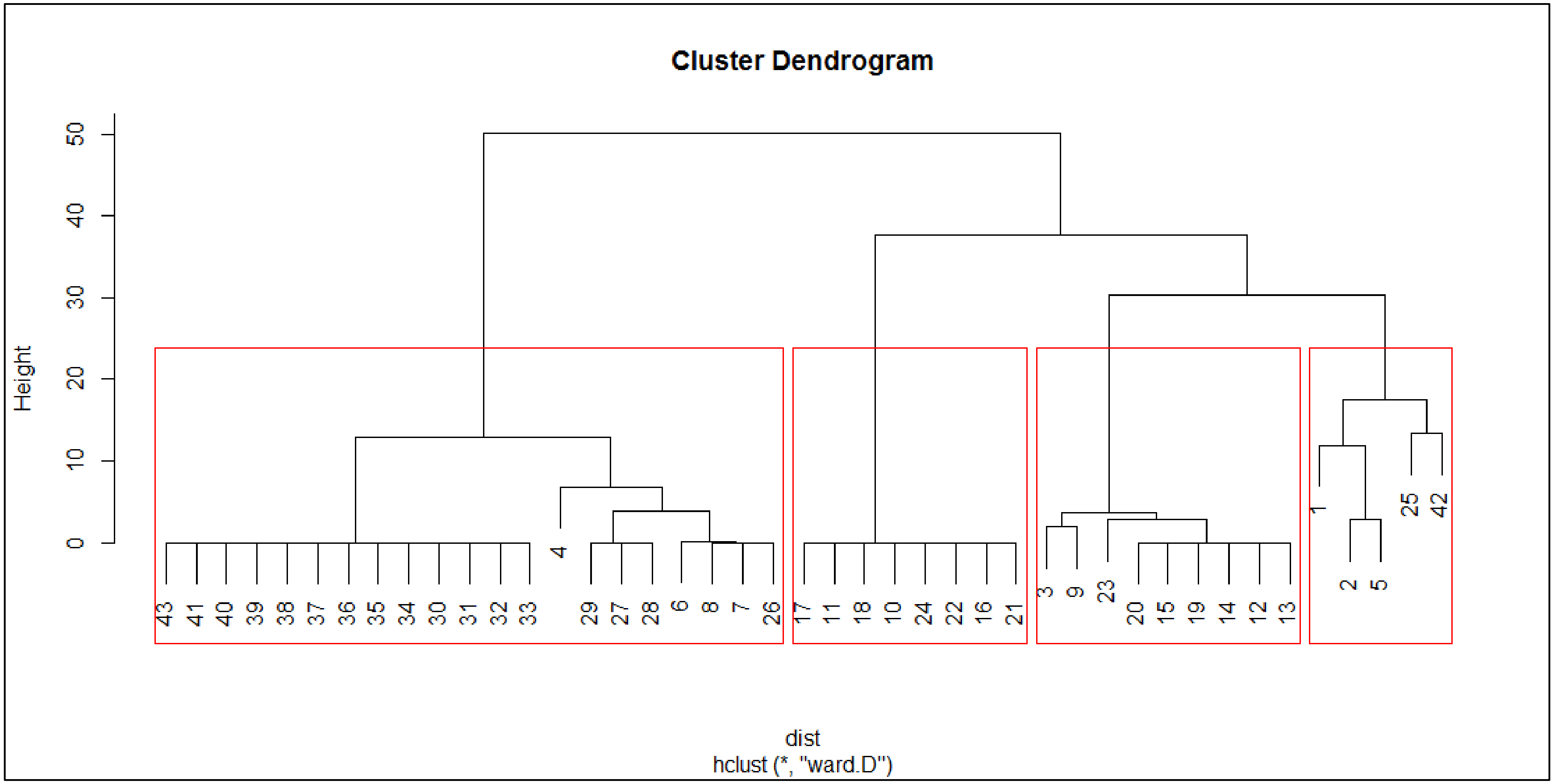



**Figure 85:** Dendogram of clusters by burial, Late Monongahela sample, mortuary cluster analysis
Left to right – Cluster 3, Cluster 4, Cluster 2, Cluster 1

### 8.4.3 Biosocial Cluster Analysis Results

Clusters are described in terms of demography, grave attributes, grave goods, and biological features in Table 114. Demographic structure and cluster dendograms are featured in Figures 86-87. For biosocial analysis, Cluster 1 was comprised of adults and subadults in village burials, a burial structure, and in house floors (subadults only) with few grave inclusions (<17 items). There was one outlier in this cluster: an early child (FC#9746) in the Household site burial structure with 102 total items (43 ceramic fragments and 59 marine shells). Individuals in this cluster had low to high upper limb MSMs and moderate to high MSMs in the lower limb, dental disease, BFT, and stress indicators. Cluster 2 consisted of subadults and adults. Two subadults were in village burials, one with a shell item; the rest of the individuals in this cluster were in the burial structure at the Household site with no associated grave goods. The biological signature of this cluster was moderate to high MSMs with dental disease, OA and LEH present in the sample. Only subadults comprised Cluster 3 with all burials located in house floors with no associated grave goods. There was no dental disease, osteoarthritis, or LEH in this cluster. Cluster 4 included only 3 young individuals: 2 females in the burial structure and 1 adolescent village burial. None of these burials had associated grave goods. MSMs for this cluster had low scores and there was no notable dental disease, osteoarthritis, or LEH.

**Table 114:** Late Monongahela - biosocial cluster analysis demographic, mortuary, and biological features

| Cluster | Demography | Grave Attributes | Grave Goods | Biological Features |
|---|---|---|---|---|
| 1 | 1 Toddler, 1 Early child, 2 Unknown Adults, 1 Adult Male, 1 Young Adult Male, 1 Middle Aged Male, 1 Old Adult Male, Adult Female, 4 Young Adult Females, 2 Middle Aged Females, 2 Old Adult Females | Burial structure: 2 Old Adult Females, 1 Early Child in secondary/primary inhumations, unknown orientations<br>House floor: 2 Subadults, extended<br>Adults: village burials, tightly flexed, right or left sided | Grave Goods: 0-17 Ceramic Items, 1-13 shell items, 0-17 Total Items<br><br>Beads: Bone beads 1-3<br>*outliers: Early Child in Burial structure – 43 ceramics, 59 shell, 102 Total Items<br>Young Adult female in village, 22 beads | Upper Limb MSMs: High latissimus dorsi and brachialis, low to moderate pronator<br>Lower Limb MSMs: High thigh extensor, moderate to high adductors, quadriceps, hip flexors, moderate soleus<br>Dental: Caries, Periodontal, Abscess,<br>Upper Limb OA, BFT, LEH |
| 2 | 1 Neonate, 2 Toddlers, 1 Unknown Adult, 3 Adult Males, 1 Early Adult Males, 1 Young Adult Male, 1 Middle Aged Male, 2 Adult Females, 1 Young Adult Female, 2 Old Adult Females | Village burials: Neonate and 1 Toddler<br>Burial structure: all other individuals | Only 1 burial (toddler) with 1 shell | Upper Limb MSMs: High brachialis, moderate pronator and latissimus<br>Lower Limb MSMs: moderate to high thigh extensor, moderate adductor, moderate knee extensor<br>Dental: AMTL, Abscesses<br>Upper Limb OA, BFT, LEH |
| 3 | 3 Neonates, 1 Toddler, 1 Early Child, 2 Unknown Subadult | House floor burials, single inhumations | No grave goods | No MSMs, no LEH, no dental disease, no OA |
| 4 | 1 Female Youth, 1 Middle Aged Female, 1 Adolescent | Village burial: adolescent<br>Burial structure: females | No grave goods | Upper Limb MSMs: low latissimus, brachialis, and pronator<br>Lower Limb MSMs: moderate thigh extensor, low adductor, low to moderate quadriceps, low hip flexor<br>No dental disease, no OA, no LEH |

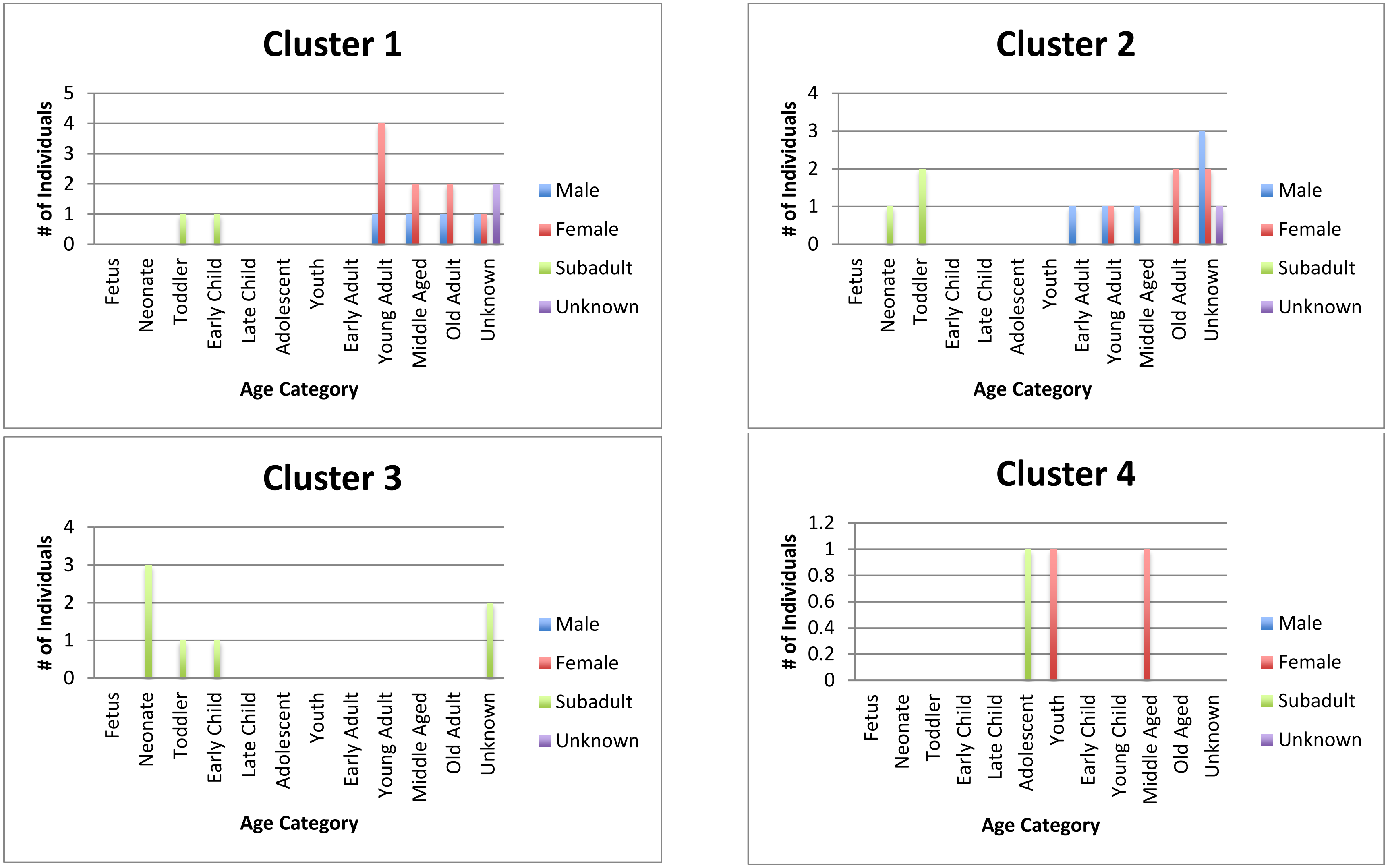



**Figure 86:** Late Monongahela - biosocial demographic structure by cluster

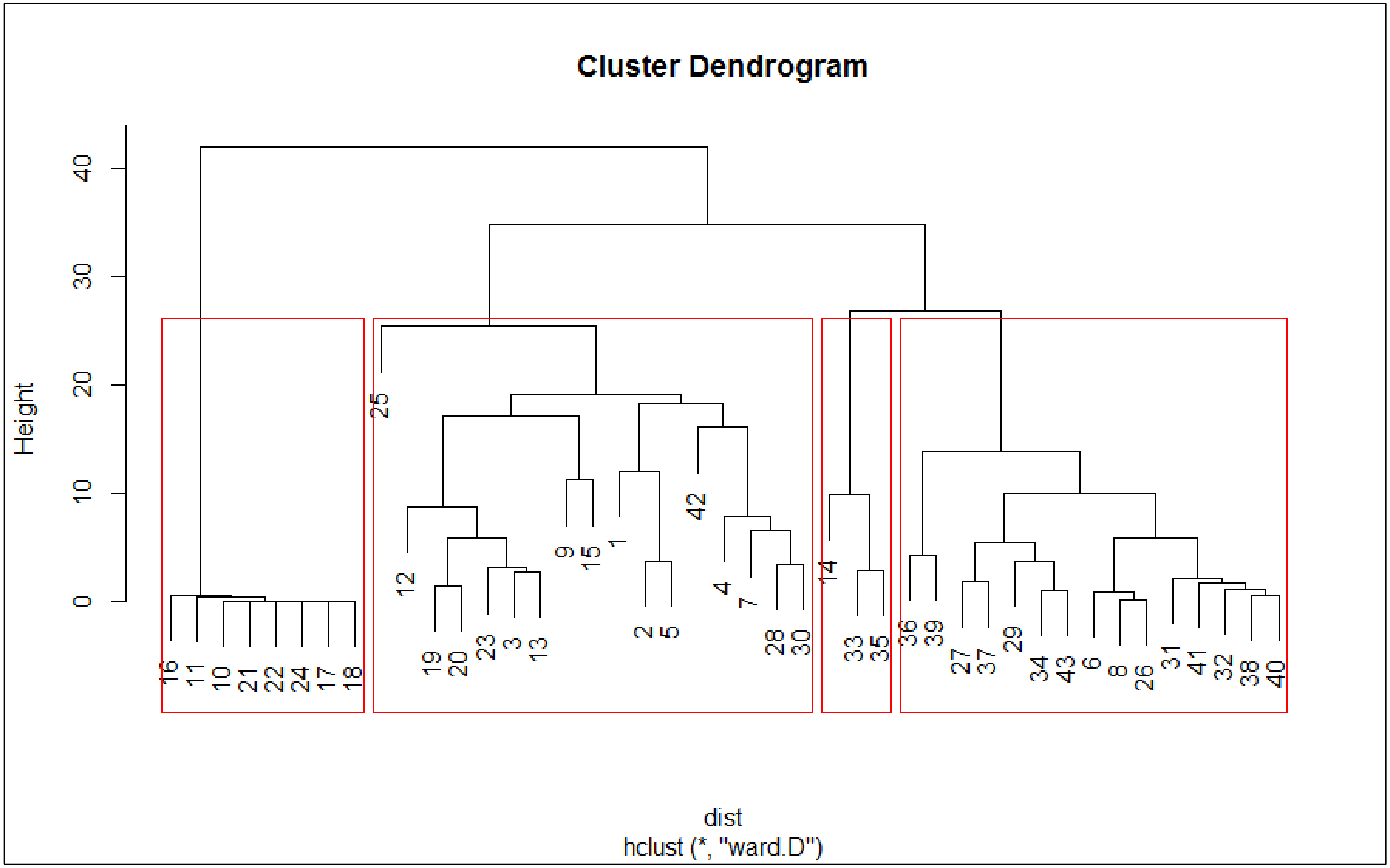



**Figure 87:** Cluster dendogram for biosocial cluster analysis, Late Monongahela sample
Left to right – Cluster 3, Cluster 1, Cluster 4, Cluster 2

## 8.5 DISCUSSION: SOCIAL STATUS AND BIOLOGICAL STATUS AMONG THE MONONGAHELA

### 8.5.1 "Social" Status Among the Monongahela: Previous Research

Few studies have been carried out for the Monongahela that directly assess their social structure via skeletal remains or mortuary analysis. The first multi-site mortuary study of the Monongahela was conducted by Davis (1984), who concluded that spatial segregation was evident for Monongahela burial practices, as adults and young children were buried in separate contexts. The general pattern elucidated from this study was that infants and young children were commonly buried in house floors, whereas adults were associated with flexed burials in the village plaza areas or along the palisades (Davis 1984). It was asserted that ranking was evident among the Monongahela, as only 27% of burials had associated artifacts. Davis (1984) identified an "elite" burial pattern (Burial Pattern A) associated with bone beads, shell artifacts, and other items such as turtle shells, though only 2% of the burials surveyed fit this category. The presence of artifacts in only a small percentage of burials was viewed as a marker of ranked and differentiated status among the Monongahela (Clark 2014).

In a survey of Monongahela mortuary behavior, Means (1999:35) argued that such interpretations of social organization cannot be divorced from village community organization as the "built environment guided, affected, and constrained behavior". This group used areas within the village to delineate sacred vs. secular spaces in a framework that conditioned activities on the household and the communal level. It was suggested that the arrangement of architectural spaces such as the palisades, households, and central plazas within villages were planned intentionally to regulate private vs. communal performance. Villages were not just physical spaces where people lived, but rather in themselves a broad cultural landscape that dictated social relationships and ritual, including mortuary treatment. In many villages, burials were clustered together in specific areas, such as between households or in plazas, indicating that corporate group membership may have influenced burial location. Location of houses, burials, and plazas were arranged in concentric patterns, which may have corresponded with astrological phenomena such as the rising and setting sun (Means 1999, 2001, 2007b). It was emphasized that the majority of burials in Mean's (1999) survey had an easterly orientation, aligning with the rising sun.

The presence of a small percentage of "status" burials with a large number of shells or beads did not indicate a strictly ranked society, as in egalitarian societies individuals can achieve high personal status through actions of war or ritual (Means 1999, 2007a,b). Such positions, as economic leader of a corporate group or shaman, may not be full-time occupations and may disappear with the death of the individual. The meanings of grave good associations are often tied to the utilitarian properties of the object, rather than simply its presence and in the case of the Monongahela many artifact classes fit under "mundane" usage such as simple pottery vessels and lithics (Means 1999). Clark (2014) also examined grave goods, body treatments, and grave orientations from several Monongahela sites such as Johnston, and identified sex specific grave goods; males were associated with items such as drills, lithic points, snail shells, and whole marine shells, whereas females were associated with shell pendants, beads, disks, and ceramic chain production items, though many burials did not contain any sex-specific items. Female sex-specific grave goods tended to appear within infant and child burials, with male-specific goods associated with burials starting in adolescence (Clark 2014). It was emphasized that items of a ritualized nature such as marine shell, increase in frequency between Early, Middle, and Late period sites (Clark 2014). The appearance of charnel houses among the Monongahela is also an important burial feature beginning with the Middle Monongahela, increasing in the Late period with subadult, males, and females represented in this context (Anderson 2002; Clark 2014).

It has been argued that alterations to the mortuary program and village organization among the Middle/Late Monongahela, such as the appearance of charnel houses and reorganization of village spaces, is due to emergent leadership and alterations to social organization (Anderson 2002). At the Household site, 16 skeletons were recovered from a charnel house (included in this study sample), compared to 24 at the Sony site. Large hearth features often accompanied charnel houses and the size of these structures was larger than that of village households of this period (Anderson 2002). At the Sony site, individuals were also buried in typical contexts: subadults in house floors and adults in activity zones within the village. It has been argued that the presence of a charnel house in these contexts indicates that those buried in this manner represented a unique social class as the construction of these burial structures and associated feasting would have required considerable effort on the part of the community (Anderson 2002). At another Late Period site, Foley Farm, social ranking was evident based on the presence of a cluster of burials with associated trade goods such as glass beads, and these burials were separated by distance, indicating specialized areas for the “haves” and “have nots” within this village site (Anderson 2002).

Outside the realms of mortuary analysis, community planning and architectural structure of settlements in the Allegheny Mountains is suggestive of several models of social organization (Means 2007a). Households were likely the basis for units of social organization among the Monongahela (Nass 1995; Nass and Hart 2000). Means (2007) proposed that within villages, formal networks such as kinship or corporate group identity linked households. There is very little evidence for dual organizations in Monongahela villages based solely upon the spatial arrangement of household and public space, but this does not mean that these networks did not exist; sodalities and emergent leadership could have had few tangible material correlates (Means 2007a). Means (2007a) instead argues for a household linked social structure by which small house clusters, linked in spatial groups, represented multifamily or multi-dwelling households and larger dwelling clusters represented larger lineage or clan groups. In this model, status distinctions do not appear to have had a significant influence on village spatial organization in either mortuary or household contexts (Means 2007a).

### 8.5.2 “Social Status” vs. “Biological Status” Among the Monongahela

#### 8.5.2.1 “Social Status” Among the Monongahela

There is much continuity across the Monongahela time periods in terms of burial patterns. Clusters 1 and 2 for both the Early and Middle periods represent undifferentiated burials including males, females, subadults, and unknown adults with few grave goods. Grave inclusions typically included bone items such as awls, lithic fragments, and ceramic fragments. For both of these periods, adults were buried in the village plaza or along the palisades, with the majority of subadults buried in house floors. Bone and shell beads were more commonly associated with subadults than adults, though one outlier was present: a young adult female (FC#442) from the Shippenport site, buried away from the village with a cache of bone and shell beads and a fetus. Similar patterns emerge in the traditional cluster analysis for the Late Monongahela period as for earlier periods. Adults of both sexes and subadults, outside of those in charnel houses, were buried in a similar manner with few grave items. The Late period is distinct in that both Clusters 1 and 3 contained burials from a specialized charnel house from the Household site. Within the charnel house burials, these are roughly undifferentiated but for one subadult burial (FC#9746) with 43 ceramic fragments and 59 shells.

Status distinctions are unclear from these patterns. Post-hoc ANOVA tests showed that males in the Early Monongahela period had significantly higher numbers of ceramic and bone items than males, females, and subadults from subsequent periods (Appendix C, Table 240), but male burials were not differentiated in terms of body position, orientation or body treatment. Two outliers among adults were present: 1 adult male from cluster 4 in the Early Monongahela sample (Hartley Site, FC#4561) and 1 adult male from Cluster 4 of the Middle Monongahela sample (Bunola Site, FC#5074). FC# 4561 had a grave good assemblage including 7 stone items, 34 bone items, 118 ceramic fragments and 9 snail shells. The male burial from the Bunola site included 166 snail shells. Following mortuary features described by Carr (1995) these burials did not reflect significant evidence of vertical hierarchies within the Monongahela complex, as they do not differ in location, body treatment, or orientation than from adult burials with fewer grave goods. Clark (2014) identified ceramic sherds, flake debitage, and animal bone as unisex grave goods for the Monongahela, but snail shells were particularly identified with male burials. In this context, shells were classified as ritualistic grave goods as they were not related to activities of subsistence, household production, communication or ornamentation unless drilled for pendants or fashioned into beads (Clark 2014). It is thus hypothesized that these adult males represent lineage or clan leaders and may have served a role of ritual importance. It important to note that roles of social or ritual significance may not be full-time occupations of the individual associated with a certain grave good type; the identity of these persons was likely multifaceted and not restricted to that communicated in the contexts of mortuary ritual (Carr 1995; Means 1999, 2007b).

The burial structure from the Household site represents a new emergent pattern of mortuary ritual in the Late period. The burials from this structure were included in Clusters 1 and 3 from this analysis (Table 113) and included adults of both sexes as well as subadults. A unique feature of these burials is that none were associated with grave goods except for one subadult; FC#9746 was a subadult buried with 43 ceramic sherds and a cache of 59 marine shells. Previous research has indicated that burial in charnel houses is a marker of emergent elites among the Monongahela in the Late period (Anderson 2002). European trade goods, such as glass beads, have been found in association with other late burials, indicating emergent status categories, possibly associated with trade networks (Anderson 2002; Lapham and Johnson 2002). Participation in the marine shell trade is also hypothesized; evidence of marine shell from Foley Farm and other Late period sites indicates that the Monongahela may have acted as middlemen between groups in the Mid-Atlantic region and groups to the north (Johnson 2001; Lapham and Johnson 2002). Emergent leadership may have been linked to trade networks, however, this cluster analysis does not reflect this status in the form of grave goods. Anderson (2002) suggests that the effort needed to construct a large structure for burial is an indication of higher status of the individuals interred within it. This assertion is also reflected by Carr (1995) as a marker of vertical status hierarchies, thus it is hypothesized that the burials from the Household site, while not differentiated by grave goods except for one case, may represent an emergent social class or rank within a previously egalitarian or non-ranked society.

Without further details, such as specific age categories and biological attributes it is difficult to surmise the nature of status, gender, and social organization among the Monongahela. From these limited data, it is clear that for the majority of the population, ritual or productive roles as well as gendered identity is not clearly delineated via grave attributes or “grave furniture” (Carr 1995). It is demonstrated that gendered social practices were not dictated by grave good type as in this study there were few differences in the number and type of grave goods associated with male, female, and subadult burials (Appendix C). Taken alone, this analysis leads to a conclusion that Monongahela society was likely egalitarian with few individuals gaining recognizable achieved status as evidenced by mortuary ritual with emergent leadership via participation in trade networks in the Late period. The nature of labor and health status will provide greater contextual meaning of social roles with more a nuanced analysis.

#### 8.5.2.2 “Biological Status” Among the Monongahela

The age structure of the clusters of the biosocial cluster analysis is of interest to questions regarding the nature of status, social organization, and gender. For the Early period, the cluster pattern included young females in Cluster 1; adults of both sexes and ages plus early-late children in Cluster 2; middle-aged to old adults of both sexes in Cluster 3; and young to middle aged adults plus neonates, toddlers, children, adolescents and youths in Cluster 4. Discrete groups were not as visible for the Middle Monongahela, with young adults in Cluster 2, while other groups had mixed adult and subadult ages.

Several salient patterns emerge when comparing age groups, burial attributes, and grave goods in the Early and Middle periods: adolescents and older subadults were buried in the village with adults with similar grave good inventories, whereas late children and younger subadults were buried in house floors. Subadults in the Late period appeared in both household and charnel house contexts; an early child (FC#9746) was the only individual in the Household site charnel house that was associated with grave goods (43 ceramic sherds, 59 marine shells). Children in the past were active participants in the social and productive environment within societies rather than passive participants in a static social framework (Halcrow and Tayles 2011). Childhood is a time of learning, becoming, and engendering (Sofaer 2011). In many archaeological cases, infants and young children were afforded different burial treatment than adults in society, such as different burial placement, grave good assemblages, or body treatment (Baxter 2005; Halcrow and Tayles 2011; Lewis 2007). Differential mortuary treatment likely fell along the lines of views of identity and personhood, with children at different ages having varied roles and identities (Halcrow and Tayles 2011). Infancy and childhood are critical periods of growth and development, where individuals are highly vulnerable to mortality from disease and malnutrition (Halcrow and Tayles 2011). Complex arrangements for the physical care and social conditioning of children were made in the past in light of these factors (Baxter 2005; Halcrow and Tayles 2011; Willis and Oxenham 2016). In the case of the Monongahela, the burial of younger subadults within the floors of houses reflects this type of care, as does the fact that younger subadults were more likely to be buried with items of personal ornamentation such as beads than adolescents and adults (Willis and Oxenham 2016). The household was the unit of the family or kin group, and the preference for mortuary ritual may have been to keep individuals who had not yet reached maturity close to the home and clan (Baxter 2005; Lewis 2007). In this pattern, adolescence was then a period of transition for Monongahela youth, representing the age at which individuals were initiated into adult roles as reflected by the mortuary pattern, as adolescents were buried in similar fashion to adults. Here, adolescence was an important marker of personhood among the Monongahela as the point in time when individuals reached perceived sexual maturity and social adulthood.

Adult age categories are another important axis for this cluster analysis. Discrete burial groups are seen for both young adults (Cluster 1 – Early, Cluster 2 - Middle) and old adults (Cluster 3 – Early). In both the Early and Middle periods, young adults were associated with unvaried grave goods in low numbers (<10 total items): ceramic, bone and lithic items. A unique feature of Cluster 1 in the Early period is that it is entirely comprised of female youths and young adults, with one unsexed adolescent. Young adult males in the Early period clustered with both females and subadults, meaning that there was no emergent burial pattern for this cohort tied with biological variables such as activity, dental disease, and osteoarthritis. The older age cluster in the Early period had a significant feature in terms of mortuary ritual, as this group was associated with higher grave good counts than younger age cohorts. In the Middle period, an old adult male burial (FC#5040) was associated with 166 snail shells. A middle-aged male (FC#4561) was associated with 118 total items, including shell items that may have had ritual significance (Clark 2014). Thus, age was likely the largest factor in emerging social status, with middle-aged to old adults taking on higher status roles, though it is important to stress that both sexes are present in the Early period group associated with high numbers of grave goods and old age. Different patterns emerge when the Late period is examined with respect to age. There were no emergent adult age clusters that had distinctive age patterns, though Cluster 3 was entirely comprised of late children and younger subadults buried in house floors. Grave goods were comparatively rare for this period in contrast with the Early and Middle period. Adults of all ages were included in charnel house contexts as well as village burial contexts.

Productive roles were heavily correlated with age, rather than with mortuary contexts. In the Early and Middle periods, clusters with more middle-aged and old adults were associated with high MSMs in both the upper and lower limbs, whereas clusters that were comprised of younger adults were associated with low MSM scores (Cluster 1 – Early, Cluster 2 – Middle, Cluster 4 – Late). In the Late period, both adults in charnel house contexts and village burials were associated with high upper and lower limb MSMs. Frequencies of osteoarthritis tended to follow the same patterns; clusters with middle-aged and old adults were associated with upper and lower limb OA. These patterns are congruent with the MSM scores, which were significantly correlated with old age (See Chapter 7). Blunt force trauma was also associated with clusters with high MSMs in both the Middle and Late periods irrespective of burial location or grave good counts. The majority of trauma in this collection was antemortem healed trauma, likely associated with occupation or small-scale raiding (See Chapter 6), though the presence of injury does not appear to have played a key role in social status or mortuary ritual as evidenced by its distribution across age and sex classes as well as burial types. There were few notable differences in activity, OA, and trauma in the cluster analysis respective of sex, indicating that age was a greater determinant of status and labor. Given that older adults had the highest MSMs, it is an indication that across the Monongahela periods, individuals were active in agricultural labor and hunting activities well into old age. This aligns with other anthropological studies in other geo-temporal contexts in which high MSM scores were correlated with old age (Niinimäki 2012; Stefanovic and Porcic 2013).

Pathology is another indicator of gender and social organization that can be examined through cluster analysis. For all Monongahela periods, dental disease was part of the principal components that were weighted in determining the structure of the clusters. For all periods, dental disease appears in higher frequencies in clusters with middle-aged and old adults. Antemortem tooth loss can be associated with age, as the longer an individual is exposed to cariogenic foodstuffs, the greater the chance of developing caries, subsequent tooth loss, and periodontal disease (Appleby 2010). Unique patterns for the Late period emerge when linear enamel hypoplasia is examined. For earlier periods, LEH was not present in high enough frequencies to be weighted in PCA analysis, but for the Late period sample, LEH was a component of PCA 3. In the biosocial cluster analysis, it was shown that LEH was present in both Clusters 1 and 2; Cluster 1 was associated with village burials, whereas Cluster 2 was primarily associated with burials in the Household site charnel house. This is an important aspect of the picture of the intersection between disease and status in the Late period, as it shows that individuals of both high status (Cluster 2 charnel house burials) and non-high status had skeletal indicators of stress (LEH), indicating that factors such as chronic disease and malnutrition affected both subsets of the population during childhood.

One significant feature of the Late period is the effect of the Little Ice Age on health and activity. According to Richardson et al. (2002). Late Monongahela site structure indicates community consolidation, suggesting population movement and aggregation into smaller territory (Richardson et al. 2002). At the beginning of the Monongahela complex, the Medieval Warming Period (900-1300AD) introduced the ideal climate for maize agriculture. Cooling temperatures brought about by the Little Ice Age (1400-1900AD) decreased the number of frost free days in the region as well as increased drought conditions that would have made maize agriculture difficult to sustain (Richardson et al. 2002). These factors, combined with other climactic events such as El Niño and volcanic eruptions, may have “pushed the Monongahela over the edge” leading to decreasing territory after 1580AD and ultimate disappearance from the regional landscape of the Ohio Valley just before 1635AD (Richardson et al. 2002:89). Other factors such as the spread of European disease through indirect contact and raiding by the Seneca also contributed to the Monongahela disappearance (Richardson et al. 2002). With drought conditions and cooler climate, subsistence strategies would have necessarily been altered or intensified, and the significant increase in MSM robusticity from previous period is one more line of evidence to this effect. Paleopathological evidence from this study supports increased resource stress or disease; rates of stress indicators increased in the Late Monongahela sample from the Middle Monongahela. For example, between these periods rates of cribra orbitalia and linear enamel hypoplasia among subadults increased from 11.4% to 21.4% and 11.5% to 21.4% respectively. The paleopathological evidence in conjunction with increased activity marker robusticity indicates that the Late Monongahela was a time of increased stress from disease, resource depletion, and increasing labor demands. These patterns may have resulted from climatological events that significantly interrupted subsistence strategies (Richardson et al. 2002).

When age categories, burial patterns, activity, dental disease and stress indicators are considered in the biosocial cluster analysis, a clearer picture of gendered social processes, status, and health emerges for the Monongahela. It is clear that status distinctions were not tied to sex but rather age, with old adults represented in burial contexts with higher caches of grave goods in the Early and Middle periods. Productive roles were not differentiated by sex, and subsistence activity carried into old age for all the Monongahela periods, indicating that while emergent leadership and/or ritual roles were associated with age, this role did not exclude individuals from contributing to group labor efforts. Gendered patterns of social organization followed an egalitarian model with respect to sex, with individuals of old age emerging as important ritual or clan leaders. This is consistent with social organization models of gerontocracy among the Iroquoians as argued by Noel (2011). Childhood was also a unique identity among the Monongahela, with pre-adolescents having a role and identity closely tied with the household and kinship affiliated space. Other marked features of status, health, and gender emerge when the Late period is examined; it was suggested that individuals buried in charnel house contexts represented emergent elites (Anderson 2002). When the Household site charnel house burials were examined as part of this cluster analysis, it was evident that patterns of dental disease, activity, and stress were not significantly different from that of individuals buried in village areas, with a similar age/sex structure represented in both contexts. Thus, emergent high status in the Late period was likely tied with membership to a specific kin group rather than productive role, sex, or age (Anderson 2002).

### 8.5.3 The Monongahela: Specialized Contexts

#### 8.5.3.1 In-situ Mother and Fetus

One mother and fetus burial among the Monongahela samples was a distinct outlier from the general burial pattern. A young adult female (FC#442) burial from the Shippenport site was located under a tree outside the confines of the village. She was placed on her right side in a flexed position. There were 30 bone beads in the pelvis region, and 44 shell beads in the neck region, as well as 4 projectile points located within the thoracic cavity. One additional point was embedded in the left 12$^{th}$ rib, adjacent to the vertebral articulation. The remains of a 24-week fetus were recovered from the pelvic area (Mayer-Oaks et al. 1952). Archaeologists originally noted that this burial was unusual for Monongahela contexts based upon Mary Butler's (1939) cultural definition of the tradition (Mayer-Oaks et al. 1952). Current models, such as the cluster analyses in the current study, also recognize this burial as an outlier from expected burial patterns: adults buried within the village and subadults in house floors.

Mayer-Oaks et al. (1952) argued that this burial represented an elite female, based on the high number of beads, who was killed by violent projectile injury. They proposed several scenarios to account for the fetal bones in the burial. First, it was suggested that the location of the fetal bones in the pelvic area, but not entirely within the pelvic inlet, was indicative that the young woman was not pregnant at the time of death. It was then argued that the fetal bones could represent a miscarriage brought about by the death of the woman, with the bone beads in the pelvic region representing a raiment or shroud covering the fetal remains. Another scenario was posited; the fetus was possibly not biologically related to the female in the burial and was perhaps part of a bead covered "medicine bag" that had been buried with its owner (Mayer-Oaks et al. 1952). The majority of these scenarios are unlikely based on the present analysis. The most likely explanation for the presence of fetal bones in the burial is that the young adult female was pregnant at the time of death. The specific location of several of the fetal bones was not recorded at the time of excavation. It is also possible that soil shifting or animal disturbance near the burial could have shifted the position of the fetal bones out of the pelvic inlet.

This burial is interesting on several theoretical levels as it represents both a pregnant individual as well as an individual who died a violent death. Very few cases of in-situ fetal maternal burials have been cited in bioarchaeological literature (Agusti and Codina 1992; Campillo et al. 1998; Cruz and Codinha 2010; Flores and Sanchez 2007; Hawkes & Wells 1975; Hogberg et al. 1987; Judd 2012; Lieverse 2015; Malgosa et al. 2004; Owlsley and Bradtmiller 1983; Persson and Persson 1984; Pol et al. 1992; Pounder et al. 1983; Segui et al 2005; Sjovold et al. 1974; Wells 1978; Willis and Oxenham 2011). Death in childbirth in prehistory was by no means rare, but despite this the loss of a mother and child would have been seen as tragic. In some cases, maternal fetal deaths have historically been given special mortuary treatment, though this is not a cultural universal (Sayer and Dickinson 2013). It should be emphasized that the lack of female-fetal in-situ burials in the archaeological record may be due to several factors: preservation bias, excavation bias, and differential burial location for fetus/infant burials (Willis and Oxenham 2011).

In the case of FC#442, this burial is not representative of childbirth death, but rather violent injury or accident by arrow wound, unrelated to the individual's pregnancy. It is argued that an unexpected and unnatural cause of death of a pregnant woman would have been seen as a rare event in which greater societal grief was invested (Sayer and Dickinson 2013). There is a growing body of literature regarding the bioarchaeology of care of individuals, but primarily this focuses on the care of individuals who are visibly ill/disabled, or of children and the elderly (Oxenham and Willis 2016). The case of this unusual burial brings forth the idea in which pregnancy could be classified as a unique gendered identity or liminal phase. Like gender itself, pregnancy and childbirth are processes of 'change and becoming' in which a new individual is brought into a society, processes through which the physical body is altered, and the cultural role of the mother may shift. Cultural attitudes towards women, bodies, and birth may be reflected in mortuary processes regarding fetuses, infants, and women (Geller 2016). In many societies, blood and other bodily functions associated with fertility and birth are considered culturally taboo, and specialized structures or spaces are created for and by women for these practices (Geller 2016). Burial may be another context through which cultural beliefs and agencies of fertility are expressed.

## 8.6 POST-CONTACT SAMPLE

### 8.6.1 PCA/MCA Analysis Results

Tables 115-118 contain PCA/MCA results for grave attributes, grave goods, and biological variables, with features of each category listed in Table 119.

