MODIFIABLE CARDIOVASCULAR RISK FACTORS IN THE EARLY ADOLESCENT PERIOD

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Modifiable Cardiovascular Risk Factors in the Early Adolescent Period

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The purpose of this study is to describe patterns and relationships among the modifiable cardiovascular risk factors of smoking behavior, overweight, physical inactivity and poor dietary behaviors within a ninth grade population. Four modifiable cardiovascular risk factors; smoking behavior, overweight, physical inactivity and poor dietary behavior were analyzed from the 2003 Youth Risk Behavior Surveillance System (YRBS) to explore associations in early adolescents, a critical developmental time frame. The specific aims of this study were to: 1) conduct a factor analysis of questions selected from the 2003 YRBS to represent the constructs of smoking behavior, physical inactivity and poor dietary behaviors; 2) to describe the modifiable risk factors of the targeted variables; 3) to examine relationships among the risk behavior factors of smoking behavior, overweight, physical inactivity and poor dietary behavior for the total sample; and 4) to examine relationships among the risk factors for subgroups identified by race and gender.

Specific items were identified from the 2003 YRBS that represented modifiable cardiovascular risk factors. For specific aim 1, factor analysis was performed on the targeted variables. Analysis of specific aim 2 was conducted using descriptive statistics for each of the factors identified in Specific Aim 1, and the additional risk factor of overweight. Specific aim 3 was analyzed using a Pearson *r* correlational model for relationships among the risk behavior factors of smoking behavior, physical inactivity and poor dietary behaviors. Logistic regression was used to explore relationships of factors with overweight. Specific aim 4 was analyzed using

logistic regression and Pearson *r* correlation for relationships among the identified risk behavior factors within demographic subgroups. While each of the four behavioral cardiovascular risk factors were present only physical inactivity, poor dietary behavior, and overweight were common factors that emerged in the final conceptual model. Findings demonstrated that gender was not associated with being overweight, but race did contribute significantly to the logistic regression model with overweight as a dependent variable. It is suggested that future directions be aimed at enhancing physical activity, improving dietary behavior, and preventing overweight for students in the 9^{th} grade.

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PREFACE

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The investigator expresses her deepest appreciation to her family; Scott husband-extraordinaire, and children Christopher, Jonathan and Jacqueline for their loving support and patience. I hope that this will be an inspiration to them as they grow up. Sincere appreciation is also offered to Dr. Carleen Zoni and Dr. Dolores Brzycki for their support, encouragement and mentoring. Above all, appreciation is offered to Eileen Bacino RN, mother, friend, and major inspiration for this project. This work is dedicated to them.

1.0 INTRODUCTION

The purpose of this study is to describe patterns and relationships among the modifiable cardiovascular risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior within a 9th-grade population of male and female students, as identified by the 2003 Youth Risk Behavior Survey (YRBS). Many studies have documented the presence of early cardiovascular pathology beginning in childhood or adolescence (Freedman et al., 2007; Morrison, Friedman, & Gray-McGuire, 2007; Rodrigues, Moyses, Bissoli, Pires, & Abreu, 2006). Further, evidence suggests that neither the at-risk youth nor the parents of the at-risk youth have an appreciation for the long-term consequences of lifestyle factors known to contribute to cardiovascular disease (Cottrell et al., 2007). This secondary analysis was performed, therefore, to explore the relationships among these modifiable risk factors. Explorations such as this age-specific study provide a foundation for health policies and health education strategies designed to reduce the initiation or continuation of negative health behaviors.

1.1 BACKGROUND TO THE PROBLEM

Cardiovascular disease consists of a group of diseases and conditions that affect the heart and blood vessels. Heart diseases can manifest as structural anomalies such as congenital malformations, functional abnormalities such as conduction system disorders, or acquired pathology such as atherosclerosis. Atherosclerosis is a pathological condition that affects the arteries, especially those that supply the heart, the brain (the carotid and cerebral arteries), and the lower limbs (the peripheral arteries), as well as the aorta (USDHHS, 2003). Atherosclerotic cardiovascular disease (CVD) is the leading cause of death in the United States (Ouchi, Kihara, Funahashi, Matsuzawa, & Walsh, 2003). Approximately 70 million people in the United States have CVD, leading to nearly 930,000 deaths per annum; nearly 16.7 million deaths around the globe each year are attributable to CVD (Braun, 2006; CDC, 2005; Querfield, 2002).

Although this acquired form of cardiovascular disease seldom manifests clinically before the fifth or sixth decade of life, the process of atherosclerosis begins early in life. For example, fatty streaks and atherosclerotic lesions have been found postmortem in the aorta and coronary vessels of children as young as 6 years