**Table 115:** Post Contact grave attribute PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Head Orientation | **0.964277875** | **0.623522726** | **1** |
| Leg Flexure | **0.989145614** | 0.001776937 | 0.0000007 |
| Body Position | **0.989145614** | 0.001776937 | 0.00000007 |
| Treatment of Body | 0.020575364 | **0.579766669** | 0.00000014 |

**Table 116:** Post-Contact grave good PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Stone | 0.070237699 | 0.071526374 | 0.023219447 |
| Bone | 0.00005817 | 0.00008864 | 0.007407553 |
| Lithics | 0.013714298 | 0.142005318 | **0.675853948** |
| Ceramics | 0.002202104 | 0.071915767 | **0.382383375** |
| Wood | 0.024353904 | 0.063429466 | **0.387759987** |
| Copper | 0.285764341 | **0.447392635** | 0.002967788 |
| Silver | 0.2568381 | 0.115332316 | 0.01544373 |
| Brass | 0.015118798 | 0.011460259 | 0.009843699 |
| Iron | 0.277413392 | 0.292357402 | 0.079359395 |
| Cloth | 0.173020865 | 0.080156139 | 0.004556269 |
| Total Items | **0.447959971** | 0.019820238 | **0.370323574** |
| Metal Beads | 0.383559214 | **0.341357006** | **0.225077321** |
| Shell Beads | **0.510887999** | **0.326401215** | 0.000815793 |
| Glass Beads | **0.542940031** | 0.004212876 | 0.001058557 |
| Metal Bead Location | 0.383559214 | **0.341357006** | **0.225077321** |
| Shell Bead Location | 0.773074251 | 0.028769856 | 0.026718065 |
| Glass Bead Location | **0.84889332** | **0.729274836** | **0.312338287** |

**Table 117:** Post-Contact biological attributes (MSMs) PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Left Deltoid - Clavicle | 0.367941231 | 0.016741455 | **0.239336972** |
| Right Deltoid – Clavicle | 0.233648327 | 0.168306219 | 0.002949788 |
| Left Trapezius | **0.440039942** | 0.008531484 | 0.003133881 |
| Right Trapezius | **0.440039942** | 0.008531484 | 0.003133881 |
| Left Pectoralis Major - Scapula | 0.334192232 | 0.015309504 | **0.349890727** |
| Right Pectoralis Major – Scapula | 0.334192232 | 0.015309504 | **0.349890727** |
| Left Pectoralis – Humerus | 0.042869505 | 0.006417583 | 0.025190761 |
| Right Pectoralis – Humerus | 0.063137467 | **0.303966441** | 0.144852405 |
| Right Latissimus Dorsi | 0.141724343 | 0.207850121 | 0.065152977 |
| Left Deltoid – Humerus | 0.300748215 | 0.011629881 | 0.159554462 |
| Right Deltoid – Humerus | 0.053935253 | **0.521801019** | 0.123069496 |
| Right Extensors | **0.416037072** | 0.046653982 | 0.051338822 |
| Right Flexors | **0.148259945** | 0.004650568 | 0.155860786 |
| Left Brachialis | **0.416037072** | 0.046653982 | 0.051338822 |
| Right Brachialis | 0.148259945 | 0.004650568 | 0.155860786 |
| Left Anconeus | 0.086076956 | **0.382847998** | 0.021117725 |
| Right Anconeus | **0.115947543** | **0.599651292** | 0.010361747 |
| Left Triceps | **0.32942536** | 0.239193436 | 0.045005479 |
| Right Triceps | **0.450194923** | 0.052918422 | 0.106697017 |
| Left Biceps | 0.27981916 | 0.19497058 | 0.007120835 |
| Right Biceps | 0.3706338 | 0.278413682 | 0.000280363 |
| Left Pronator Teres | 0.222053565 | **0.545765491** | 0.041063827 |
| Right Pronator Teres | **0.480098274** | 0.026222975 | 0.000102856 |
| Left Adductor Magnus – Innominate | 0.137089605 | 0.054641049 | 0.001323072 |
| Right Adductor Magnus – Innominate | 0.211971206 | 0.000397839 | 0.047834083 |
| Left Gluteus Maximus – Femur | **0.487077085** | 0.033610756 | **0.28615955** |
| Right Gluteus Maximus – Femur | **0.573014471** | 0.247324041 | 0.001199513 |
| Left Adductor Magnus – Femur | **0.400962257** | 0.181418239 | 0.111359365 |
| Right Adductor Magnus – Femur | **0.639572824** | 0.010634742 | **0.130325054** |
| Left Vastus Intermedius | **0.399448846** | 0.067410053 | 0.099675377 |
| Right Vastus Intermedius | **0.544371074** | 0.002615172 | **0.298416398** |
| Left Vastus Medialis | **0.539905141** | 0.041845305 | **0.254950452** |
| Right Vastus Medialis | **0.796283145** | 0.105085664 | 0.001443519 |
| Left Vastus Lateralis | **0.493847466** | 0.048208281 | **0.20919266** |
| Right Vastus Lateralis | **0.764094798** | 0.062054356 | 0.011566976 |
| Left Gastrocnemius | **0.412897728** | 0.041333209 | **0.276740121** |
| Right Gastrocnemius | **0.721410499** | 0.132982579 | 0.038112838 |
| Left Iliacus | 0.298691002 | 0.290026461 | 0.030571544 |
| Right Iliacus | 0.338177107 | 0.215916999 | 0.0231572 |
| Left Pectineus | 0.321726693 | 0.000160227 | 0.298126208 |
| Right Pectineus | **0.725298122** | 0.041682751 | 0.004425829 |
| Left Soleus | 0.054773753 | 0.001133533 | 0.005046617 |
| Right Soleus | **0.348477552** | 0.026765387 | 0.163849982 |

**Table 118:** Post-Contact biological attributes (pathology) PCA scores

| Variable | PCA1 | PCA2 | PCA3 |
|---|---|---|---|
| Schmorl's Nodes | 0.321860482 | 0.019749262 | 0.160046145 |
| Cribra Orbitalia/Porotic Hyperostosis | **0.409015523** | 0.104757808 | 0.142522623 |
| Linear Enamel Hypoplasia | 0.015189931 | **0.290466452** | 0.043664408 |
| Upper Limb Osteoarthritis | 0.005318339 | 0.139952403 | 0.005691028 |
| Lower Limb Osteoarthritis | 0.114943051 | 0.003864365 | 0.002317754 |
| Vertebral Osteoarthritis | **0.133144438** | 0.011927269 | 0.00005048 |
| Antemortem Tooth Loss | 0.019232043 | 0.002428539 | **0.424111915** |
| Caries | 0.014175557 | 0.107768336 | 0.000191479 |
| Periodontitis | 0.00838504 | 0.000000136 | 0.001840495 |
| Dental Calculus | 0.104879424 | 0.052155608 | 0.025203716 |
| Non-specific Infection | 0.000678875 | 0.001570897 | 0.006089897 |

**Table 119:** Post-Contact PCA components for grave attributes, grave goods, and biological attributes

| PCA | Grave Attributes | Grave Goods | Biological Attributes |
|---|---|---|---|
| PCA1 | Head orientation, leg flexure, body position | Total items, shell beads, glass beads, glass bead location | Left/right trapezius, right flexors/extensors, left brachialis, right anconeus, left/right triceps, right pronator teres, left/right gluteus maximus, left/right adductor magnus, left/right vastus intermedius, left/right vastus medialis, left/right vastus lateralis, left/right gastrocnemius, right iliacus, right soleus, cribra orbitalia, vertebral osteoarthritis |
| PCA2 | Head orientation, treatment of body | Copper items, metal beads, shell beads, metal bead location, glass bead location | Right pectoralis, right deltoid, left/right anconeus, left pronator teres, LEH |
| PCA3 | Head orientation | Lithics, ceramics, wood, total items, metal beads, metal bead location, glass bead location | Left deltoid, left/right pectoralis major, left gluteus maximus, right adductor magnus, right vastus intermedius, left vastus medialis, left gastrocnemius, AMTL |

### 8.6.2 Mortuary Cluster Analysis Results

The attributes of each cluster are listed in Table 120, whereas the demographic structure of each cluster is depicted in Figure 88. A cluster dendogram is pictured in Figure 89. Cluster 1 consisted of males, females, and subadults in extended burials with high number of glass beads, high grave good counts, low counts of shell beads, and moderate counts of lithic items. Cluster 2 included males, females, and subadults in extended burial with a low number of grave goods, glass beads, and lithics. Only 1 female represented Cluster 3; this burial was oriented east in the extended position with 821 glass beads, 39 total items, 19 metal beads, and 19 shell beads. Cluster 4 included males, females, subadults, and unknown adults in extended burials with moderate numbers of grave goods, moderate numbers of glass beads, and low counts of lithic items.

**Table 120:** Post-Contact - traditional demographic-mortuary cluster analysis

| Cluster | Demography | Grave Attributes | Grave Goods |
|---|---|---|---|
| 1 | 2 Males, 4 Females, 3 Subadults | Easterly or western orientation, extended burials, cemetery | Large grave good count: >30 items, <60 lithics<br>Beads: 76-1000 glass beads, low numbers of shell beads (<50), |
| 2 | 1 Male, 4 Females, 1 Subadult, 12 Unknown | Unknown orientations, extended burials | Low grave good counts: <30 items, <10 lithics, No to moderate glass beads (<250), |
| 3 | 1 Female | East orientation, extended inhumation | Moderate grave goods: 39 total items<br>Beads: 821 glass beads in fill, 39 total items, 19 metal beads, 19 shell beads |
| 4 | 2 Males, 7 Females, 14 Subadults, 6 Unknown | South, West and East orientations, extended inhumations | Low grave goods: <30 total items, <5 lithics<br>Beads: low to moderate/high glass beads (0-645) |

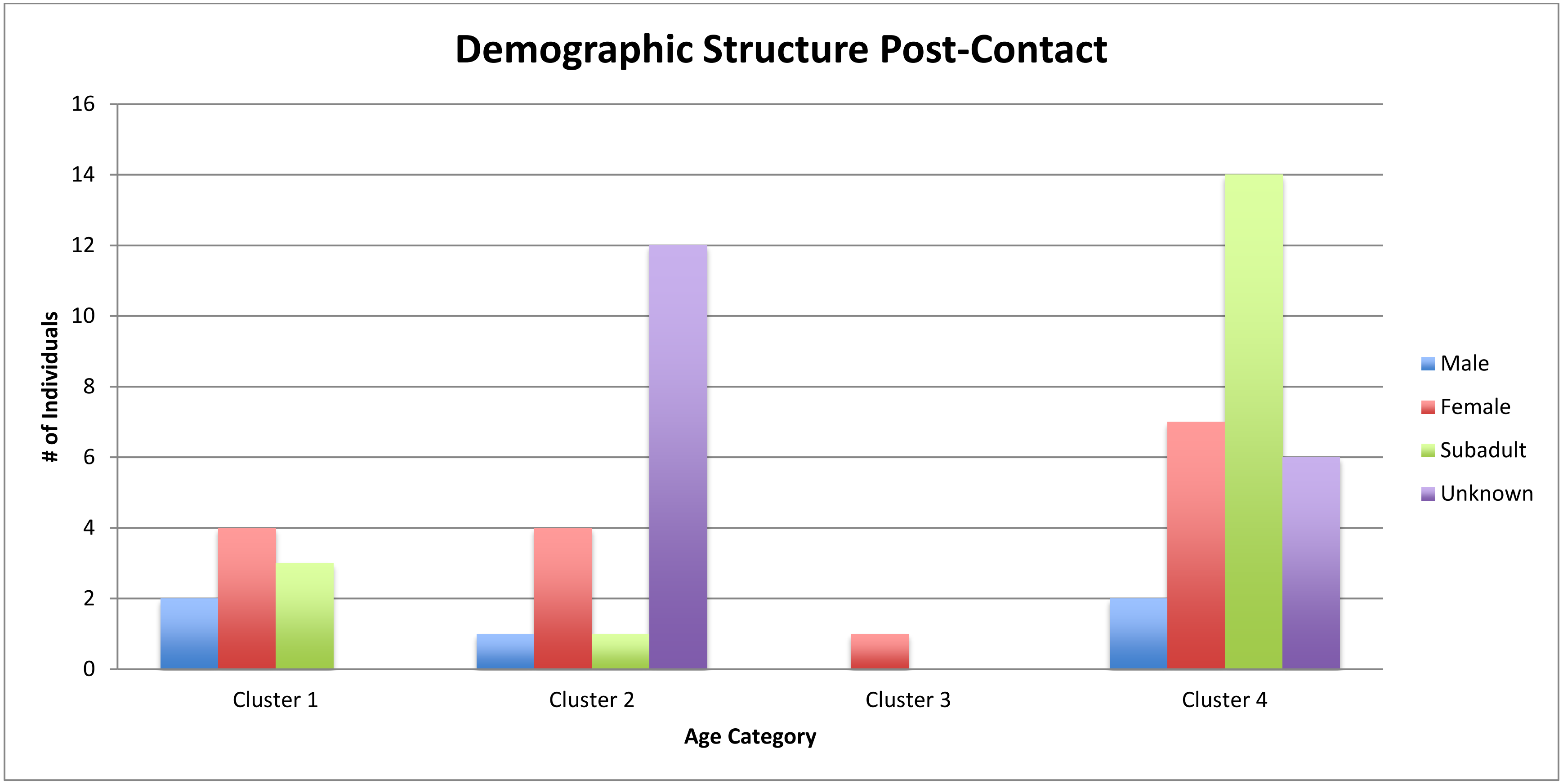



**Figure 88:** Post-Contact - traditional demographic-mortuary structure cluster analysis by age/sex

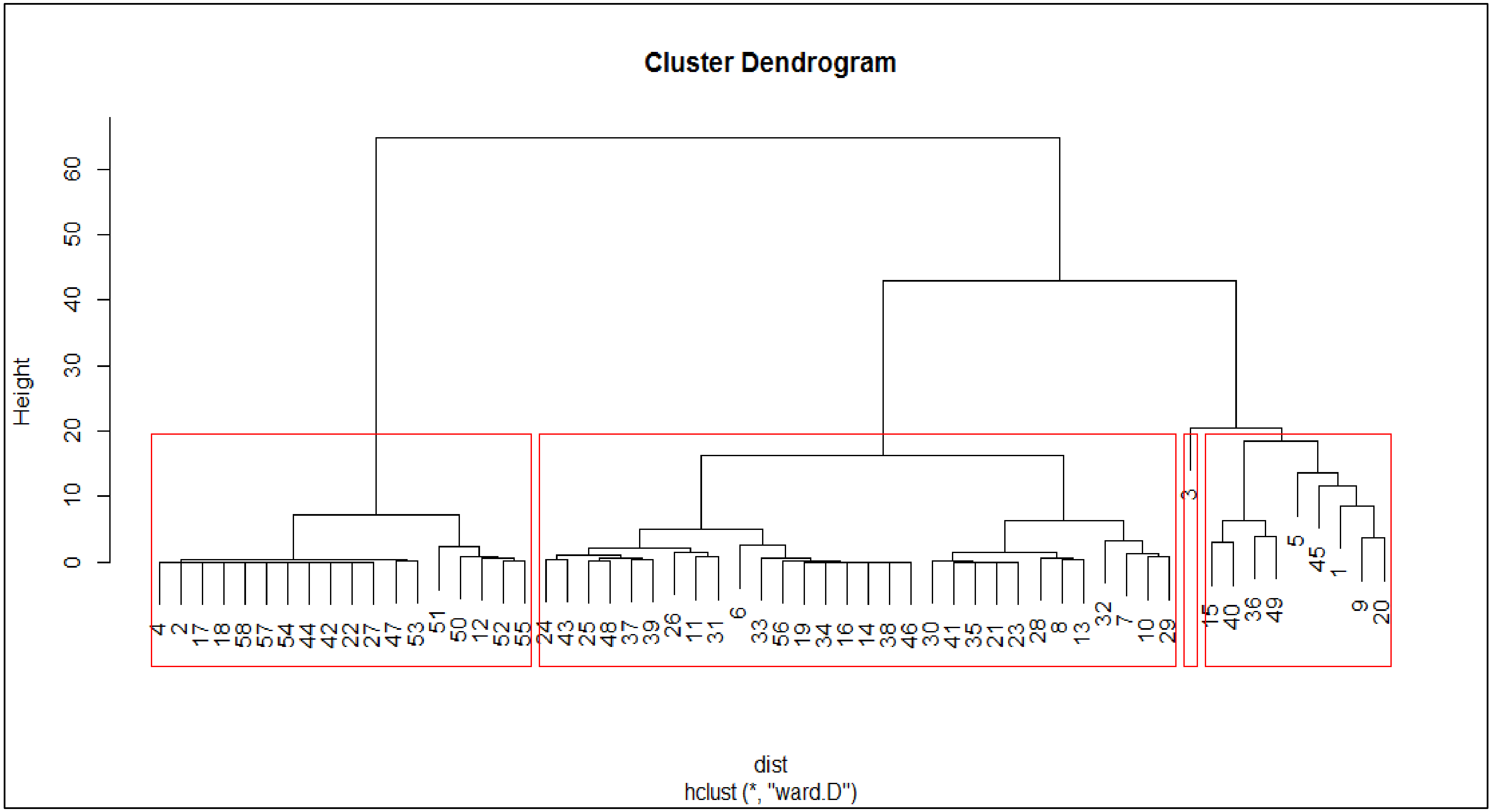



**Figure 89:** Cluster dendogram, mortuary cluster analysis, Post-Contact sample
Left to right – cluster 2, cluster 4, cluster 4, cluster 1

### 8.6.3 Biosocial Cluster Analysis Results

Attributes of each cluster are listed in Table 121 and demographic profiles are depicted in Figure 90. Figure 91 shows a cluster dendogram depicting the distribution of burials in each cluster. Cluster 1 was comprised of adults of all ages and both sexes, with 1 early child, 2 adolescents and 1 youth. This cluster represents individuals with low to moderate upper limb MSMs and moderate lower limb MSMs. Burials in Cluster 1 were associated with higher grave good counts (<60 items), high counts of glass beads, lithic items, and metal/shell beads. Cluster 2 was comprised of females, 1 youth and unknown burials associated with low to moderate grave good counts and low to moderate upper limb MSM scores, and low lower limb MSM scores. Cluster 3 included adults of both sexes, primarily of middle age, with moderate grave good counts and low MSM scores. Subadults primarily are included in Cluster 4, ranging from toddler to youth, with 5 females ranging from youth to middle age. Cluster 4 burials are associated with few grave goods and low MSM scores, but there was a high amount of missing MSM data for this cluster. Stress indicators and AMTL were present in all clusters.

**Table 121**: Post-Contact - biosocial cluster analysis demographic, mortuary, and biological features

| Cluster | Demography | Grave Attributes | Grave Goods | Biological Features |
|---|---|---|---|---|
| 1 | 2 Adolescents, 1 Youth, 1 Adult Male, 1 Young Adult Male, 1 Middle Aged Male, 1 Adult Female, 1 Female Youth, 2 Middle Aged Females, 1 Old Adult Female, 1 Early Child | East, West, and South orientations, extended burials | High grave goods: <60 total items, <37 lithics<br><br>Beads: 60-1239 glass beads, low counts shell beads and metal beads in 1 female burial | Upper Limb MSMs: low to moderate deltoid, low brachialis, biceps, triceps, pronator, supinator,<br>Lower Limb MSMs: Low to high gluteus maximus, low to moderate adductor magnus, low to moderate quadriceps, moderate soleus<br>Vertebral Osteoarthritis, Cribra orbitalia, LEH, AMTL |
| 2 | 1 Youth, 4 Adult Females, 12 Unknown | Unknown orientation, extended burials | Low grave goods: <30 total items, <10 lithics<br><br>Beads: low glass beads (<280), | Upper Limb MSMs: low pectoralis, low to moderate deltoid<br>Lower Limb MSMs: low gluteus maximus, adductors, quadriceps, soleus, Cribra orbitalia, AMTL |
| 3 | 2 Middle Aged Males, 2 Adult Females, 1 Middle Aged Female | East or Southwest orientation, extended burials | Moderate grave goods: <50 total items<br><br>Beads: 300-700 glass beads, shell beads | All MSMs low score<br>Vertebral Osteoarthritis<br>Cribra orbitalia, LEH, AMTL |
| 4 | 3 Toddlers, 3 Early Children, 2 Late Children, 3 Adolescents, 2 Youths, 6 Unknown, 2 Adult Females, 2 Female Youths, 1 Middle Aged Female | East, West, and South orientations, extended burials | Low grave goods: <30 total items<br><br>Beads: Low glass beads (<100)<br>1 outlier: female (FC# 3403) with 545 glass beads | All MSMs low score, missing data<br>Cribra orbitalia, LEH, AMTL |

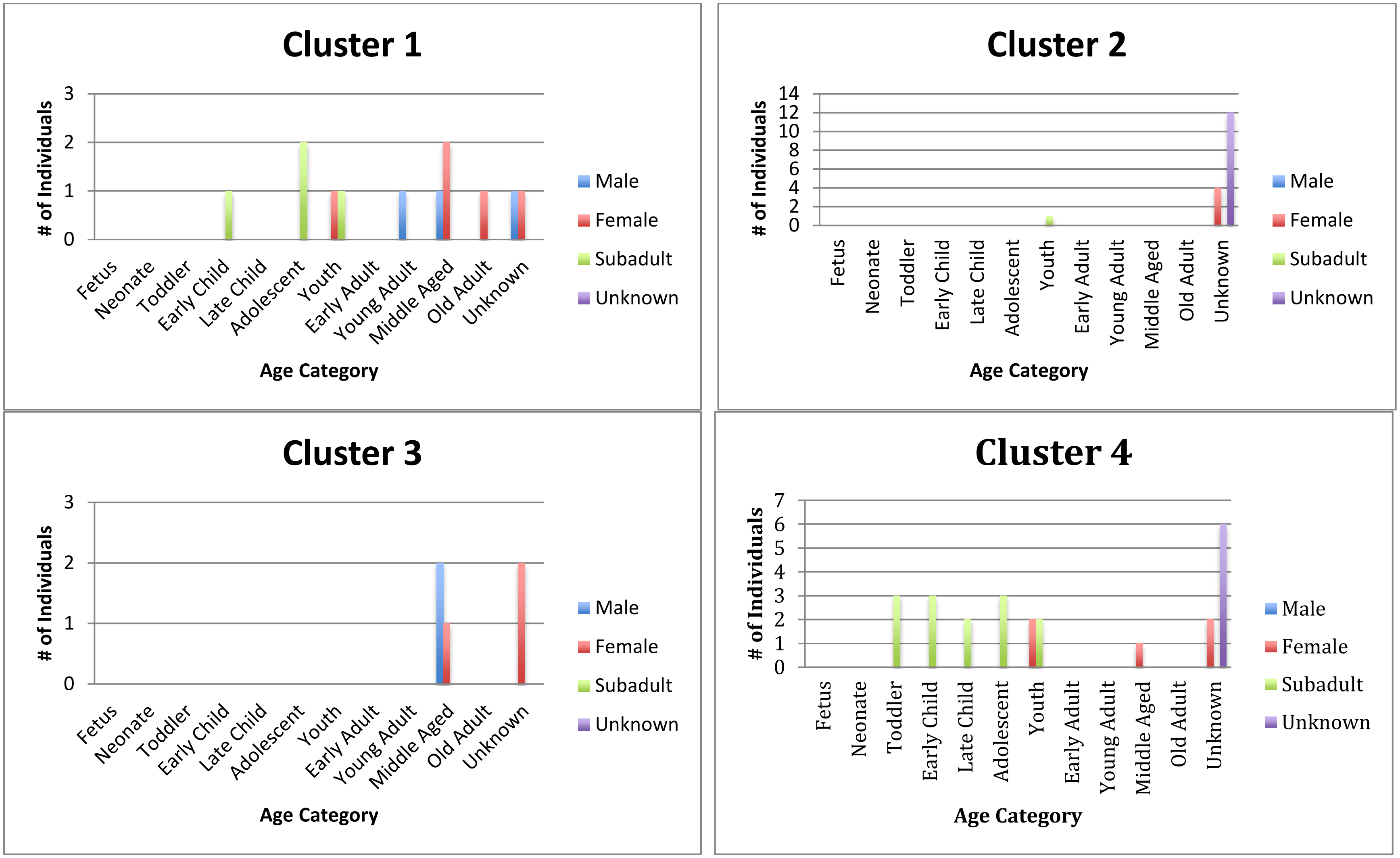



**Figure 90:** Post-Contact - biosocial demographic structure by cluster

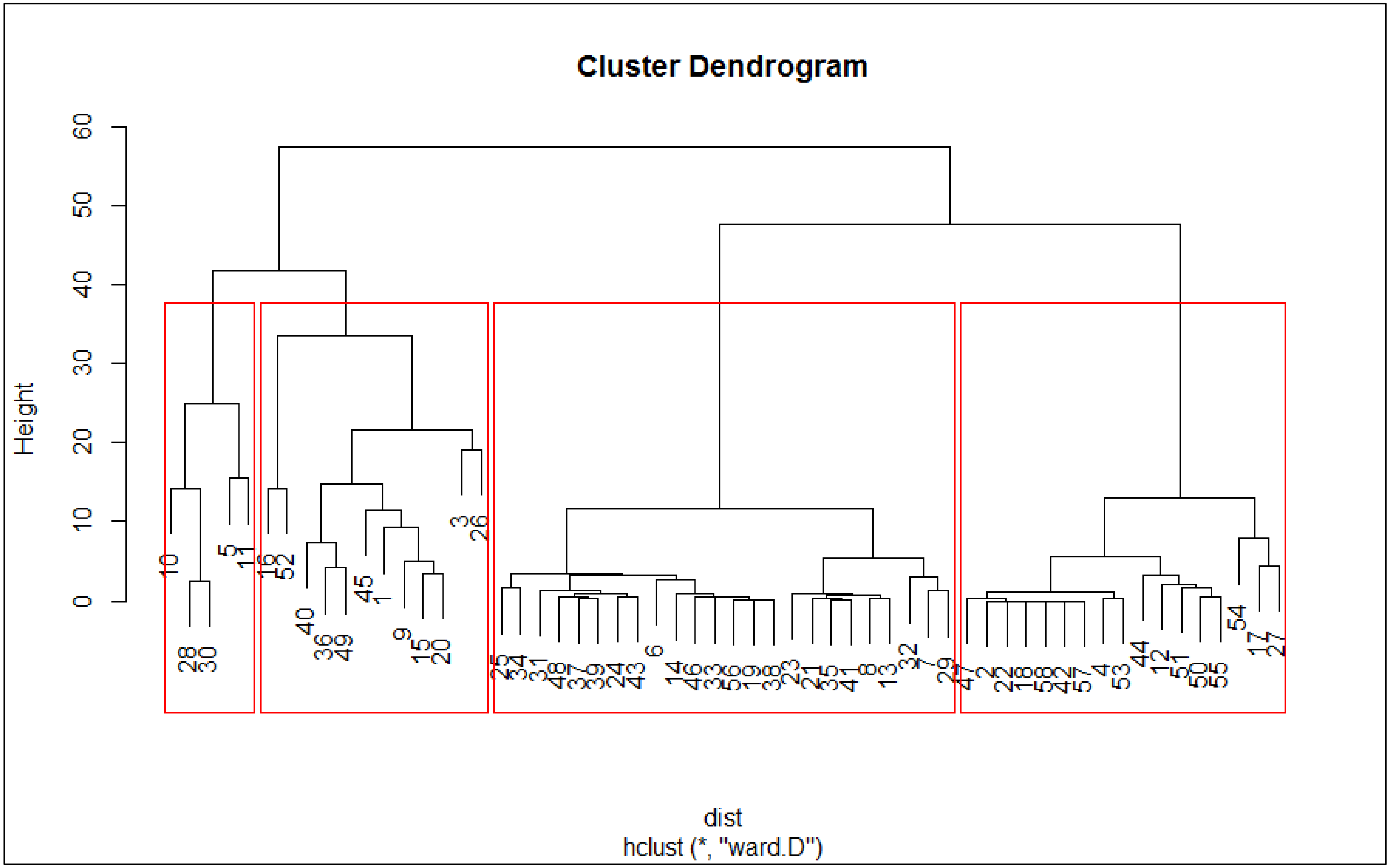



**Figure 91:** Cluster dendogram, biosocial cluster analysis, Post-Contact Sample
Left to right – cluster 3, cluster 1, cluster 4, cluster 2

## 8.7 DISCUSSION: SOCIAL STATUS AND BIOLOGICAL STATUS IN THE POST-CONTACT ERA

### 8.7.1 Life Among the Delaware and Ohio Country Groups: Historical and Archaeological Perspectives

The Post-Contact sample is comprised entirely of burials from the Chamber's site, a cemetery in Lawrence County, Pennsylvania. This cemetery was associated with the nearby Kuskuskies Towns, inhabited by indigenous peoples from the Delaware Tribe (Brown et al. 2014; McConnell 1992). By the early 1700's, the Delaware had been forced to move westward into the Ohio Country from their original territory in eastern Pennsylvania and New Jersey (Obermeyer 2009). Historical maps show that the Kuskuskies Towns may have had affiliations with Iroquoian nations (Mitchell 1755). The period of intensive occupation by the Delaware was from the mid-1750s to 1778, after the Delaware pulled back from settlements at Kittanning following British raids (Croghan 1759-1763; LeRoy and Leininger n.d.). The towns were along trade routes and commonly traveled trails (Wallace 1971). The presence of trade silver in indigenous graves, including those from the Chamber's Site, indicate that indigenous groups living in the Kuskuskies Towns were actively engaged in trade with Europeans (Cowin 2003). Cowin (2003) argued that hides and pelts were a commodity for indigenous groups in the region.

Life in the Kuskuskies Towns reflected a people that had incorporated European lifeways into traditional Native American social structures. Houses took the form of European style cabins, and these indigenous communities adopted animal husbandry; families kept pigs, chickens, and cattle and developed a preference for European cookware alongside native made wooden and ceramic items. Milk and butter were favored foodstuffs alongside traditional native foods made of maize and beans (Croghan 1759-1763; Heckewelder n.d: 41-44, Jones 1772-1773: 57, Kenny 1761-1763: 22, McConnell 1992). It is important to stress that while Native American groups had adopted many aspects of European material culture and subsistence, these aspects were incorporated and interpreted within an indigenous world view (McConnell 1992). Investigations of Delaware burials have noted that European trade silver (Figures 92-93), glass beads (Figure 94), brass bells, tinklers, and thimbles (Figure 95-96) were incorporated into indigenous burial practices (Brown et al. 2014; Cowin 2003).

Social organization and political leadership fell under the control of headmen, including some notable historical figures such as Shingas and Tamaqua, who were Delaware leaders who played key roles in conflict and diplomacy. Shingas promoted resistance to the British and was a key organizer of some indigenous efforts to this effect (Brown et al. 2014; McConnell 1992). His brother, Tamaqua, was the leader of the faction that promoted diplomacy and played a key role in negotiations with the British that brokered a tentative peace agreement until 1763 when the French and Indian War broke out (McConnell 1992; Post 1758). Encroaching settlement and warfare from conflicts with Europeans led to the ultimate abandonment of the Ohio Country towns, with migration further westward in the late 1770's. Historians postulated that Kuskuskies settlements were entirely abandoned by 1778. What is important to note was that emergent Delaware leaders played key roles in shaping diplomatic relations between Europeans and indigenous groups in the Ohio Valley region during the occupation of the Kuskuskies Towns. Leadership and emergent leadership roles in turn may be evident in the mortuary program (McConnell 1992).


**Figure 92:** Silver wire bracelet and clasp, burial 9, Chamber's site

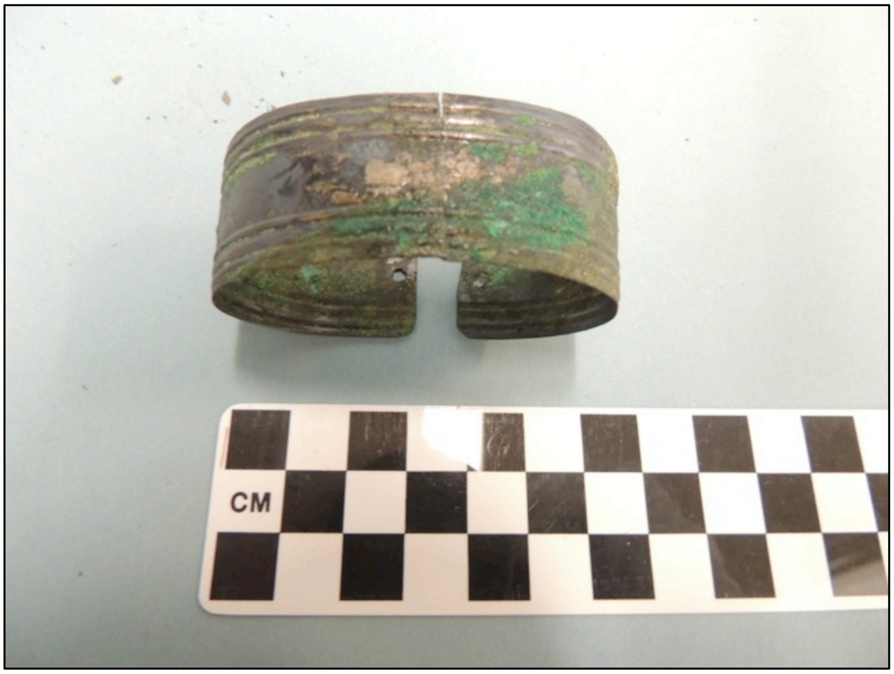



**Figure 93:** Silver bracelet, burial 18, Chamber's site


**Figure 94:** Glass beads, burial 1, Chamber's site


**Figure 95:** Brass tinklers, burial 7, Chamber's site


**Figure 96:** Thimbles, burial 7, Chamber's site

### 8.7.2 "Social Status" vs. "Biological Status" Among the Delaware

#### 8.7.2.1 "Social" Status Among the Delaware

Traditional cluster analysis shows very little differentiation by sex and age in terms of burial "furniture" and funerary treatment of the body. Sexes and ages were well represented in all but Cluster 3, consisting of a female burial with a high number of glass beads. Among all clusters, European trade items such as silver artifacts, glass beads, and metal tinklers were present. Adult males and females had significantly higher numbers of glass beads compared to subadults in post-hoc ANOVA tests (Appendix C, Table 240). Historical accounts demonstrate a preference for European made items among the Delaware in burials, accompanied by indigenous items. Accounts of the burial of the wife of Shingas, for example, detail the placement of scissors, needles, thread, deer hide moccasins and other personal items inside a European style coffin. A hole was placed in the lid of the coffin to allow her spirit to find its way to the afterlife (M'Cullough n.d.; McConnell 1992; McLure 1748-1820:90). Coffins may have been adopted for use under the influence of missionaries; several Baptist, Moravian, and Quaker missions travelled into the Ohio country during the occupation of the Kuskuskies Towns (McConnell 1992). However, the presence of missionaries and the use of coffins does not equate to the adoption of Christianity by indigenous groups living on the confluence of native and European territory during the 18$^{th}$ century (Brown et al. 2014).

The patterns of burial revealed by this cluster analysis are clear: a preference for items of personal ornamentation with few utilitarian goods included in burials. According to representatives of the Delaware Tribe of Oklahoma, this mortuary fashion is consistent with traditional Delaware dress (Brown et al. 2014). Traditional Delaware dress involves the heavy embellishment of both men and women's clothes as a "combination of cloth, ribbon, and deer hide to which beads, quillwork and metal (German silver in most cases) embellishments such as tinklers, buckles, and brooches are added" (Brown et al. 2014: 35). Glass beadwork and other jewelry as well as wampum and silver items were also part of the burial "outfit". Modern Delaware mortuary ritual includes the placement of items that were important to the deceased within the coffin. Men are more commonly buried with knives and rattles, whereas women's funerary "furniture" includes mirrors, and needles. In the case of both men and women, the body is painted with red ochre (Brown et al. 2014). These patterns are similar to those observed for the Chamber's site: items sewn onto personal dress and non-utilitarian personal items such as medals and vanity boxes were common grave goods, and many bones were distinctly stained with red ochre.

Grave goods at the Chamber's site were similar to distributions found at other historic Delaware cemeteries, such as Wapwallopen and Montgomery and included: clothing-related items, silver pendants and medals, rings, vanity boxes, thimbles, knives, spoons, projectile points, ceramic fragments, smoking pipes and gunflints. What is discernable from the archaeological record is that a significant change is seen between distributions of grave goods in pre-migration Delaware cemeteries and the assemblage at the Chamber's site. Cushman (2007) stated that at the Minisink cemetery, a pre-migration site on the border of Pennsylvania and New Jersey, child burials were primarily associated with ornamentation whereas adults were buried with items of utilitarian value. The picture of burial "furniture" at Chamber's is notably altered from that of the earlier cemeteries. Based upon this cluster analysis and reports by the Delaware Tribe, ornamentation such as glass beads, bells, tinkling cones, brooches and buckles are found in high quantities in both child and adult burials and across the sexes, though utilitarian items such as ceramic sherds and gunflints are primarily associated with adults (Brown et al. 2014). It is hypothesized that minor alterations in concepts of dress and ornamentation were brought about by migration and further involvement in European trade, while maintenance of gendered social structures were maintained.

Continuity and change are observable within the mortuary record of other indigenous groups following contact. Nassaney (1989, 2004) documented shifting gender politics among the 17th century New England Narragansett. Changing styles of pottery, pipe smoking, and increased production of wampum indicate that men and women as producers of material culture responded to the alterations and upheaval brought about by European intrusion and population decline by creating a new material world in which status, gender, and world view were communicated (Nassaney 2004). It was notable that wampum, an indicator of status in the Narragansett mortuary program, was more commonly associated with males and adolescent female graves than other demographic groups such as adult women and children (Nassaney 1989). Nassaney (1989) suggested that the increased quantities of wampum in male burials represented new emergent leadership status as communities shifted, and that the presence of wampum in adolescent graves may have been a marker of the significant loss felt by the community when a young female perished at the threshold of sexual maturity (Nassaney 1989). Despite the changes to grave good patterning, traditional body treatment and positioning was maintained (Nassaney 1989). Rodning (2011) emphasized that among the Cherokee, the concept of men's vs. women's space was maintained following death, with Cherokee male burials associated with structures of male power such as townhouses, and female burials associated with clan and household dwellings. Prior to contact, females were buried with turtle shell rattles, whereas males were associated with gorgets and shell pins. Following contact, males were more likely to be buried with grave goods, and a greater variety of goods, than females, though alterations to burial spaces were not evident (Rodning 2011). In the case of the Delaware, there is little evidence for shifting gendered identities in the burials at Chamber's following contact. There are few differences between age and sex with respect to grave good distributions.

#### 8.7.2.2 "Biological" Status Among the Delaware

Very little information can be gleaned from the biosocial cluster analysis in this case in regards to gendered patterns of health and activity. Stress indicators and dental disease were present across all clusters, ages, and sexes. Preservation bias was an issue in interpretation of cluster analysis results because many bones lacked sufficient surface preservation for recording of MSMs or were incomplete. For example, Cluster 1 represents slightly higher MSM scores than other clusters, but for these other groupings the MSM data was not as complete. What can be demonstrated is similar activity patterning to earlier Monongahela groups, because there were very few differences between clusters in terms of activity markers. Age was a significant factor in the expression of MSMs as clusters with more middle-aged and old adults had higher scores but these were still minimal. This supports previous research linking MSM expression with age (Stefanovic and Porcic 2013), indicating that like the Monongahela, Delaware adults were active well into older ages. The only other significant biological variable revealed in PCA was vertebral osteoarthritis. Clusters associated with higher MSMs were also associated with OA, which is highly linked with aging (Appleby 2010; Weiss and Jurmain 2007).

# 9.0 DISCUSSION

This chapter addresses each research question through an investigation of results and discussion provided in Chapters 6, 7, and 8.

## 9.1 RESEARCH QUESTIONS: HYPOTHESES REVISITED

The goal of this research was to use a bioarchaeological approach to evaluate three questions concerning gender from the Early Woodland period to the post-contact Ohio Valley (3000BP-1778AD).

1. Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time period?
2. Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?
3. What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course in indigenous societies?

Each research question and their associated hypotheses are addressed by time period in tables: question 1 (Tables 122-126), question 2 (Tables 127-131), and question 3 (Tables 132-136). For each prediction, acceptance or rejection is stated, followed by the evidence or rationale from Chapters 6-8. After each set of hypotheses is presented, each question is discussed in detail.

**Table 122:** Early Woodland – question 1

| **Question 1: Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time period?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| There will be little differentiation in grave goods between the sexes. There will be few subadults in the sample. | **Partially** | **Mortuary cluster analysis**: males and females appear in each cluster and in all burial classes, including elite Cluster 4<br>**Biosocial cluster analysis**: males and females appear in each cluster with no discernable pattern of grave goods by sex<br>**Subadults**: present in higher numbers than expected (1 neonate, 4 early children, 2 late children, 5 adolescents, 3 youths) |
| Elite burial classes can be identified | **Accepted** | **Mortuary cluster analysis:** high counts of grave goods including exotic items (metal beads, stone hemispheres, copper animal effigies) in Cluster 4<br>**Biosocial cluster analysis:** high grave good counts in Cluster 4, similar to mortuary analysis |
| Lower MSM scores will occur in higher status burials, as emergent elites may have served non-labor functions. | **Rejected** | **Biosocial cluster analysis**: no discernable difference between lay population and elites from Cluster 4 was observed in MSM patterning. |

**Table 123:** Early Monongahela – question 1

| **Question 1: Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time period?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Generally children were buried in house floors, while adolescents to older adults were buried in the village along palisades. | **Accepted** | **Mortuary cluster analysis**: children were typically found in house floors, flexed adults in village burials<br>**Biosocial cluster analysis**: children younger than adolescents in house burials, adolescents and adults in flexed village burials (See Chapter 8) |
| There will be age based differentiation in grave good distribution with older adults having a larger number and greater variation in grave goods. | **Partially** | **Biosocial cluster analysis**: children and older adults have highest grave good counts and variability. One outlier is an older adult male with markedly large grave good cache 34 bone items, 118 ceramic fragments) in Cluster 3, only composed of older adults. |
| Males will have more robust lower limb MSMs and females will have higher MSM scores in the shoulder and lower arm. | **Rejected** | **MSM analysis**: Males had higher robusticity in shoulder and elbow flexors, but no significant differences in major muscles of lower limb, indicating males were engaged in bow hunting. |
| Younger and middle aged individuals will have higher MSM scores than older adults. | **Rejected** | **MSM analysis:** Older adults scored higher than younger and middle aged adults for forearm flexors, knee extensors, and hip adductors; MSM scores were correlated with age. |

**Table 124:** Middle Monongahela – question 1

| Question 1: Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time period? | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| There will be little differentiation in burial pattern between the Early and Middle Monongahela. | **Accepted** | **Mortuary cluster analysis:** consistent general burial patterns between the two groups with children in house floors and adults in village in flexed position<br>**Biosocial cluster analysis**: same age and sex pattern as Early Monongahela, children in house floors, adolescents and adults in flexed position in village contexts |
| Children will be buried in house floors and adolescents to older adults will be buried in the village along the palisades. | **Accepted** | **Mortuary cluster analysis**: children (up to age 10) were typically found in house floors, adults in flexed village burials<br>**Biosocial cluster analysis**: same pattern as above |
| Age based differentiation was hypothesized in grave good distribution, with older adults having a larger number and greater variation | **Partially** | **Biosocial cluster analysis:** children (birth to age 10) and older adults have highest grave good counts and variability<br>Middle Monongahela assemblage does not have a specific old age cluster like that of Early Monongahela<br>Cluster 2 represents young adults and fetus/neonates with few grave goods. One outlier is a young adult female with an arrow wound buried outside village with fetus. |
| Males will have greater robusticity in the lower limb, with females exhibiting higher scores in the shoulder and lower arm. | **Rejected** | **MSM analysis**: males had higher robusticity in shoulder flexors/extensors/rotators and elbow flexors/extensors, males higher in thigh adductors, thigh extensors, knee flexors/extensors<br>Males engaged in bow hunting, labor-intensive agriculture (<br>Females had similar MSM patterning, but lower scores. |
| Younger and middle aged individuals will have higher MSM scores than older adults | **Rejected** | **MSM analysis**: older adults scored higher than younger and middle aged adults for forearm flexors, hip flexors, knee extensors, knee flexors<br>MSM scores were correlated with age. |

**Table 125:** Late Monongahela – question 1

| Question 1: Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time period? | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| There will be a marked shift in burial pattern as charnel houses have been noted at several sites. | **Accepted** | **Mortuary cluster analysis**: one site with charnel house, Cluster 3 representative of both males, females and one subadult<br>**Biosocial cluster analysis**: charnel house burials represented in all but Cluster 3 (subadults only) |
| Individuals buried in charnel houses in the Late Monongahela sample will represent a class of emergent elites with males represented in higher numbers. | **Rejected** | **Mortuary cluster analysis**: both males and females in charnel house (more females) plus one subadult; village burials and house floor burials fit demographic pattern of Early and Middle Monongahela periods<br>Charnel house burials have no grave goods, except for the subadult burial<br>**Biosocial cluster analysis**: young and middle-aged adult males, females of all age groups, one child in charnel house<br>Village and house burials fit Early and Middle period demographics. |
| General MSM robusticity will increase from Early and Middle Monongahela periods. | **Accepted** | **MSM Analysis**: MSM scores all significantly higher than previous periods |
| Individuals in charnel house will have significantly lower MSM scores than the rest of the community, with older adults scoring the lowest of the age groups | **Rejected** | **MSM Analysis**: old adults scored significantly higher than younger age cohorts for shoulder rotators, knee flexors/extensors, old age correlated with high MSM robusticity<br>**Biosocial cluster analysis**: individuals from charnel house in both high and low MSM score clusters, no specialized labor evident |

**Table 126:** Post-Contact – question 1

| **Question 1: Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time period?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Elites will be males with high numbers of grave goods with prestige items. | **Rejected** | **Mortuary cluster analysis**: males represent all grave good clusters (low to high, mundane to exotic goods), no changes in burial position or location,<br>Cluster 3 consisted of a high status female with heavy ornamentation (large numbers of glass beads, metal beads, shell beads, silver artifacts)<br>**Biosocial cluster analysis**: same pattern for males as mortuary analysis. |
| Older age was a contributing factor to high status. | **Rejected** | **Biosocial cluster analysis**: both young and old adults with large grave good caches including European goods such as glass beads and silver |
| Labor patterns similar to those of the Monongahela will persist into the historical period | **Rejected** | **MSM analysis**: low MSM scores overall for entire sample (preservation a confounding factor), no differentiation by sex or age |
| MSMs will decrease with age | **Rejected** | **MSM analysis**: no significant difference between age cohorts in MSM score, all MSMs generally gracile across age groups |

### 9.1.1 Research Question 1: Discussion

*Are social roles and funerary treatment clearly distinguished by biological sex, age, and activity in the Ohio Valley in each time period?* Clear distinctions of social roles and funerary treatment are not recognizable by sex, age, or activity in most cases. However, several nuances are evident from each time period. Early Woodland subadults were included in mound burials, whereas previous research indicated that children and infants were extremely rare in Adena contexts (Milner 2004; Milner and Jeffries 1987). Cluster analyses demonstrated that an elite social class likely existed based on burial patterns; Cluster 4 in the mortuary analysis included three individuals buried with exotic items such as metal beads, stone hemispheres, and carved stone tablets. Both males and females of young and old age stages are represented in this cluster, and the biosocial analysis revealed no distinction in MSM scores between elites and non-elites. This is a departure from Rodrigues' (2006) findings that among Turner Mound elites, males had significantly reduced MSM scores compared with the non-elites, whereas female elites had similar MSM patterning to the non-elites.

Several key patterns were also evident in the Monongahela periods. Though clear distinctions in social role and funerary treatment are not identifiable by sex or activity, age was a contributing factor in burial treatment. Adolescence was the perceived threshold of transition between childhood and adulthood, as adolescents received identical funerary treatment to adults, whereas younger children and infants were buried in house floors with higher numbers of grave goods. Older adults in the Early period also formed a unique cluster, with higher grave good counts than younger adults, though this pattern is not visible in the Middle or Late period samples. Patterns of labor are not differentiated by sex, with the exception of hunting as evidenced by increased elbow MSM robusticity among males for all Monongahela periods. This is indicative that Iroquoian models for gendered labor practices are not particularly applicable to the Monongahela. The correlation between MSM robusticity and age indicates that adults were active in agricultural labor and other activities such as hunting, craft production, and food preparation into older adulthood.

The pattern of activity, funerary treatment, and social roles are barely distinguishable between the Early and Middle Monongahela periods, but clear alterations are evident for the Late Monongahela sample. These patterns, however, are not clear along the lines of sex and age. In the Late Monongahela period, charnel houses appeared in the mortuary ritual sphere, with maintenance of traditional funerary behavior at some sites. Burial in the charnel houses was not determined by sex, age, or activity; no differences in these distributions exist between individuals in the charnel house context and those in village burials. Despite this, MSM robusticity did increase overall for the entire community from the Early and Middle Monongahela periods. It is argued that the Little Ice Age was a significant contributing factor in this configuration, as drought conditions would have made maize agriculture more labor intensive with increased need for carrying water, clearing land for more gardens during shorter growing seasons, and foraging further afield for wild food sources (Richardson et al. 2002).

For the Post-Contact period, all hypotheses regarding the nature of status, funerary treatment, and ties to sex, age, and activity were rejected. It is demonstrated by the cluster analyses and MSM analysis that elaborate burials, in the form of large assemblages of European goods, were not differentiated by sex or age. There were no differences between the sexes or different age cohorts in activity patterning, indicating little division of labor. In this respect, Iroquoian models of sociopolitical organization as well as gendered labor practices (Noel 2011; Venables 2010) are not appropriate proxies for the historic Delaware.

**Table 127:** Early Woodland – question 2

| **Question 2: Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| The Early Woodland Adena will have low incidences of dental disease, infectious disease, and stress markers. | **Accepted** | P**athology**: low rates of AMTL, caries, periodontal disease, abscess<br>Low rates of LEH, cribra orbitalia<br>Low non-specific infection<br>1 case of blastomycosis, no TB |
| Activity patterns will be differentiated by rank. | **Rejected** | **Biosocial cluster analysis**: no difference in elite burials in MSM patterning<br>**Pathology**: Low incidences of OA, low rates of trauma |
| MSM scores will be lower than those of the Monongahela samples. | **Partially** | **MSM analysis**: Early Woodland sample scored moderately for most MSMS, Early and Middle Monongahela periods not significantly more robust<br>Late Monongahela significantly more robust. |

**Table 128:** Early Monongahela – question 2

| **Question 2: Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Infectious disease will increase from the Early Woodland period | **Accepted** | **Pathology**: increase in non-specific infection compared to Early Woodland |
| Maxillary sinusitis rates will increase. | **Rejected** | **Pathology**: no maxillary sinusitis in Early Woodland or Early Monongahela samples. |
| Rates of dental disease will be high, and more so amongst Early Monongahela females | **Partially** | **Pathology**: general increase in rates of AMTL rates between Early Woodland and Early Monongahela<br>Individual rates: Females had higher caries rates and periodontitis rates, but males had significantly higher AMTL and calculus rates<br>Percentage of teeth affected: Males had higher percentages of teeth affected by all dental conditions |
| Stress indicators will increase from the Early Woodland | **Accepted** | **Pathology**: cribra orbitalia and LEH increased |
| MSM scores will increase from the Early Woodland | **Partially** | **MSM analysis**: overall more robust than Early Woodland, but not significantly higher. |
| Early Monongahela females will have higher MSM scores in upper limb due to agricultural activities, and Early Monongahela males would have higher robusticity scores in the lower limb due to activity. | **Rejected** | **MSM analysis**: males had higher robusticity in forearm flexors/extensors, but no difference in lower limb |

**Table 129:** Middle Monongahela – question 2

| **Question 2: Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| There will be an increase in infectious disease from Early Woodland and Early Monongahela periods. | **Accepted** | **Pathology**: increase in non-specific infection from Early Woodland, only small increase from Early Monongahela<br>Presence of blastomycosis, TB, possible treponemal infection, chondroblastoma |
| Maxillary sinusitis will increase from Early Monongahela | **Partially** | **Pathology**: only two cases of maxillary sinusitis were identified<br>May indicate increase in population, but cannot rule out missing maxillae in other samples |
| Rates of dental disease will be high, and more so amongst females | **Partially** | **Pathology**: Increase in AMTL, caries, periodontitis, calculus, and abscess from Early Woodland and Early Monongahela<br>Males had higher rates of AMTL, caries, periodontal disease, and abscesses than females (both by individual rate and percentage of teeth affected) |
| Stress indicators will increase | **Accepted** | **Pathology**: marginal increases are seen from Early Monongahela in cribra orbitalia and LEH, higher than Early Woodland |
| MSM scores will increase from previous periods. | **Rejected** | **MSM analysis**: few differences between Early and Middle Monongahela sample, not statistically significant |
| Females will have higher scores in upper limb MSMs due to agricultural activities, and males would have higher robusticity scores in the lower limb due to activity related to mobility. | **Rejected** | **MSM analysis**: males had higher robusticity in shoulder flexors/extensors/rotators, elbow flexors/extensors, thigh adductors, thigh extensors, knee flexors/extensors<br>Males engaged in bow hunting, labor-intensive agriculture<br>Females had similar MSM patterning, but lower scores. |

**Table 130:** Late Monongahela – question 2

| **Question 2: Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Infectious disease will increase from earlier periods | **Rejected** | **Pathology**: rates of non-specific infection decreased from Early and Middle Monongahela periods, only 1-2% higher than Early Woodland (difference not negligible) |
| Maxillary sinusitis rates will increase | **Rejected** | **Pathology**: no cases of maxillary sinusitis were recorded for the Late Monongahela sample |
| Rates of dental disease will be high, and more so amongst females | **Partially** | **Pathology**: rates of all dental diseases are high and comparable to those from the Middle Monongahela period<br>Males had higher rates of dental pathologies except for abscesses (both individual rate and percentage of teeth effected) |
| Stress indicators will increase. | **Accepted** | Pathology: cribra orbitalia decreased slightly from Middle Monongahela period, but nearly doubled for subadults.<br>LEH nearly doubled overall and among subadults compared to Middle Monongahela sample |
| MSM scores will increase. | **Accepted** | MSM analysis: overall robusticity scores were highest for Late Monongahela sample, statistically significant |
| Emergent elite males will exhibit less MSM robusticity than females and non-elites. | **Rejected** | **Biosocial cluster analysis**: no difference in MSM patterning between individuals in charnel house vs. traditional burial pattern<br>**MSM analysis**: all males had higher robusticity scores in shoulder, forearm, and thigh muscles than females |

**Table 131:** Post-Contact – question 2

| **Question 2: Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Dental disease will decrease among the historic Delaware | **Accepted** | Pathology: rates of AMTL, caries, periodontitis, and abscesses lower than Monongahelans |
| Stress indicators will increase | **Partially** | **Pathology**: rates of cribra orbitalia increased overall and among females, males and subadults<br>LEH decreased overall, but increased among females and males |
| Infectious disease will increase | **Rejected** | **Pathology:** rates of non-specific infection decreased, there were no cases of TB or any other known infectious disease |
| MSMs will be lower among individuals of high rank and older adults. | **Rejected** | **MSM Analysis**: there were no significant differences between adults of different ages or between the sexes<br>**Biosocial cluster analysis**: individuals of high rank vs. low rank did not have different MSM patterning |

### 9.1.2 Research Question 2: Discussion

*Is there a significant difference in disease, dietary consumption, and activity patterns among individuals of the same and different ranks for each pre- and post-contact group?* There were no significant differences in health and activity patterns among individuals of different ranks within each sample, so social status played very little role in patterns of health, diet, and activity among indigenous groups in the Ohio Valley. For each of these periods, it is important to stress that absence of lesions does not necessarily mean absence of a disease in a population as man conditions only leave skeletal markers in approximately 5% of cases, and poor preservation may account for the loss of lesions (Ortner 2003). For example, in the present study preservation of the maxilla did not allow for evaluation or observation of sinusitis, leading to only two identifiable cases in the entire sample. Despite these concerns, some interesting patterns do emerge when the data is examined between time periods.

For the Early Woodland sample, rates of dental disease and infectious disease were low, supporting initial hypotheses regarding the nature of health and diet in this period. The Adena-Hopewell were likely mobile foragers, though very little settlement data is available (Keener and Nye 2007; Milner 2004). Low rates of dental disease indicate that this group was not reliant on cariogenic cereals as a primary food source, supporting previous research that suggests Early Woodland groups were engaged in hunting, foraging, and weedy plant propagation (Hart and Asch-Sidell 1997; Keener and Nye 2007). Very little infectious disease was evident for this sample, along with low rates of stress indicators, indicating that prior to the adoption of wide scale agriculture, populations experienced less developmental stress and lower rates of infection. MSM rates were not significantly different between individuals of different ranks, indicating that even elites were engaged in everyday labor activities. This is a departure from previous research by Rodrigues (2006), who observed that elite Hopewell males had lower muscle robusticity scores than their female counterparts and the lay population.

Among the Monongahela, patterns of disease, stress, diet, and activity are noticeably different than the Early Woodland. Infectious disease increased, with the Early and Middle Monongahela periods affected by higher rates of non-specific infection, tuberculosis and other infectious pathologies. Key patterns are notable when observing rates of dental disease among the Monongahela. It was expected that females would have higher rates of dental disease than males due to reproductive demands and decreased resistance to cariogenic bacteria during periods of pregnancy and lactation following the wide scale adoption of agriculture (Lukacs 2008). The opposite pattern is evident for all Monongahela periods; males had markedly higher rates of dental disease. It is hypothesized here that even though ranking by sex is not evident in the mortuary program, males could have had differential access to maize, with females consuming more foraged foods and supplemental crops. Another possibility is that males had greater levels of physiological stress, leading to caries and related dental pathologies. As evidenced by cribra orbitalia and LEH, physiological stress increased during the Late Monongahela period, possibly due to the hardship imposed by the Little Ice Age (Richardson et al. 2002). MSM patterning was expected to be different among male elites during the Late Monongahela period, but the mortuary record and MSM analysis demonstrate that there was no significant difference in sex structure of charnel house burials, nor were there significant differences in MSM patterning and robusticity between individuals buried in these structures and those in the traditional mortuary program.

For the Post-Contact sample, several hypotheses were rejected. Rates of infectious disease, as a function of contact, were expected to increase but pathological analysis demonstrates markedly low rates of non-specific infection and no instances of TB or other known infectious pathologies following Silliman (2005) and Pfeiffer and Fairgrieve (1994). There were no differences in MSM patterning between males and females, age groups, or between individuals with large grave good caches vs. undifferentiated burials, indicating no evidence for gendered or ranked division of labor practices. Rates of dental disease were expected to decrease following the incorporation of animal husbandry into indigenous subsistence practices, and from historical records indicating that conflict interrupted maize farming (Gist 1759; LeRoy and Leininger n.d.). This prediction was supported by pathology results with a reduction in dental disease in this sample. Stress indicators did increase among males and females, indicating developmental stress (LEH) and perhaps during adulthood (as evidenced by cribra orbitalia).

**Table 132:** Early Woodland – question 3

| **Question 3: What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course in indigenous societies?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Few subadults will be included in the mortuary assemblage | **Rejected** | **Mortuary cluster analysis**: both adults and subadults were identified in the mortuary assemblage<br>**Biosocial cluster analysis**: neonates, young children, late children, and adolescents were present in the sample |
| Emergent status and leadership among older adults would be evidenced by increased elaboration in funerary treatment | **Rejected** | **Biosocial cluster analysis:** age estimates for individuals in elite ranked burials included young adults as well as older adults |
| Dental disease was will increase with older adults | **Unclear** | **Pathology**: dental disease rates were low<br>**Nuanced cluster analysis**: dental disease was not significant in PCA analysis so it was not factored into clustering |
| MSM scores will decrease with age | **Rejected** | **MSM Analysis**: MSM robusticity did not decrease with age in this sample |

**Table 133:** Early Monongahela – question 3

| **Question 3: What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course in indigenous societies?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Status will increase with age, evidenced by differential burial patterns | **Partially** | **Biosocial cluster analysis**: infants and young children were buried in house floors with high number of grave goods; adolescents and adults were buried in the flexed position in the village<br>Adult burials were differentiated by age, with Cluster 3 representing older adults with moderate to large grave good assemblages |
| Stress indicators will be more frequent among subadults | **Partially** | **Pathology**: rates of cribra orbitalia were higher among adults, whereas LEH rates were higher in subadults |
| Dental disease rates will be highest among older adults as a factor of the aging process | **Accepted** | **Pathology**: reflected in the age structure of the population, more old adult males and males had higher rates of AMTL, caries, and periodontal disease (by percentage of teeth affected)<br>**Biosocial cluster analysis**: Cluster 3 (all older adults) had periodontal disease, AMTL, and caries as significant biological feature, though dental disease was present in Clusters 1 and 4. |
| MSM scores will decrease with age | **Rejected** | **MSM Analysis**: older adults scored significantly higher for shoulder rotators, elbow flexors, thigh adductors, and knee extensors than younger age cohorts; high MSM robusticity was correlated with older age |

**Table 134:** Middle Monongahela – question 3

| **Question 3: What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course in indigenous societies?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Status will increase with age, evidenced by differential burial pattern | **Partially** | **Nuanced cluster analysis**: young children and infants were buried in house floors with high numbers of grave goods, adolescents and adults in flexed position in village burials<br>No cluster of older adults with high number of grave goods<br>Cluster 3 is represented by young children and young adults with few grave goods |
| Stress indicators will increase among subadults | **Rejected** | **Pathology**: rates of cribra orbitalia were comparable to that of adults, rates of LEH were lower among subadults than adults |
| Dental disease rates will be highest among older adults as a factor of the aging process | **Partially** | **Pathology**: dental disease rates among males were higher than females, more males in the older adult age cohort may bias these results<br>**Biosocial cluster analysis**: unclear pattern, all clusters have caries, AMTL and periodontitis as a significant biological features, even those entirely comprised of children and young adults |
| MSM scores will decrease with age | **Rejected** | **MSM analysis**: older adults scored significantly higher for arm flexors, knee extensors, and knee flexors than younger age cohorts, high MSM robusticity is correlated with older age |

**Table 135:** Late Monongahela – question 3

| **Question 3: What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course in indigenous societies?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Status was expected to increase with age, evidenced by differential burial patterns. | **Partially** | **Biosocial cluster analysis**: young children and infants buried in house floors with grave goods, adults buried in village in flexed position<br>No difference between younger and older adults in terms of grave good distribution |
| Older adults will be interred in charnel house structures | **Rejected** | **Biosocial cluster analysis**: both younger and older adults were buried in charnel houses |
| Indicators of stress will be highest during the Late Monongahela period | **Partially** | P**athology**: rates of LEH were highest during the Late Monongahela, but rates of cribra orbitalia were highest in the Post-Contact sample |
| Stress indicators will be higher in subadults | **Partially** | **Pathology:** rates of cribra orbitalia higher in subadults, LEH higher in subadults than females but lower than males |
| Dental disease rates will be highest among older adults as a factor of the aging process | **Partially** | **Pathology**: higher male dental disease, older adult cohort contains more males (males more likely to live to older age = longer periods of attrition and higher rates of dental disease)<br>**Biosocial cluster analysis**: unclear pattern all clusters, have significant dental pathology |
| MSM scores will decrease with age | **Rejected** | **MSM analysis**: older adults scored significantly higher in shoulder rotators, knee flexors/extensors than younger age cohorts; high MSM robusticity correlated with older age |

**Table 136:** Post-Contact – question 4

| **Question 3: What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course in indigenous societies?** | | |
|---|---|---|
| **Hypothesis** | **Accepted?** | **Evidence** |
| Older adult males would hold higher social status as reflected by an increase in grave goods, especially European silver and glass bead trade items | **Rejected** | **Biosocial cluster analysis**: no association between age, sex, and grave good distribution is reflected in the mortuary pattern; all ages and sexes represented in elite and undifferentiated contexts |
| Stress indicators will increase in subadults | **Partially** | **Pathology:** rates of cribra orbitalia are high among subadults, rates of LEH are low |
| The demographic profile was expected to represent a catastrophic assemblage due to the spread of European disease | **Accepted** | **Pathology**: high numbers of adolescents, youths, and young adults in the mortuary assemblage with mortality decreasing with older age |
| Rates of dental disease and infectious disease will increase across all age groups due to contact | **Rejected** | **Pathology**: dental disease rates decrease for adults and subadults in this period<br>No non-specific infection, TB or maxillary sinusitis |

### 9.1.3 Research Question 3: Discussion

*What changes in social status, exchange networks, environment, and subsistence strategy are reflected in patterns of physical health, activity and funerary treatment between individuals at different stages of life course?* Many patterns are identifiable with respect to age in these groups studied. For the Early Woodland period, social status was not dependent upon old age, as young and older adults represented the elite burial cohort. It is important to emphasize that subadults were not included in elite contexts, which is suggestive of emergent leadership or ritual role upon adulthood. Exchange networks are evident in the grave good distributions; elite burials contain items made of copper, hematite and other non-local materials, indicating a wide network of exchange during the Adena – Hopewell complex. Milner (2004) hypothesized that Adena elites were instrumental in establishing and maintaining shared trade networks, though that is not clear in this sample. There were no age differences reflected in pathology, nor were activity patterns significant with respect to age. MSM patterns did suggest a hunting-foraging economy. The forearm flexors and extensors had moderate to high scores, indicating bow use in hunting as bow loading is associated with considerable biomechanical stress on these attachment sites (Shuler et al. 2012).

For the Monongahela, several interesting aspects of social status are evident with respect to age in terms of burial practices. Throughout all time periods, young children and infants were buried in house floors with moderate to high numbers of grave goods, especially beads. Adolescents and adults were buried in the flexed position in village contexts, with varied amounts of grave goods. For the Early Monongahela period, significant status was reserved for older adults as reflected in Cluster 3 of the nuanced cluster analysis; older adults were associated with moderate to high numbers of grave goods whereas other adult clusters had fewer items. This pattern is not as directly indicated for the Middle Monongahela where Cluster 3 consisted of younger adults with few grave items, though no specific old age cluster was evident. While it was expected that Late Monongahela charnel houses would primarily contain older adult males, presumed to be emergent elites engaged in trade networks following Anderson (2002), this pattern is not observed. The charnel house at the Household site contained both males and females of young to older adult age, and one early child. Grave goods were not associated with the adults in this context, but the child's grave good assemblage included shells and ceramic sherds.

An agricultural subsistence strategy is evident for the Monongahela samples based on MSM analysis, though other activities such as craft production could have contributed to these patterns. In the Early phase, heavy shoulder muscle use along with high robusticity of the forearm attachments, thigh extensors, and knee flexors/extensors is indicative of heavy load bearing, land clearing, planting, and harvesting. Increased robusticity of the forearm flexors and extensors suggests a continued reliance on hunting as a supplemental subsistence resource (Shuler et al. 2012). Similar patterns characterized the Middle Monongahela phase. The Late Monongahela phase was defined by increased overall robusticity in most of the muscle attachment sites, especially the shoulder flexors/extensors/rotators, the forearm flexors/extensors, the thigh extensors, and the knee extensors. These scores were significantly higher than other time periods (Appendix B). With respect to age, for the entirety of the

Monongahela sequence, increased MSM robusticity was correlated with older age, indicating that adults were productive in agricultural labor into the older ranges of life course. Patterns of stress were also unique for the Monongahela sequence, rates of LEH and cribra orbitalia were high, with subadults defined by higher rates of cribra orbitalia than adults, and slightly reduced rates of LEH compared with adult males. Taken together, the MSM data and the stress indicators point to a period of instability for the Monongahela during the Late phase. This corresponds to intense periods of drought during the Little Ice Age (Richardson et al. 2002), indicating that climate change put significant amounts of environmental stress on Monongahela communities just prior to their demise.

Marked differences are observed in the interaction between age, subsistence, physical health, and status in the Post-Contact group in contrast with pre-contact samples. Social status was not linked to age or sex as both sexes and all age groups are represented in high status and undifferentiated burials. MSM robusticity was low across the board with no associations between MSM score, sex, and age. The reduction of MSMs following contact is indicative of a significant shift in subsistence strategy. Historical documents report that several events may have interrupted maize agriculture during the mid-1700s. Gist (1759) reported that in 1756 there was a smallpox outbreak following British raids on indigenous settlements near Kittanning; accounts of the Kuskuskies Towns at this time reveal that during that summer the community had failed to plant corn and the townspeople were starving (Gist 1759). Pontiac's Rebellion and the French and Indian conflict had significantly impacted these communities as men were engaged in warfare and diplomacy, with battles and skirmishes interrupting or impeding access to farming (McConnell 1992). Another line of evidence for hardship during this period of turmoil is the rates of stress indicators for the Post-Contact sample. Adult males had high rates of both cribra orbitalia and LEH, adult females had increased levels of LEH compared to the pre-contact era, and subadults had increased levels of cribra orbitalia. There were few cases of infectious disease observed. However, when the age structure of this sample is examined, it is evident that this represents catastrophic mortality, possibly corresponding with outbreaks of European disease as reported by military personnel, captives, and missionaries in the mid-1700s (Gist 1759; LeRoy and Leininger n.d.); M'Cullough n.d.; Morris 1759).

# 10.0 SUMMARY AND CONCLUSION

This chapter concludes this research study with a summary discussion that outlines the patterns revealed by these analyses in terms of gender and social organization in each time period. Finally, the implications of this study are discussed along with potential directions for future research.

## 10.1 GENDER AND SOCIAL STATUS

### 10.1.1 Early Woodland

When all analyses are examined as an interconnected whole, the picture of gendered social organization emerges on several levels for the time periods in this study. Perhaps the most recognizable signature is that of the elite class revealed in cluster analysis for the Early Woodland sample. The burial pattern for this class includes large caches of exotic items such copper, hematite, and shell, along with local materials such as animal bone, antler, local stone, and worked into the form of copper animal effigies, stone carvings and hemispheres, headdresses, gorgets, beads, and jewelry. The items in this collection of "grave furniture" have been associated with shamanic practitioners among the Hopewell (Carr and Case 2006; Field et al. 2006; Rodrigues 2006). In the Early Woodland sample, only three burials were identified in this cluster, represented by one old adult male, one young adult female, and one unknown adult. It is argued that this cluster represents a class of shamanic practitioners akin to those identified for the Hopewell (Carr and Case 2006). While the burials have a similar shamanic "toolkit" to Hopewell practitioners, there are differences in MSM patterning between the study sample and those from Hopewell contexts. Rodrigues (2006) examined MSMs for the Turner Mound group and found that males among the elite, shamanic social class had significantly lower MSM scores than females in this class and the laypeople; female shamans had similar MSM patterning to the rest of the community. Among the Adena in southwestern PA, the pattern of activity and status may have been different even among ritual elites. In the current study, MSMs for the cluster from the nuanced analysis associated with shamanic elites indicated that there was not a notable difference in MSM patterning between these elites and their parishioners, nor were there notable levels of disease, stress, or injury in the whole of the Early Woodland sample.

It is argued that the shamanic class represents a separate gendered social group, or "third gender", reflecting queer frameworks defined by Alberti (2013) and Voss (2008). Rodrigues (2006) and Carr and Case (2006) stressed that the unique burial toolkit, combined with significant differences in MSM patterning, points to shamanic elites as an example of a unique gendered social class that emerged through recognized social status and specialized occupation, including both males and females. In the current study, there were no differences in muscle use between these elites and the rest of the community, but it is still stressed that the role of religious practitioner or spiritual interventionist is often associated with gender fluidity (Carr and Case 2006; Hollimon 2001b; Jordan 2001). Hollimon (2001b) emphasized that indigenous societies recognized gender as fluid, in which an individual could change gender. This ability was associated with supernatural forces. It is important to emphasize that not every shaman was gender fluid and not every "two-spirit" person was a shaman, but gender ambiguity is viewed by many North American societies as spiritually powerful (Hollimon 2001b; Roscoe 1998). Living between the thresholds of sexual boundaries was connected with having powers to cross through worlds (Hollimon 2001b). The role of shamanic ritual is to establish contact with the supernatural world through the experiences of the interventionist; the shaman has the ability to thus move through different spiritual domains, including those of the living and the dead (Jordan 2001). Shamanism in this respect is not merely a religion but a worldview that incorporates ecology, economy, and social structures (Jordan 2001; Pentikäïnen 1998).

Archaeologists have argued that shamanistic rituals and worldviews have the potential to leave few material correlates as the components of shamanistic rituals are intangible, mental journeys through which the shaman and ritual participants communicate with the spiritual world (Jordan 2001). However, many shamanistic practices have deeply associated materiality. Jordan (2001:102) argued "if the actions of the shaman are contextualized within a wider suite of practices then a number of themes can be opened out into a 'thicker' description of the material dimensions to a shamanistic world-view." The materiality of shamanism is thus reflected in several respects: 1) the routine and ritual use of animal body provides a connection between the cosmological "processes of landscape enculturation, forming ... embodied community *habitus*" (Jordan 2001:102), 2) landscape enculturation includes the use and care of sacred sites and the selection of places in the regional landscape for ritual use, through which material culture is created and deposited, and 3) human created objects (material culture) becomes imbued with animate life force, and such animate items in turn have symbolic value in as a link between human-supernatural realms (Jordan 2001: 102-103).

These concepts can be directly related to both Adena-Hopewell material culture and the use of the physical landscape. Adena-Hopewell artifacts are often stylized representations of animal effigies or human-animal hybrids (Carr and Case 2006) such as the copper bear tooth pendant found in the McKees Rocks burial or the elk headdress recovered from Cresap Mound (Dragoo 1963). Mounds were places of ritual that permanently altered the physical landscape; considerable effort was undertaken in construction and they were a visible, tangible result of considerable community effort, organized ritual, and community remembrance (Milner 2004). It is in this context that the importance of shamanic identities for the Adena-Hopewell is reflected in mortuary activity. The artifacts in elite burials among the Adena-Hopewell, in the form of exotic items and animal effigies, relate to Jordan's (2001) connection of material culture, ritual, and the landscape. Shamanic practitioners likely had very deep ritual ties to burial mounds as places of transition from life to death, societal memory, and shared community belief (Brown 2006; Carr and Case 2006). In the case of the study sample, it is then argued that the elite class of burials identified in Cluster 4 by multivariate analysis, represents a small but key component of Adena social structure as shamans or similar religious interventionists, and it is possible that this class represented a distinct gendered social category, especially since this status was not restricted to biological sex or age.

While considerable attention has been given to this elite class, other portions of Adena social relationships can be inferred from the current study. The presence of subadults in burial mounds indicates that children, even as young as neonates, were personalized as important members of the wider community (Lewis 2007). This is especially significant since past archaeological research has tended to conceptualize children as absent from the Adena-Hopewell burial complex (Milner 2004). This is evidence that a bioarchaeological that incorporates nuanced age categories into analysis can add deeper contextual meaning to previously studied sites (Sofaer 2006b). Bioarchaeological analyses also shed light on patterns of community health and activity among Early Woodland people. From these analyses it is clear that hunting and foraging activities were not differentiated by sex or by age, thus gendered labor divisions among the wider community were not deeply ingrained. Patterns of community health were reflective of this subsistence strategy, as reliance on cariogenic foodstuffs is not indicated by dental disease patterns nor are differential dietary practices based on sex. The picture of social structure among the Adena can be summarized: these communities were based on a mixed foraging-hunting subsistence economy based on a shared division of labor between sexes and ages. Inclusion in burial ritual is a marker of personhood, and both children and adults were important to community identity. Adena societies were not generally strictly stratified, especially along the lines of biological sex and age, though emergent elite leaders likely played significant roles in trade, kinship identity, and community organization, with specialized gendered identity reserved for shamanic practitioners (Case and Carr 2006; Milner 2004).

### 10.1.2 The Monongahela

This study revealed a number of important facets of gendered social life among the Monongahela. With respect to social status, unlike the Early Woodland, there was no evidence of specialized or unique gendered social categories within Monongahela societies. Age, however, may have played a significant role in social roles as indicated by the general burial pattern of the Monongahela. When nuanced age categories are integrated into cluster analyses, key stages of personhood in the life course emerge. For the entire sequence, adolescence was an important social marker. Young children and infants were buried in house floors with caches of beads and personal items. When this is integrated into previous archaeological theories about community organization, it is suggestive of Means' (2007a) model that the household was the key unit of social interaction. Young children in this respect were tied to the household unit, with the home conceptualized as the child's connection to the community. This connection was both abstract and tangible as in life the family or kinship group was likely the basic component of social relationships and the home was the physical, material correlate of those relationships (Means 2007a). Adolescence represented the boundary or phase at which an individual entered adulthood, as reflected by the marked shift in mortuary treatment at this age. Adolescents were given identical burial treatment to adults in all age categories, typically in flexed burials in the village. The placement of adult burial clusters near house clusters in the village is explained as representative of shared kin identity (Means 1999, 2007a).

There is little differentiation in the mortuary program among the adult age groups. In the Early Monongahela sample, there was one cluster revealed during nuanced cluster analysis that was reserved for middle-aged and older adults, and these individuals were buried with a larger number of grave goods than younger age cohorts. This is suggestive, though not definitive, for old age as a factor of social status and authority as modeled by Noel (2011). For the rest of the Monongahela sequence, there is no direct evidence of old age as a significant social variable, as burials in the Middle and Late periods were not differentiated by age, burial type, and grave good assemblages. With respect to sex, there is no indication in this analysis via multivariate statistical inference that males or females had significantly different social importance or role. Clark (2014) identified several classes of sex specific burial artifacts in analyses of burials from the Johnston site, but in the current study burial artifacts did not cluster with either sex.

There was one distinct outlier to the common mortuary complex. The burial of a female and her fetus was discovered outside the village at the Shippingport site, dating to the Middle Monongahela period. The female had an embedded projectile point in the posterior left 12$^{th}$ rib adjacent to the vertebral articulation, and she was buried with a large cache of bone and shell beads. Both the location and high number of beads were unusual, but full analysis revealed bones of 24-week fetus among the assemblage. In-situ perinate-maternal burials are rare in the archaeological record (Wallis and Oxenham 2011). This burial represents a unique context, the death of a pregnant woman through violent injury. Pregnancy is specialized gendered identity. Anthropological scholarship has acknowledged the idea of reserved female associated physical spaces for fertility related bodily functions such as childbirth and menses (Geller 2016). This case presents a rare opportunity to explore the notion of specialized space in the mortuary contexts associated with fertility (or loss thereof in this case).

Dental disease analyses can shed some light on gendered dietary patterns. In this study it was hypothesized that females would have higher rates of dental disease than males due to the decreased resistance to cariogenic bacteria brought about by the high reproductive demands associated with agricultural subsistence (Lukacs 2008). For the Monongahela, the opposite was observed but this may be due to several factors. First, males were more likely to live to old age in these groups. The aging process results in increased dental disease, as longer periods of attrition, wear, and exposure to cariogenic bacteria will have an adverse effect on oral health (Appleby 2010). Second it is possible that there was gendered preference for food consumption, with males consuming more maize, with a sanctioned female preference for meat, fish, foraged foods, and other agricultural products.

Anderson (2002) theorized that the appearance of charnel houses and other community ritual centers was indicative of emergent male elites during the Late Monongahela period. In the present study, there was no significant difference with respect to age, sex, burial artifacts or biological variables with individuals buried in the charnel house at the Household site to those in traditional mortuary contexts at other Late period sites (Johnson, Beazell School). Thus, burial in specialized structures was not reserved by sex, age, or productive role. From this analysis it is suggested that community consolidation and resource stress (as evidenced by increased MSMs and stress indicators) may have brought about alterations in the ritual sphere during the Late period.

Analyses of MSMs were a prominent component of this bioarchaeological investigation. For the Monongahela, the pattern of MSM distribution is indicative of intensive maize agriculture. Heavy use of the shoulder musculature and forearm flexors/extensors, as well as moderate pronation/supination indicates frequent load bearing; clearing land for agricultural use, soil preparation, digging, harvesting, processing corn and other agricultural products all require heavy, repeated use of the upper limb musculature. High robusticity of the forearm flexors/extensors also indicates bow use, and these variables were significant among males for all three Monongahela samples. MSMs from the lower limb were also robust among the Monongahela including thigh adductors, thigh extensors, and knee flexors/extensors. Agricultural labor requires frequent squatting and rising during planting and harvesting, as well as during food processing. Hunting as a supplemental activity may have required walking over considerable distances. With respect to sex, males scored higher than females in use of shoulder musculature in the Middle and Late periods, and in the lower limb in the Late period. Females had moderate to high MSM scores for these attachment, with similar patterning to males. Age was also an important factor in MSM expression, as older age was correlated to high MSM robusticity for the entire Monongahela sequence. Outside of these patterns, the Late period sample had significantly higher MSM robusticity scores than the Early and Middle periods.

Stress indicators also increased during the Late period, with significant increases in subadult cribra orbitalia and LEH, along with LEH in males. Coupled with increased MSM robusticity into old age, these results suggest both increased adult labor demands and increased childhood stress in the Late period. These biological features correspond to the timing of the Little Ice Age, the effects of which could have had a severe impact on Monongahela agriculture (Richardson et al. 2002). The current study suggests that increased labor demands from drought seasons brought about the changes in MSM robusticity and increasingly poor crop yields contributed to systemic stress.

This investigation revealed the Monongahela sequence to be a tradition heavily engaged in intensive maize agriculture with little gendered differentiation in labor practices or social status. From the mortuary context and community organization, it can be inferred that the household was an important unit of social interaction. Personhood was very closely tied to the family unit as evidenced by child burials in house floors, whereas adolescence was the age of emergence into perceived sexual maturity and social adulthood.

### 10.1.3 The Post-contact Delaware

Bioarchaeological inquiry into the nature of gender, contact, and social organization is a key facet of the present analysis. For the Post-Contact period, there was no evidence of burial differentiation by age or sex; males, females, and all age ranges are represented in burials with large grave good assemblages and in those with few items. There was no difference in burial location or body position for this group, as all inhumations were in coffins in an extended position.

The only discernable information regarding the intersection of gender, biology and social interaction follows from skeletal analyses and demographic profiling. In the Delaware sample, rates of dental disease were significantly lower than those of the Monongahela, indicating a decreased reliance on maize as the primary food source. Rates of dental disease were markedly higher for females than males, following the expected pattern for agriculturalists outlined by Lukacs (2008), indicating that increased fertility may have played an important role in oral health for females during this period. MSM patterning did not support the hypothesis of a gendered division of labor, as there was no significant difference between males and females or young and old adults. Cribra orbitalia frequencies increased for males, females, and subadults, but only females and females experienced increases in LEH. These patterns indicate that historically documented disease events and warfare had a notable effect on population health during the mid-1700s. Based on the demographic profile, it is clear that the cemetery represents a catastrophic mortality event; the use of the site (1756-1778AD) corresponds with documented epidemics of smallpox in the late 1750's (Gist 1759).

The main contribution of bioarchaeological analyses in relation to the Post-Contact sample is that it provides an important backdrop to historical accounts regarding the historic Delaware (Gist 1759; Morris 1759; LeRoy and Leininger n.d, M'Cullough n.d.). Ferris (2009) emphasized the importance of archaeological inquiry into patterns of continuity and change, focusing on the lived experience of Native Americans during the colonial period. Historical narratives tend to focus on depopulation and decline, denying Native American agency, with a distinct misrepresentation of the myriad ways in which indigenous worldviews were negotiated and maintained, despite the intrusion of Europeans into indigenous subsistence territories, the incorporation of European trade goods into Native trade and social systems, and in many cases, the conversion to Christianity (Ferris 2009). The historic Delaware are an example of native lived colonialism in this respect, as maintenance of ceremonial dress was integrated with the adoption of coffins in mortuary ritual (Brown et al. 2014) and native foods such as deer and corn were consumed along with adopted foodstuffs such as milk and butter (LeRoy and Leininger n.d.).

## 10.2 CONCLUSION

This bioarchaeological study is significant on many levels. The results of this study will have a wider impact on the field of anthropology, as it contributes more broadly to anthropological theory regarding aspects of gendered social processes as functions of subsistence-settlement patterns, environmental shifts, and cultural contact by providing a diachronic study of changes to the social and physical landscapes of indigenous life across multiple time periods rather than focusing on the lived experiences of indigenous peoples at one moment in time. This project considers criticisms of recent scholarship focusing on gender and individualization, through life course theory, moving beyond binary distinctions of male versus female and child versus adult (Sofaer 2006), integrating current theoretical perspectives that allow for more nuanced analysis than previous archaeological investigations of social structure in the deep cultural past of the Ohio Valley region. This analysis provides new lines of inquiry to build upon previous research in settlement, subsistence, and mortuary analysis for this region.

This study also provides a direct methodological comparison of traditional mortuary analysis and integrative bioarchaeological modeling via multivariate statistics. Specifically, the cluster analyses and discussion section, as presented in Chapter 8, demonstrates that both traditional mortuary analysis following O'Shea (1984) (grave goods and burial attributes compared by binary sex) and biosocial analysis advocated by Robb et al. 1998 (integration of grave goods, burial attributes, detailed age categories, biological sex, MSMs, and patterns of disease) via Ward's method of clustering provide useful contextual information. It is then a conclusion of my research that both levels of analysis should be performed in bioarchaeological inquiry into the interaction between "social status" and "biological status" as some important distinctions are lost in both types of analysis. In the mortuary cluster analysis, clear distinctions and groupings of artifact classes and burial types were observed, allowing for initial modeling of social interaction. Following with biosocial analysis integrating complicated age distinctions and biological variables allows the researcher to observe changes in burial patterns once elements of life course and skeletal analysis are integrated. It was observed in the current study that while essential to studies of gender and social status, the interpretation of biosocial cluster analyses is complicated by the integration of a large number of variables, and some of the simpler distinctions revealed in traditional mortuary analysis are lost. In future studies it is clear that both types of clustering are useful matrices, and stable isotopes, DNA, and other archaeometric data could be incorporated into biosocial analysis.

The current study is also significant in that it represents an example of indigenous involvement in the research process, as the Post-Contact sample was in the process of repatriation under NAGPRA at the start of the analysis. The Delaware Tribe of Oklahoma provided key documents and resources for this study and to the Carnegie Museum of Natural History and expressed interest in the results of this analysis to provide deep historical context for the Chamber's site and the larger Ohio Valley. The integration of Native American tribes and indigenous scholarship should be encouraged for bioarchaeological projects in North American contexts, as indigenous voices add an important level of cultural context in anthropological inquiry.

Future lines of inquiry were identified by this study. There is a need for further research into bioarchaeology of obstetrics and pregnancy. In-situ perinate-maternal contexts are rare and represent important opportunities to investigate fertility associated gendered space in the mortuary context (Geller 2016); pregnancy is a liminal phase that in itself is a process of becoming and transition for both the mother and child. Pregnancy thus carries important social meaning in numerous ways in different societies. Bioarchaeological ethnographic modeling is one avenue through which this could be explored in future studies. While there is a growing body of archaeological and bioarchaeological literature regarding non-binary genders in North America (Carr and Case 2006; Hollimon 2001b, 2011; Rodrigues 2006), bioarchaeological analysis of specialized contexts will provide deeper meaning to the nature of how gender was expressed, negotiated, and performed (and the variations of these factors) in Native American societies. Ethnohistorical literature such as Roscoe (1998) has emphasized that non-binary gender identity was (and is) a significant feature of indigenous social life. The current study emphasized the presence of a specialized "third gender" class of shamanistic practitioners among the Adena, modeled after similar studies of the Hopewell (Carr and Case 2006; Rodrigues 2006). It is likely that unique, non-binary gender identities were a common feature of the past in North America, and further nuanced bioarchaeological analysis is necessary to reveal these patterns.

# APPENDICES

These appendices provide supplemental statistical information. Appendix A includes tables regarding pathology analysis, Appendix B addresses MSMs by bone, and Appendix C presents burial statistics. The following tables list all abbreviations used in this section:

| Time Period | Abbreviation |
|---|---|
| Early Woodland | EW |
| Early Monongahela | EM |
| Middle Monongahela | MM |
| Late Monongahela | LM |
| Post-Contact | PC |

| Demographics | Abbreviation |
|---|---|
| Male | M |
| Female | F |
| Subadult | S |
| Unknown | U |

| Age Group | Abbreviation* |
|---|---|
| Fetus | F |
| Neonate | N |
| Toddler | T |
| Early Child | EC |
| Late Child | LC |
| Adolescent | Ad |
| Youth | Y |
| Early Adult | EA |
| Young Adult | YA |
| Middle-Aged Adult | MA |
| Old Adult | OA |
| Adult | A |

*abbreviations may be combined – e.g. MMEAF = middle Monongahela early adult female

| Side | Abbreviation |
|---|---|
| Left | L |
| Right | R |

# APPENDIX A: PATHOLOGY

This section lists additional tables and figures relating to completeness, preservation and pathology as a supplement to Chapter 6 in this volume.

**Table 137:** Early Woodland bone counts by sex*

| Early Woodland Sample Bone Counts | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
| **Skull** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Frontal | 17 | 6 | 35.3 | 21 | 11 | 52.4 | 16 | 2 | 12.5 | 51 | 1 | 1.9 |
| Occipital | 17 | 6 | 35.3 | 21 | 9 | 42.8 | 16 | 0 | 0 | 51 | 1 | 1.9 |
| L Temporal | 17 | 11 | 64.7 | 21 | 11 | 52.4 | 16 | 1 | 6.3 | 51 | 3 | 5.8 |
| R Temporal | 17 | 8 | 47.1 | 21 | 11 | 52.4 | 16 | 1 | 6.3 | 51 | 1 | 1.9 |
| L Parietal | 17 | 9 | 52.9 | 21 | 11 | 52.4 | 16 | 2 | 12.5 | 51 | 1 | 1.9 |
| R Parietal | 17 | 9 | 52.9 | 21 | 10 | 47.6 | 16 | 2 | 12.5 | 51 | 1 | 1.9 |
| L Zygomatic | 17 | 2 | 11.8 | 21 | 3 | 14.3 | 16 | 0 | 0 | 51 | 0 | 0 |
| R Zygomatic | 17 | 1 | 5.9 | 21 | 0 | 0 | 16 | 0 | 0 | 51 | 0 | 0 |
| L Mandible | 17 | 7 | 41.2 | 21 | 7 | 33.3 | 16 | 2 | 12.5 | 51 | 1 | 1,9 |
| R Mandible | 17 | 5 | 29.4 | 21 | 5 | 23.8 | 16 | 2 | 12.5 | 51 | 0 | 0 |
| L Maxilla | 17 | 3 | 17.6 | 21 | 3 | 14.3 | 16 | 1 | 6.3 | 51 | 0 | 0 |
| R Maxilla | 17 | 3 | 17.6 | 21 | 2 | 9.5 | 16 | 1 | 6.3 | 51 | 1 | 1.9 |
| **Upper Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Clavicle | 17 | 1 | 5.9 | 21 | 4 | 19 | 16 | 1 | 6.3 | 51 | 1 | 1.9 |
| R Clavicle | 17 | 2 | 11.8 | 21 | 3 | 14.3 | 16 | 1 | 6.3 | 51 | 1 | 1.9 |
| L Humerus | 17 | 3 | 17.6 | 21 | 7 | 33.3 | 16 | 1 | 6.3 | 51 | 0 | 0 |
| R Humerus | 17 | 5 | 29.4 | 21 | 0 | 0 | 16 | 3 | 18.8 | 51 | 2 | 2.8 |
| L Radius | 17 | 3 | 17.6 | 21 | 4 | 19 | 16 | 0 | 0 | 51 | 0 | 0 |
| R Radius | 17 | 1 | 5.9 | 21 | 0 | 0 | 16 | 0 | 0 | 51 | 1 | 1.9 |
| L Ulna | 17 | 2 | 11.8 | 21 | 3 | 14.3 | 16 | 1 | 6.3 | 51 | 0 | 0 |
| R Ulna | 17 | 1 | 5.9 | 21 | 2 | 9.5 | 16 | 0 | 0 | 51 | 1 | 1.9 |
| Carpals | 272 | 7 | 2.5 | 336 | 3 | 0.8 | 256 | 0 | 0 | 816 | 0 | 0 |
| Metacarpals | 170 | 6 | 3.5 | 210 | 14 | 6.6 | 160 | 2 | 1.2 | 510 | 0 | 0 |
| Phalanges | 476 | 7 | 1.5 | 588 | 21 | 3.5 | 448 | 0 | 0 | 1428 | 0 | 0 |
| **Axial** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Scapula | 17 | 1 | 5.9 | 21 | 0 | 0 | 16 | 0 | 0 | 51 | 1 | 1.9 |
| R Scapula | 17 | 0 | 0 | 21 | 0 | 0 | 16 | 1 | 6.3 | 51 | 1 | 1.9 |
| L Ilium | 17 | 4 | 23.5 | 21 | 3 | 14.3 | 16 | 0 | 0 | 51 | 1 | 1.9 |
| R Ilium | 17 | 4 | 23.5 | 21 | 4 | 19 | 16 | 0 | 0 | 51 | 1 | 1.9 |
| L Ischium | 17 | 4 | 23.5 | 21 | 3 | 14.3 | 16 | 0 | 0 | 51 | 1 | 1.9 |
| R Ischium | 17 | 2 | 11.8 | 21 | 6 | 28.5 | 16 | 2 | 12.6 | 51 | 1 | 1.9 |
| L Pubis | 17 | 0 | 0 | 21 | 0 | 0 | 16 | 0 | 0 | 51 | 0 | 0 |
| R Pubis | 17 | 1 | 5.9 | 21 | 0 | 0 | 16 | 0 | 0 | 51 | 0 | 0 |
| L Patella | 17 | 2 | 11.8 | 21 | 1 | 4.8 | 16 | 0 | 0 | 51 | 1 | 1.9 |
| R Patella | 17 | 0 | 0 | 21 | 0 | 0 | 16 | 1 | 6.3 | 51 | 0 | 0 |
| Manubrium | 17 | 1 | 5.9 | 21 | 0 | 0 | 16 | 0 | 0 | 51 | 0 | 0 |
| Sternum | 17 | 0 | 0 | 21 | 1 | 4.8 | 16 | 0 | 0 | 51 | 0 | 0 |
| Ribs | 408 | 21 | 5.1 | 504 | 46 | 9.1 | 384 | 16 | 4.1 | 1224 | 1 | .10 |
| Cervical | 119 | 10 | 8.4 | 147 | 24 | 16.3 | 112 | 5 | 4.5 | 357 | 10 | 2.8 |
| Thoracic | 204 | 33 | 16.1 | 252 | 61 | 24.2 | 192 | 28 | 14.5 | 612 | 11 | 1.7 |
| Lumbar | 85 | 15 | 17.6 | 105 | 24 | 22.8 | 80 | 13 | 16.2 | 255 | 2 | .70 |
| Sacral | 85 | 13 | 15.3 | 105 | 19 | 18.1 | 80 | 4 | 5 | 255 | 0 | 0 |

*(N = number expected, n = number present)

**Table 137:** (continued)

| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lower Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Femur | 17 | 10 | 58.8 | 21 | 5 | 23.8 | 16 | 1 | 6.3 | 51 | 0 | 0 |
| R Femur | 17 | 7 | 41.1 | 21 | 8 | 38.1 | 16 | 1 | 6.3 | 51 | 2 | 3.9 |
| L Tibia | 17 | 6 | 35.3 | 21 | 4 | 19 | 16 | 0 | 0 | 51 | 2 | 3.9 |
| R Tibia | 17 | 2 | 11.8 | 21 | 4 | 19 | 16 | 1 | 6.3 | 51 | 3 | 5.8 |
| L Fibula | 17 | 0 | 0 | 21 | 2 | 9.5 | 16 | 0 | 0 | 51 | 0 | 0 |
| R Fibula | 17 | 0 | 0 | 21 | 2 | 9.5 | 16 | 0 | 0 | 51 | 0 | 0 |
| Tarsals | 119 | 22 | 18.5 | 147 | 23 | 15.6 | 112 | 1 | .89 | 357 | 1 | 3.9 |
| Metatarsals | 170 | 3 | 1.8 | 210 | 13 | 6.2 | 160 | 0 | 0 | 510 | 0 | 0 |
| Phalanges | 476 | 1 | .21 | 588 | 5 | .85 | 448 | 0 | 0 | 1428 | 0 | 0 |

**Table 138:** Early Monongahela bone counts by sex*

| Early Monongahela Sample Bone Counts | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
| **Skull** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Frontal | 9 | 8 | 88.8 | 11 | 8 | 72.7 | 21 | 8 | 38.1 | 9 | 0 | 0 |
| Occipital | 9 | 6 | 66.6 | 11 | 8 | 72.7 | 21 | 13 | 61.9 | 9 | 1 | 11.1 |
| L Temporal | 9 | 5 | 55.5 | 11 | 6 | 54.5 | 21 | 14 | 66.6 | 9 | 0 | 0 |
| R Temporal | 9 | 6 | 88.8 | 11 | 8 | 72.7 | 21 | 14 | 66.6 | 9 | 1 | 11.1 |
| L Parietal | 9 | 7 | 77.7 | 11 | 10 | 90.9 | 21 | 15 | 71.4 | 9 | 0 | 0 |
| R Parietal | 9 | 6 | 66.6 | 11 | 10 | 90.9 | 21 | 15 | 71.4 | 9 | 0 | 0 |
| L Zygomatic | 9 | 3 | 33.3 | 11 | 8 | 72.7 | 21 | 9 | 42.8 | 9 | 0 | 0 |
| R Zygomatic | 9 | 3 | 33.3 | 11 | 7 | 63.6 | 21 | 7 | 33.3 | 9 | 0 | 0 |
| L Mandible | 9 | 4 | 44.4 | 11 | 8 | 72.7 | 21 | 10 | 47.6 | 9 | 0 | 0 |
| R Mandible | 9 | 4 | 44.4 | 11 | 8 | 72.7 | 21 | 8 | 38.1 | 9 | 9 | 100 |
| L Maxilla | 9 | 4 | 44.4 | 11 | 6 | 54.5 | 21 | 9 | 42.9 | 9 | 0 | 0 |
| R Maxilla | 9 | 3 | 33.3 | 11 | 6 | 54.5 | 21 | 10 | 47.6 | 9 | 0 | 0 |
| **Upper Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Clavicle | 9 | 6 | 66.6 | 11 | 8 | 72.7 | 21 | 8 | 38.1 | 9 | 0 | 0 |
| R Clavicle | 9 | 7 | 77.7 | 11 | 10 | 90.9 | 21 | 9 | 42.9 | 9 | 0 | 0 |
| L Humerus | 9 | 6 | 66.6 | 11 | 9 | 81.8 | 21 | 14 | 66.6 | 9 | 0 | 0 |
| R Humerus | 9 | 6 | 66.6 | 11 | 8 | 72.7 | 21 | 15 | 71.4 | 9 | 0 | 0 |
| L Radius | 9 | 6 | 66.6 | 11 | 9 | 81.8 | 21 | 12 | 57.1 | 9 | 0 | 0 |
| R Radius | 9 | 6 | 66.6 | 11 | 9 | 81.8 | 21 | 10 | 47.6 | 9 | 0 | 0 |
| L Ulna | 9 | 7 | 77.7 | 11 | 10 | 90.9 | 21 | 12 | 57.1 | 9 | 0 | 0 |
| R Ulna | 9 | 8 | 88.8 | 11 | 10 | 90.9 | 21 | 12 | 57.1 | 9 | 0 | 0 |
| Carpals | 117 | 50 | 42.7 | 176 | 81 | 46.0 | 336 | 35 | 7.4 | 117 | 0 | 0 |
| Metacarpals | 90 | 58 | 64.4 | 110 | 78 | 70.9 | 210 | 44 | 20.9 | 90 | 1 | 1.1 |
| Phalanges | 252 | 116 | 46.1 | 308 | 151 | 49.0 | 588 | 98 | 16.6 | 252 | 1 | .39 |
| **Axial** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Scapula | 9 | 3 | 33.3 | 11 | 3 | 27.2 | 21 | 9 | 42.8 | 9 | 0 | 0 |
| R Scapula | 9 | 2 | 22.2 | 11 | 3 | 27.2 | 21 | 10 | 47.6 | 9 | 0 | 0 |
| L Ilium | 9 | 5 | 55.5 | 11 | 0 | 0 | 21 | 16 | 76.2 | 9 | 0 | 0 |
| R Ilium | 9 | 5 | 55.5 | 11 | 8 | 72.7 | 21 | 14 | 66.6 | 9 | 0 | 0 |
| L Ischium | 9 | 5 | 55.5 | 11 | 9 | 81.8 | 21 | 10 | 47.6 | 9 | 0 | 0 |
| R Ischium | 9 | 6 | 66.6 | 11 | 9 | 81.8 | 21 | 9 | 42.8 | 9 | 0 | 0 |
| L Pubis | 9 | 2 | 22.2 | 11 | 5 | 45.4 | 21 | 9 | 42.8 | 9 | 0 | 0 |
| R Pubis | 9 | 2 | 22.2 | 11 | 3 | 27.2 | 21 | 6 | 28.5 | 9 | 0 | 0 |
| L Patella | 9 | 7 | 77.7 | 11 | 6 | 54.5 | 21 | 4 | 19.0 | 9 | 0 | 0 |
| R Patella | 9 | 5 | 55.5 | 11 | 5 | 45.4 | 21 | 3 | 14.2 | 9 | 1 | 11.1 |
| Manubrium | 9 | 3 | 33.3 | 11 | 5 | 45.4 | 21 | 2 | 9.5 | 9 | 0 | 0 |
| Sternum | 9 | 3 | 33.3 | 11 | 5 | 45.4 | 21 | 3 | 14.2 | 9 | 0 | 0 |
| Ribs | 216 | 77 | 35.6 | 264 | 109 | 41.2 | 504 | 207 | 41.1 | 216 | 1 | .46 |
| Cervical | 63 | 36 | 57.1 | 77 | 56 | 72.7 | 147 | 73 | 49.6 | 63 | 37 | 58.7 |
| Thoracic | 108 | 74 | 68.5 | 132 | 101 | 76.5 | 252 | 127 | 50.4 | 108 | 4 | 3.7 |
| Lumbar | 45 | 31 | 68.9 | 55 | 43 | 78,1 | 105 | 63 | 60 | 45 | 0 | 0 |
| Sacral | 45 | 21 | 46.6 | 55 | 34 | 61.8 | 105 | 20 | 19.0 | 45 | 0 | 0 |

*(N = number expected, n = number present)

**Table 138:** (continued)

| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lower Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Femur | 9 | 6 | 66.6 | 11 | 9 | 81.8 | 21 | 13 | 61.9 | 9 | 0 | 0 |
| R Femur | 9 | 4 | 44.4 | 11 | 10 | 90.9 | 21 | 17 | 80.9 | 9 | 0 | 0 |
| L Tibia | 9 | 4 | 44.4 | 11 | 7 | 63.6 | 21 | 14 | 66.6 | 9 | 0 | 0 |
| R Tibia | 9 | 5 | 55.5 | 11 | 8 | 72.7 | 21 | 14 | 66.6 | 9 | 1 | 11.1 |
| L Fibula | 9 | 3 | 33.3 | 11 | 8 | 72.7 | 21 | 8 | 38.1 | 9 | 1 | 11.1 |
| R Fibula | 9 | 3 | 33.3 | 11 | 3 | 27.2 | 21 | 12 | 57.1 | 9 | 1 | 11.1 |
| Tarsals | 126 | 67 | 53.2 | 154 | 77 | 50 | 294 | 73 | 24.8 | 126 | 14 | 11.1 |
| Metatarsals | 90 | 57 | 63,3 | 110 | 67 | 60.9 | 210 | 59 | 28.1 | 90 | 10 | 11.1 |
| Phalanges | 252 | 52 | 20.6 | 308 | 58 | 18.8 | 588 | 28 | 4.8 | 252 | 18 | 7.1 |

**Table 139:** Middle Monongahela bone counts by sex*

| Middle Monongahela Sample Bone Counts | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
| **Skull** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Frontal | 20 | 14 | 70 | 18 | 11 | 61.1 | 26 | 17 | 65.3 | 10 | 0 | 0 |
| Occipital | 20 | 14 | 70 | 18 | 12 | 66.6 | 26 | 16 | 61.5 | 10 | 1 | 10 |
| L Temporal | 20 | 12 | 60 | 18 | 10 | 55.5 | 26 | 19 | 73.1 | 10 | 1 | 10 |
| R Temporal | 20 | 14 | 60 | 18 | 11 | 61.1 | 26 | 19 | 73.1 | 10 | 0 | 0 |
| L Parietal | 20 | 15 | 75 | 18 | 13 | 72.2 | 26 | 21 | 80.7 | 10 | 1 | 10 |
| R Parietal | 20 | 15 | 75 | 18 | 12 | 66.6 | 26 | 21 | 80.1 | 10 | 2 | 20 |
| L Zygomatic | 20 | 12 | 60 | 18 | 9 | 50 | 26 | 15 | 57.6 | 10 | 0 | 0 |
| R Zygomatic | 20 | 10 | 50 | 18 | 10 | 55.5 | 26 | 11 | 42.3 | 10 | 0 | 0 |
| L Mandible | 20 | 10 | 50 | 18 | 9 | 50 | 26 | 15 | 57.6 | 10 | 0 | 0 |
| R Mandible | 20 | 13 | 65 | 18 | 10 | 55.5 | 26 | 15 | 57.6 | 10 | 0 | 0 |
| L Maxilla | 20 | 11 | 55 | 18 | 8 | 44.4 | 26 | 13 | 50 | 10 | 0 | 0 |
| R Maxilla | 20 | 11 | 55 | 18 | 9 | 50 | 26 | 10 | 38.4 | 10 | 0 | 0 |
| **Upper Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Clavicle | 20 | 14 | 70 | 18 | 13 | 72.2 | 26 | 12 | 46.1 | 10 | 1 | 10 |
| R Clavicle | 20 | 13 | 65 | 18 | 14 | 77.7 | 26 | 11 | 42.3 | 10 | 0 | 0 |
| L Humerus | 20 | 13 | 65 | 18 | 14 | 77.7 | 26 | 19 | 73,1 | 10 | 0 | 0 |
| R Humerus | 20 | 15 | 75 | 18 | 13 | 72.2 | 26 | 13 | 50 | 10 | 0 | 0 |
| L Radius | 20 | 13 | 65 | 18 | 14 | 77.7 | 26 | 15 | 57.6 | 10 | 0 | 0 |
| R Radius | 20 | 12 | 60 | 18 | 13 | 72.2 | 26 | 15 | 57.6 | 10 | 0 | 0 |
| L Ulna | 20 | 15 | 75 | 18 | 14 | 77.7 | 26 | 14 | 53.8 | 10 | 0 | 0 |
| R Ulna | 20 | 14 | 70 | 18 | 15 | 83.3 | 26 | 19 | 73.1 | 10 | 0 | 0 |
| Carpals | 320 | 106 | 33.1 | 288 | 97 | 33.6 | 416 | 29 | 6.9 | 160 | 11 | 6.8 |
| Metacarpals | 200 | 95 | 47.5 | 180 | 107 | 59.4 | 260 | 94 | 36.2 | 100 | 3 | 3 |
| Phalanges | 560 | 187 | 33.4 | 504 | 194 | 38.4 | 728 | 132 | 18.1 | 280 | 46 | 16.4 |
| **Axial** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Scapula | 20 | 8 | 40 | 18 | 2 | 11.1 | 26 | 13 | 50 | 10 | 0 | 0 |
| R Scapula | 20 | 6 | 30 | 18 | 3 | 16.6 | 26 | 12 | 46.2 | 10 | 0 | 0 |
| L Ilium | 20 | 14 | 70 | 18 | 10 | 55.5 | 26 | 17 | 65.4 | 10 | 0 | 0 |
| R Ilium | 20 | 14 | 70 | 18 | 6 | 33.3 | 26 | 18 | 69.2 | 10 | 0 | 0 |
| L Ischium | 20 | 16 | 80 | 18 | 14 | 77.7 | 26 | 13 | 50 | 10 | 0 | 0 |
| R Ischium | 20 | 13 | 65 | 18 | 12 | 66.6 | 26 | 16 | 61.5 | 10 | 1 | 10 |
| L Pubis | 20 | 9 | 45 | 18 | 7 | 38.8 | 26 | 11 | 42.3 | 10 | 0 | 0 |
| R Pubis | 20 | 10 | 50 | 18 | 8 | 44.4 | 26 | 11 | 42.3 | 10 | 0 | 0 |
| L Patella | 20 | 14 | 70 | 18 | 12 | 66.6 | 26 | 5 | 19.2 | 10 | 2 | 20 |
| R Patella | 20 | 11 | 55 | 18 | 10 | 5.5 | 26 | 4 | 15.4 | 10 | 1 | 10 |
| Manubrium | 20 | 13 | 65 | 18 | 8 | 44.4 | 26 | 4 | 15.3 | 10 | 0 | 0 |
| Sternum | 20 | 13 | 65 | 18 | 10 | 55.5 | 26 | 5 | 19.2 | 10 | 0 | 0 |
| Ribs | 833 | 298 | 35.7 | 432 | 235 | 54.4 | 624 | 282 | 45.2 | 240 | 21 | 8.7 |
| Cervical | 140 | 119 | 83.5 | 126 | 82 | 65.1 | 182 | 106 | 58.2 | 70 | 1 | 1.4 |
| Thoracic | 240 | 193 | 80.4 | 216 | 129 | 59.2 | 312 | 191 | 61.2 | 120 | 6 | 5.0 |
| Lumbar | 100 | 80 | 80 | 90 | 60 | 66.6 | 140 | 90 | 64.2 | 50 | 12 | 24 |
| Sacral | 100 | 61 | 61 | 90 | 11 | 12.2 | 140 | 31 | 22.1 | 50 | 4 | 8.0 |

*(N = number expected, n = number present)

**Table 139:** (continued)

| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lower Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Femur | 20 | 14 | 70 | 18 | 15 | 83.3 | 26 | 19 | 73.1 | 10 | 0 | 0 |
| R Femur | 20 | 10 | 50 | 18 | 13 | 72.2 | 26 | 18 | 69.2 | 10 | 0 | 0 |
| L Tibia | 20 | 13 | 65 | 18 | 13 | 72.2 | 26 | 16 | 61.5 | 10 | 0 | 0 |
| R Tibia | 20 | 12 | 60 | 18 | 13 | 72.2 | 26 | 19 | 73.1 | 10 | 0 | 0 |
| L Fibula | 20 | 12 | 60 | 18 | 11 | 61.1 | 26 | 14 | 53.8 | 10 | 0 | 0 |
| R Fibula | 20 | 10 | 50 | 18 | 10 | 55.5 | 26 | 12 | 46.1 | 10 | 0 | 0 |
| Tarsals | 280 | 122 | 43.6 | 252 | 145 | 57.5 | 364 | 63 | 17.3 | 140 | 16 | 11.4 |
| Metatarsals | 200 | 108 | 54 | 180 | 101 | 56.1 | 260 | 49 | 18.8 | 100 | 9 | 9 |
| Phalanges | 560 | 99 | 17.6 | 504 | 99 | 19.6 | 728 | 45 | 6.2 | 280 | 9 | 3.2 |

**Table 140:** Late Monongahela bone counts by sex*

| Late Monongahela Sample Bone Counts | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
| **Skull** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Frontal | 10 | 8 | 80 | 16 | 6 | 37.5 | 14 | 10 | 71.4 | 3 | 0 | 0 |
| Occipital | 10 | 8 | 80 | 16 | 5 | 31.3 | 14 | 8 | 57.1 | 3 | 0 | 0 |
| L Temporal | 10 | 7 | 70 | 16 | 6 | 37.5 | 14 | 7 | 50 | 3 | 0 | 0 |
| R Temporal | 10 | 7 | 70 | 16 | 7 | 43.7 | 14 | 9 | 64.3 | 3 | 0 | 0 |
| L Parietal | 10 | 8 | 80 | 16 | 8 | 50 | 14 | 10 | 71.4 | 3 | 0 | 0 |
| R Parietal | 10 | 7 | 70 | 16 | 8 | 50 | 14 | 10 | 71.4 | 3 | 0 | 0 |
| L Zygomatic | 10 | 7 | 8- | 16 | 7 | 43.7 | 14 | 7 | 50 | 3 | 0 | 0 |
| R Zygomatic | 10 | 5 | 50 | 16 | 6 | 37.5 | 14 | 6 | 42.9 | 3 | 0 | 0 |
| L Mandible | 10 | 6 | 60 | 16 | 8 | 50 | 14 | 9 | 64.3 | 3 | 0 | 0 |
| R Mandible | 10 | 7 | 70 | 16 | 8 | 50 | 14 | 10 | 71.4 | 3 | 0 | 0 |
| L Maxilla | 10 | 6 | 60 | 16 | 4 | 25 | 14 | 9 | 64.3 | 3 | 1 | 33.3 |
| R Maxilla | 10 | 5 | 50 | 16 | 5 | 31.3 | 14 | 9 | 64.3 | 3 | 0 | 0 |
| **Upper Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Clavicle | 10 | 5 | 50 | 16 | 9 | 56.3 | 14 | 6 | 42.9 | 3 | 0 | 0 |
| R Clavicle | 10 | 6 | 60 | 16 | 10 | 62.5 | 14 | 4 | 28.5 | 3 | 0 | 0 |
| L Humerus | 10 | 6 | 60 | 16 | 12 | 75 | 14 | 6 | 42.9 | 3 | 2 | 66.6 |
| R Humerus | 10 | 6 | 60 | 16 | 12 | 75 | 14 | 5 | 35.7 | 3 | 3 | 100 |
| L Radius | 10 | 6 | 60 | 16 | 12 | 75 | 14 | 5 | 35.7 | 3 | 0 | 0 |
| R Radius | 10 | 6 | 60 | 16 | 10 | 62.5 | 14 | 4 | 28.5 | 3 | 0 | 0 |
| L Ulna | 10 | 7 | 70 | 16 | 11 | 84.6 | 14 | 7 | 50 | 3 | 3 | 100 |
| R Ulna | 10 | 6 | 60 | 16 | 10 | 62.5 | 14 | 5 | 35.7 | 3 | 0 | 0 |
| Carpals | 160 | 65 | 40.6 | 256 | 85 | 33.2 | 224 | 17 | 7.6 | 48 | 0 | 0 |
| Metacarpals | 100 | 49 | 49 | 160 | 100 | 62.5 | 140 | 36 | 25.7 | 30 | 0 | 0 |
| Phalanges | 280 | 119 | 42.5 | 448 | 202 | 45.1 | 392 | 47 | 11.9 | 84 | 0 | 0 |
| **Axial** | **N** | **N** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Scapula | 10 | 5 | 50 | 16 | 4 | 25 | 14 | 6 | 42.8 | 3 | 1 | 33.3 |
| R Scapula | 10 | 2 | 20 | 16 | 5 | 31.3 | 14 | 5 | 35.7 | 3 | 3 | 100 |
| L Ilium | 10 | 4 | 40 | 16 | 8 | 50 | 14 | 8 | 57.1 | 3 | 0 | 0 |
| R Ilium | 10 | 4 | 40 | 16 | 8 | 50 | 14 | 8 | 57.1 | 3 | 0 | 0 |
| L Ischium | 10 | 4 | 40 | 16 | 8 | 50 | 14 | 4 | 28.6 | 3 | 0 | 0 |
| R Ischium | 10 | 4 | 40 | 16 | 10 | 62.5 | 14 | 4 | 28.6 | 3 | 1 | 33.3 |
| L Pubis | 10 | 4 | 40 | 16 | 6 | 37.5 | 14 | 3 | 21.4 | 3 | 0 | 0 |
| R Pubis | 10 | 4 | 40 | 16 | 4 | 25 | 14 | 6 | 40 | 3 | 0 | 0 |
| L Patella | 10 | 6 | 60 | 16 | 10 | 62.5 | 14 | 1 | 7.1 | 3 | 0 | 0 |
| R Patella | 10 | 6 | 60 | 16 | 12 | 75 | 14 | 0 | 0 | 3 | 0 | 0 |
| Manubrium | 10 | 3 | 30 | 16 | 6 | 37.5 | 14 | 1 | 7.1 | 3 | 0 | 0 |
| Sternum | 10 | 4 | 40 | 16 | 6 | 37.5 | 14 | 4 | 28.6 | 3 | 0 | 0 |
| Ribs | 240 | 72 | 30 | 384 | 115 | 30.2 | 336 | 130 | 38.7 | 72 | 0 | 0 |
| Cervical | 70 | 4 | 5.7 | 112 | 61 | 54.5 | 98 | 37 | 37.8 | 21 | 1 | 4.8 |
| Thoracic | 120 | 65 | 54.2 | 192 | 119 | 61.9 | 168 | 96 | 57.1 | 36 | 1 | 27.8 |
| Lumbar | 50 | 30 | 60 | 80 | 58 | 72.5 | 70 | 35 | 50 | 15 | 1 | 6.6 |
| Sacral | 50 | 24 | 48 | 80 | 40 | 50 | 70 | 5 | 7.1 | 15 | 3 | 20 |

*(N = number expected, n = number present)

**Table 140:** (continued)

| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lower Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Femur | 10 | 7 | 70 | 16 | 12 | 75 | 14 | 6 | 42.8 | 3 | 0 | 0 |
| R Femur | 10 | 5 | 50 | 16 | 11 | 68.7 | 14 | 6 | 42.8 | 3 | 0 | 0 |
| L Tibia | 10 | 5 | 50 | 16 | 10 | 62.5 | 14 | 7 | 50 | 3 | 0 | 0 |
| R Tibia | 10 | 5 | 50 | 16 | 9 | 56.2 | 14 | 8 | 57.1 | 3 | 0 | 0 |
| L Fibula | 10 | 4 | 40 | 16 | 6 | 37.5 | 14 | 5 | 35.7 | 3 | 1 | 33.3 |
| R Fibula | 10 | 4 | 40 | 16 | 4 | 25 | 14 | 2 | 14.3 | 3 | 1 | 33.3 |
| Tarsals | 140 | 65 | 46.4 | 224 | 121 | 54 | 196 | 15 | 7.6 | 42 | 12 | 28.6 |
| Metatarsals | 100 | 62 | 62 | 160 | 86 | 53.8 | 140 | 24 | 17.1 | 30 | 11 | 36.6 |
| Phalanges | 280 | 60 | 21.4 | 448 | 85 | 19.1 | 392 | 0 | 0 | 84 | 16 | 19.1 |

**Table 141:** Post-Contact bone counts by sex*

| Post-Contact Sample Bone Counts | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
| **Skull** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| Frontal | 5 | 5 | 100 | 16 | 9 | 56.3 | 18 | 5 | 27.7 | 19 | 3 | 15.8 |
| Occipital | 5 | 4 | 80 | 16 | 9 | 56.3 | 18 | 10 | 55.5 | 19 | 4 | 21.1 |
| L Temporal | 5 | 5 | 100 | 16 | 15 | 93.8 | 18 | 7 | 38.8 | 19 | 6 | 31.6 |
| R Temporal | 5 | 4 | 80 | 16 | 10 | 62.5 | 18 | 9 | 50 | 19 | 4 | 21.1 |
| L Parietal | 5 | 4 | 80 | 16 | 12 | 75 | 18 | 11 | 61.1 | 19 | 5 | 26.3 |
| R Parietal | 5 | 5 | 100 | 16 | 11 | 68.8 | 18 | 8 | 50 | 19 | 5 | 26.3 |
| L Zygomatic | 5 | 5 | 100 | 16 | 5 | 31.3 | 18 | 2 | 11.1 | 19 | 0 | 0 |
| R Zygomatic | 5 | 5 | 100 | 16 | 6 | 37.5 | 18 | 1 | 5.5 | 19 | 1 | 5.3 |
| L Mandible | 5 | 5 | 100 | 16 | 16 | 100 | 18 | 10 | 55.5 | 19 | 3 | 15.8 |
| R Mandible | 5 | 3 | 60 | 16 | 15 | 93.8 | 18 | 4 | 22.2 | 19 | 3 | 15.8 |
| L Maxilla | 5 | 4 | 80 | 16 | 10 | 62.5 | 18 | 5 | 27.7 | 19 | 1 | 5.3 |
| R Maxilla | 5 | 4 | 80 | 16 | 11 | 68.8 | 18 | 5 | 27.7 | 19 | 1 | 5.3 |
| **Upper Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Clavicle | 5 | 4 | 80 | 16 | 6 | 37.5 | 18 | 2 | 11.1 | 19 | 0 | 0 |
| R Clavicle | 5 | 2 | 40 | 16 | 6 | 27.5 | 18 | 3 | 16.6 | 19 | 0 | 0 |
| L Humerus | 5 | 5 | 100 | 16 | 8 | 50 | 18 | 3 | 16.6 | 19 | 1 | 5.3 |
| R Humerus | 5 | 4 | 80 | 16 | 10 | 62.5 | 18 | 5 | 27.7 | 19 | 2 | 10.5 |
| L Radius | 5 | 3 | 60 | 16 | 4 | 25 | 18 | 2 | 11.1 | 19 | 1 | 5.3 |
| R Radius | 5 | 4 | 80 | 16 | 5 | 31.3 | 18 | 0 | 0 | 19 | 0 | 0 |
| L Ulna | 5 | 4 | 80 | 16 | 4 | 25 | 18 | 4 | 22.2 | 19 | 2 | 10.5 |
| R Ulna | 5 | 3 | 60 | 16 | 8 | 50 | 18 | 2 | 11.1 | 19 | 1 | 5.3 |
| Carpals | 80 | 2 | 2.5 | 256 | 3 | 1.1 | 288 | 0 | 0 | 304 | 0 | 0 |
| Metacarpals | 50 | 4 | 8.0 | 160 | 23 | 14,4 | 180 | 2 | 1.1 | 190 | 0 | 0 |
| Phalanges | 140 | 9 | 6.4 | 448 | 18 | 4.0 | 504 | 7 | 1.4 | 532. | 1 | 0.18 |
| **Axial** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Scapula | 5 | 1 | 20 | 16 | 4 | 25 | 18 | 0 | 0 | 19 | 0 | 0 |
| R Scapula | 5 | 3 | 60 | 16 | 4 | 25 | 18 | 1 | 5.5 | 19 | 0 | 0 |
| L Ilium | 5 | 4 | 80 | 16 | 10 | 62.5 | 18 | 3 | 16.6 | 19 | 0 | 0 |
| R Ilium | 5 | 4 | 80 | 16 | 10 | 62.5 | 18 | 3 | 16.6 | 19 | 0 | 0 |
| L Ischium | 5 | 2 | 40 | 16 | 5 | 31.3 | 18 | 1 | 5.5 | 19 | 0 | 0 |
| R Ischium | 5 | 2 | 40 | 16 | 7 | 43.8 | 18 | 1 | 5.5 | 19 | 0 | 0 |
| L Pubis | 5 | 1 | 20 | 16 | 0 | 0 | 18 | 0 | 0 | 19 | 0 | 0 |
| R Pubis | 5 | 1 | 20 | 16 | 0 | 0 | 18 | 0 | 0 | 19 | 0 | 0 |
| L Patella | 5 | 0 | 0 | 16 | 2 | 12.5 | 18 | 2 | 11.1 | 19 | 0 | 0 |
| R Patella | 5 | 1 | 20 | 16 | 2 | 12.5 | 18 | 1 | 5.5 | 19 | 0 | 0 |
| Manubrium | 5 | 0 | 0 | 16 | 2 | 12.5 | 18 | 0 | 0 | 19 | 0 | 0 |
| Sternum | 5 | 0 | 0 | 16 | 1 | 6.3 | 18 | 0 | 0 | 19 | 0 | 0 |
| Ribs | 120 | 18 | 15 | 384 | 46 | 11.9 | 432 | 52 | 12.1 | 456 | 0 | 0 |
| Cervical | 35 | 17 | 48.6 | 112 | 52 | 46.4 | 126 | 28 | 22.2 | 132 | 2 | 1.5 |
| Thoracic | 60 | 36 | 60 | 192 | 86 | 44.8 | 216 | 39 | 18.1 | 228 | 4 | 1.7 |
| Lumbar | 25 | 19 | 76 | 80 | 39 | 48.8 | 90 | 15 | 16.6 | 95 | 2 | 2.1 |
| Sacral | 25 | 16 | 64 | 80 | 34 | 42.5 | 90 | 9 | 56.3 | 95 | 0 | 0 |

*(N = number affected, n = number present)

**Table 141:** (continued)

| | Males | | | Females | | | Subadults | | | Unsexed Adults | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lower Limb** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** | **N** | **n** | **%** |
| L Femur | 5 | 2 | 40 | 16 | 16 | 100 | 18 | 3 | 16.6 | 19 | 1 | 5.3 |
| R Femur | 5 | 4 | 80 | 16 | 16 | 100 | 18 | 3 | 16.6 | 19 | 3 | 15.8 |
| L Tibia | 5 | 5 | 100 | 16 | 9 | 56.3 | 18 | 1 | 6.2 | 19 | 1 | 5.3 |
| R Tibia | 5 | 4 | 80 | 16 | 10 | 62.5 | 18 | 3 | 16.6 | 19 | 1 | 5.3 |
| L Fibula | 5 | 0 | 0 | 16 | 4 | 25 | 18 | 1 | 6.2 | 19 | 0 | 0 |
| R Fibula | 5 | 2 | 40 | 16 | 5 | 31.3 | 18 | 1 | 6.2 | 19 | 0 | 0 |
| Tarsals | 70 | 10 | 14.2 | 224 | 25 | 11.2 | 252 | 17 | 6.7 | 266 | 5 | 1.9 |
| Metatarsals | 50 | 6 | 12 | 160 | 17 | 10.6 | 180 | 12 | 6.7 | 190 | 1 | 0.52 |
| Phalanges | 140 | 0 | 0 | 448 | 0 | 0 | 504 | 1 | 0.19 | 532 | 2 | 0.38 |

**Table 142:** Frequencies of AMTL in maxillary dentition by sex

| Time/Sex | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM M | 60 | 40 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 40 | 60 | 60 |
| EM F | 0 | 0 | 0 | 0 | 22 | 11 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 |
| EM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM M | 33 | 33 | 27 | 25 | 28 | 15 | 23 | 23 | 16 | 25 | 25 | 31 | 38 | 38 | 50 | 38 |
| MM F | 20 | 38 | 21 | 27 | 25 | 23 | 41 | 33 | 27 | 33 | 27 | 27 | 29 | 25 | 29 | 29 |
| MM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 33 | 60 | 33 | 29 | 12 | 29 | 29 | 14 | 14 | 14 | 25 | 25 | 25 | 29 | 80 | 20 |
| LM F | 14 | 14 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 14 | 40 | 40 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC F | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PCU | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 143:** Frequencies of AMTL in mandibular dentition by sex

| Time/Sex | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 11 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 22 | 14 |
| EW F | 10 | 11 | 22 | 11 | 10 | 0 | 0 | 12 | 14 | 14 | 14 | 0 | 0 | 0 | 25 | 0 |
| EW S | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 11 | 8 | 8 | 0 | 0 | 0 | 0 | 50 | 50 | 50 | 25 | 0 | 0 | 14 | 0 | 0 |
| EM M | 75 | 50 | 100 | 17 | 20 | 25 | 40 | 20 | 25 | 25 | 20 | 60 | 60 | 100 | 60 | 40 |
| EM F | 33 | 20 | 30 | 10 | 22 | 12 | 20 | 20 | 20 | 20 | 0 | 10 | 20 | 40 | 30 | 27 |
| EM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM M | 53 | 53 | 40 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 0 | 7 | 33 | 75 | 71 | 66 |
| MM F | 38 | 69 | 43 | 36 | 14 | 7 | 7 | 21 | 14 | 7 | 14 | 20 | 31 | 50 | 58 | 42 |
| MM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 50 | 83 | 50 | 14 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 17 | 50 | 83 | 33 |
| LM F | 30 | 38 | 62 | 33 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 12 | 25 | 62 | 50 | 22 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 |
| PC F | 6 | 18 | 18 | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 11 | 12 | 18 | 12 |
| PC S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC U | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 |

**Table 144:** Frequencies by tooth count of Caries in maxillary dentition by sex

| Time/Sex | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| EW F | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 33 | 0 | 0 | 0 | 0 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM M | 50 | 33 | 25 | 33 | 33 | 50 | 33 | 100 | 50 | 0 | 0 | 0 | 0 | 50 | 50 | 0 |
| EM F | 0 | 0 | 28 | 12 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 | 17 |
| EM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 33 | 0 |
| MM M | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 100 |
| MM F | 50 | 66 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 14 | 33 | 25 | 0 |
| MM S | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 0 | 50 | 0 | 50 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 |
| LM F | 40 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC F | 25 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 |
| PC S | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC U | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 145:** Frequencies by tooth count of caries in mandibular dentition by sex

| Time/Sex | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 25 |
| EW F | 0 | 17 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM M | 100 | 0 | 100 | 0 | 14 | 33 | 33 | 50 | 100 | 100 | 100 | 100 | 100 | 0 | 50 | 66 |
| EM F | 20 | 17 | 0 | 0 | 11 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 17 | 14 |
| EM S | 0 | 28 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 |
| EM U | 50 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 33 | 0 |
| MM M | 83 | 38 | 43 | 20 | 10 | 9 | 22 | 14 | 0 | 17 | 9 | 17 | 0 | 100 | 50 | 66 |
| MM F | 50 | 33 | 0 | 20 | 17 | 0 | 17 | 0 | 0 | 12 | 11 | 0 | 22 | 25 | 0 | 40 |
| MM S | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 9 | 33 | 0 |
| MM U | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 40 | 0 | 0 | 25 |
| LM F | 57 | 20 | 0 | 20 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 33 | 17 | 25 | 0 | 28 |
| LM S | 0 | 100 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 50 | 0 |
| PC F | 17 | 33 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 27 | 17 |
| PC S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC U | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 40 | 20 |

**Table 146:** Post-hoc p-values by time period for caries

| Tooth 5 | EW | EM | MM | LM |
|---|---|---|---|---|
| **EW** | | | | .007 |
| **MM** | | | | .008 |
| **PC** | | | | .004 |
| **Tooth 17** | **EW** | **EM** | **MM** | **LM** |
| **EW** | | .001 | | .004 |
| **EM** | | | .004 | .008 |
| **PC** | | | .010 | .019 |
| **Tooth 28** | **EW** | **EM** | **MM** | **LM** |
| **EW** | | | | .003 |
| **EM** | | | | .017 |
| **MM** | | | | .003 |
| **PC** | | | | .000 |
| **Tooth 29** | **EW** | **EM** | **MM** | **LM** |
| **EW** | | | | .021 |
| **PC** | | | | .007 |

**Table 147:** Post-hoc p-values by sex for caries

| Tooth 2 | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| EWM | .000 | | | | .001 | | | |
| EWS | .000 | | | | .002 | | | |
| EWU | .000 | | | | .000 | | | |
| EMF | .000 | | | | .000 | | | |
| EMM | .018 | | | | | | | |
| EMS | .000 | | | | .000 | | | |
| EMU | .008 | | | | .046 | | | |
| MMM | .000 | | | | .002 | | | |
| MMS | .000 | | | | .000 | | | |
| LMF | .000 | | | | .000 | | | |
| LMM | .018 | | | | | | | |
| LMS | .008 | | | | .046 | | | |
| PCF | .000 | | | | .000 | | | |
| PCM | .000 | | | | .001 | | | |
| PCS | .000 | | | | .000 | | | |
| PCU | .000 | | | | .001 | | | |
| **Tooth 5** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EWF | | | | .045 | | | | .001 |
| EWM | | | | .045 | | | | .001 |
| EWS | | | | .045 | | | | .001 |
| EWU | | | | .013 | | | | .000 |
| EMF | | | | .032 | | | | .000 |
| EMS | | | | .021 | | | | .000 |
| EMU | | | | .032 | | | | .000 |
| MMF | | | | .025 | | | | .000 |
| MMM | | | | .025 | | | | .000 |
| MMS | | | | .018 | | | | .000 |
| LMF | | | | .016 | | | | .000 |
| LMS | | | | | | | | .003 |
| PCF | | | | .014 | | | | .000 |
| PCM | | | | .032 | | | | .000 |
| PCS | | | | .021 | | | | .000 |
| PCU | | | | .025 | | | | .000 |

**Table 147:** (continued)

| Tooth 8 | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **EWF** | | | | .000 | | | | |
| **EWM** | | | | .000 | | | | |
| **EWU** | | | | .000 | | | | |
| **EWS** | | | | .000 | | | | |
| **EMS** | | | | .000 | | | | |
| **EMU** | | | | .000 | | | | |
| **MMF** | | | | .000 | | | | |
| **MMM** | | | | .000 | | | | |
| **MMS** | | | | .000 | | | | |
| **LMF** | | | | .000 | | | | |
| **LMS** | | | | .000 | | | | |
| **PCF** | | | | .000 | | | | |
| **PCM** | | | | .000 | | | | |
| **PCS** | | | | .000 | | | | |
| **PCU** | | | | .000 | | | | |

**Table 148:** Post-hoc p-values by sex for caries

| Tooth 9 | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| EWF | | | | .000 | | | | |
| EWM | | | | .000 | | | | |
| EWU | | | | .000 | | | | |
| EWS | | | | .000 | | | | |
| EMF | | | | .000 | | | | |
| EMM | | | | .000 | | | | |
| EMS | | | | .000 | | | | |
| EMU | | | | .000 | | | | |
| MMF | | | | .000 | | | | |
| MMM | | | | .000 | | | | |
| MMS | | | | .000 | | | | |
| MMU | | | | .000 | | | | |
| LMF | | | | .000 | | | | |
| LMS | | | | .000 | | | | |
| PCF | | | | .000 | | | | |
| PCM | | | | .000 | | | | |
| PCS | | | | .000 | | | | |
| PCU | | | | .000 | | | | |
| **Tooth 15** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EWM | .002 | | | .043 | | | | |
| EWS | .010 | | | | | | | |
| EWU | .000 | | | .021 | | | | |
| EMF | .001 | | | .032 | | | | |
| EMS | .001 | | | .032 | | | | |
| MMF | .025 | | | | | | | |
| MMM | .002 | | | .043 | | | | |
| MMS | .001 | | | .026 | | | | |
| LMF | .004 | | | .054 | | | | |
| LMS | .043 | | | | | | | |
| PCF | .005 | | | | | | | |
| PCM | .004 | | | .054 | | | | |
| PCS | .001 | | | .026 | | | | |
| PCU | .002 | | | .043 | | | | |

**Table 148:** (continued)

| Tooth 17 | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **EWF** | | | | | .038 | .001 | .006 | |
| **EWS** | | | | | .021 | .004 | | |
| **EWU** | | | | | .023 | .000 | .002 | |
| **EWM** | | | | | .038 | .001 | .006 | |
| **EMF** | | | | | .038 | .001 | .006 | |
| **EMS** | | | | | .038 | .001 | .006 | |
| **EMU** | | | | | | .013 | .047 | |
| **MMS** | | | | | .031 | .000 | .004 | |
| **MMU** | | | | | | .013 | .047 | |
| **LMM** | | | | | | .013 | .047 | |
| **PCF** | | | | | | .001 | .018 | |
| **PCM** | | | | | .049 | .001 | .011 | |
| **PCS** | | | | | .049 | .001 | .011 | |
| **PCU** | | | | | .049 | .001 | .011 | |

**Table 149:** Post-hoc p-values by sex for caries

| Tooth 25 | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| EWM | | | | .000 | | | | |
| EWS | | | | .000 | | | | |
| EWU | | | | .000 | | | | |
| EMF | | | | .000 | | | | |
| EMS | | | | .000 | | | | |
| EMU | | | | .000 | | | | |
| MMF | | | | .000 | | | | |
| MMM | | | | .000 | | | | |
| MMS | | | | .000 | | | | |
| LMF | | | | .000 | | | | |
| LMM | | | | .000 | | | | |
| LMS | | | | .000 | | | | |
| PCF | | | | .000 | | | | |
| PCM | | | | .000 | | | | |
| PCS | | | | .000 | | | | |
| PCU | | | | .000 | | | | |
| **Tooth 26** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EWF | | | | .000 | | | | |
| EWM | | | | .000 | | | | |
| EWS | | | | .000 | | | | |
| EWU | | | | .000 | | | | |
| EMF | | | | .000 | | | | |
| EMS | | | | .000 | | | | |
| EMU | | | | .000 | | | | |
| MMF | | | | .000 | | | | |
| MMM | | | | .000 | | | | |
| MMS | | | | .000 | | | | |
| LMF | | | | .000 | | | | |
| LMM | | | | .000 | | | | |
| LMS | | | | .000 | | | | |
| LMU | | | | .000 | | | | |
| PCF | | | | .000 | | | | |
| PCM | | | | .000 | | | | |
| PCS | | | | .000 | | | | |
| PCU | | | | .000 | | | | |

**Table 150:** Post-hoc p-values by sex for caries

| Tooth 27 | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **EWM** | | | | .000 | | | | |
| **EWS** | | | | .003 | | | | |
| **EWU** | | | | .000 | | | | |
| **EMF** | | | | .000 | | | | |
| **EMS** | | | | .000 | | | | |
| **EMU** | | | | .003 | | | | |
| **MMF** | | | | .000 | | | | |
| **MMM** | | | | .000 | | | | |
| **MMS** | | | | .000 | | | | |
| **LMF** | | | | .000 | | | | |
| **LMM** | | | | .000 | | | | |
| **LMS** | | | | .003 | | | | |
| **LMU** | | | | .003 | | | | |
| **PCF** | | | | .000 | | | | |
| **PCM** | | | | .000 | | | | |
| **PCS** | | | | .000 | | | | |
| **PCU** | | | | .000 | | | | |
| **Tooth 28** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EWF** | | | | .002 | | | | |
| **EWM** | | | | .000 | | | .053 | .025 |
| **EWS** | | | | .000 | | | | |
| **EWU** | | | | .000 | | | .053 | .025 |
| **EMF** | | | | .000 | | | | .007 |
| **EMS** | | | | .000 | | | .030 | .013 |
| **EMU** | | | | .000 | | | | .040 |
| **LMF** | | | | .002 | | | | |
| **LMM** | | | | .007 | | | | |
| **LMS** | | | | .002 | | | | |
| **MMM** | | | | .000 | | | | |
| **MMF** | | | | .000 | | | .015 | .006 |
| **MMS** | | | | .000 | | | .021 | .008 |
| **PCF** | | | | .000 | | | .010 | .004 |
| **PCM** | | | | .000 | | | .053 | .025 |
| **PCS** | | | | .000 | | | .018 | .007 |
| **PCU** | | | | .000 | | | .053 | .025 |

**Table 150:** (continued)

| Tooth 29 | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **EWF** | | | | .000 | | | | .047 |
| **EWM** | | | | .000 | | | | .022 |
| **EWS** | | | | .000 | | | | |
| **EWU** | | | | .000 | | | | .030 |
| **EMF** | | | | .000 | | | | .013 |
| **EMS** | | | | .000 | | | | .022 |
| **EMU** | | | | .003 | | | | |
| **MMF** | | | | .000 | | | | |
| **MMM** | | | | .000 | | | | .016 |
| **MMS** | | | | .000 | | | | |
| **LMF** | | | | .000 | | | | |
| **LMM** | | | | .009 | | | | |
| **LMS** | | | | .003 | | | | |
| **PCF** | | | | .000 | .055 | | | .005 |
| **PCM** | | | | .000 | | | | .030 |
| **PCS** | | | | .000 | | | | .009 |
| **PCU** | | | | .000 | | . | | .022 |

**Table 151:** Post-hoc p-values, dental caries, time period/age

| Tooth 4 | EWYA | EMYA | EMMA | EMOA | EMUA | MMYA | MMMA | MMOA | LMEA | LMYA | LMMA | LMOA | LMUA | PCUA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EWAd** | | | | .001 | | | | | .001 | | | .001 | | |
| **EWY** | | | | .001 | | | | | .001 | | | .001 | | |
| **EWYA** | | | | .001 | | | | | .001 | | | .001 | | |
| **EMAd** | | | | .000 | | | | | .000 | | | .000 | | |
| **EMEA** | | | | .001 | | | | | .001 | | | .001 | | |
| **EMY** | | | | .000 | | | | | .000 | | | .000 | | |
| **EMYA** | | | | .000 | | | | | .000 | | | .000 | | |
| **EMMA** | | | | .001 | | | | | .001 | | | .001 | | |
| **MMY** | | | | .000 | | | | | .000 | | | .000 | | |
| **MMEA** | | | | .001 | | | | | .001 | | | .001 | | |
| **MMYA** | | | | .000 | | | | | .000 | | | .000 | | |
| **MMMA** | | | | .000 | | | | | .000 | | | .000 | | |
| **MMOA** | | | | .000 | | | | | .000 | | | .000 | | |
| **LMAd** | | | | .001 | | | | | .001 | | | .001 | | |
| **LMYA** | | | | .000 | | | | | .000 | | | .000 | | |
| **LMMA** | | | | .000 | | | | | .000 | | | .000 | | |
| **PCY** | | | | .000 | | | | | .000 | | | .000 | | |
| **PCYA** | | | | .001 | | | | | .001 | | | .001 | | |
| **PCMA** | | | | .000 | | | | | .000 | | | .000 | | |
| **PCOA** | | | | .001 | | | | | .001 | | | .001 | | |

**Table 152:** Post-hoc p-values, dental caries, time period/age/sex

| Tooth | Time/Age/Sex | >Time/Age/Sex |
|---|---|---|
| **Tooth 4** | EMOAF, EMMAM, LMEAM, LMOAM | EWYS, EWAF, EWYAM, EWAM, EWAU, EMAdS, EMYF, EMEAF, EMYAF, EMMAF, EMMAM, MMAdS, MMYF, MMYS, MMEAF, MMYAF, MMYAM, MMMAM, MMOAM, LMAdS, LMYAF, LMMAF, LMAF, LMYAM, LMMAM, PCAdS, PCYS, PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU |
| **Tooth 5** | EMMAM, LMEAM, LMYAM, LMOAM | EWAdS, EWAF, EWYAM, EWAM, EWAU, EMAdS, EMYF, EMEAF, EMYAF, EMMAF EMAU, MMYS, MMYF, MMEAF, MMYAF, MMMAF, MMYAM, MMMAM, LMAdS, LMYAF, LMMAF, LMOAF, LMAF, LMMAM, LMAM, PCAdS, PCYS PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU |
| **Tooth 8** | EMMAM | EWAF, EWYAM, EWAM, EWAU, EMAdS, EMYF, EMEAF, EMYAF, EMMAF, EMOAF, EMAU, MMAdS, MMYS, MMEAF, MMYAF, MMMAF, MMYAM, MMMAM, MMOAM, LMAdS, LMAF, LMYAF, LMMAF, LMEAM, LMYAM, LMMAM, LMOAM, PCAdS, PCYS, PCEAF, PCAF, PCYAM, PCAM, PCAU |
| **Tooth 9** | EMMAM | Same as Tooth 8 |
| **Tooth 15** | EWAF, EMMAM, LMAM | EWYS, EWAM, EWAU, EMAdS, EMYF, EMEAF, EMYAF, EMMAF, EMAM, EMAU, MMAdS, MMYAF, MMYAM, MMMAM, MMOAM, LMAdS, LMYAF, LMMAF, LMAF, LMYAM, LMMAM, PCAdS, PCYS, PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU |
| | MMEAF | EWAU, EMAdS, MMYAF, PCAdS, PCMAF, PCAU |
| | PCAF | EWAU, EMAdS |
| **Tooth 21** | EMYS, EMOAF, EMMAM, | EWYS, EWAF, EWYAM, EWOAM, EWAM, EWAU, EMAdS, EMYF, EMEAF, EMYAF, EMMAF, EMAM, EMAU, MMYS, MMEAF, MMYAF, MMOAF, MMYAM, MMMAM, MMOAM, MMAU, LMAdS, LMYAF, LMMAF, LMAF, LMYAM, LMMAM, LMOAM, LMAU, PCAd, PCYS, PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU |
| | MMYAF | EWAF, EWAM, EWAU, EMAdS, EMYAF, EMAU, MMYAM, MMOAM, PCAdS, PCAF, PCAU |
| | MMMAM | EWAF, EWAM, EWAU, EMAdS, EMYAF, EMAU, MMYAM, MMOAM, PCAdS, PCAF, PCAU |
| **Tooth23** | EMMAM, MMOAF, MMMAM | EWAF, EWAM, EWAU, EMAdS, EMYF, EMEAF, EMYAF, EMMAF, EMAM, EMAU, MMYS, MMEAF, MMYAF, MMMAF, MMOAM, MMAU, LMAdS, LMMAF, LMAF, LMEAM, LMYAM, LMOAM, LMYAF, LMAU, PCAdS, PCYS, PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU |

**Table 153:** Post-hoc p-values, dental caries, time period/age/sex

| | | |
|---|---|---|
| **Tooth 24** | EMMAM, MMMAM, LMYAF | EWAM, EWAU, EMAdS, EMYS, EMYF, EMEAF, EMYAF, EMMAF, EMAM, EMAU, MMAdS, MMYS, MMEAF, MMYAF, MMMAF, MMYAM, MMOAM, MMAU, LMAdS, LMYAF, LMMAF, LMAF, LMEAM, LMYAM, LMMAM, LMOAM, LMAU, PCAdS, PCYS, PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU, |
| **Tooth 25** | EMMAM | EWAM, EWAU, EMAdS, EMYF, EMYAF, EMEAF, EMMAF, EMAU, MMAdS, MMYS, MMEAF, MMYAF, MMMAF, MMYAM, MMMAM, MMOAM, LMAdS, LMYAF, LMAF, LMEAM, LMMAM, LMOAM, PCAdS, PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU |
| **Tooth 28** | EMMAM, LMEAM, LMYAM | EWAF, EWAM, EWAU, EMAdS, EMYS, EMYF, EMEAF, EMYAF, EMMAF, EMOAF, EMAU, MMAdS, MMYS, MMYF, MMEAF, MMYAF, MMMAF, MMOAF, MMYAM, MMMAM, MMAM, LMAdS, LMYAF, LMMAM, LMOAM, PCAdS, PCYS, PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU |
| | LMAF | EWAU, EMAdS, EMAU, MMEAF, MMYAF, MMYAM, LMAdS, PCMAF, PCAU |
| | LMYAM | EWAU, EMAdS, EMAU, MMEAF, MMYAF, MMYAM, LMAdS, PCMAF, PCAU |
| **Tooth 29** | EMMAM, MMYF, LMEAM | EWYS, EWAF, EWYAM, EWOAM, EWAM, EWAU, EMAdS, EMYF, EMEAF, EMYAF, EMMAF, EMAU, MMAdS, MMEAF, MMYAF, MMMAF, MMYAM, MMOAM, LMAdS, LMYAF, LMMAF, LMMAM, LMOAM, PCAdS, PCYS, PCYF, PCEAF, PCMAF, PCOAF, PCAF, PCYAM, PCMAM, PCAM, PCAU |
| | MMYS | EWAU, EMYAF, MMYAF, MMYAM, MMOAM, PCAdS, PCAF, PCMAF, PCAU |
| | MMOAF | EWAU, EMYAF, MMYAF, MMYAM, MMOAM, PCAdS, PCAF, PCMAF, PCAU |
| | LMAF | EWAU, EMYAF, MMYAF, MMYAM, MMOAM, PCAdS, PCAF, PCMAF, PCAU |
| | LMYAM | EWAU, EMYAF, MMYAF, MMYAM, MMOAM, PCAdS, PCAF, PCMAF, PCAU |

**Table 154:** Frequencies by tooth Count of periodontal disease in maxillary dentition by sex

| Time/Sex | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM M | 60 | 40 | 60 | 50 | 50 | 66 | 50 | 25 | 25 | 20 | 40 | 20 | 20 | 60 | 60 | 60 |
| EM F | 14 | 50 | 25 | 44 | 22 | 44 | 11 | 22 | 22 | 22 | 33 | 44 | 24 | 25 | 25 | 25 |
| EM S | 0 | 0 | 0 | 0 | 12 | 11 | 12 | 14 | 14 | 14 | 12 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM M | 58 | 58 | 64 | 58 | 50 | 69 | 69 | 62 | 58 | 66 | 66 | 75 | 62 | 62 | 66 | 54 |
| MM F | 31 | 31 | 21 | 27 | 25 | 23 | 25 | 25 | 33 | 27 | 27 | 27 | 21 | 17 | 21 | 14 |
| MM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 66 | 100 | 83 | 71 | 100 | 75 | 57 | 57 | 43 | 57 | 50 | 62 | 62 | 86 | 83 | 80 |
| LM F | 43 | 28 | 28 | 28 | 25 | 28 | 38 | 0 | 14 | 28 | 57 | 43 | 57 | 43 | 60 | 60 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 0 | 50 | 25 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 0 |
| PC F | 7 | 14 | 14 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 12 | 6 | 6 |
| PC S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC U | 0 | 33 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 33 | 0 |

**Table 155:** Frequencies by tooth count of periodontal disease in mandibular dentition by sex

| Time/Sex | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 11 | 10 | 10 | 9 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 22 | 28 |
| EW F | 10 | 22 | 22 | 22 | 10 | 0 | 0 | 12 | 14 | 14 | 14 | 0 | 0 | 0 | 25 | 0 |
| EW S | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 |
| EW U | 11 | 8 | 8 | 0 | 0 | 0 | 0 | 50 | 0 | 50 | 25 | 0 | 0 | 0 | 0 | 0 |
| EM M | 75 | 100 | 100 | 50 | 60 | 100 | 80 | 60 | 75 | 75 | 80 | 100 | 100 | 100 | 60 | 80 |
| EM F | 77 | 70 | 50 | 50 | 55 | 50 | 40 | 40 | 40 | 40 | 40 | 50 | 30 | 40 | 50 | 45 |
| EM S | 0 | 0 | 0 | 0 | 0 | 12 | 14 | 12 | 12 | 12 | 12 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 |
| MM M | 86 | 80 | 80 | 66 | 66 | 60 | 46 | 40 | 40 | 46 | 56 | 66 | 80 | 100 | 85 | 73 |
| MM F | 38 | 53 | 42 | 35 | 28 | 20 | 21 | 21 | 21 | 20 | 26 | 20 | 38 | 37 | 50 | 66 |
| MM S | 0 | 8 | 18 | 11 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 9 | 8 | 9 | 0 |
| MM U | 50 | 66 | 50 | 66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 66 | 83 | 100 | 85 | 71 | 57 | 42 | 42 | 28 | 27 | 28 | 66 | 100 | 83 | 83 | 100 |
| LM F | 40 | 50 | 62 | 44 | 40 | 55 | 37 | 37 | 42 | 37 | 37 | 50 | 62 | 75 | 75 | 66 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 0 | 100 | 100 | 0 | 0 | 0 | 0 |
| PC M | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 50 | 25 |
| PC F | 37 | 35 | 35 | 31 | 23 | 6 | 0 | 0 | 0 | 0 | 0 | 5 | 22 | 35 | 41 | 35 |
| PC S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC U | 0 | 12 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 16 | 0 |

**Table 156:** Frequencies by tooth count of calculus in maxillary dentition by sex

| Time/Sex | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW F | 100 | 50 | 33 | 50 | 0 | 0 | 0 | 0 | 33 | 33 | 20 | 50 | 50 | 40 | 33 | 50 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM M | 50 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM F | 25 | 12 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 14 | 12 | 0 | 14 | 20 | 0 |
| EM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM M | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM F | 25 | 0 | 14 | 25 | 20 | 0 | 0 | 16 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM S | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 50 | 50 | 50 | 50 | 50 | 50 | 100 | 100 | 33 | 100 | 66 | 66 | 66 | 50 | 66 | 50 |
| PC F | 50 | 46 | 30 | 50 | 37 | 20 | 40 | 50 | 25 | 60 | 28 | 27 | 30 | 50 | 61 | 33 |
| PC S | 33 | 42 | 27 | 16 | 16 | 16 | 0 | 0 | 12 | 0 | 0 | 0 | 16 | 27 | 37 | 25 |
| PC U | 50 | 75 | 100 | 66 | 66 | 33 | 50 | 33 | 100 | 33 | 33 | 0 | 0 | 100 | 50 | 25 |

**Table 157:** Frequencies by tooth count of calculus in mandibular dentition by sex

| Time/Sex | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW F | 25 | 0 | 0 | 25 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 12 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM M | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM F | 20 | 0 | 0 | 11 | 11 | 11 | 12 | 16 | 20 | 16 | 0 | 11 | 0 | 0 | 0 | 0 |
| EM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM M | 0 | 0 | 0 | 10 | 10 | 9 | 11 | 14 | 25 | 16 | 9 | 8 | 16 | 0 | 0 | 0 |
| MM F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM U | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 50 | 50 | 50 | 50 | 50 | 50 | 66 | 66 | 33 | 66 | 25 | 33 | 0 | 50 | 50 | 33 |
| PC F | 50 | 58 | 66 | 38 | 44 | 10 | 14 | 16 | 33 | 12 | 18 | 27 | 41 | 46 | 60 | 58 |
| PC S | 50 | 40 | 28 | 25 | 14 | 20 | 14 | 50 | 20 | 25 | 10 | 33 | 50 | 33 | 25 | 100 |
| PC U | 100 | 80 | 28 | 20 | 16 | 25 | 25 | 0 | 0 | 0 | 20 | 33 | 50 | 33 | 80 | 80 |

**Table 158:** Frequencies by tooth count of abscess in maxillary dentition by sex

| Time/Sex | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM M | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM F | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 6 | 0 | 0 | 6 | 7 | 0 | 0 | 0 |
| MM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 12 | 12 | 0 | 0 | 16 | 0 |
| LM F | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 14 | 0 | 0 | 0 | 0 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 159:** Frequencies by tooth count of abscess in mandibular dentition by sex

| Time/Sex | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW F | 10 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM M | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| EM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM M | 6 | 6 | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| MM F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 6 | 0 | 0 |
| MM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 |
| LM F | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 |
| LM S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 160:** Frequencies of LEH in maxillary dentition by sex

| Time /Sex | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9 | 0 | 0 | 0 | 0 | 0 |
| EM M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM S | 20.0 | 20.0 | 11.1 | 20.0 | 16.6 | 16.6 | 20.0 | 20.0 | 20.0 | 16.6 | 14.2 | 16.6 | 14.2 | 11.1 | 14.2 | 20.0 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM T | 7.1 | 5.9 | 4.3 | 5.6 | 5.9 | 5.0 | 5.3 | 6.3 | 6.2 | 5.9 | 4.8 | 5.0 | 5.9 | 4.8 | 5.6 | 6.3 |
| MM M | 0 | 0 | 0 | 0 | 0 | 25.0 | 25.0 | 33.3 | 25.0 | 10.0 | 12.5 | 0 | 0 | 0 | 0 | 0 |
| MM F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM S | 0 | 0 | 0 | 0 | 0 | 14.2 | 12.5 | 25.0 | 28.6 | 25.0 | 12.5 | 11.1 | 0 | 0 | 0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM T | 0 | 0 | 0 | 0 | 0 | 14.2 | 13.6 | 31.2 | 13.0 | 12.5 | 8.7 | 4.3 | 0 | 0 | 0 | 0 |
| LM M | 0 | 0 | 0 | 20.0 | 33.3 | 50.0 | 50.0 | 75.0 | 40.0 | 66.6 | 33.3 | 40.0 | 0 | 0 | 0 | 0 |
| LM F | 0 | 0 | 0 | 0 | 14.2 | 0 | 16.6 | 20.0 | 33.3 | 28.6 | 28.6 | 16.6 | 16.6 | 0 | 0 | 0 |
| LM S | 0 | 0 | 0 | 0 | 0 | 50.0 | 50.0 | 33.3 | 50.0 | 50.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LM T | 0 | 0 | 0 | 5.9 | 21.4 | 25.9 | 33.3 | 41.7 | 38.5 | 41.7 | 28.6 | 25.0 | 7.1 | 0 | 0 | 0 |
| PC M | 0 | 25.0 | 0 | 0 | 25.0 | 33.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC F | 0 | 7.7 | 0 | 0 | 12.5 | 0 | 0 | 0 | 25.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC S | 0 | 0 | 0 | 0 | 33.3 | 22.2 | 14.2 | 11.1 | 12.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC T | 0 | 7.1 | 0 | 0 | 19.0 | 13.6 | 6.3 | 5.6 | 11.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 161:** Frequencies of LEH in mandibular dentition by sex

| Time /Sex | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW M | 25.0 | 14.2 | 0 | 0 | 0 | 14.2 | 0 | 0 | 0 | 0 | 20.0 | 0 | 0 | 0 | 25.0 | 25.0 |
| EW F | 0 | 0 | 0 | 25.0 | 20.0 | 25.0 | 50.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EW T | 5.3 | 3.6 | 0.0 | 5.3 | 4.5 | 12.5 | 12.5 | 0 | 0.0 | 0 | 12.5 | 0 | 0 | 0 | 5.9 | 6.3 |
| EM M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM F | 0 | 0 | 0 | 0 | 0 | 11.1 | 12.5 | 0 | 0 | 0 | 12.5 | 0 | 0 | 0 | 0 | 0 |
| EM S | 20.0 | 14.2 | 25.0 | 16.6 | 28.6 | 42.9 | 40.0 | 33.3 | 25.0 | 75.0 | 33.3 | 33.3 | 0 | 16.6 | 14.2 | 16.6 |
| EM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EM T | 8.3 | 5.6 | 10.5 | 5.0 | 9.1 | 18.2 | 20.0 | 22.2 | 7.7 | 25.0 | 17.6 | 10.0 | 0 | 7.2 | 5.6 | 5.9 |
| MM M | 0 | 0 | 0 | 0 | 0 | 18.2 | 0 | 0 | 25.0 | 33.3 | 27.3 | 0 | 0 | 0 | 0 | 0 |
| MM F | 0 | 25.0 | 33.3 | 20.0 | 16.6 | 0 | 0 | 0 | 0 | 25.0 | 22.2 | 10.0 | 11.1 | 25.0 | 33.3 | 0 |
| MM S | 0 | 10.0 | 16.6 | 0 | 16.6 | 28.6 | 12.5 | 20.0 | 20.0 | 25.0 | 22.2 | 25.0 | 11.1 | 50.0 | 10.0 | 0 |
| MM U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MM T | 0 | 10.5 | 9.09 | 4.3 | 8.3 | 14.8 | 4.0 | 8.7 | 16.6 | 27.3 | 24.1 | 10.0 | 8.3 | 11.8 | 13.3 | 0 |
| LM M | 0 | 0 | 0 | 0 | 0 | 20.0 | 25.0 | 25.0 | 25.0 | 20.0 | 40.0 | 20.0 | 20.0 | 0 | 0 | 0 |
| LM F | 0 | 0 | 0 | 20.0 | 16.6 | 16.6 | 11.1 | 0 | 0 | 0 | 20.0 | 16.6 | 0 | 0 | 0 | 0 |
| LM S | 0 | 0 | 14.2 | 100 | 100 | 50.0 | 100 | 0 | 0 | 100 | 100 | 0 | 100 | 20.0 | 0 | 0 |
| LM U | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 |
| LM T | 0 | 0 | 8.3 | 22.2 | 18.2 | 28.6 | 18.8 | 9.1 | 10.0 | 15.4 | 41.7 | 16.6 | 16.6 | 9.1 | 0 | 0 |
| PC M | 0 | 0 | 0 | 0 | 25.0 | 25.0 | 0 | 0 | 0 | 0 | 0 | 33.3 | 50.0 | 0 | 0 | 0 |
| PC F | 0 | 0 | 0 | 7.7 | 22.2 | 10.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50.0 | 20.0 | 0 | 20.0 | 16.6 | 25.0 | 0 | 0 | 0 |
| PC U | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PC T | 0 | 0 | 0 | 3.8 | 11.5 | 8.7 | 0 | 7.7 | 8.3 | 0 | 4.5 | 8.7 | 9.1 | 0 | 0 | 0 |

**Table 162**: Post-hoc p-values, Kruskall-Wallis, LEH by time period

| **Tooth 10** | **EW** | **EM** | **MM** | **LM** | **PC** |
|---|---|---|---|---|---|
| **LM** | .001 | .000 | .002 | | .000 |
| **Tooth 11** | **EW** | **EM** | **MM** | **LM** | **PC** |
| **LM** | .052 | .013 | .024 | | .003 |
| **Tooth 23** | **EW** | **EM** | **MM** | **LM** | **PC** |
| **EM** | | | | | .031 |
| **LM** | | | .021 | | |
| **Tooth 26** | **EW** | **EM** | **MM** | **LM** | **PC** |
| **EM** | | | | | .042 |
| **MM** | | | | | .006 |
| **Tooth 27** | **EW** | **EM** | **MM** | **LM** | **PC** |
| **MM** | | | | | .006 |
| **LM** | | | | | .010 |

**Table 163:** Post-hoc p-values for tooth 26, Kruskall-Wallis, LEH by time period/sex

| | EWM | EWS | EWU | EMM | EMF | EMU | MMM | LMM | LMF | LMU | PCM | PCF | PCS | PCU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMS** | .036 | | .036 | | .004 | | .036 | | .005 | | .009 | .001 | .002 | .009 |
| **MMF** | | | | | .042 | | | | .054 | | | .014 | .024 | |
| **LMS** | .017 | .038 | .017 | .038 | .007 | .038 | .024 | .032 | .007 | .038 | .009 | .005 | .005 | .009 |

**Table 164:** Early Woodland elemental frequencies of BFT by sex

| Bone | Side | M | F | S | U | T |
|---|---|---|---|---|---|---|
| Humerus (Distal Diaphysis | R | 16.66 | 0 | 0 | 0 | 11.11 |

**Table 165:** Early Monongahela elemental frequencies of BFT by sex

| Bone | Side | M | F | S | U | T |
|---|---|---|---|---|---|---|
| MT2 | R | 25.00 | 0 | 0 | 0 | 6.25 |
| MT4 | R | 20.00 | 0 | 0 | 0 | 5.26 |
| Parietal | L | 0 | 0 | 5.88 | 0 | 2.63 |
| Frontal | Mid | 0 | 12.5 | 0 | 0 | 3.33 |
| Nasals | L+R | 20.00 | 0 | 0 | 0 | 11.11 |
| L5 | N/A | 0 | 14.2 | 0 | 0 | 7.14 |

**Table 166:** Middle Monongahela elemental frequencies of BFT by sex

| Bone | Side | M | F | S | U | T |
|---|---|---|---|---|---|---|
| Clavicle | R | 7.69 | 0 | 0 | 0 | 2.70 |
| Scapula | R | 11.11 | 0 | 0 | 0 | 3.33 |
| MT3 | L | 0 | 9.09 | 0 | 0 | 3.70 |
| Proximal Foot Phalanx | | 7.69 | 0 | 0 | 0 | 2.94 |
| Intermediate Foot Phalanx | | 50.00 | 0 | 0 | 0 | 9.09 |
| Mandible | R | 10.00 | 0 | 0 | 0 | 2.56 |
| S1 | | 6.66 | 0 | 0 | 0 | 3.57 |

**Table 167:** Late Monongahela elemental frequencies of BFT by sex

| Bone | Side | M | F | S | U | T |
|---|---|---|---|---|---|---|
| Ulna (Midshaft) | L | 0 | 8.3 | 0 | 0 | 4.76 |
| Parietal | L | 0 | 14.2 | 0 | 0 | 6.25 |
| Parietal | R | 20.00 | 0 | 0 | 0 | 6.25 |
| Mandible | R | 16.6 | 0 | 0 | 0 | 6.25 |

**Table 168:** Early Woodland elemental frequencies of SFT by sex

| Bone | Side | M | F | S | U | T |
|---|---|---|---|---|---|---|
| Frontal | Right | 9.0 | 0 | 0 | 0 | 3.0 |
| Humerus (Prox Art) | Right | 100 | 0 | 0 | 0 | 33.33 |
| Tibia (Distal Diaphysis) | Right | 0 | 14.7 | 0 | 0 | 6.25 |

**Table 169**: Early Woodland elemental frequencies of SFT by sex

| Bone | Side | M | F | S | U | T |
|---|---|---|---|---|---|---|
| Ribs | Left | 0 | 6.66 | 0 | 0 | 2.94 |

**Table 170:** Early Woodland non-specific infection, elemental frequencies by sex

| Bone | Number Present | Number Affected | Male Frequency | Female Frequency | Unknown Sex Frequency | Subadult Frequency |
|---|---|---|---|---|---|---|
| L Occipital | 34 | 1 | 11.11 | 0 | 0 | 0 |
| R Occipital | 32 | 1 | 10.00 | 0 | 0 | 0 |
| R Parietal | 44 | 1 | 0 | 0 | 0 | 0 |
| L Proximal Articulation Ulna | 11 | 1 | 0 | 33.33 | 0 | 0 |

**Table 171:** Early Woodland non-specific infection, elemental frequencies by age

| Bone | #Pres | #Aff | F | N | T | EC | LC | AD | Y | EA | YA | MA | OA | UA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L Occipital | 34 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.3 |
| R Occipital | 32 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.5 |
| R Parietal | 44 | 1 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| L Proximal Articulation of Ulna | 11 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |

**Table 172:** Early Monongahela non-specific infection, elemental frequencies by sex

| Bone | Number Present | Number Affected | Male Frequency | Female Frequency | Unknown Sex Frequency | Subadult Frequency |
|---|---|---|---|---|---|---|
| R Mid Clavicle | 28 | 1 | 0 | 10.00 | 0 | 0 |
| L Distal Radial Diaphysis | 28 | 1 | 0 | 0 | 0 | 7.69 |
| R Distal Radial Diaphysis | 24 | 1 | 0 | 11.11 | 0 | 0 |
| R Distal Radial Articulation | 18 | 1 | 0 | 11.11 | 0 | 0 |
| L Proximal Ulnar Articulation | 20 | 1 | 0 | 10.00 | 0 | 0 |
| L Proximal Ulnar Diaphysis | 34 | 1 | 0 | 9.09 | 0 | 0 |
| L Mid Ulnar Diaphysis | 34 | 1 | 0 | 9.09 | 0 | 0 |
| L Distal Ulnar Diaphysis | 31 | 2 | 0 | 10.00 | 0 | 7.14 |
| L Mid Femoral Diaphysis | 33 | 2 | 16.66 | 10.00 | 0 | 0 |
| L Distal Femoral Diaphysis | 29 | 2 | 20.00 | 11.11 | 0 | 0 |
| L Distal Femoral Articulation | 19 | 2 | 20.00 | 14.28 | 0 | 0 |
| R Distal Femoral Diaphysis | 29 | 1 | 0 | 10.00 | 0 | 0 |
| L Proximal Tibial Articulation | 18 | 1 | 0 | 12.50 | 0 | 0 |
| L Proximal Tibial Diaphysis | 28 | 1 | 0 | 11.11 | 0 | 0 |
| L Mid Tibial Diaphysis | 29 | 2 | 0 | 22.22 | 0 | 0 |
| L Distal Tibial Diaphysis | 26 | 1 | 0 | 10.00 | 0 | 0 |
| R Proximal Tibial Articulation | 20 | 1 | 0 | 11.11 | 0 | 0 |
| R Proximal Tibial Diaphysis | 29 | 1 | 0 | 11.11 | 0 | 0 |
| R Mid Tibial Diaphysis | 29 | 2 | 0 | 22.22 | 0 | 0 |
| R Distal Tibial Diaphysis | 28 | 1 | 0 | 11.11 | 0 | 0 |
| L Mid Fibular Diaphysis | 23 | 1 | 0 | 11.11 | 0 | 0 |
| L Distal Fibular Diaphysis | 19 | 1 | 0 | 14.28 | 0 | 0 |
| R Mid Fibular Diaphysis | 20 | 1 | 0 | 33.33 | 0 | 0 |
| R Distal Fibular Diaphysis | 20 | 1 | 0 | 20.00 | 0 | 0 |
| R 3rd metacarpal | 24 | 1 | 14.28 | 0 | 0 | 0 |

**Table 173:** Early Monongahela non-specific infection, elemental frequencies by age

| Bone | Number Present | Number Affected | F | N | T | EC | LC | AD | Y | EA | YA | MA | OA | UA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R Mid Clavicle | 28 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 |
| L Distal Radius | 28 | 1 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| R Distal Radius | 24 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| R Distal Articulation Radius | 18 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| L Proximal Articulation Radius | 20 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| L Proximal Ulna | 34 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 |
| L Mid Ulna | 34 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 |
| L Distal Ulna | 31 | 2 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| L Mid Femur | 33 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 25 | 0 | 0 |
| L Distal Femur | 29 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 25 | 0 | 0 |
| L Distal Femur Articulation | 19 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 20 | 0 | 0 |
| R Distal Femur | 29 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| L Proximal Articulation Tibia | 18 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| L Proximal Tibia | 28 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| L Mid Tibia | 29 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 25 | 0 | 0 | 0 |
| L Distal Tibia | 26 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 |
| R Proximal Articulation Tibia | 20 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| R Proximal Tibia | 29 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 |
| R Mid Tibia | 29 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 25 | 0 | 0 | 0 |
| R Distal Tibia | 28 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 25 | 0 | 0 | 0 |
| L Mid Fibula | 23 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| L Distal Fibula | 19 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |

**Table 173:** (continued)

| Bone | Number Present | Number Affected | F | N | T | EC | LC | AD | Y | EA | YA | MA | OA | UA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R Mid Fibula | 20 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| R Distal Fibula | 20 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 |
| R 3rd metacarpal | 24 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

**Table 174:** Middle Monongahela non-specific infection, elemental frequencies by sex

| Bone | Number Present | Number Affected | Male Frequency | Female Frequency | Unknown Sex Frequency | Subadult Frequency |
|---|---|---|---|---|---|---|
| L Frontal | 57 | 1 | 0 | 0 | 25.00 | 0 |
| R Frontal | 55 | 1 | 0 | 0 | 50.00 | 0 |
| L Occipital | 53 | 1 | 0 | 6.66 | 0 | 0 |
| R Occipital | 53 | 1 | 0 | 6.66 | 0 | 0 |
| R Distal Clavicular Diaphysis | 39 | 1 | 0 | 0 | 50.00 | 0 |
| L Distal Clavicular Articulation | 25 | 1 | 0 | 0 | 0 | 100.00 |
| R Proximal Humeral Articulation | 30 | 2 | 7.14 | 9.09 | 0 | 0 |
| R Proximal Ulnar Articulation | 28 | 1 | 0 | 7.69 | 0 | 0 |
| L Proximal Ulnar Diaphysis | 45 | 2 | 0 | 6.66 | 0 | 5.88 |
| R Proximal Ulnar Diaphysis | 48 | 3 | 7.69 | 7.14 | 0 | 5.55 |
| L Mid Ulnar Diaphysis | 47 | 1 | 0 | 7.14 | 0 | 0 |
| R Proximal Femoral Trochanter | 27 | 1 | 0 | 7.69 | 0 | 0 |
| L Distal Femoral Diaphysis | 49 | 1 | 0 | 0 | 0 | 5.00 |
| R Distal Femoral Articulation | 26 | 1 | 10.00 | 0 | 0 | 0 |
| L Proximal Tibial Articulation | 29 | 1 | 9.09 | 0 | 0 | 0 |
| R Proximal Tibial Articulation | 32 | 1 | 9.09 | 0 | 0 | 0 |
| L Proximal Tibial Diaphysis | 41 | 2 | 8.33 | 0 | 0 | 5.88 |
| R Proximal Tibial Diaphysis | 47 | 1 | 8.33 | 0 | 0 | 0 |
| R Distal Tibial Diaphysis | 42 | 1 | 0 | 0 | 0 | 5.26 |
| L Distal Tibial Articulation | 35 | 1 | 3.33 | 0 | 0 | 0 |
| R Proximal Fibular Diaphysis | 36 | 1 | 0 | 0 | 0 | 7.14 |
| R Mid Fibular Diaphysis | 38 | 1 | 0 | 0 | 0 | 6.66 |
| R Distal Fibular diaphysis | 38 | 1 | 0 | 0 | 0 | 8.33 |
| L Scapula | 41 | 2 | 0 | 7.69 | 0 | 5.88 |
| R Scapula | 44 | 2 | 0 | 7.14 | 0 | 6.25 |
| R Ilium | 38 | 3 | 0 | 11.76 | 0 | 5.26 |
| R Ischium | 47 | 1 | 0 | 7.69 | 0 | 0 |
| R Pubis | 30 | 1 | 0 | 11.11 | 0 | 0 |
| L Metacarpals | 41 | 1 | 0 | 0 | 0 | 5.88 |

**Table 175:** Middle Monongahela non-specific infection, elemental frequencies by age

| Bone | #Pres | #Aff | F | N | T | EC | LC | AD | Y | EA | YA | MA | OA | UA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L Frontal | 57 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| R Frontal | 55 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| L Occipital | 53 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| R Occipital | 53 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| R Distal Clavicle | 39 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 |
| L Distal Articulation Clavicle | 25 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 |
| R Proximal Articulation Humerus | 30 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 33 | 0 | 0 | 0 |
| R Proximal Articulation Ulna | 28 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 |
| L Proximal Ulna | 45 | 2 | 0 | 0 | 0 | 25 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 |
| R Proximal Ulna | 48 | 3 | 0 | 0 | 0 | 33 | 0 | 0 | 33 | 0 | 0 | 11 | 0 | 0 |
| L Mid Ulna | 47 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 |
| R Proximal Femur | 27 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 |
| L Distal Femur | 49 | 1 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| R Distal Articulation Femur | 26 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| L Proximal Articulation Tibia | 29 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 |
| R Proximal Articulation Tibia | 32 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 |
| L Proximal Tibia | 41 | 2 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 |
| R Proximal Tibia | 47 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 |
| R Distal Tibia | 42 | 1 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| L Distal Articulation Tibia | 35 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 |
| R Proximal Fibula | 36 | 1 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| R Mid Fibula | 38 | 1 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| R Distal Fibula | 38 | 1 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| L Scapula | 41 | 2 | 0 | 0 | 0 | 0 | 20 | 0 | 33 | 0 | 0 | 0 | 0 | 0 |
| R Scapula | 44 | 2 | 0 | 0 | 0 | 0 | 25 | 0 | 33 | 0 | 0 | 0 | 0 | 0 |
| R Ilium | 38 | 3 | 0 | 0 | 0 | 0 | 16 | 0 | 33 | 33 | 0 | 0 | 0 | 0 |
| R Ischium | 47 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 |
| R Pubis | 30 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 |
| L Metacarpals | 41 | 1 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 176:** Late Monongahela non-specific infection, elemental frequencies by sex

| Bone | Number Present | Number Affected | Male Frequency | Female Frequency | Unknown Sex Frequency | Subadult Frequency |
|---|---|---|---|---|---|---|
| R Zygomatic | 18 | 1 | 0 | 16.66 | 0 | 0 |
| R Proximal Humeral Artic | 19 | 1 | 14.28 | 0 | 0 | 0 |
| Hand Phalanges | 28 | 1 | 0 | 0 | 0 | 14.28 |

**Table 177:** Late Monongahela non-specific infection, elemental frequencies by age

| Bone | #Pres | #Aff | F | N | T | EC | LC | AD | Y | EA | YA | MA | OA | UA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R Zygomatic | 18 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 |
| R Proximal Articulation Humerus | 19 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 |
| Hand Phalanges | 28 | 1 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**APPENDIX B**: **ACTIVITY**

MSM robusticity was evaluated statistically for each MSM using Kruskall-Wallis H tests, followed by Mann-Whitney U post-hoc analysis for any significant results. MSMs were tested by time period, time period/sex, time period/age, and time period/age/sex variables. The results are presented by bone and several abbreviations may be used for muscle names (Table 178).

**Table 178:** Muscle abbreviations

| Abbreviation | Meaning |
|---|---|
| Brach | Brachialis |
| Ancon | Anconeus |
| Pro | Pronator |
| Ter | Teres |
| Quad | Quadratus |
| Supin | Supinator |
| TFL | Tensor Fasciae Latae |
| Ad | Adductor |
| Mag | Magnus |
| Obt | Obturator |
| Ext | Externus |
| Intern | Internus |
| Int | Intermedius |
| Vast | Vastus |
| Inf | Inferior |
| Sup | Superior |
| Gem | Gemellus |
| Gast | Gastrocnemus |

### B.1.1 The Clavice

**Table 179:** P-Values by time period, clavicle attachments

| **R Trapezoid Ligament** | **EW** | **EM** | **MM** | **LM** |
|---|---|---|---|---|
| **PC** | | .000 | .001 | .000 |
| **L Conoid Ligament** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .010 | .004 | .006 | .004 |
| **R Conoid Ligament** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .010 | .001 | .002 | .002 |
| **L Deltoid** | **EW** | **EM** | **MM** | **LM** |
| **EW** | | .007 | .024 | .017 |
| **LM** | | .028 | | |
| **PC** | | .029 | .007 | |
| **L Deltoid** | **EW** | **EM** | **MM** | **LM** |
| **EW** | | .002 | .000 | .000 |
| **PC** | | .015 | .054 | |

**Table 180:** P-Values by time period/sex, clavicle attachments

| R Subclavius | EWM | EWF | EMF | EMM | MMM | LMF | LMM | LMS | PCM | PCF | PCS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMS** | | .053 | .024 | .025 | .007 | .021 | .055 | .047 | | | .016 |
| **MMM** | | | | .023 | | | .025 | | | | .054 |
| **PCF** | | | .009 | | | | .009 | | | | .020 |
| **PCM** | | | .043 | .033 | .053 | | | | | | |

**Table 181:** P-Values by time period/sex, left deltoid

| Time Period/Sex | EM Females | EM Males | MM Males |
|---|---|---|---|
| **EW Females** | .032 | .036 | .024 |
| **MM Subadults** | .032 | .026 | .024 |
| **LM Males** | .004 | .011 | .001 |
| **PC Females** | .032 | .036 | .024 |
| **PC Males** | .021 | .027 | .013 |

**Table 182:** P-Values by time period/sex, right deltoid

| Time Period/Sex | EMF | EMM | MMM | LMF | LMM | LMS |
|---|---|---|---|---|---|---|
| **EW Females** | .007 | .015 | .007 | .021 | .055 | .047 |
| **MM Subadults** | .047 | | .052 | | | |
| **PC Males** | .047 | | .052 | | | |

**Table 183:** P-Values by time period/sex, right deltoid

| Time Period/Age | EM Middle Aged | EM Old Adult | MM Middle Aged | MM Old Adults | MM Unknown Adults |
|---|---|---|---|---|---|
| **EW Young Adults** | .016 | .031 | .032 | .025 | .031 |
| **MM Youths** | .036 | | | .056 | |
| **MM Young Adults** | .017 | .056 | .042 | .030 | .056 |
| **LM Early Adults** | .016 | .031 | .032 | .025 | .031 |
| **LM Old Adults** | .017 | .056 | .042 | .030 | .056 |
| **PC Middle Aged** | .009 | .028 | .021 | .015 | .028 |
| **PC Unknown Adults** | .016 | .031 | .032 | .025 | .031 |

### B.1.2 The Scapula

**Table 184:** P-Values by time period, scapula attachments

| L Pectoralis Major | EW | EM | MM | LM |
|---|---|---|---|---|
| **EM** | | | .031 | |
| **PC** | | | .004 | |

**Table 185:** P-Values by time period/sex, scapula attachments

| L Trapezius | EWF | EWM | EMF | EMM | EMS | MMM | MMF | MMS | LMF | LMM | LMS | PCF | PCM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMM** | | | | | .031 | | | .031 | | | | | |
| **MMM** | | | | | .014 | .007 | | .014 | .021 | .055 | .047 | | .016 |
| **L Pectoralis Major** | | | | | | | | | | | | | |
| **MMM** | | | .050 | | .011 | .052 | | .011 | .040 | | | .011 | .030 |
| **MMF** | | | | | .016 | | | .016 | | | | .016 | .046 |
| **LMM** | | | .034 | | | | | .034 | | | | .034 | |

**Table 186:** P-Values time period/age, left pectoralis major

| Time Period/Age | MMYA | MMMA | MMOA | LMOA |
|---|---|---|---|---|
| **EMAd** | .024 | .002 | .032 | .016 |
| **EMYA** | | .006 | | |
| **EMMA** | | .038 | | |
| **MMY** | .024 | .002 | .032 | .016 |
| **LMY** | .024 | .002 | .032 | .016 |
| **LMYA** | | .023 | | |
| **PCMA** | | .005 | .050 | |
| **PCUA** | .024 | .002 | .032 | .016 |

### B.1.3 The Humerus

**Table 187:** P-Values for time period, humerus MSMs

| **L Supraspinatus** | **EW** | **EM** | **MM** | **LM** |
|---|---|---|---|---|
| **PC** | .038 | .000 | .000 | .000 |
| **R Supraspinatus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .002 | .000 | .000 |
| **L Infraspinatus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .037 | .000 | .000 | .000 |
| **R Infraspinatus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .017 | .001 | .002 |
| **L Teres Minor** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .002 | .000 | .000 |
| **R Teres Minor** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .010 | .001 | .000 |
| **L Pectoralis Major** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .015 | .002 | .000 | .002 |
| **R Pectoralis Major** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .008 | .001 | .001 |
| **L Latissimus Dorsi** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .000 | .001 | .001 | .000 |
| **R Latissimus Dorsi** | **EW** | **EM** | **MM** | **LM** |
| **EM** | | | | .046 |
| **PC** | | .043 | .001 | .000 |
| **L Teres Major** | **EW** | **EM** | **MM** | **LM** |
| **MM** | | | | .002 |
| **PC** | .019 | .000 | .008 | .000 |
| **R Teres Major** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .011 | .016 | .001 |
| **L Deltoid** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .000 | .002 | .001 | .000 |
| **R Deltoid** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .004 | .001 | .001 |
| **L Coracobrachialis** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .000 | .001 | .002 | .000 |
| **Left Extensors** | **EW** | **EM** | **MM** | **LM** |
| **EM** | .029 | | | |
| **MM** | .006 | | | |
| **LM** | .008 | | | |
| **PC** | .000 | .000 | .000 | .000 |
| **Right Extensors** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .005 | .000 | .008 |
| **Left Flexors** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .000 | .000 | .000 | .000 |
| **Right Flexors** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .000 | .000 | .002 |

**Table 188:** Post-hoc p-values, time period/sex, humerus - part 1

| **L Supraspinatus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
|---|---|---|---|---|---|---|---|---|
| **EMS** | | | .017 | .042 | .057 | .019 | .035 | .038 |
| **PCF** | | | .001 | .009 | .010 | .001 | .005 | .007 |
| **PCM** | | | .001 | .009 | .010 | .001 | .005 | .007 |
| **PCS** | | | .017 | .042 | .057 | .019 | .035 | .038 |
| **R Supraspinatus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMM** | | | .053 | | | .028 | | |
| **EMS** | | | .023 | | .043 | .019 | .046 | .056 |
| **PCF** | | | .023 | | .043 | .019 | .046 | .056 |
| **PCM** | | | .003 | | .006 | .001 | .008 | .014 |
| **PCS** | | | .023 | | .043 | .019 | .046 | .056 |
| **Left Infraspinatus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .014 | .037 | .029 | .025 | .031 | .033 |
| **PCF** | | | .014 | .037 | .029 | .025 | .031 | .033 |
| **PCM** | | | .001 | .007 | .003 | .002 | .004 | .005 |
| **PCS** | | | .014 | .037 | .029 | .025 | .031 | .033 |
| **Left Teres Minor** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | | .043 | | .027 | | .020 |
| **PCF** | | | | .043 | | .027 | | .020 |
| **PCM** | | | .022 | .009 | .020 | .003 | .027 | .002 |
| **PCS** | | | | .042 | | .027 | | .020 |
| **Right Teres Minor** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | | | | .021 | | .046 |
| **PCF** | | | | | | .021 | | .046 |
| **PCM** | | | .027 | | .042 | .002 | .024 | .010 |
| **PCS** | | | | | | .021 | | .046 |
| **L Pectoralis Major** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | .053 | | | | .037 | | |
| **LMS** | | .053 | | | | .037 | | |
| **PCF** | | .027 | | .014 | | .002 | .052 | |
| **PCM** | | .014 | .053 | .007 | .027 | .001 | .024 | .014 |
| **PCS** | | .033 | | .041 | | .018 | | |
| **Right Pectoralis Major** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMF** | | | | | | | | .051 |
| **EMS** | | | | | | | | .034 |
| **LMS** | | | | | | | | .034 |
| **PCF** | | | | .006 | .015 | .004 | .013 | .002 |
| **PCM** | | | | | | .051 | | .026 |
| **PCS** | | | | | | | | .034 |
| **Left Latissimus Dorsi** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMF** | | .040 | | .015 | | | .013 | |
| **EMS** | .052 | | | | | | | |
| **MMF** | | .045 | | .016 | | | .013 | |
| **LMS** | | .052 | | | | | | |
| **PCF** | .021 | .006 | | .002 | | .009 | .002 | .012 |
| **PCM** | .021 | .006 | | .002 | | .009 | .002 | .012 |
| **PCS** | | .017 | | .021 | | .056 | .024 | .055 |

**Table 189:** Post-hoc p-values, time period/sex, humerus MSMs - part 2

| L Teres Major | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| MMF | | | .057 | .004 | | .015 | .001 | .001 |
| PCF | | | .036 | .006 | | .020 | .003 | .002 |
| PCM | | | .036 | .006 | | .020 | .003 | .002 |
| PCS | | | | .039 | | | .028 | .019 |
| **L Deltoid** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMF | | .037 | | .040 | | | | |
| MMF | .028 | | | .024 | | .051 | | |
| PCF | .019 | .004 | | .003 | | .007 | .018 | .011 |
| PCM | .026 | .005 | | .005 | | .011 | .027 | .016 |
| PCS | .042 | .011 | | .018 | | .035 | .056 | .036 |
| **R Deltoid** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMF | | | | .058 | | .036 | | |
| MMF | | | | | | .032 | | |
| PCF | | | | .002 | .050 | .001 | .010 | .004 |
| PCM | | | | | | .037 | | .057 |
| **L Coracobrachialis** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMF | | .026 | | | | | | |
| EMS | .044 | .003 | | .022 | | .045 | .044 | .015 |
| MMF | | .007 | | | | | | .044 |
| MMM | | .032 | | | | | | |
| LMF | | .036 | | | | | | |
| PCF | .009 | .000 | .011 | .002 | .032 | .006 | .006 | .001 |
| PCM | | .005 | | .051 | | | | .033 |
| PCS | .044 | .003 | | .022 | | .045 | .044 | .015 |
| **R Coracobrachialis** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMF | | | | .039 | | | | .025 |
| EMS | | | | .008 | | .046 | | .006 |
| MMF | | | | .005 | | | | .003 |
| LMF | | | | .027 | | | | .017 |
| PCF | | | .023 | .000 | | .006 | .024 | .000 |
| PCS | | | | .008 | | .046 | | .006 |
| **L Extensors** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMF | | .013 | | | | | | |
| EMM | | .029 | | | | | | |
| EMS | .006 | .000 | .018 | .014 | .030 | .029 | .030 | .034 |
| MMF | | .004 | | | | | | |
| MMM | | .004 | | | | | | |
| LMF | | .004 | | | | | | |
| LMM | | .006 | | | | | | |
| PCF | .002 | .000 | .009 | .007 | .019 | .018 | .019 | .027 |
| PCM | .002 | .000 | .009 | .007 | .019 | .018 | .019 | .027 |
| PCS | .006 | .000 | .018 | .014 | .030 | .029 | .030 | .034 |

**Table 190:** Post-hoc p-values, time period/sex, humerus MSMs - part 3

| R Extensors | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| EMS | | | .34 | .057 | .015 | .021 | .053 | |
| PCF | | | .019 | .050 | .004 | .007 | .036 | |
| PCM | | | .004 | .012 | .001 | .001 | .008 | .054 |
| **L Flexors** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | .026 | .003 | .010 | .009 | .012 | .018 | .019 | .022 |
| PCF | .016 | .002 | .005 | .004 | .005 | .010 | .011 | .016 |
| PCM | .016 | .002 | .005 | .004 | .005 | .010 | .011 | .016 |
| PCS | .026 | .003 | .010 | .009 | .012 | .018 | .019 | .022 |
| **R Flexors** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | | .030 | .007 | .016 | .024 | |
| PCF | | | .002 | .027 | .003 | .007 | .015 | |
| PCM | | .056 | .000 | .004 | .000 | .001 | .002 | .025 |

**Table 191:** Significant groups in post-hoc tests time period/age/sex, humerus MSMs

| MSM | Age Group | <Age Group(s) |
|---|---|---|
| **L Supraspinatus** | EMAS | EMYAF, EMOAF, MMMAF, MMOAF, MMMAM, MMOAM |
| | MMEAF | EMYAF, EMOAF, MMOAF, MMMAM, MMOAM |
| | PCAS | EMYAF, EMOAF, MMMAF, MMOAF, MMMAM, MMOAM |
| | PCAF | EMYAF, EMOAF, MMMAF, MMOAF, MMMAM, MMOAM |
| | PCOAF | EMYAF, EMOAF, MMMAF, MMOAF, MMMAM, MMOAM, |
| | PCMAM | EMYF, EMYAF, EMOAF, EMMAM, MMMAF, MMOAF, MMMAM, MMOAM, LMAF, LMMAF, LMYAM |
| **L Infraspinatus** | EMAS | EMYAF, EMOAF, MMMAF, MMOAF, MMMAM, MMOAM |
| | MMEAF | EMOAF, MMMAF, MMOAF, MMMAM, MMOAM |
| | PCAS | EMYAF, EMOAF, MMMAF, MMOAF, MMMAM, MMOAM |
| | PCAF | EMYAF, EMOAF, MMMAF, MMOAF, MMMAM, MMOAM |
| | PCMAM | EMYF, EMYAF, EMOAF, EMMAM, MMMAF, MMOAF, MMMAM, MMOAM, LMAF, LMMAF, LMYAM |
| **L Teres Major** | MMEAF | EMOAF, EMMAM, EMOAM, MMYAM, MMMAM LMYAF, LMMAF, LMAF, LMYAM, LMMAM, LMOAM |
| | PCAS | EMOAF, EMMAM, EMOAM, MMMAM, LMMAF, LMMAM, OMAOM |
| | PCAF | EMOAF, EMMAM, EMOAM, MMMAM, LMMAF, LMMAM, LMOAM, |
| | PCMAF | EMOAF, EMMAM, EMOAM, MMMAM, LMMAF, LMMAM, LMOAM |
| | PCMAM | EMYAF, EMOAF, EMMAM, EMOAM, MMYAM, MMMAM, LMYAF, LMMAF, LMAF, LMYAM, LMMAM, LMOAM, |

### B.1.4 The Ulna

**Table 192:** Post-hoc p-values for time period, ulna MSMs

| L Brachialis | EW | EM | MM | LM |
|---|---|---|---|---|
| PC | | .007 | .001 | .000 |
| **R Brachialis** | **EW** | **EM** | **MM** | **LM** |
| PC | | .001 | .000 | .000 |
| **L Anconeus** | **EW** | **EM** | **MM** | **LM** |
| EM | | | | .001 |
| MM | | | | .000 |
| PC | | | | .001 |
| **R Anconeus** | **EW** | **EM** | **MM** | **LM** |
| EM | | | | .012 |
| MM | | | | .000 |
| PC | | .027 | | .000 |
| **R Triceps Brachii** | **EW** | **EM** | **MM** | **LM** |
| PC | | .038 | .037 | .001 |

**Table 193:** Post-hoc p-values, time period/sex, ulna MSMs

| L Brachialis | EWM | EMF | EMM | MMF | MMM | LMF | LMM | LMS | PCS | PCU |
|---|---|---|---|---|---|---|---|---|---|---|
| EWF | | | | | .0250 | | .020 | | | |
| EMF | | | | | | | .022 | | | |
| MMF | | | | | | | .016 | | | |
| PCF | .030 | | .005 | .050 | .001 | .002 | .000 | | | .030 |
| PCM | .024 | .056 | .005 | .041 | .002 | .002 | .001 | | | .024 |
| PCS | | | | | .050 | | .020 | | | |
| **R Brachialis** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** | **LMS** | **PCS** | **PCU** |
| PCF | | .022 | .002 | .020 | .001 | .003 | .001 | | | |
| PCM | | .028 | .003 | .027 | .001 | .004 | .002 | | | |
| **L Anconeus** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** | **LMS** | **PCS** | **PCU** |
| EWF | | | | | | .053 | .041 | | | |
| MMF | | | | | .045 | .000 | .001 | | | |
| PCF | .057 | | | | | .008 | .006 | .057 | .057 | .057 |
| PCM | .030 | | .030 | | .015 | .001 | .001 | .030 | .030 | .030 |
| **R Anconeus** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** | **LMS** | **PCS** | **PCU** |
| EMF | | | | | | .031 | .041 | | | |
| MMF | | | | | | .001 | .005 | | | |
| PCF | | | | | | .013 | .012 | | | |
| PCM | | .039 | .005 | | .008 | .000 | .000 | .022 | .022 | |

**Table 194:** Post-hoc p-values, time period/age, ulna MSMs

| **L Brach** | **EWYA** | **EMYA** | **EMMA** | **EMOA** | **EMUA** | **MMYA** | **MMMA** | **MMOA** | **LMEA** | **LMYA** | **LMMA** | **LMOA** | **LMUA** | **PCUA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMEA** | | | | | | | | .023 | | .053 | | .047 | .047 | |
| **EWAU** | | | | | | | | .023 | | .053 | | .047 | .047 | |
| **MMEA** | | | .036 | | | | | .002 | .050 | .014 | .052 | .014 | .014 | |
| **PCYA** | | | | | | | | .023 | | .053 | | .047 | .047 | |
| **PCMA** | .009 | .009 | .003 | | .028 | .024 | .004 | .000 | .016 | .001 | .007 | .001 | .001 | .028 |
| **PCOA** | | | | | | | | .023 | | .053 | | .047 | .047 | |
| **R Brach** | **EWYA** | **EMYA** | **EMMA** | **EMOA** | **EMUA** | **MMYA** | **MMMA** | **MMOA** | **LMEA** | **LMYA** | **LMMA** | **LMOA** | **LMUA** | **PCUA** |
| **EWYA** | | | | | | | | .037 | | | | | | |
| **EMYA** | | | | | | | | .021 | | | | | | |
| **MMY** | | | | | | | | .037 | | | | | | |
| **MMEA** | | | .033 | .011 | .011 | | .034 | .001 | .043 | .006 | .012 | | .011 | |
| **MMYA** | | | | | | | | .035 | | | | | | |
| **LMOA** | | | | | | | | .021 | | | | | | |
| **PCYA** | | | | .029 | .029 | | | .012 | | | .043 | | .029 | |
| **PCMA** | | | .005 | .003 | .003 | .015 | .004 | .000 | .022 | .001 | .002 | | .003 | |
| **PCOA** | | | | .029 | .029 | | | .012 | | .032 | .043 | | .029 | |
| **L Ancon** | **EWYA** | **EMYA** | **EMMA** | **EMOA** | **EMUA** | **MMYA** | **MMMA** | **MMOA** | **LMEA** | **LMYA** | **LMMA** | **LMOA** | **LMUA** | **PCUA** |
| **EMAd** | | | .034 | | | | | | .042 | .034 | .018 | | .010 | |
| **EMYA** | | | | | | | | | | | | .034 | .034 | |
| **EMOA** | | | | | | | | | | | | .040 | .040 | |
| **EMUA** | | | | | | | | | | | | .040 | .040 | |
| **MMY** | | | | | | | | | | | | .040 | .040 | |
| **MMEA** | | | .028 | | | | | | | .028 | .013 | .005 | .005 | |
| **MMMA** | | | | | | | | | | | .040 | .015 | .015 | |
| **PCYA** | | | .034 | | | | | | .042 | .034 | .018 | .010 | .010 | .042 |
| **PCMA** | | | .007 | | | .047 | | .047 | .038 | .007 | .003 | .001 | .001 | |
| **R Ancon** | **EWYA** | **EMYA** | **EMMA** | **EMOA** | **EMUA** | **MMYA** | **MMMA** | **MMOA** | **LMEA** | **LMYA** | **LMMA** | **LMOA** | **LMUA** | **PCUA** |
| **EMAd** | | | .034 | | | | | | .044 | .022 | .019 | .009 | | |
| **EMYA** | | | | | | | | | | | | .031 | | |
| **EMOA** | | | | | | | | | | | | .041 | | |
| **MMEA** | | | .032 | | | | | | | .017 | .015 | .004 | | |
| **MMYA** | | | .041 | | | | | | | .020 | .019 | .004 | | |
| **MMMA** | | | | | | | | | | | | .054 | | |
| **PCYA** | | | .034 | | | | | | .044 | .022 | .019 | .009 | | |
| **PCMA** | | | .003 | | | | .018 | .020 | .029 | .001 | .001 | .000 | | |

**Table 195:** Post-hoc analysis, significant groups by time period/age/sex, ulna MSMs

| MSM | Time/Age/Sex | <Time/Age/Sex |
|---|---|---|
| **R Brachialis** | EWYAF | MMOAM |
| | EMYAF | MMOAM |
| | MMEAF | EMMAF, EMOAF, EMOAM, EMAM, MMMAF, MMOAF, MMOAM, LMYAF, LMAF, LMEAM, LMYAM, LMMAM |
| | PCYAF | EMMAF, EMAM, MMOAF, MMOAM, LMEAM, LMMAM |
| | PCMAF | EMMAF, EMOAF, EMOAM, EMAM, MMYAF, MMOAF, MMMAM, MMOAM, LMYAF, LMMAF, LMAF, LMEAM, LMYAM, LMMAM, PCYS |
| | PCOAF | EMMAF, EMOAF, EMOAM, EMAM, MMOAF, MMOAM, LMAF |
| | PCMAM | EMMAF, EMOAF, EMOAM, EMAM, MMMAF, MMOAF, MMOAM, LMYAF, LMAF, LMEAM, LMYAM, LMMAM |

### B.1.5 The Radius

**Table 196**: Post-hoc p-values, time period, radius MSMs

| **L Biceps** | **EW** | **EM** | **MM** | **LM** |
|---|---|---|---|---|
| **PC** | | .008 | .002 | .000 |
| **R Biceps** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .003 | .000 | .000 |
| **R Pronator Teres** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .010 | .002 | .000 |
| **L Supinator** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .020 | .000 | .000 | .000 |
| **R Supinator** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .000 | .000 | .000 |
| **L Pronator Quadratus** | **EW** | **EM** | **MM** | **LM** |
| **MM** | | | | .048 |
| **PC** | .008 | .001 | .002 | .000 |
| **R Pronator Quadratus** | **EW** | **EM** | **MM** | **LM** |
| **MM** | | .036 | | .010 |
| **PC** | | .000 | .011 | .000 |

**Table 197:** Post-hoc p-values, time period/sex, radius MSMs

| **L Biceps** | **EWM** | **EWF** | **EMF** | **EMM** | **EMS** | **MMF** | **MMM** | **LMF** | **LMM** | **PCS** |
|---|---|---|---|---|---|---|---|---|---|---|
| **EMF** | | | | .045 | | | .021 | | .005 | |
| **MMF** | | | | | | | .043 | | .009 | |
| **PCF** | .033 | | | .004 | .033 | | .002 | .016 | .000 | .033 |
| **PCM** | .019 | | .050 | .001 | .019 | .026 | .001 | .005 | .000 | .019 |
| **R Biceps** | **EWM** | **EWF** | **EMF** | **EMM** | **EMS** | **MMF** | **MMM** | **LMF** | **LMM** | **PCS** |
| **MMF** | | | | | | | | | .049 | |
| **PCF** | | | | .016 | | | .003 | .003 | .002 | |
| **PCM** | | | .038 | .004 | | .026 | .001 | .001 | .000 | |
| **R Pro Ter** | **EWM** | **EWF** | **EMF** | **EMM** | **EMS** | **MMF** | **MMM** | **LMF** | **LMM** | **PCS** |
| **EMS** | | | | .038 | | | | .026 | | |
| **PCF** | | | | .024 | | | .034 | .011 | .044 | |
| **PCM** | | | .033 | .006 | | | .007 | .001 | .012 | |
| **L Supinator** | **EWM** | **EWF** | **EMF** | **EMM** | **EMS** | **MMF** | **MMM** | **LMF** | **LMM** | **PCS** |
| **EMF** | | | | .012 | | | | | | |
| **EMS** | | | .043 | .002 | | .040 | .018 | .025 | .008 | |
| **MMF** | | | | .010 | | | | | | |
| **MMM** | | | | .047 | | | | | | |
| **LMF** | | | | .039 | | | | | | |
| **PCF** | | | .043 | .002 | | .040 | .018 | .025 | .008 | |
| **PCM** | | .034 | .006 | .000 | | .005 | .001 | .002 | .000 | |
| **R Supinator** | **EWM** | **EWF** | **EMF** | **EMM** | **EMS** | **MMF** | **MMM** | **LMF** | **LMM** | **PCS** |
| **LMF** | | | | .025 | | | | | | |
| **PCF** | | | .014 | .000 | | .009 | .004 | .028 | .001 | |
| **PCM** | | | .004 | .000 | | .002 | .001 | .010 | .000 | |
| **L Pro Quad** | **EWM** | **EWF** | **EMF** | **EMM** | **EMS** | **MMF** | **MMM** | **LMF** | **LMM** | **PCS** |
| **EMS** | | | | .037 | | | | .029 | .034 | |
| **PCF** | | .022 | .015 | .006 | | .034 | .020 | .003 | .005 | |
| **PCM** | | .022 | .015 | .006 | | .034 | .020 | .003 | .005 | |
| **R Pro Quad** | **EWM** | **EWF** | **EMF** | **EMM** | **EMS** | **MMF** | **MMM** | **LMF** | **LMM** | **PCS** |
| **EMS** | | .025 | | .032 | | | | .025 | .029 | |
| **MMM** | | | .031 | | | | | .037 | | |
| **PCF** | | | .017 | .032 | | | | .019 | .026 | |
| **PCM** | | .041 | .000 | .001 | | .011 | .024 | | .001 | |

**Table 198:** Post-hoc p-values, time period/age, radius MSMs

| L Bicep | EW MA | EM Ad | EM MA | EM OA | MM YA | MM MA | MM OA | MM UA | LM EA | LM YA | LM MA | LM OA | LM UA | PCY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMY** | | | | | | | | | | | | .055 | | |
| **EMYA** | | | | .043 | | | .017 | | | | | .022 | | |
| **MMY** | | | | | | | | | | | | .055 | | |
| **MMEA** | | | .038 | .025 | | .056 | .009 | | | .038 | | .012 | | |
| **PCYA** | | | .055 | .030 | | | .025 | | | .055 | | .022 | | |
| **PCMA** | .017 | .017 | .002 | .002 | .011 | .003 | .000 | | .017 | .002 | .008 | .001 | .051 | .017 |
| **PCOA** | .046 | .046 | .039 | .021 | | .053 | .016 | | .046 | .039 | .053 | .015 | .051 | .046 |
| **R Bicep** | **EW MA** | **EM Ad** | **EM MA** | **EM OA** | **MM YA** | **MM MA** | **MM OA** | **MM UA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **LM UA** | **PCY** |
| **EMEA** | | | | .047 | | | .051 | | | | .030 | | | |
| **EMYA** | | | | | | | | | | | .049 | | | |
| **MMEA** | | | | .047 | | .045 | .034 | | | | .018 | | | |
| **MMMA** | | | | | | .041 | .028 | | | | .015 | | | |
| **PCAd** | | | | .047 | | | .051 | | | | .030 | | | |
| **PCYA** | | | | .047 | | | .051 | | | | .030 | | | |
| **PCMA** | | | .003 | .002 | | .000 | .000 | .019 | | .001 | .000 | .001 | .030 | |
| **R Pro Teres** | **EW MA** | **EM Ad** | **EM MA** | **EM OA** | **MM YA** | **MM MA** | **MM OA** | **MM UA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **LM UA** | **PCY** |
| **EMAd** | | | .034 | .054 | | | .054 | | | | .018 | .018 | .054 | |
| **EMYA** | | | .030 | | | | .056 | | | | .013 | .012 | | |
| **PCMA** | | | .001 | .012 | .010 | .018 | .002 | | | .011 | .000 | .000 | .012 | |
| **L Supin** | **EW MA** | **EM Ad** | **EM MA** | **EM OA** | **MM YA** | **MM MA** | **MM OA** | **MM UA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **LM UA** | **PCY** |
| **EMAd** | | | .008 | .008 | .048 | .025 | .011 | | | .050 | .002 | .008 | | |
| **EMYA** | | | | | | | | | | | .048 | | | |
| **MMEA** | | | .039 | .044 | | | | | | | .007 | .044 | | |
| **LMYA** | | | | | | | | | | | .033 | | | |
| **PCYA** | | | .008 | .008 | .048 | .025 | .011 | | | .050 | .002 | .008 | | |
| **PCMA** | | | .000 | .001 | .008 | .002 | .001 | | | .010 | .000 | .001 | .020 | |
| **R Supin** | **EW MA** | **EM Ad** | **EM MA** | **EM OA** | **MM YA** | **MM MA** | **MM OA** | **MM UA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **LM UA** | **PCY** |
| **PCYA** | | | .025 | .030 | | .018 | .040 | | | | .017 | .043 | | |
| **PCMA** | | | .000 | .002 | .006 | .000 | .000 | | | .008 | .000 | .002 | .049 | |

**Table 198:** (continued)

| R Pro Quad | EW MA | EM Ad | EM MA | EM OA | M M YA | MM MA | MM OA | MM UA | LM EA | LM YA | LM MA | LM OA | LM UA | PCY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MMEA** | | | .026 | | | | | | | .032 | .040 | .054 | | |
| **MMYA** | | | .029 | | | | | | | .039 | .054 | | | |
| **PCYA** | | | .029 | .054 | | | | | | .032 | .035 | .041 | .054 | |
| **PCMA** | | | .000 | .007 | | .001 | .007 | | .035 | .000 | .001 | .002 | .007 | |

### B.1.6 The Innominate

**Table 199:** Post-hoc p-values, time period, innominate MSMs

| R Gluteus Maximus | EW | EM | MM | LM |
|---|---|---|---|---|
| PC | | .005 | .001 | .003 |
| **Left Gluteus Minimus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .004 | .026 | .001 |
| **R Gluteus Minimus** | **EW** | **EM** | **MM** | **LM** |
| PC | | | .030 | .002 |
| **L Tensor Fasciae Latae** | **EW** | **EM** | **MM** | **LM** |
| MM | | .023 | | |
| PC | | .002 | | .009 |
| **R Tensor Fasciae Latae** | **EW** | **EM** | **MM** | **LM** |
| MM | | .015 | | .015 |
| PC | | .001 | | .001 |
| **L Adductor Magnus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .002 | .014 | .005 |
| **R Adductor Magnus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .004 | .012 | .003 |
| **Left Gracilis** | **EW** | **EM** | **MM** | **LM** |
| EM | | | .011 | |
| PC | | | .026 | |
| **L Iliacus** | **EW** | **EM** | **MM** | **LM** |
| MM | | | | .015 |
| PC | | | | .004 |
| **R Iliacus** | **EW** | **EM** | **MM** | **LM** |
| EW | | | | .041 |
| MM | | | | .028 |
| PC | | | | .008 |
| **L Obturator Externus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .010 | .001 | .005 |
| **R Obturator Externus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .006 | .001 | .002 |
| **L Obturator Internus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .001 | .000 | .000 |
| **R Obturator Internus** | **EW** | **EM** | **MM** | **LM** |
| EM | | | .057 | |
| PC | | .008 | .000 | .002 |
| **L Piriformis** | **EW** | **EM** | **MM** | **LM** |
| PC | | .033 | .034 | .002 |
| **R Piriformis** | **EW** | **EM** | **MM** | **LM** |
| MM | | | | .07 |
| PC | | | | .002 |
| **L Superior Gemellus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .001 | .001 | .000 |
| **R Superior Gemellus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .001 | .001 | .000 |
| **L Inferior Gemellus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .000 | .000 | .000 |
| **R Inferior Gemellus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .000 | .000 | .000 |

**Table 200**: Post-hoc p-values, time period/sex, innominate MSMs - part 1

| R Gluteus Maximus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| EMS | | | | | | .051 | | .021 |
| MMS | | | | | | | | .056 |
| LMF | | | | | | | | .056 |
| PCF | | | .030 | .017 | .024 | .006 | | .002 |
| PCM | | | | | | .051 | | .021 |
| PCS | | | | | | | | .056 |
| **L Gluteus Minimus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMF | | | | | | | | .041 |
| EMS | | | .013 | .017 | .054 | .025 | .041 | .001 |
| MMM | | | | | | | | .009 |
| MMF | | | | | | | | .001 |
| MMS | | | .013 | .017 | .054 | .025 | .041 | .001 |
| LMF | | | | | | | | .007 |
| PCF | | | .004 | .001 | .046 | .012 | .033 | .000 |
| PCM | | | .049 | | | | | .002 |
| **R Gluteus Maximus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMM | | | | | | | | .056 |
| EMF | | | | | | | | .032 |
| EMS | | | .026 | .031 | .024 | .014 | .029 | .001 |
| LMF | | | | | | | | .045 |
| MMM | | | | | | | | .054 |
| MMF | | | | | | | | .020 |
| MMS | | | .026 | .031 | .024 | .014 | .029 | .001 |
| PCF | | | .054 | | .042 | .018 | | .000 |
| PCM | | | | | | | | .006 |
| **L Gluteus Medius** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMF | | | | | | | | .052 |
| EMS | | | | .029 | | .036 | | .007 |
| MMF | | | | | | | | .055 |
| MMS | | | | .029 | | .036 | | .007 |
| LMF | | | | | | | | .024 |
| PCF | | | .044 | .012 | .029 | .011 | | .001 |
| PCM | | | | | | | | .012 |
| **L Tensor Fascia Latae** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | .046 | .009 | | | | .043 |
| MMM | | | | .037 | | | | |
| MMF | | | .043 | .002 | | | | .057 |
| PCF | | | .054 | .005 | | | | .055 |
| PCM | | | .033 | .004 | | | .057 | .033 |
| **R Tensor Fascia Latae** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | .024 | .033 | | | .043 | .024 |
| MMF | | | .005 | .030 | | | .026 | .009 |
| PCF | | | .013 | .033 | | | .037 | .015 |
| PCM | | | .009 | .021 | | | .025 | .010 |

**Table 200:** (continued)

| L Adductor Magnus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **EMS** | | | .047 | .008 | | .036 | .048 | .020 |
| **MMF** | | | | .021 | | | | |
| **MMS** | | | | .022 | | | | .046 |
| **LMS** | | | | .022 | | | | .046 |
| **PCF** | | | | .006 | | .044 | | .022 |
| **PCM** | .057 | | .007 | .001 | .028 | .004 | .008 | .002 |

**Table 201:** Post-hoc p-values, time period/sex, innominate MSMs - part 2

| **R Adductor Magnus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
|---|---|---|---|---|---|---|---|---|
| **EMS** | | | .040 | .016 | | .030 | .041 | .019 |
| **MMS** | | | | .039 | | | | .046 |
| **LMS** | | | | .039 | | | | .046 |
| **PCF** | | | | .018 | | .036 | | .022 |
| **PCM** | | | .024 | .007 | | .013 | .025 | .008 |
| **L Obturator Externus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .009 | .011 | .008 | .003 | .011 | .012 |
| **PCF** | | | | | | .031 | | |
| **PCM** | | | .009 | .011 | .008 | .003 | .011 | .012 |
| **R Obturator Externus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .005 | .006 | .012 | .002 | .006 | .007 |
| **PCF** | | | | | | .020 | | |
| **PCM** | | | .005 | .006 | .012 | .002 | .006 | .007 |
| **L Obturator Internus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .010 | .015 | .009 | .002 | .012 | .015 |
| **PCF** | | | .010 | .015 | .009 | .002 | .012 | .015 |
| **PCM** | | | .010 | .015 | .009 | .002 | .012 | .015 |
| **R Obturator Internus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .049 | .033 | .013 | .008 | .026 | .033 |
| **PCF** | | | .049 | .033 | .013 | .008 | .026 | .033 |
| **PCM** | | | .049 | .033 | .013 | .008 | .026 | .033 |
| **L Piriformis** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMM** | | | | | | | .052 | |
| **EMS** | .052 | | .034 | | | | .022 | .042 |
| **PCM** | .025 | | .004 | | .022 | .029 | .002 | .008 |
| **R Piriformis** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | .047 | | .042 | | | | .021 | .037 |
| **MMF** | | | | | | | .050 | |
| **PCM** | .022 | | .006 | | .034 | .030 | .002 | .006 |
| **L Superior Gemellus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .007 | .009 | .024 | .012 | .009 | .011 |
| **PCF** | | | .007 | .009 | .024 | .012 | .008 | .011 |
| **PCM** | | | .007 | .009 | .024 | .012 | .008 | .011 |
| **R Superior Gemellus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .008 | .008 | .035 | .015 | .008 | .018 |
| **PCF** | | | .008 | .008 | .035 | .015 | .008 | .018 |
| **PCM** | | | .008 | .008 | .035 | .015 | .008 | .018 |
| **L Inferior Gemellus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .005 | .007 | .011 | .010 | .006 | .009 |
| **PCF** | | | .005 | .007 | .011 | .010 | .006 | .009 |
| **PCM** | | | .005 | .007 | .011 | .010 | .006 | .009 |
| **R Inferior Gemellus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .006 | .006 | .013 | .010 | .005 | .014 |
| **PCF** | | | .006 | .006 | .013 | .010 | .005 | .014 |
| **PCM** | | | .006 | .006 | .013 | .010 | .005 | .014 |

**Table 202:** Post-hoc p-values, time period/sex, innominate MSMs - part 3

| L Quadratus Femoris | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **EMS** | | | .028 | .020 | | | | |
| **PCF** | | | .004 | .003 | .025 | .014 | | |
| **PCM** | | | .028 | .020 | | | | |
| **R Quadratus Femoris** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .026 | .013 | | | | |
| **LMF** | | | .046 | .019 | | | | |
| **PCF** | | | .004 | .002 | .033 | .047 | | |
| **PCM** | | | .026 | .013 | | | | |

**Table 203:** Post-hoc p-values, innominate MSMs, time period/age

| **L TFL** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **M MY** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAd** | .045 | | .050 | .016 | .016 | | | | | | | .016 | .050 | |
| **MMY** | | | | .034 | .036 | | | | | | | .034 | | |
| **MMEA** | | | | .036 | .043 | | | | | | | .035 | | |
| **PCMA** | | | .011 | .002 | .003 | | | | .043 | | .053 | .002 | .016 | |
| **PCA** | .045 | | .051 | .016 | .016 | | | | | | | .016 | .050 | |
| **R TFL** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **M MY** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | .037 | | .023 | .027 | | | | | | | | .020 | .013 | |
| **MMY** | | | | | | | | | | | | .054 | .035 | |
| **MMEA** | .035 | | .012 | .014 | | | | | | | | .008 | .006 | |
| **MMMA** | | | | | | | | | | | | .051 | | |
| **PCYA** | | | | | | | | | | | | | | |
| **PCMA** | .018 | | .003 | .003 | | | | | | | .034 | .002 | .002 | |
| **PCA** | .037 | | .023 | .027 | | | | | | | | .020 | .013 | |
| **L Ad Mag** | **EM Y** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **M MY** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | | | .015 | .042 | .004 | | | .018 | | | | .015 | .039 | |
| **EMEA** | | | .035 | | .010 | | | .043 | | | | .035 | | |
| **MMY** | | | | | .017 | | | | | | | | | |
| **MMEA** | | | | | .019 | | | | | | | | | |
| **MMYA** | | | .045 | | .010 | | | .042 | | | | .045 | | |
| **MMOA** | | | | | .040 | | | | | | | | | |
| **LMAd** | | | .035 | | .010 | | | .043 | | | | .035 | | |
| **PCMA** | .051 | | .001 | .004 | .000 | | .052 | .000 | .009 | | .015 | .001 | .004 | |
| **PCA** | | | .035 | | .010 | | | .043 | | | | .035 | | |
| **R Ad Mag** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **M MY** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | | | .012 | | .003 | | | .024 | | | | .016 | .029 | |
| **EMEA** | | | .030 | .008 | | | | .056 | | | | .039 | | |
| **EMMA** | | | | | .047 | | | | | | | | | |
| **MMY** | | | | | .014 | | | | | | | | | |
| **MMEA** | | | | | .016 | | | | | | | | | |
| **MMYA** | | | | | .018 | | | | | | | | | |
| **MMOA** | | | | | .043 | | | | | | | | | |
| **LMAd** | | | .030 | .008 | | | | .056 | | | | .039 | | |
| **LMYA** | | | | | .042 | | | | | | | | | |
| **PCYA** | | | | | | | | | | | | | | |
| **PCMA** | | | .002 | .039 | .000 | | | .003 | .031 | | .032 | .002 | .011 | |
| **PCA** | | | .030 | .008 | | | | .056 | | | | .039 | | |

**Table 204:** Post-hoc p-values, innominate MSMs, time period/age

| L Obt Ext | EM Y | EM EA | EM YA | EM MA | EM OA | MM Y | MM YA | MM MA | MM OA | LM EA | LM YA | LM MA | LM OA | PC OA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAd** | .022 | .047 | .015 | .012 | .022 | .047 | .015 | .001 | .009 | | .011 | .015 | .047 | .047 |
| **MMEA** | | | | | | | | .014 | | | | | | |
| **PCMA** | .005 | .022 | .002 | .001 | .005 | .022 | .002 | .000 | .001 | | .001 | .002 | .022 | .022 |
| **R Obt Ext** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | .013 | .032 | .013 | .007 | .013 | .032 | .007 | .001 | | | .006 | .008 | .032 | |
| **MMEA** | | | | | | | | .036 | | | | | | |
| **MMYA** | | | | | | | | | | | | | | |
| **PCYA** | | | | | | | | | | | | | | |
| **PCMA** | .002 | .013 | .002 | .000 | .002 | .013 | .000 | .000 | .000 | | .000 | .001 | .013 | .013 |
| **PCA** | | | | | | | | | | | | | | |
| **L Obt Intern** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | .026 | .054 | .015 | .015 | .026 | .026 | .015 | .000 | .010 | | .012 | .018 | .054 | |
| **MMEA** | | | | | | | | .005 | | | | | | |
| **MM OA** | | | | | | | | .045 | | | | | | |
| **PCMA** | .006 | .026 | .002 | .002 | .006 | .006 | .002 | .000 | | | .001 | .003 | .026 | |
| **R Obt Intern** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | .052 | | . | .033 | .052 | .052 | .030 | .002 | .010 | | .026 | .039 | | |
| **EMYA** | | | | | | | | .014 | | | | | | |
| **MMEA** | | | | | | | | .014 | | | | | | |
| **PCMA** | .017 | .052 | | .006 | .017 | .017 | .004 | .000 | .001 | | .003 | .009 | .052 | |
| **L Sup Gem** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | .017 | .039 | .011 | .011 | .039 | .039 | .009 | .008 | .033 | | .009 | .039 | | |
| **MMEA** | .017 | .039 | .011 | .011 | .039 | .039 | .009 | .008 | .033 | | .009 | .011 | .039 | |
| **PCMA** | .004 | | .001 | .001 | .017 | .017 | .001 | .000 | .005 | | .001 | .001 | .017 | |

**Table 204:** (continued)

| R Sup Gem | EMY | EM EA | EM YA | EM MA | EM OA | MM Y | MM YA | MM MA | MM OA | LM EA | LM YA | LM MA | LM OA | PC OA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAd** | .018 | .041 | .018 | .010 | .041 | .018 | .012 | .008 | .052 | | .010 | .012 | .041 | |
| **MMEA** | .018 | .041 | .018 | .010 | .041 | | .018 | .008 | .053 | | .010 | .012 | .041 | |
| **PCMA** | .004 | .018 | .004 | .001 | .018 | .004 | .002 | .001 | .012 | | .001 | .002 | .018 | |
| **L Inf Gem** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | .014 | .033 | .009 | .009 | .033 | .033 | .006 | .006 | .020 | | .007 | .009 | .033 | |
| **PCMA** | .003 | .014 | .001 | .001 | .014 | .014 | .000 | .000 | .002 | | .000 | .001 | .014 | |
| **R Inf Gem** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | .014 | .033 | .014 | .007 | .033 | .014 | .007 | .005 | .027 | | .007 | .033 | | |
| **PCMA** | .003 | .014 | .003 | .000 | .014 | .003 | .000 | .000 | .004 | | .000 | .001 | .014 | |

**Table 205:** Post-hoc p-values, innominate MSMs, time period/age

| L Quad Femoris | EM Y | EM EA | EM YA | EM MA | EM OA | MM Y | MM YA | MM MA | MM OA | LM EA | LM YA | LM MA | LM OA | PC OA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAd** | | | .028 | .020 | .018 | | .045 | .029 | | | | | .028 | |
| **MMEA** | | | | .053 | .053 | | | | | | | | | |
| **MMOA** | | | | .037 | .051 | | | | | | | | | |
| **LMYA** | | | .040 | .020 | .031 | | | .029 | | | | | .040 | |
| **LMMA** | | | | .053 | .053 | | | | | | | | | |
| **PCMA** | .044 | | .005 | | .004 | .044 | .008 | .003 | | | | | | |
| **PCA** | | | .028 | .020 | .018 | | .045 | .029 | | | | | .028 | |
| **R Quad Femoris** | **EM Y** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| **EMAd** | | | .026 | .013 | .018 | | | .020 | | | | | .043 | |
| **MMEA** | | | | .041 | | | | | | | | | | |
| **MMYA** | | | | .043 | | | | | | | | | | |
| **MMOA** | | | .043 | .011 | .035 | | | .017 | | | | | | |
| **LMYA** | | | .043 | .011 | .035 | | | .017 | | | | | | |
| **LMMA** | | | | .041 | | | | | | | | | | |
| **PCMA** | .040 | | .004 | .001 | .004 | .040 | .058 | .002 | | | | | .010 | |
| **PCA** | | | .026 | .013 | .018 | | | .020 | | | | | .043 | |

### B.1.7 The Femur

**Table 206:** Post-hoc p-values, femur MSMs, time period - part 1

| **L Gluteus Maximus** | **EW** | **EM** | **MM** | **LM** |
|---|---|---|---|---|
| **PC** | .001 | .000 | .000 | .000 |
| **R Gluteus Maximus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .001 | .000 | .010 | .000 |
| **L Gluteus Medius** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .006 | .000 | .000 |
| **R Gluteus Medius** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .034 | .003 | .000 |
| **L Gluteus Minimus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .001 | .000 | .000 |
| **R Gluteus Minimus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .011 | .017 | .000 |
| **L Adductor Magnus** | **EW** | **EM** | **MM** | **LM** |
| **EM** | | | | .034 |
| **MM** | .033 | | | .003 |
| **PC** | .000 | .003 | .004 | .000 |
| **R Adductor Magnus** | **EW** | **EM** | **MM** | **LM** |
| **EM** | | | | .008 |
| **MM** | | | | .001 |
| **PC** | .002 | .024 | .046 | .000 |
| **L Vastus Intermedius** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .028 | .000 | .000 | .000 |
| **R Vastus Intermedius** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .000 | .004 | .000 |
| **L Vastus Medius** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .026 | .001 | .000 | .000 |
| **R Vastus Medius** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .037 | .001 | .004 | .000 |
| **L Vastus Lateralis** | **EW** | **EM** | **MM** | **LM** |
| **EW** | | .035 | .042 | |
| **PC** | .027 | .000 | .000 | .000 |
| **R Vastus Lateralis** | **EW** | **EM** | **MM** | **LM** |
| **EW** | | .027 | .047 | |
| **PC** | | .000 | .000 | .000 |
| **L Obturator Externus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .000 | .000 | .000 |
| **R Obturator Externus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .004 | .001 | .000 |
| **L Obturator Internus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .000 | .000 | .000 |
| **R Obturator Internus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .003 | .000 | .000 |
| **L Quadratus Femoris** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .000 | .000 | .004 |

**Table 206:** (continued)

| R Quadratus Femoris | EW | EM | MM | LM |
|---|---|---|---|---|
| PC | | .000 | .000 | .003 |
| **L Popliteus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .006 | .012 | .000 |
| **R Popliteus** | **EW** | **EM** | **MM** | **LM** |
| PC | | .001 | .007 | .000 |

**Table 207:** Post-hoc p-values, femur MSMs, time period - part 2

| L Gastrocnemius | EW | EM | MM | LM |
|---|---|---|---|---|
| PC | .000 | .001 | .002 | .000 |
| R Gastrocnemius | EW | EM | MM | LM |
| PC | .005 | .000 | .003 | .001 |
| L Iliacus | EW | EM | MM | LM |
| PC | .008 | .000 | .001 | .000 |
| R Iliacus | EW | EM | MM | LM |
| PC | .002 | .000 | .002 | .001 |
| L Pectineus | EW | EM | MM | LM |
| PC | | .000 | .004 | .001 |
| R Pectineus | EW | EM | MM | LM |
| MM | | .058 | | |
| PC | | .001 | | .002 |

**Table 208**: Post-hoc p-values, femur MSMs, time period/sex – part 1

| L Gluteus Maximus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| MMF | | .044 | .007 | .013 | | .002 | | .025 |
| PCF | | .001 | .000 | .000 | .017 | .000 | .001 | .000 |
| PCM | | .018 | .015 | .013 | | .012 | .055 | .020 |
| PCU | | .030 | .026 | .022 | | .021 | | .035 |
| R Gluteus Maximus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
| MMF | | | .052 | .029 | | | | |
| PCF | .010 | .002 | .000 | .000 | .025 | .014 | .001 | .001 |
| PCM | | | | .042 | | | | |
| PCU | | .028 | .035 | .020 | | | | .036 |
| L Gluteus Medius | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
| EMS | | | .034 | .045 | .045 | .012 | .019 | .015 |
| PCF | | | .006 | .017 | .008 | .000 | .001 | .002 |
| PCM | | | .005 | .010 | .006 | .001 | .002 | .001 |
| R Gluteus Medius | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
| EMS | | | .049 | | .020 | | .013 | .023 |
| PCF | | | .050 | | .005 | | .003 | .016 |
| PCM | | | .008 | .016 | .001 | .017 | .001 | .003 |
| L Gluteus Minimus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
| EMS | | | | .038 | | .036 | .031 | .041 |
| PCF | | | .001 | .001 | .006 | .000 | .000 | .000 |
| PCM | | | .017 | .007 | .055 | .004 | .004 | .007 |
| R Gluteus Minimus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
| EMS | | | | .037 | | | .013 | .040 |
| MMM | | | | | | | .020 | |
| PCF | | | .033 | .014 | .022 | | .001 | .013 |
| PCM | | | .016 | .007 | .014 | | .001 | .007 |

**Table 209**: Post-hoc p-values, femur MSMs, time period/sex - part 2

| **L Adductor Magnus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
|---|---|---|---|---|---|---|---|---|
| **EMF** | | .052 | | | | | .031 | .025 |
| **MMF** | | .014 | | .018 | | .034 | .002 | .002 |
| **PCF** | .026 | .005 | | .005 | | .009 | .001 | .001 |
| **PCM** | .008 | .002 | .054 | .002 | | .004 | .001 | .000 |
| **R Adductor Magnus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMF** | | | | | | . | .021 | .013 |
| **EMS** | | | | | | | | .038 |
| **MMF** | | | | | | | .003 | .003 |
| **MMU** | | | | | | | | .038 |
| **PCF** | .008 | .018 | | .007 | | .012 | .000 | |
| **PCM** | | | | | | | | .033 |
| **PCS** | | | | | | | | .038 |
| **PCU** | | | | | | | | .038 |
| **L Vastus Intermedius** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **MMF** | | | | | | .009 | .028 | |
| **PCF** | | | .002 | .002 | | .000 | .000 | .002 |
| **PCM** | | | .011 | .008 | .016 | .001 | .002 | .010 |
| **R Vastus Intermedius** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **MMF** | | | | .016 | | | | |
| **PCF** | | | .006 | .000 | .034 | .001 | .001 | .004 |
| **PCM** | | | | .020 | | | | |
| **L Vastus Medialis** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **MMF** | | | | | | .030 | | |
| **PCF** | | | .011 | .000 | .016 | .000 | .000 | .003 |
| **PCM** | | | .028 | .003 | .041 | .002 | .004 | .011 |
| **R Vastus Medialis** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMF** | | | | .038 | | | | |
| **MMF** | | | | .010 | | | .045 | |
| **PCF** | .024 | | .012 | .000 | .023 | .000 | .000 | .001q |
| **PCM** | | | | .023 | | | | |
| **L Vastus Lateralis** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EWF** | | | | .027 | | | | |
| **EWM** | | | | .027 | | | | |
| **LMM** | | | | .033 | | | | |
| **PCF** | | | .000 | .000 | .000 | .000 | .000 | .004 |
| **PCM** | | | .007 | .001 | .009 | .001 | .012 | .032 |
| **PCS** | | | | .016 | | .032 | | |
| **PCU** | | | | .016 | | .032 | | |
| **R Vastus Lateralis** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EWF** | | | | .012 | | .042 | | |
| **PCF** | | | .000 | .000 | .000 | .000 | .001 | .005 |
| **PCM** | | | | .008 | | .027 | | |
| **PCS** | | | | .017 | | .042 | | |
| **PCU** | | | | .017 | | .042 | | |

**Table 209:** (continued)

| L Obturator Externus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **EMS** | | | | .034 | | .047 | .044 | .037 |
| **PCF** | | | .002 | .001 | .001 | .000 | .000 | .001 |
| **PCM** | | | .015 | .006 | .013 | .007 | .007 | .006 |
| **R Obturator Externus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | | .038 | .051 | | .046 | .041 |
| **PCF** | | | .022 | .010 | .006 | .022 | .008 | .009 |
| **PCM** | | | .017 | .007 | .008 | .018 | .008 | .008 |

**Table 210:** Post-hoc p-values, femur MSMs, time period/sex - part 3

| L Obturator Internus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| EMS | | | | .030 | | .028 | .040 | .033 |
| PCF | | | .001 | .001 | .001 | .000 | .000 | .001 |
| PCM | | | .013 | .005 | .011 | .003 | .006 | .005 |
| **R Obturator Internus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | .015 | .028 | .027 | .049 | .035 | .031 |
| PCF | | | | .006 | .001 | | .005 | .005 |
| PCM | | | .012 | .005 | .003 | .028 | .005 | .005 |
| **L Quadratus Femoris** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | .029 | .029 | | .030 | | |
| MMF | | | .041 | | | .036 | | |
| PCF | | | .000 | .001 | .027 | .000 | .026 | .018 |
| PCM | | | .003 | .005 | | .003 | | .039 |
| **R Quadratus Femoris** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | .046 | .052 | | | | |
| PCF | | | .001 | .004 | .003 | .004 | .037 | .010 |
| PCM | | | .008 | .012 | .018 | .020 | | .025 |
| **L Popliteus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | .043 | | | | .033 | .043 |
| PCF | | | .006 | | | .040 | .003 | .006 |
| PCM | | | .007 | .058 | .052 | .036 | .004 | .007 |
| **R Popliteus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | .029 | | .038 | .043 | .038 | .017 |
| PCF | | | .002 | .048 | | | .007 | .001 |
| PCM | | | .003 | .027 | .027 | .029 | .007 | .002 |
| **L Gastrocnemius** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | .033 | .045 | | .015 | | | | .052 |
| MMF | | | | .039 | | | | |
| PCF | .007 | .020 | .028 | .001 | .052 | .005 | .009 | .008 |
| PCM | .007 | .014 | .027 | .002 | .046 | .010 | .014 | .010 |
| **R Gastrocnemius** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EMS | | | .054 | .015 | | | | .047 |
| MMF | | | | .025 | | | | |
| PCF | .032 | | .002 | .000 | | .005 | .019 | .004 |
| PCM | .031 | .042 | .009 | .002 | | .015 | .025 | .009 |
| **L Iliacus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| MMF | | | .038 | .025 | | .046 | | .054 |
| PCF | | | .001 | .001 | | .001 | .014 | .003 |
| PCM | .040 | .040 | .003 | .002 | | .004 | .017 | .004 |
| **R Iliacus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| MMF | | | | .036 | | | | |
| PCF | .006 | .041 | | .000 | .012 | .003 | .006 | .002 |
| PCM | .047 | | | .010 | | | | .047 |
| **L Pectineus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| EWF | | | | .046 | | | | |
| MMF | | | .051 | .016 | | | | |
| PCF | | .019 | .002 | | | .003 | .005 | .006 |
| PCM | | .040 | .018 | .006 | | .029 | .033 | .024 |

**Table 211:** Post-hoc p-values, femur MSMs, time period/age/sex - part 1

| **L Gluteus Maximus** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MMY** | | | | .014 | .032 | | | .021 | .015 | | | | |
| **MMEA** | | | | .021 | .053 | | | .032 | .022 | | | | |
| **PCY** | | | .033 | .014 | .032 | | | .021 | .015 | | | | |
| **PCMA** | .032 | .032 | .007 | .002 | .009 | | | .003 | .002 | | .012 | .026 | .044 |
| **PCA** | .025 | .025 | .001 | .000 | .004 | | .026 | .000 | .000 | .025 | .003 | .012 | .021 |
| **R Gluteus Maximus** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** |
| **MMEA** | | | | .045 | | | | | | | | | |
| **MMYA** | .051 | | | .008 | | | | | | | .036 | | |
| **PCY** | .035 | | | .012 | | | | | | | .034 | .051 | .051 |
| **PCMA** | .023 | | .050 | .003 | | | | | .026 | | .013 | .026 | |
| **PCA** | .023 | .023 | .005 | .000 | .023 | .049 | | .015 | .002 | .023 | .001 | .003 | .003 |
| **L Gluteus Minimus** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** |
| **EMAd** | | | | .033 | | | | | .022 | | .044 | | .024 |
| **MMEA** | | | | .024 | | | | | .009 | | .028 | | .020 |
| **PCMA** | .038 | | .013 | .003 | .038 | | .007 | .016 | .000 | | .002 | .020 | .003 |
| **PCA** | | | .045 | .009 | | | | | .002 | | .008 | | .008 |
| **L Ad Magnus** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** |
| **EMAd** | | | | | | | | | | | | | .055 |
| **EMEA** | | | | | | | | | | | | | .055 |
| **EMYA** | | | | | | | | | | | | | .041 |
| **MMEA** | | | | .010 | .030 | | | .044 | | | .012 | .010 | .004 |
| **MMYA** | | | | | | | | | | | | | .027 |
| **PCY** | | | | .010 | .030 | | | .044 | | | .012 | .010 | .004 |
| **PCMA** | | | | .002 | .009 | .055 | | .009 | .025 | | .002 | .002 | .001 |
| **PCA** | | | | .004 | .023 | | | | | | .004 | .004 | .001 |
| **R Ad Magnus** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM EA** | **LM YA** | **LM MA** | **LM OA** |
| **EMAd** | | | | | | | | | | | .048 | | .035 |
| **EMEA** | | | | | | | | | | | .048 | | .035 |
| **EMYA** | | | | | | | | | | | .037 | | .024 |
| **MMEA** | | | | .023 | | | | .053 | | | .010 | .019 | .007 |
| **MMYA** | | | | .046 | | | | | | | .016 | .039 | .011 |
| **MMOA** | | | | | | | | | | | .043 | | .028 |
| **MMA** | | | | | | | | | | | .048 | | .035 |
| **PCY** | | | | .009 | | | | .024 | | | .003 | .008 | .002 |
| **PCMA** | | | | .035 | | | | | | | .012 | .030 | .008 |
| **PCA** | | | | .003 | | | | .010 | | | .001 | .003 | .001 |

**Table 212:** Post-hoc p-values, femur MSMs, time period/age/sex - part 2

| L Vast Int | EMY | EMYA | EMMA | EMOA | MMY | MMYA | MMMA | MMOA | LMYA | LMMA | LMOA | PCOA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMY** | | | .019 | | | | .036 | .023 | | .049 | .030 | |
| **MMEA** | | | .023 | | | | .047 | .025 | | | .043 | |
| **MMYA** | | | .008 | | | | .012 | .005 | | .051 | .017 | |
| **PCY** | | | .024 | | | | .048 | .027 | | | .042 | |
| **PCMA** | | .038 | .000 | | | | .000 | .000 | .011 | .002 | .000 | |
| **PCA** | | .038 | .000 | | | | .000 | .000 | .011 | .002 | .000 | |
| **R Vast Int** | **EMY** | **EMYA** | **EMMA** | **EMOA** | **MMY** | **MMYA** | **MMMA** | **MMOA** | **LMYA** | **LMMA** | **LMOA** | **PCOA** |
| **EMY** | | | .043 | | | | | | | | | |
| **EMYA** | | | .007 | | | | | | | | | |
| **EWYA** | | | .021 | | | | | | | | | |
| **MMY** | | | .043 | | | | | | | | | |
| **MMYA** | | | .000 | | | | .049 | .027 | | .050 | .050 | .052 |
| **MMEA** | | | .005 | | | | | | | | | |
| **PCY** | | | .005 | | | | | | | | | .054 |
| **PCMA** | | | .000 | | | | .007 | .004 | .013 | .009 | .009 | .018 |
| **PCA** | | .037 | .000 | | | | .001 | .001 | .003 | .002 | .002 | .005 |
| **L Vast Medialis** | **EMY** | **EMYA** | **EMMA** | **EMOA** | **MMY** | **MMYA** | **MMMA** | **MMOA** | **LMYA** | **LMMA** | **LMOA** | **PCOA** |
| **EMAd** | | | | .020 | | | .049 | | | | .043 | |
| **EMY** | | | | .020 | | | .049 | | | | .043 | |
| **EMEA** | | | | .020 | | | .049 | | | | .043 | |
| **MMEA** | | | | .028 | | | | | | | | |
| **MMYA** | | | | .031 | | | .055 | | | | | |
| **PCY** | | | | .017 | | | .039 | | | | .036 | |
| **PCMA** | | .033 | .013 | .001 | | .042 | .001 | .002 | .013 | .003 | .001 | |
| **PCA** | | .033 | .013 | .001 | | | .001 | .002 | .013 | .003 | .001 | |
| **L Vast Lateralis** | **EMY** | **EMYA** | **EMMA** | **EMOA** | **MMY** | **MMYA** | **MMMA** | **MMOA** | **LMYA** | **LMMA** | **LMOA** | **PCOA** |
| **EWYA** | | | | | | | .029 | .021 | | | | |
| **MMEA** | | | | | | | | .036 | | | | |
| **LMYA** | | | | | | | .047 | .034 | | | | |
| **PCY** | | .006 | .003 | .004 | | .026 | .000 | .000 | | .016 | .006 | |
| **PCMA** | | .003 | .002 | .002 | | .013 | .000 | .000 | .037 | .008 | .003 | |
| **PCOA** | | | .045 | .031 | | | .027 | .021 | | | | |
| **PCA** | | .001 | .001 | .001 | | .008 | .000 | .000 | .027 | .005 | .001 | |

**Table 212:** (continued)

| R Vast Lateralis | EMY | EMYA | EMMA | EM OA | MMY | MM YA | MMMA | MMOA | LMYA | LMMA | LMOA | PCOA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PCY** | .047 | .007 | .002 | .024 | | .024 | .001 | .001 | .023 | .018 | .018 | |
| **PCMA** | | .010 | .002 | .039 | | .040 | .001 | .001 | .039 | .029 | .029 | |
| **PCA** | .024 | .002 | .000 | .014 | | .007 | .000 | .000 | .007 | .006 | .006 | |
| **R Obt Externus** | **EMY** | **EMYA** | **EMMA** | **EM OA** | **MMY** | **MM YA** | **MMMA** | **MMOA** | **LMYA** | **LMMA** | **LMOA** | **PCOA** |
| **EMAd** | | | .038 | | | .044 | | .038 | .041 | | .024 | .006 |
| **MMMA** | | | | | | | | | | | | .034 |
| **PCMA** | .029 | .008 | .001 | | .029 | .001 | .008 | .001 | .001 | .014 | .001 | .001 |
| **PCA** | .039 | .014 | .002 | | .039 | .002 | .016 | .002 | .002 | .021 | .003 | .001 |

**Table 213:** Post-hoc p-values, femur MSMs, time period/age/sex - part 3

| L Obt Internus | EMY | EM EA | EM YA | EM MA | EM OA | MM Y | MM YA | MM MA | MM OA | LM YA | LM MA | LM OA | PC OA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EMAd | | | | .025 | | | .024 | .040 | .035 | .035 | | .018 | |
| PCMA | | | .010 | .002 | .032 | | .001 | .001 | .001 | .001 | .017 | .001 | |
| PCA | | | .010 | .002 | .032 | | .001 | .001 | .001 | .001 | .017 | .001 | |
| **R Obt Internus** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| EMAd | | | | .028 | | | .033 | | | .031 | | .018 | .004 |
| MMMA | | | | | | | | | | | | | .049 |
| PCMA | .022 | | .005 | .001 | | .022 | .000 | .001 | .009 | .000 | .009 | .001 | .000 |
| PCA | .029 | | .009 | .001 | | .029 | .001 | .004 | .015 | .001 | .015 | .001 | .000 |
| **L Quad Femoris** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| EMAd | | | | .012 | .031 | | | | .039 | | | | |
| MMEA | | | | .029 | | | | | | | | | |
| LMYA | | | | .031 | | | | | | | | | |
| PCY | | | | .051 | | | | | | | | | |
| PCMA | .022 | | .005 | .000 | .004 | | .013 | .007 | .001 | .053 | .009 | .022 | |
| PCA | .022 | | .005 | .000 | .004 | | .013 | .007 | .001 | .053 | .009 | .022 | |
| **L Popliteus** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| EMAd | | | | .058 | | | | | .022 | .043 | | .020 | |
| MMEA | | | .044 | .044 | | | | | .007 | .020 | .044 | .018 | |
| MMYA | | | | | | | | | .015 | .047 | | .036 | |
| PCMA | | | .044 | .044 | | | | | .007 | .020 | .044 | .018 | |
| PCA | | | .007 | .007 | | | | .020 | .000 | .002 | .007 | .004 | |
| **R Popliteus** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| EMAd | | | .038 | .035 | | | | | .038 | .038 | .022 | .009 | |
| MMEA | | | | | | | | | | | | .026 | |
| MMYA | | | | | | | | | | | .049 | .021 | |
| PCMA | | | .008 | .008 | | | | .022 | .008 | .008 | .007 | .004 | |
| PCA | .036 | | .002 | .002 | | | | .005 | .002 | .002 | .002 | .001 | |
| **L Gast** | **EMY** | **EM EA** | **EM YA** | **EM MA** | **EM OA** | **MM Y** | **MM YA** | **MM MA** | **MM OA** | **LM YA** | **LM MA** | **LM OA** | **PC OA** |
| EMAd | | | | .015 | .045 | | .052 | | | .043 | | .014 | |
| LMMA | | | | .039 | | | | | | | | .046 | |
| MMMA | | | | .026 | | | | | | | | .042 | |
| PCY | | | | .015 | .045 | | .052 | | | .043 | | .014 | |
| PCMA | | | | .001 | .017 | | .011 | | .013 | .007 | | .006 | |
| PCA | .045 | | | .000 | .010 | | .004 | | .004 | .002 | | .003 | .045 |

**Table 213:** (continued)

| R Gast | EMY | EM EA | EM YA | EM MA | EM OA | MM Y | MM YA | MM MA | MM OA | LM YA | LM MA | LM OA | PC OA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EMAd** | .042 | | | .015 | | | | | | .047 | .042 | | |
| **MMEA** | | | | .037 | | | | | | | | | |
| **MMMA** | | | | .027 | | | | | | | | | |
| **PCY** | .042 | | | .015 | | | | | | .047 | .042 | | |
| **PCMA** | .009 | .044 | .049 | .000 | .044 | | .007 | | .015 | .004 | .009 | .044 | .044 |
| **PCA** | .009 | .044 | .049 | .000 | .044 | | .007 | | .015 | .004 | .009 | .044 | .044 |

**Table 214:** Post-hoc -values, femur MSMs, time period/age/sex - part 4

| L Iliacus | EMY | EMEA | EMYA | EMMA | EM OA | MMMA | MMOA | LMYA | LMMA | LMOA |
|---|---|---|---|---|---|---|---|---|---|---|
| **EMAd** | .049 | | | | | | | | | |
| **MMY** | .049 | | | | | | | | | |
| **MMEA** | .016 | | | .026 | | | | .045 | | |
| **LMY** | .049 | | | | | | | | | |
| **PCY** | .023 | | | .050 | | | | | | |
| **PCMA** | .004 | .052 | .032 | .003 | .013 | .01 | .004 | .006 | | .014 |
| **PCA** | .004 | .052 | .032 | .003 | .013 | .011 | .004 | .006 | | .014 |
| **L Pectineus** | **EMY** | **EMEA** | **EMYA** | **EMMA** | **EM OA** | **MMMA** | **MMOA** | **LMYA** | **LMMA** | **LMOA** |
| **MMEA** | | | | | .025 | | | | | |
| **MMYA** | | | | .024 | .015 | .055 | .021 | .047 | | |
| **PCY** | | | | .031 | .012 | | .028 | .041 | .046 | |
| **PCMA** | | | | .024 | .010 | .041 | .019 | .033 | .041 | |
| **PCA** | | | | .014 | .006 | .020 | .007 | .019 | .029 | |

**Table 215:** Significant results from post-hoc tests, femur MSMs, time period/age/sex - part 1

| MSM | Time/Age/Sex | <Time/Age/Sex |
|---|---|---|
| **L Gluteus Maximus** | MMYF | EWYAM, EMYAF, EMMAF, EMMAM, MMMAM, MMOAM, LMAF, LMYAM, LMAM |
| | MMEAF | EWYAM, EMMAF, MMMAM, MMOAM, LMAF, LMYAM, LMAM |
| | MMYAF | MMMAM, MMOAM |
| | PCYF | EWYAM, EMYAF, EMMAF, EMMAM, MMMAM, MMOAM< LMAF, LMYAM, LMAM |
| | PCMAF | EWYAM, EMYAF, EMMAF, EMMAM, MMMAM, MMOAM, LMAF, LMYAM, LMAM |
| | PCAF | EWYAM, EWMAM, EMYF, EMEAF, EMYAF, EMMAF, EMOAF, EMAF, EMMAM, EMOAM, EMAM, MMMAF, MMOAF, MMYAM, MMMAM, MMOAM, LMYAF, LMOAF, LMAF, LMEAM, LMYAM, LMMAM, LMAM |
| | PCMAM | EWYAM, EWMAM, EMYF, EMEAF, EMYAF, EMMAF, EMOAF, EMAF, EMMAM, EMOAM, EMAM, MMMAM, MMOAM, LMYAF, LMAF, LMEAM, LMYAM, LMMAM, LMAM |
| | PCAU | EMMAF, MMMAM, MMOAM, LMYAM |
| **L Vastus Intermedius** | | |
| | EMYF | EMMAF, EMAF, MMOAF, MMMAM, MMOAM, LMAF, LMOAM |
| | EMYAF | EMMAF, MMMAM, LMAF, |
| | MMEAF | EMMAF, MMOAF, MMMAM, MMOAM, |
| | MMYAF | EMMAF, EMAF, MMOAF, MMMAM, MMOAM, LMOAF, LMAF, LMOAM |
| | MMMAF | EMMAF, MMMAM, LMAF, |
| | MMYAM | EMMAF, MMMAM, LMAF |
| | PCYF | EMMAF, EMAF, MMOAF, MMMAM, MMOAM, LMOAF, LMAF, LMOAM |
| | PCMAF | EMMAF, EMAF, MMOAF, MMMAM, MMOAM, LMOAF, LMAF, LMOAM, |
| | PCAF | EMYAF, EMMAF, EMAF, EMMAM, EMAM, MMMAF, MMOAF, MMYAM, MMMAM, MMOAM, LMYAF, LMMAF, LMOAF, LMAF, LMMAM, LMOAM, |
| | PCMAM | EMYAF, EMMAF, EMAF, EMMAM, EMAM, MMOAF, MMMAM, MMOAM, LMYAF, LMMAF, LMOAF, LMAF, LMMAM, LMOAM |

**Table 216**: Significant results from post-hoc tests, femur MSMs, time period/age/sex - part 2

| MSM | Time/Age/Sex | <Time/Age/Sex |
|---|---|---|
| **R Vastus Intermedius** | | |
| | EMYAF | EMMAF, EMMAM, LMYAF |
| | MMEAF | EMMAF, EMMAM, MMOAF, MMMAM, LMYAF, LMMAM, LMOAM, PCOAF |
| | MMYAF | EMMAF, EMMAM, MMOAF, MMMAM, LMYAF LMMAM, LMOAM, PCOAF |
| | PCYF | EMMAF, EMMAM, MMOAF, MMMAM, LMYAF, LMMAM, LMOAM, PCOAF |
| | PCMAF | EMMAF, EMMAM, EMAM, MMOAF, MMMAM, MMOAM, LMYAF, LMMAF, LMOAF, LMMAM, LMOAM, PCOAF |
| | PCAF | EMYAF, EMMAF, EMMAM, EMAM, MMMAF, MMOAF, MMMAM, MMOAM, LMYAF, LMMAF, LMOAF, LMMAM, LMOAM, PCOAF, |
| | PCMAM | EMMAF, EMAF, EMMAM, MMMAF, MMOAF, MMMAM, MMOAM, LMYAF, LMMAM, LMOAM, PCOAF, |
| **L Vastus Lateralis** | | |
| | PCYF | EMYAF, EMOAF, EMAF, EMMAM, EMOAM, EMAM, MMMAF, MMOAF, MMYAM, MMOAM, LMOAF, LMOAM, |
| | PCMAF | MMMAF, MMOAF, MMMAM, MMOAM, |
| | PCOAF | EMMAM, MMMAF, MMOAF, MMMAM, MMOAM |
| | PCAF | EMYAF, EMMAF, EMOAF, EMAF, EMMAM, EMOAM, EMAM, MMMAF, MMOAF, MMYAM, MMMAM, MMOAM, LMYAF, LMMAF, LMOAF, LMAF, LMMAM, LMOAM, |
| | PCMAM | EMYAF, EMMAF, EMOAF, EMAF, EMMAM, EMOAM, EMAM, MMMAF, MMOAF MMYAM, MMMAM, MMOAM LMYAF, LMMAF, LMOAF, LMAF, LMMAM, LMOAM, |

### B.1.8 The Tibia

**Table 217**: Post-hoc p-values, tibia MSMs, time period

| **L Soleus** | **EW** | **EM** | **MM** | **LM** |
|---|---|---|---|---|
| **EW** | | | .027 | |
| **LM** | | .000 | .000 | |
| **PC** | | .001 | .000 | |
| **R Soleus** | **EW** | **EM** | **MM** | **LM** |
| **MM** | .020 | .000 | | |
| **LM** | .020 | .000 | | |
| **PC** | .004 | .000 | | |
| **L Popliteus** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .003 | .010 | .006 |
| **R Popliteus** | **EW** | **EM** | **MM** | **LM** |
| **MM** | | .010 | | .050 |
| **PC** | | .001 | | .005 |
| **L Semimembranosus** | **EW** | **EM** | **MM** | **LM** |
| **EM** | | | | .016 |
| **MM** | | | | .001 |
| **R Semimembranosus** | **EW** | **EM** | **MM** | **LM** |
| **EM** | | | .001 | .002 |
| **PC** | | | .005 | .008 |
| **R Tibialis Posterior** | **EW** | **EM** | **MM** | **LM** |
| **PC** | .007 | .005 | .000 | .000 |
| **L Tibialis Anterior** | **EW** | **EM** | **MM** | **LM** |
| **PC** | | .005 | .001 | .000 |
| **R Tibialis Anterior** | **EW** | **EM** | **MM** | **LM** |
| **EM** | | | .015 | .045 |
| **PC** | .015 | .025 | .000 | .000 |

**Table 218:** Post-hoc p-values, tibia MSMs, time period/sex - part 1

| L Soleus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **LMF** | | | .013 | .010 | .003 | .000 | | |
| **LMM** | | | .030 | .019 | .013 | .000 | | |
| **PCF** | .024 | | | .040 | .038 | .002 | | |
| **PCM** | | | .007 | .005 | .003 | .000 | | |
| **R Soleus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **MMF** | .006 | | .001 | .009 | | | | |
| **MMM** | .013 | | .002 | .023 | | | | |
| **LMM** | .016 | | .007 | .031 | | | | |
| **PCF** | .007 | | .002 | .013 | | | | |
| **PCM** | .001 | | .000 | .002 | | | | |
| **PCU** | | | | | | | | |
| **L Popliteus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .019 | .015 | | .021 | .035 | .042 |
| **MMS** | | | .019 | .015 | | .021 | .035 | .042 |
| **PCF** | | | .010 | .009 | | .010 | .028 | .042 |
| **PCM** | | | .010 | .009 | | .010 | .028 | .042 |
| **R Popliteus** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMS** | | | .039 | .016 | | | | |
| **MMF** | | | .033 | .009 | | | | |
| **MMM** | | | | .025 | | | | |
| **PCF** | | | .005 | .001 | | | .014 | .026 |
| **PCM** | | | .024 | .007 | | | .049 | |

**Table 219:** Post-hoc p-values, tibia MSMs, time period/sex - part 2

| R Semimembranosus | EWF | EWM | EMF | EMM | MMF | MMM | LMF | LMM |
|---|---|---|---|---|---|---|---|---|
| **EMF** | | | | | | | | .014 |
| **EMM** | | | | | .030 | .007 | .054 | .002 |
| **EMS** | | | | | .035 | .017 | .047 | .005 |
| **PCF** | | | | | .045 | .011 | | .001 |
| **PCM** | | | | | | | | .014 |
| **R Tibialis Posterior** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMF** | | | | | | | | .009 |
| **EMM** | | | | | | | | .007 |
| **MMM** | | | | | | | | .009 |
| **LMF** | | | | | | | | .020 |
| **PCF** | .004 | | .006 | | .002 | .002 | .002 | .000 |
| **PCM** | .011 | | .025 | | .013 | .013 | .011 | .000 |
| **L Tibialis Anterior** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EWF** | | | | | | | | .023 |
| **EMF** | | | | | | | | .014 |
| **MMF** | | | | | | | | .014 |
| **MMM** | | | | | | | | .017 |
| **LMF** | | | | | | | | .017 |
| **PCF** | | | .036 | .028 | .006 | .018 | .018 | .000 |
| **PCM** | | | .036 | .028 | .006 | .018 | .018 | .000 |
| **R Tibialis Anterior** | **EWF** | **EWM** | **EMF** | **EMM** | **MMF** | **MMM** | **LMF** | **LMM** |
| **EMF** | | | | | | | | .007 |
| **EMM** | | | | | | | | .017 |
| **LMF** | | | | | | | | .038 |
| **PCF** | .015 | | .053 | | .001 | .001 | .009 | .000 |
| **PCM** | .030 | | | | .006 | .004 | .032 | .000 |

**Table 220:** Post hoc p-values, tibia MSMs, time period/age

| **L Soleus** | **EMY** | **EMYA** | **EMMA** | **EMOA** | **MMYA** | **MMMA** | **MMOA** | **LMYA** | **LMMA** |
|---|---|---|---|---|---|---|---|---|---|
| **EMAd** | | | | | | | | | |
| **MMY** | | | | | | | | | |
| **MMEA** | | | | | | | | | |
| **LMY** | | | | | | | | | |
| **PCY** | | | | | | | | | |
| **PCMA** | .013 | .018 | .012 | | .033 | .000 | .001 | | |
| **PCA** | | | | | | | | | |
| **R Soleus** | **EMY** | **EMYA** | **EMMA** | **EMOA** | **MMYA** | **MMMA** | **MMOA** | **LMYA** | **LMMA** |
| **MMEA** | | | | .025 | | | | | |
| **MMYA** | | | .024 | .015 | | .055 | .021 | .047 | |
| **PCY** | | | .031 | .012 | | | .028 | .041 | .046 |
| **PCMA** | | | .024 | .010 | | .041 | .019 | .033 | .041 |
| **PCA** | | | .014 | .006 | | .020 | .007 | .019 | .029 |

# APPENDIX C: MORTUARY STATISTICS

## C.1 GRAVE ATTRIBUTES: CHI2 TEST OF HOMOGENEITY

Chi-square (Chi-2) tests of homogeneity were performed to assess differences across groups in Time Period, Time/Period/Sex, and Time Period/Age, for the nominal variables burial location, head orientation, leg flexure, body position, and treatment of the body. Comparisons for Time Period/Age/Sex were not possible due to small sample sizes.

### C.1.1 Time Period

Grave attribute variables were compared by time period using Chi-2 tests of homogeneity. See Tables 221-226 for results.

**Table 221:** P-values of Chi-2 tests of grave attributes by time period

| Variable | Chi-2 P-Value |
|---|---|
| Burial Location | .000 |
| Head Orientation | .000 |
| Leg Flexure | .000 |
| Body Position | .000 |
| Treatment of the Body | .000 |

**Table 222:** Significant differences between time periods and body location

| Body Location | Group 1 > | Groups |
|---|---|---|
| Mound | EW | EM, MM, LM, PC |
| Household | EM | EW, PC |
| | MM | EW |
| | LM | EW |
| Burial Structure | LM | EW, EM, MM, PC |
| Cemetery | PC | EW, EM, MM, LM |
| Other | None | |
| Unknown | MM | EW, EM, LM |

**Table 223:** Significant differences between time periods and head orientation

| Head Orientation | Group 1 > | Groups |
|---|---|---|
| North | None | |
| South | PC | MM, LM |
| East | EM, MM | EW, LM |
| | PC | EW |
| West | None | |
| Northeast | None | |
| Northwest | None | |
| Southeast | PC | MM |
| Southwest | EW | MM |
| Unknown | EW | EM, LM |
| | MM | EM, LM, PC |
| | LM | EM, PC |

**Table 224:** Significant differences between time periods and leg flexure

| Leg Flexure | Group 1 > | Groups |
|---|---|---|
| Straight | PC | EW, EM, MM, LM |
| Legs Bent Right | LM | EW, EM, MM, PC |
| Legs Bent Left | LM | EW, EM, MM, PC |
| Other | None | |
| Tightly Flexed <90 degrees | EM | EW, LM, PC |
| | LM | PC |
| Loosely Flexed >90 degrees | EM | EW, PC |
| Unknown | EW | EM, PC |
| | MM | EM, PC |

**Table 225**: Significant differences between time periods and body position

| Body Position | Group 1 > | Groups |
|---|---|---|
| Left Side | EM | EW, MM, PC |
| | LM | EW, PC |
| Right Side | EM | EW, PC |
| | MM | EW, PC |
| Supine | PC | EW, EM, MM, LM |
| Prone | None | |
| Other | LM | EW, MM, PC |
| Unknown | EW, MM | EM, PC |

**Table 226**: Significant differences between time periods and treatment of body

| Treatment of Body | Group 1 > | Groups |
|---|---|---|
| Single, Primary Inhumation | EW | LM |
| | EM | EW |
| | MM | EW, LM, PC |
| | PC | EW, LM |
| Single, Secondary Inhumation | LM | EW, EM, MM, PC |
| Multiple, Primary Inhumation | EW | EM, MM, LM, PC |
| Multiple, Secondary Inhumation | EW | EM, MM, LM, PC |
| Cremation | None | |
| Other | None | |
| Unknown | None | |

### C.1.2 Time Period/Sex

Chi2 tests of homogeneity were carried out to determine significant differences in grave attributes between groups in Time Period/Sex. Results are listed in Tables 227-232.

**Table 227:** P-values Chi-2 grave attributes by time period/sex

| Variable | Chi-2 P-Value |
|---|---|
| Burial Location (EW v. EM) | .000 |
| Head Orientation (EW v EM) | .010 |
| Leg Flexure (EW v EM) | .000 |
| Body Position (EW v EM) | .000 |
| Treatment of the Body (EW v. EM) | .006 |
| Burial Location (EW v MM) | .000 |
| Head Orientation (EW v MM) | .001 |
| Leg Flexure (EW v MM) | .186 |
| Body Position (EW v MM) | .036 |
| Treatment of Body (EW v MM) | .000 |
| Burial Location (EW v LM) | .000 |
| Head Orientation (EW v LM) | .056 |
| Leg Flexure (EW v LM) | .000 |
| Body Position (EW v LM) | .000 |
| Treatment of Body (EW v LM) | .008 |
| Burial Location (EW v PC) | .000 |
| Head Orientation (EW v PC) | .004 |
| Leg Flexure (EW v PC) | .000 |
| Body Position (EW v PC) | .000 |
| Treatment of Body (EW v PC) | .000 |
| Burial Location (EM v MM) | .017 |
| Head Orientation (EM v MM) | .177 |
| Leg Flexure (EM v MM) | .001 |
| Body Position (EM v MM) | .001 |
| Treatment of Body (EM v MM) | .470 |
| Burial Location (EM v LM) | .000 |
| Head Orientation (EM v LM) | .027 |
| Leg Flexure (EM v LM) | .000 |
| Body Position (EM v LM) | .000 |
| Treatment of Body (EM v LM) | .225 |
| Burial Location (EM v PC) | .000 |
| Head Orientation (EM v PC) | .224 |
| Leg Flexure (EM v PC) | .000 |
| Body Position (EM v PC) | .000 |
| Treatment of Body (EM v PC) | .643 |
| Burial Location (MM v LM) | .000 |
| Head Orientation (MM v LM) | .036 |
| Leg Flexure (MM v LM) | .000 |
| Body Position (MM v LM) | .001 |
| Treatment of Body (MM v LM) | .006 |
| Burial Location (MM v PC) | .000 |
| Head Orientation (MM v PC) | .003 |
| Leg Flexure (MM v PC) | .000 |
| Body Position (MM v PC) | .000 |
| Treatment of Body (MM v PC | .727 |
| Burial Location (LM v PC) | .000 |
| Head Orientation (LM v PC) | .008 |

**Table 227:** (continued)

| Variable | Chi-2 P-Value |
|---|---|
| Leg Flexure (LM v PC) | .000 |
| Body Position (LM v PC) | .000 |
| Treatment of Body (LM v PC) | .015 |

**Table 228:** Significant differences between time period/sex for burial location

| Body Location | Group 1 > | Groups |
|---|---|---|
| Mound | EWF, EWM, EWS, EWU | EMF, EMM, EMS, EMU, MMF, MMM, MMS, MMU, LMF, LMM, LMS, LMU, PCF, PCM, PCS, PCU |
| | LMS | LMF, MMF, MMM, MMU |
| House | EMS | EWU |
| | MMS | EWU |
| | LMS | EWF, EWU, LMF, PCF, PCS, PCU |
| | LMU | EWU |
| Burial Structure | LMF, LMM | EWU, EMS, PCF, PCS, PCU |
| | LMM | MMF, MMM, MMU |
| Village | EMF, EMM, EMS, EMU | EWF, EWM, EWS, EWU, PCF, PCM, PCS, PCU |
| | EMF | MMS |
| | MMF | EWF, EWM, EWS, EWU, MMS, LMS, PCF, PCM, PCS, PCU |
| | MMM | MMS, PCF, PCS, PCU |
| | MMS | PCF, PCS, PCU |
| | MMU | PCF, PCS, PCU |
| | MMM, MMU | EWF, EWM, EWS, EWU |
| | LMF | PCF, PCS, PCU |
| | LMF, LMM, LMU | EWU |
| Cemetery | PCF, PCM, PCS, PCU | EWF, EWM, EWS, EWU, EMF, EMM, EMS, EMU, MMF, MMM, MMS, MMU, LMF, LMM, LMS, LMU |
| Other | None | |
| Unknown | MMM, MMS, MMU | EWU |

**Table 229:** Significant differences by time period/sex for head orientation

| Head Orientation | Group 1 > | Groups |
|---|---|---|
| North | None | |
| South | EWM | EWU |
| East | EMS | EWF, EWU, LMF, LMS |
| | MMS | EWU, LMF |
| West | None | |
| Northeast | None | |
| Northwest | None | |
| Southeast | PCM | MMS |
| Southwest | None | |
| Unknown | EWU | LMF, LMM, LMS |
| | EWF, EWS, PCU | PCS |
| | LMM | PCS |
| | LMF, LMS | EMF, EMM, EMS, PCF, PCM, PCS |
| | MMM, MMU, PCU | PCS |

**Table 230:** Significant differences by time period/sex for leg flexure

| Leg Flexure | Group 1 > | Groups |
|---|---|---|
| Straight | EWU | PCF |
| | PCF, PCM, PCS | EMF, EMU |
| | PCF | EMM |
| | PCS | EWF, EWM, EWS, EWU, EMM, EMS, MMF, MMM, MMS, MMU, LMF, LMM, LMS, LMU, PCU |
| Legs Bent Right | LMF, LMM, LMU | EWU |
| Legs Bent Left | LMS | EWU, EMS, , MMF, MMM, MMS, MMU, LMF, PCF, PCM, PMS, PCU |
| Other | None | |
| Tightly Flexed <90 degrees | EWU | EMF, EMM |
| | EMM | LMF, LMS, PCF, PCS, PCU |
| Loosely Flexed >90 degrees | EMF | EWU |
| Unknown | EWF, EWS, EWU | EMS |
| | MMU | EMS, PCS |
| | LMF, LMM | PCS |
| | PCU | PCS |

**Table 231:** Significant difference by time period/sex for body position

| Body Position | Group 1 > | Groups |
|---|---|---|
| Left Side | EMF | EWF, EWU, LMF |
| | EMF, EMM | PCF, PCS, PCU |
| | LMF | EWU |
| | LMS | MMM, MMS, PCF, PCS, PCU |
| Right Side | EMF | EWU |
| | MMF, MMM | EWU |
| Supine | EWU | PCF |
| | PCF | MMF, MMM, MMS, MMU |
| | PCS | EWF, EWM, EWS, EWU, LMF, LMM, LMS, LMU, PCU |
| | PCF, PCS | EMF, EMM, EMU |
| Prone | None | |
| Other | None | |
| Unknown | EWF, EWS, EWU | EMS |
| | EWU | PCF, PCS |
| | MMU | EMS, PCS |
| | LMF, LMM | PCS |
| | PCU | PCS |

**Table 232:** Significant differences by time period/sex for treatment of body

| Treatment of Body | Group 1 > | Groups |
|---|---|---|
| Single, Primary Inhumation | EWU | EMS, EMU, MMF, MMM, MMU, LMS, PCF, PCM, PCS, PCU |
| | EMS, EMU | EWF, EWM, EWS |
| | MMF, MMS | EWF, EWM, EWS, EWU |
| | MMM | EWF, EWM, EWS, LMF |
| | MMU | EWF |
| | LMS | EWF |
| | PCF, PCS, PCU | EWF, EWM, EWS |
| | PCS, PCU | LMF |
| Single, Secondary Inhumation | LMF | EWU, MMS |
| Multiple, Primary Inhumation | EWF | EMS |
| | PCF | MMF, MMM, MMS, MMU |
| Multiple, Secondary Inhumation | None | |
| Cremation | None | |
| Other | None | |
| Unknown | None | |

### C.1.3 Time Period/Age

Chi2 analysis of homogeneity was performed by Time Period/Sex for all grave attribute variables to examine differences in the number of individuals per group in each category of grave data. Significant differences and p-values are listed in Tables 233-238.

**Table 233:** P-values from Chi-2 tests by time period/age

| Variable | Chi-2 p-value |
|---|---|
| Burial Location (EW v EM) | .000 |
| Head Orientation (EW v EM) | .263 |
| Leg Flexure (EW v EM) | .005 |
| Body Position (EW v EM) | .005 |
| Treatment of Body | .396 |
| Burial Location (EW v MM) | .000 |
| Head Orientation (EW v MM) | .840 |
| Leg Flexure (EW v MM) | .293 |
| Body Position (EW v MM) | .012 |
| Treatment of Body (EW v MM) | .063 |
| Burial Location (EW v LM) | .000 |
| Head Orientation (EW v LM) | .995 |
| Leg Flexure (EW v LM) | .000 |
| Body Position (EW v LM) | .000 |
| Treatment of Body (EW v LM) | .192 |
| Burial Location (EW v PC) | .000 |
| Head Orientation (EW v PC) | .211 |
| Leg Flexure (EW v PC) | .007 |
| Body Position (EW v PC) | .000 |
| Treatment of Body (EW v PC) | .122 |
| Burial Location (EM v MM) | .006 |
| Head Orientation (EM v MM) | .000 |
| Leg Flexure (EM v MM) | .046 |
| Body Position (EM v MM) | .094 |
| Treatment of Body (EM v MM) | .294 |
| Burial Location (EM v LM) | .005 |
| Head Orientation (EM v LM) | .000 |
| Leg Flexure (EM v LM) | .000 |
| Body Position (EM v LM) | .003 |
| Treatment of Body (EM v LM) | .089 |
| Burial Location (EM v PC) | .000 |
| Head Orientation (EM v PC) | .000 |
| Leg Flexure (EM v PC) | .000 |
| Body Position (EM v PC) | .000 |
| Treatment of Body (EM v PC) | .753 |
| Burial Location (MM v LM) | .000 |

**Table 233:** (continued)

| | |
|---|---|
| Head Orientation (MM v LM) | .848 |
| Leg Flexure (MM v LM) | .000 |
| Burial Position (MM v LM) | .025 |
| Treatment of Body (MM v LM) | .004 |
| Burial Location (MM v PC) | .000 |
| Head Orientation (MM v PC) | .000 |
| Leg Flexure (MM v PC) | .000 |
| Body Position (MM v PC) | .022 |
| Treatment of Body (MM v PC) | .378 |
| Burial Location (LM v PC) | .000 |
| Head Orientation (LM v PC) | .000 |
| Leg Flexure (LM v PC) | .000 |
| Body Position (LM v PC) | .000 |
| Treatment of Body (LM v PC) | .003 |

**Table 234:** Significant differences by time period/age, burial location

| Body Location | Group 1 > | Groups |
|---|---|---|
| Mound | EWA, EWU | EMAd, EMA, EMEC, EMF, EMLC, EMMA, EMN, EMOA, EMS, EMT, EMYA, EMY, MMAd, MMA, MMEA, MMEC, MMF, MMLC, MMMA, MMN, MMOA, MMT, MMYA, MMY, LMAd, LMA, LMEA, LMEC, LMMA, LMN, LMOA, LMS, LMT, LMYA, LMY, PCAd, PCA, PCEC, PCLC, PCMA, PCOA, PCT, PCU, PYA, PCY |
| Household | EMEC, EMLC | EWA |
| | EMEC, MMAd | MMA |
| | EMLC | PCA |
| | MMAd, MMLC | EWA, EWU |
| | LMEC, LMN, LMS | EWA, EWU, PCA |
| | LMS | MMA, MMMA |
| Burial Structure | LMA, LMEA, LMEC, LMMA, LMOA, LMY | EWA, EWU |
| | LMEA, LMOA, LMY | MMA |
| Village | EMAd, EMA, EMEA, EMEC, EMF, EMMA, EMN, EMOA, EMS, EMT, EMYA, EMY | EWA, EWU, PCA |
| | MMA, MMEA, MMF, MMLC, MMMA, MMOA, MMYA, MMY | EWA, EWU |
| | LMAd, LMA, LMMA, LMT, LMYA | EWA, EWU, PCA |
| Cemetery | PCAd, PCA, PCLC, PCMA, PCOA, PCS, PCT, PCU, PCYA, PCY | EWA, EWU, EMA, MMAd, MMA, MMEA, MMEC< MMF, MMLC< MMMA, MMN, MMT, MMYA, MMY |
| | PCA, PCEC, PCMA, PCY | LMA, LMYA |
| | PCA | EWAd, EWA, EWEC, EWMA, EWOA, EWS, EWU, EWYA, EWY |
| Other | MMY | EWA, EWU |
| Unknown | MMT, MMY | EWA, EWU |
| | MMT | PCA |

**Table 235:** Significant differences by time period/sex, head orientation

| Head Orientation | Group 1 > | Groups |
|---|---|---|
| North | None | |
| South | None | |
| East | None | |
| West | None | |
| Northeast | PCOA | PCA |
| Northwest | PCOA | MMA, PCA |
| Southeast | EMEA | MMA |
| | PCYA | MMA |
| Southwest | None | |
| Unknown | None | |

**Table 236:** Significant differences by time period/sex, leg flexure

| Leg Flexure | Group 1 > | Groups |
|---|---|---|
| Straight | PCAd, PCEC, PCMA, PCY | EWU |
| | PCAd, PCEC | LMA |
| | PCAd, PCEC, PCLC, PCMA, PCT, PCYA, PCY | MMA, MMMA, MMOA |
| | EMN | MMA |
| Legs Bent Right | LMAd, LMMA, LMYA | EWA, EWU |
| | LMAd | PCA |
| Legs Bent Left | LMEC, LMN, LMS | EWA, EWU, PCA |
| | LMS | EMEA |
| Other | None | |
| Tightly Flexed <90 degrees | EMAd, EMEA, EMMA, EMOA, EMT, EMY, EWOA, EWYA | EWA |
| | EMAd, EMEA, EMMA, EMOA, EMY | PCA |
| | EWOA, EWYA | EWA, PCA |
| | MMAd | PCA |
| Loosely Flexed >90 degrees | EMYA, EMLC | EWA |
| Unknown | None | |

**Table 237:** Significant differences by time period/sex, body position

| Body Position | Group 1 > | Groups |
|---|---|---|
| Left Side | MMEA | EWA, EWU |
| | EWOA, LMN, LMS | EWA |
| | EWOA | EWA |
| | EWU, PCA | EWOA |
| | LMEC, LMN | PCA |
| Right Side | EMYA, EMOA | EWA, EWU |
| | MMAd, MMEA, MMY | EWA, EWU |
| Supine | PCAd, PCEC, PCMA, PCY | EWU, MMA, MMMA, MMOA |
| | PCAd, PCEC | LMA |
| Prone | None | |
| Other | EMAd | EWA, EWU |
| | LMAd, LMMA, LMYA | EWA, EWU |
| | LMAd | MMA, PCA |
| Unknown | None | |

**Table 238**: Significant differences by time period/sex, treatment of body

| Treatment of Body | Group 1 > | Groups |
|---|---|---|
| Single, Primary Inhumation | LMA, LMOA, LMY | PCA |
| Single, Secondary Inhumation | LMOA | PCA |
| Multiple, Primary Inhumation | LMY | PCA |
| Multiple, Secondary Inhumation | None | |
| Cremation | None | |
| Other | None | |
| Unknown | None | |

## C.2 ANOVA: GRAVE GOODS

Frequencies of different types of grave goods (stone, bone, lithics, ceramics, copper, wood, silver, brass, iron, cloth, total number, metal beads, shell beads, bone beads, and glass beads) were compared across Time Period, Time Period/Sex, Time Period/Age, and Time Period/Age/Sex. One-way ANOVA was utilized to determine if observed differences in grave good frequency were significant. Tukey post-hoc procedures were utilized to determine specific relationships between data groups. Significant differences and associated p-values are listed in Tables 239-260.

**Table 239:** Significant variables by time period, grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .001 | EM | EW (.001), MM (.002), LM (.005), PC (.027) |
| Lithics | .010 | EW | EM (.001), MM (.039), LM (.000) |
| Ceramics | .009 | EM | EW (.005), PC (.027) |
| Wood | .003 | PC | EW (.004), EM (.024), MM (.009), LM (.034) |
| Silver | .000 | PC | EW (.001), EM (.006), MM (.002), LM (.003) |
| Brass | .001 | PC | EW (.002), EM (.012), MM (.004), LM (.018) |
| Iron | .000 | PC | EW (.000), EM (.000), MM (.000), LM (.000) |
| Cloth | .000 | PC | EW (.000), EM (.000), MM (.000), LM (.001) |
| TI | .045 | PC | EW (.000) |
| GB | .000 | PC | EW (.000), EM (.000), MM (.000), LM (.000) |

**Table 240**: Significant variables by time period/sex, grave goods

| | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Stone | .032 | MMU | EWF (.019), EWS (.011), EMF (.038), MMF (.004), MMS (.007), LMF (.005), LMS (.009), PCF (.009), PCS (.004), PCU (.004) |
| Bone | .000 | EMM | EWM (.000), EWF (.000), EWU (.000), EMF (.009), EMS (.000), EMU (.000), MMM (.000), MMF (.000), MMS (.000), MMU (.000), LMM (.000), LMF (.000), LMS (.000), LMU (.011), PCM (.000), PCF (.000), PCS (.000), PCU (.000) |
| Lithics | .028 | PCM | EWF (.054), EMM (.043), EMF (.038), EMS (.013), EMU (.043), MMM (.012), MMF (.012), MMS (.047), LMM (.040), LMF (.014), LMS (.018), PCU (.033) |
| Ceramics | .005 | EMM | EWM (.004), EWF (.002), EWU (.004), EMM (.000), EMF (.013), EMU (.012), MMM (.001), MMF (.001), MMS (.000), LMM (.046), LMF (.003), LMS (.050), PCF (.001), PCS (.001), PCU (.001) |
| Wood | .000 | PCS | EWM (.004), EWF (.002), EWS (.004), EWU (.000), EMM (.007), EMF (.002), EMS (.000), EMU (.007), MMM (.000), MMF (.000), MMS (.000), MMU (.002), LMM (.004), LMF (.000), LMS (.001), PCF (.000), PCU (.000) |
| Silver | .000 | PCF | EWM (.000), EWF (.000), EWS (.000), EWU (.000), EMM (.000), EMF (.000), EMS (.000), EMU (.000), MMM (.000), MMF (.000), MMS (.000), MMU (.000), LMM (.000), LMF (.000), LMS (.000), PCU (.000) |
| Brass | .001 | PCS | EWM (.007), EWF (.003). EWS (.007), EWU (.000), EMM (.012), EMF (.004), EMS (.000), EMU (.012), MMM (.000), MMF (.000), MMS (.000), MMU (.003), LMM (.007), LMF (.001), PCF (.001), PCU (.001) |

**Table 240:** (continued)

| | P-Value | Group> | Group (p-value) |
|---|---|---|---|
| Iron | .000 | PCM | EWM (.000), EWF (.000), EWS (.000), EWU (.000), EMM (.000), EMF (.000), EMS (.000), EMU (.000), MMM (.000), MMF (.000), MMS (.000), MMU (.000), LMM (.000), LMF (.000), LMS (.000), LMU (.011), PCF (.042), PCU (.030) |
| Cloth | .000 | PCF | EWM (.001), EWF (.000), EWS (.001), EWU (.000), EMM (.002), EMF (.001), EMS (.000), EMU (.002), MMM (.000), MMF (.000), MMS (.000), MMU (.000), LMM (.001), LMF (.000), LMS (.000), PCS (.037), PCU (.000) |
| Total | .012 | EMM | EWU (.027), MMF (.039), LMF (.044) |
| Glass Beads | .000 | PCM | EWM (.000), EWF (.000), EWS (.000), EWU (.000), EMM (.000), EMF (.000), EMS (.000), EMU (.000), MMM (.000), MMF (.000), MMS (.000), MMU (.000), LMM (.000), LMF (.000), LMS (.000), LMU (.000) PCS (.000), PCU (.000) |
| | | PCF | EWM (.039), EWF (.019), EWS (.039), EWU (.000), EMM (.057), EMF (.027), EMS (.002), EMU (.057), MMM (.004), MMF (.004), MMS (.001), MMU (.019), LMM (.039), LMF (.006), LMS (.010), PCM (.000), PCU (.024) |

**Table 241:** Significant variables by time period/age (EW v EM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .001 | EMYA | EWEC (.005), EWY (.016), EWYA (.023), EWA (.000), EMN (.007), EMT (.041), EMEC (.007), EMAd (.016), EMY (.003), EMA (.000) |
| Shell | .000 | EMMA | EWEC (.000), EWY (.001), EWYA (.000), EWA (.000), EMN (.000), EMT (.021), EMEC (.000), EMLC (.008), EMAd (.001), EMY (.004), EMYA (.001), EMOA (.008), EMA (.000) |
| Total | .008 | EMMA | EWA (.001), EMA (.000) |
| Bone Beads | .002 | | EWEC (.001), EWAd (.028), EWY (.005). EWYA (.001), EWA (.000), EMN (.001). EMT (.028), EMEC (.028), EMLC (.028), EMAd (.013), EMYA (.001), EMOA (.028), EMA (.000) |

**Table 242:** Significant variables by time period/age (EW v MM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Ceramics | .018 | MMA | EWA (.000), MMEC (.038), MMOA (.011) |
| Metal Beads | .013 | EWYA | EWEC (.005), EWAd (.043), EWY (.009), EWA (.000), MMEC (.000), MMLC (.003), MMAd (.003), MMY (.015), MMEA (.009), MMYA (.000), MMMA (.000), MMOA (.000), MMA (.000) |
| Shell Beads | .011 | EWYA | EWEC (.006), EWY (.017), EWA (.000), MMEC (.001), MMLC (.006), MMAd (.014), MMEA (.017), MMYA (.000), MMMA (.000), MMOA (.000), MMA (.000) |
| BB (EW v MM) | .007 | MMAd | EWEC (.039), EWYA (.039), EWA (.000), MMEC (.009), MMLC (.039), MMYA (.004), MMMA (.001), MMOA (.002), MMA (.001) |

**Table 243:** Significant variables by time period/age (EW v LM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Ceramics | .000 | LMEC | EWEC (.000), EWAd (.005), EWY (.001), EWYA (.000), EWA (.000), LMN (.000), LMYA (.001), LMMA (.000), LMOA (009), LMA (.000), LMS (.005) |
| Total | .033 | LMEC | EWEC (.004), EWY (.010), EWYA (.017), EWA (.000), LMN (.004), LMYA (.003), LMMA (.002), LMOA (.053), LMA (.001), LMS (.037) |
| Metal Beads | .032 | EWYA | EWEC (.019), EWY (.026), EWA (.000), LMN (.000), LMT (.010), LMEC (.026), LMYA (.002), LMMA (.005), LMOA (.005), LMA (.001) |
| Shell Beads | .038 | EWYA | EWEC (.014), EWY (.032), EWA (.000), LMN (.013), LMT (.013), LMEC (.032), LMYA (.002), LMMA (.006), LMOA (.006), LMA (.001) |
| Bone Beads | .040 | LMYA | EWA (.000), LMMA (.041), LMOA (.041), LMA (.005) |

**Table 244:** Significant variables by time period/age (EW v PC), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .000 | PCAd | EWEC (.000), EWAd (.042), EWY (.002), EWYA (.035), EWA (.000), PCT (.002), PCEC (.000), PCLC (.011), PCY (.000), PCMA (.000), PCA (.000) |
| Wood | .000 | PCEC | EWEC (.000), EWAd (.000), EWY (.000), EWYA (.000), EWA (.000), PCT (.000), PCLC (.000), PCAd (.000), PCY (.000) PCMA (.000), PCA (.000) |
| Brass | .000 | PCEC | EWEC (.006), EWY (.017), EWYA (.006), EWA (.000), PCT (.017), PCY (.001), PCMA (.001), PCA (.000) |
| Iron | .000 | PCY | EWA (.000) |
| | | PCA | EWA (.005) |
| Total | .000 | PCMA | EWEC (.035), EWA (.001), PCA (.000) |
| Metal Beads | .008 | EWYA | EWEC (.008), EWAd (.045), EWY (.011), EWA (.000), PCT (.011), PCEC (.004), PCLC (.045), PCAd (.002), PCY (.001), PCMA (.000), PCA (.000) |
| Shell Beads | .041 | EWYA | EWA (.004), PCA (.005) |
| Glass Beads | .000 | PCMA | EWEC (.007), EWY (.024), EWYA (.007), EWA (.000), PCT (.024), PCAd (.012), PCA (.000) |

**Table 245:** Significant variables by time period/age (EM v MM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .000 | EMYA | EMY (.040), EMA (.002), MMN (.004), MMLC (.015), MMYA (.006), MMMA (.004), MMOA (.004), MMA (.004) |
| Metal Beads | .000 | MMY | EMF (.000), EMN (.006), EMT (.006), EMEC (.000), EMLC (.006), EMAd (.001), EMY (.000), EMYA (.000), EMMA (.000), EMOA (.006), EMA (.000), MMN (.000), MMT (.006), MMEC (.000), MMLC (.000), MMAd (.001), MMEA (.001), MMYA (.000), MMMA (.000), MMOA (.000), MMA (.000) |
| Shell Beads | .000 | MMY | EMF (.000), EMN (.004), EMT (.006), EMLC (.004), EMAd (.001), EMY (.000), EMYA (.000), EMMA (.000), EMOA (.004), EMA (.000), MMN (.000), MMT (.000), MMEC (.002), MMLC (.000), MMAd (.001), MMEA (.0010), MMYA (.000), MMMA (.000), MMOA (.000), MMA (.000 |

**Table 246:** Significant variables by time period/age (EM v LM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Lithics | .005 | EMT | EMF (.000), EMN (.001) EMEC (.000), EMAd (.000), EMY (.000), EMYA (.000), EMMA (.000), EMOA (.001), EMA (.000), LMN (.000), LMT (.000), LMEC (.000), LMYA (.000), LMMA (.000), LMOA (.000), LMA (.000), LMS (.001) |

**Table 247:** Significant variables by time period/age (EM v PC), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .043 | EMYA | EMA (.011), PCY (.033), PCMA (.033), PCA (.004) |
| Wood | .000 | PCEC | EMF (.000), EMN (.000), EMT (.000), EMEC (.000), EMLC (.000), EMAd (.000), EMY (.000), EMYA (.000), EMMA (.000), EMOA (.000), EMA (.000), PCT (.000), PCLC (.000), PCAd (.000), PCY (.000), PCMA (.000), PCA (.000) |
| Shell | .002 | EMMA | EMF (.010), EMEC (.010), EMAd (.020), EMYA (.019), EMA (.000), PCT (.020), PCEC (.006), PCAd (.002), PCY (.000), PCMA (.000), PCA (.000 |
| Cloth | .024 | PCMA | EMY (.043), EMYA (.043), EMMA (.024), EMA (.002), PCY (.037), PCA (.001) |
| Bone Beads | .042 | EMEC | EMYA (.029), EMA (.003), PCY (.013), PCMA (.013), PCA (.001) |

**Table 248:** Significant variables by time period/age (MM v LM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Metal Beads | .002 | MMY | MMN (.000), MMT (.007), MMEC (.000), MMLC (.000), MMEA (.001), MMYA (.000), MMMA (.000), MMOA (.000), MMA (.000), LMN (.000), LMT (.000), LMEC (.000), LMYA (.000), LMMA (.000), LMOA (.000), LMA (.000), LMS (.007) |
| Shell Beads | .000 | MMY | MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMAd (.000), MMY (.000), MMEA (.000), MMYA (.000), MMMA (.000), MMOA (.000), MMA (.000), LMN (.000), LMT (.000), LMEC (.000), LMYA (.000), LMMA (.000), LMOA (.000), LMA (.000), LMS (.001) |

**Table 249:** Significant variables by time period/age (MM v PC), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .001 | PCAd | MMN (.000), MMT (.004), MMEC (.045), MMLC (.000), MMAd (.006),MMY (.044), MMEA (.006), MMYA (.000), MMMA (.000), MMOA (.000), MMA (.000), PCT (.006), PCEC (.001), PCLC (.035), PCY (.000), PCMA (.000), PCA (.000) |
| Wood | .000 | PCEC | MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMAd (.000), MMY (.000), MMEA (.000), MMYA (.000), MMMA (.000), MMOA (.000), MMA (.000), PCT (.000), PCLC (.000), PCAd (.000), PCY (.000), PCMA (.000), PCA (.000) |
| Brass | .005 | PCEC | MMN (.010), MMLC (.025), MMYA (.013), MMMA (.005), MMOA (.010), MMA (.005), PCY (.017), PCMA (.023), PCA (.005) |
| Cloth | .001 | PCMA | MMN (.001), MMT (.018), MMEC (.018), MMLC (.003), MMYA (.001), MMMA (.000), MMOA (.001), MMA (.000), PCY (.006), PCA (.000) |
| Glass Beads | .008 | PCMA | MMN (.005), MMLC (.020), MMYA (.007), MMMA (.002), MMOA (.005), MMA (.002), PCA (.008) |

**Table 250**: Significant variables by time period/age (LM v PC), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .004 | PCAd | LMN (.006), LMT (.006), LMEC (.017), LMYA (.001), LMMA (.002), LMOA (.009), LMA (.000), PCT (.017), PCEC (.006), PCY (.001), PCMA (.001), PCA (.000) |
| Ceramics | .035 | LMEC | LMN (.017), LMT (.022), LMYA (.044), LMMA (.020), LMA (.015), PCT (.037), PCEC (.017), PCAd (.010), PCY (.005), PCMA (.009), PCA (.033) |
| Wood | .000 | PCEC | LMN (.000), LMT (.000), LMEC (.000)< LMYA (.000), LMMA (.000), LMOA (.000), LMA (.000), LMS (.000), PCT (.000), PCLC (.000), PCAd (.000), PCY (.000), PCMA (.000), PCA (.000) |
| Brass | .033 | PCEC | LMA (.047), PCA (.033) |
| Shell | .003 | LMEC | LMN (.001), LMT (.001), LMYA (.000), LMMA (.001), LMOA (.000), LMA (.000), LMS (.016), PCT (.003), PCEC (.001), PCLC (.015), PCAd (.001), PCY (.000), PCMA (.000), PCA (.000) |
| Cloth | .015 | PCMA | LMYA (.016), LMMA (.044), LMOA (.044), LMA (.005), PCY (.038), PCA (.001 |

**Table 251:** Significant variables by time period/age/sex (EW v EM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .004 | EMYAF | EWEC (.009), EWY (.029), EWAM (.002), EWAF (.000), EWAU (.000), EMF (.013), EMEC (.041), EMLC (.029), EMAd (.029), EMAM (.029), EMA (.001) |
| Shell | .000 | EMMAM | EWEC (.000), EWY (.000), EWYAM (.003), EWYAF (.003), EWAM (.000), EWAF (.000), EWAU (.000), EMF (.000), EMN (.007), EMEC (.000), EMLC (.001), EMAd (.000), EMYF (.003), EMYAF (.000), EMAM (.001), EMAU (.000) |
| Total | .005 | EMMAM | EWEC (.002), EWY (.012), EWYAM (.037), EWAM (.0020), EWAF (.000), EWAU (.000), EMF (.013), EMEC (.007), EMAd (.010), EMYF (.041), EMAM (.018), EMAU (.000) |
| Metal Beads | .000 | EWYAF | EWEC (.000), EWAd (.000), EWY (.000), EWYAM (.000), EWAM (.000), EWAF (.000), EWAU (.000), EMF (.000), EMN (.000), EMT (.000), EMEC (.000), EMLC (.000), EMAd (.000), EMYS (.000), EMYF (.000), EMYAF (.000) EMMAM (.000) |
| Shell Beads | .000 | EWYAF | EWEC (.000), EWAd (.000), EWY (.000), EWYAM (.000), EWAM (.000), EWAF (.000), EWAU (.000), EMF (.000), EMN (.000), EMT (.000), EMEC (.000), EMLC (.000), EMAd (.000), EMYS (.000), EMYF (.000), EMYAF (.000) EMMAM (.000) |
| Bone Beads | .000 | EMEC | EWEC (.000), EWAd (.001), EWY (.000), EWYAM (.001), EWYAF (.001), EWAM (.000), EWAF (.000), EWAU (.000), EMF (.000), EMN (.001), EMT (.001), EMLC (.000), EMAd (.000), EMYS (.023), EMYAF (.000), EMMAM (.001), EMAM (.000), EMAU (.000) |

**Table 252:** Significant variables by time period/age/sex (EW v MM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Ceramics | .016 | MMAU | EWAM (.023), EWAF (.004), EWAU (.000), MMN (.025), MMOAM (.023) |
| Metal Beads | .000 | EWAd | EWYAF (.000) |
| Shell Beads | .000 | EWYAF | EWEC (.000), EWAd (.000), EWY (.000), EWYAM (.000), EWAM (.000), EWAF (.000), MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMYS (.006), MMEAF (.000), MMYAM (.000), MMYAF (.000), |
| Bone Beads | .016 | MMLC | EWAM (.026), EWAF (.007), EWAU (.000), MMN (.038), MMMAM (.031), MMMAF (.047), MMOAM (.026), MMAU (.004) |

**Table 253:** Significant variables by time period/age/sex (EW v LM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Ceramics | .033 | LMYAF | EWAU (.016) |
| Metal Beads | .000 | EWYAF | EWEC (.000), EWAd (.000), EWY (.000), EWYAM (.000), EWAM (.000), EWAF (.000), EWAU (.000), LMN (.000), LMT (.000), LMEC (.000), LMYAM (.000), LMYAF (.000), LMMAM (.000), LMMAF (.000), LMOAF (.000), LMAM (.000), LMAF (.000), LMAU (.000), LMS (.000), |
| Shell Beads | .000 | EWYAF | EWEC (.000), EWAd (.000), EWY (.000), EWYAM (.000), EWAM (.000), EWAF (.000), EWAU (.000), LMN (.000), LMT (.000), LMEC (.000), LMYAM (.000), LMYAF (.000), LMMAM (.000), LMMAF (.000), LMOAF (.000), LMAM (.000), LMAF (.000), LMAU (.000), LMS (.000), |
| Bone Beads | .010 | LMYAF | EWEC (.007), EWY (.022), EWAM (.001), EWAF (.000), LMN (.007), LMT (.007), LMMAF (.022), LMOAF (.007), LMAM (.022), LMAU (.022) |

**Table 254:** Significant variables by time period/age/sex (EW v PC), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Bone | .000 | PCT | EWEC (.033), EWAM (.010), EWAF (.003), EWAU (.001), PCF (.033), PCEC (.033), PCMAF (.033), PCAF (.005), PCA (.007) |
| Ceramics | .000 | PCMAF | EWAM (.022), EWAF (.008), EWAU (.003), PCAF (.011), PCA (.002) |
| Wood | .000 | PCF | EWEC (.000), EWAd (.000), EWY (.000), EWAM (.000), EWAF (.000), EWAU (.000), PCN (.000), PCT (.000), PCEC (.000), PCAF (.000), PCA (.000) |
| Silver | .000 | PCMAF | EWAM (.043), EWAF (.018), EWAU (.002), PCA (.007), |
| Brass | .000 | PCF | EWEC (.016), EWY (.041), EWAM (.004), EWAF (001), EWAU (.000), PCEC (.016), PCAd (.041), PCMAM (.041), PCMAF (.027), PCAF (.002), PCA (.001) |
| Iron | .000 | PCAd | EWAU (.028) |
| Cloth | .000 | PCMAF | EWEC (.000), EWAd (.000), EWY (.000), EWAM (.000), EWAF (.000), EWAU (.000), PCN (.000), PCT (.000), PCEC (.000), PCAF (.000), PCA (.000) |
| Total | .000 | PCAF | EWEC (.000), EWY (.003), EWYAM (.009), EWAM (.000), EWAF (.000), EWAU (.000), PCN (.0110), PCEC (.011), PCMAM (.016), PCAF (.000), PCA (.000) |
| Metal Beads | .000 | EWYAF | EWEC (.000), EWAd (.000), EWY (.000), EWAM (.000), EWAF (.000), EWAU (.000), PCN (.000), PCT (.000), PCEC (.000), PCAF (.000), PCA (.000) |
| Shell Beads | .000 | EWYAF | EWEC (.000), EWAd (.001), EWY (.000), EWYAM (.001), EWAM (.000), EWAF (.000), EWAU (.000), PCF (.000), PCN (.000), PCT (.000), PCEC (.000), PCAd (.003), PCAF (.000), PCA (.000) |
| Glass Beads | .000 | PCMAM | EWEC (.018), EWY (.039), EWAM (.002), EWAF (.002), EWAU (.000), PCEC (.018), PCAF (.015), PCA (.015) |

**Table 255:** Significant variables by time period/age/sex (EM v MM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Metal Beads | .001 | MMYS | EMF (.000), EMN (.000), EMT (.000), EMEC (.000), EMLC (.000), EMAd (.000), EMYS (.000), EMYF (.000), EMYAF (.000), EMMAM (.000), EMMAF (000), EMAM (.000), EMAU (.000), MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMEAF (.000), MMMAM (.000), MMMAF (.000), MMOAM (.000), MMOAF (.000), MMAM (.000), MMAF (.000), MMAU (.000) |
| Shell Beads | .000 | MMYS | EMF (.000), EMN (.000), EMT (.000), EMEC (.001), EMLC (.000), EMAd (.000), EMYS (.000), EMYF (.000), EMYAF (.000), EMMAM (.000), EMMAF (000), EMAM (.000), EMAU (.000), MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMEAF (.000), MMMAM (.000), MMMAF (.000), MMOAM (.000), MMOAF (.000), MMAM (.000), MMAF (.000), MMAU (.000) |

**Table 256:** Significant variables by time period/age/sex (EM v LM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Lithics | .022 | EMT | EMF (.000), EMN (.002), EMEC (.000), EMLC (.000), EMAd (.000), EMYS (.000), EMYAF (.000), EMMAM (.000), EMMAF (.002), EMAM (.000), EMAU (.000), LMN (.000), LMT (.000), LMEC (.002), LMYAM (.002), LMMAF (.000), LMOAF (.000), LMAM (.000), LMAF (.000), LMAU (.000), LMS (.001) |
| Shell | .000 | EMMAM | MMF (.015), LMYAF (.021), LMOAF (.040) |

**Table 257**: Significant variables by time period/age/sex (EM v PC), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Wood | .000 | PCF | EMF (.000), EMN (.000), EMT (.000), EMEC (.000), EMLC (.000), EMAd (.000), EMYS (.000), EMYF (.000), EMYAF (.000), EMMAM (.000), EMMAF (.000), EMAM (.000), EMAU (.000), PCN (.000), PCT (.000), PCEC (.000), PCAd (.000), PCMAM (.000), PCMAF (.000), PCAF (.000), 123 (.000) |
| Shell | .031 | EMMAM | EMF (.007), EMEC (.014), EMLC (.023), EMAd (.014), EMYAF (.013), EMAM (.023), EMAU (.001), PCF (.005), PCEC (.005), PCAd (.014), PCMAM (.014), PCMAF (.005), PCAF (.000), PCA (.000) |
| Cloth | .000 | PCMAF | EMF (.000), EMN (.001), EMT (.001), EMEC (.000), EMLC (.000), EMYS (.000), EMYF (.000), EMYAF (.000), EMMAM (.000), EMMAF (.001), EMAM (.000), EMS (.000), PCF (.035), PCN (.0010), PCT (.000), PCEC (.000), PCAd (.001), PCMAM (.000), PCAF (.000), PCA (.000) |

**Table 258**: Significant variables by time period/age/sex (MM v LM), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Metal Beads | .000 | MMYS | MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMEAF (.000), MMYAM (.000), MMYAF (.000), MMMAM (.000), MMOAM (.000), MMOAF (.000), MMAU (.000), MMAF (.000), MMAU (.000), LMN (.000), LMT (.000), LMEC (.000), LMYAM (.000), LMYAF (.000), LMMAM (.000), LMMAF (.000), LMOAF (.000), LMAM (.000), LMAF (.000), LMAU (.000), LMS (.000) |
| Shell Beads | .000 | MMYS | MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMEAF (.000), MMYAM (.000), MMYAF (.000), MMMAM (.000), MMOAM (.000), MMOAF (.000), MMAU (.000), MMAF (.000), MMAU (.000), LMN (.000), LMT (.000), LMEC (.000), LMYAM (.000), LMYAF (.000), LMMAM (.000), LMMAF (.000), LMOAF (.000), LMAM (.000), LMAF (.000), LMAU (.000), LMS (.000) |

**Table 259**: Significant variables by time period/age/sex (MM v PC), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Wood | .000 | PCF | MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMEAF (.000), MMYAM (.000), MMYAF (.000), MMMAM (.000), MMOAM (.000), MMOAF (.000), MMAU (.000), MMAF (.000), MMAU (.000), LMN (.000), LMT (.000), LMEC (.000), PCN (.000), PCT (.000), PCEC (.000), PCAd (.000), PCMAM (.000), PCMAF (.000), PCAF (.000), PCA (.000) |
| Cloth | .000 | PCMAF | MMN (.000), MMT (.000), MMEC (.000), MMLC (.000), MMEAF (.000), MMYAM (.000), MMYAF (.000), MMMAM (.000), MMOAM (.000), MMOAF (.000), MMAU (.000), MMAF (.000), MMAU (.000), LMN (.000), LMT (.000), LMEC (.000), PCN (.000), PCT (.000), PCEC (.000), PCAd (.000), PCMAM (.000), PCMAF (.000), PCAF (.000), PCA (.000) |
| Metal Beads | .003 | PCF | MMN (.000), MMT (.005), MMEC (.001), MMLC (.000), MMEAF (.000), MMYAM (.000), MMYAF (.000), MMMAM (.004), MMOAM (.001), MMOAF (.001), MMAU (.000), MMAF (.001), MMAU (.000), LMN (.019), LMT (.019), LMEC (.000), PCN (.001), PCT (.019), PCEC (.001), PCMAM (.004), PCMAF (.001), PCAF (.000), PCA (.000) |

**Table 260**: Significant variables by time period/age/sex (LM v PC), grave goods

| Variable | P-Value | Group > | Group (p-value) |
|---|---|---|---|
| Wood | .000 | PCF | LMN (.000), LMT (.000), LMEC (.000), LMYAM (.000), LMYAF (.000), LMMAM (.000), LMMAF (.000), LMOAF (.000), LMAM (.000), LMAF (.000), LMAU (.000), LMS (.000), PCN (.000), PCT (.000), PCEC (.000), PCAd (.000), PCMAM (.000), PCMAF (.000), PCAF (.000), PCA (.000) |
| Cloth | .000 | PCMAF | LMN (.000), LMT (.000), LMEC (.003), LMYAM (.003), LMYAF (.000), LMMAM (.003), LMMAF (.000), LMOAF (.000), LMAM (.000), LMAF (.000), LMAU (.000), LMS (.003), PCN (.003), PCT (.000), PCEC (.000), PCAd (.002), PCMAM (.000), PCAF (.000), PCA (.000) |
| Total | .003 | PCMAF | LMN (.003), LMT (.004), LMEC (.040), LMYAM (.047), LMYAF (.006), LMMAM (.005), LMMAF (.008), LMOAF (.008), LMAM (.000), LMAF (.000), LMS (.040), PCN (.047), PCT (.046), PCAF (.003), PCA (.000) |

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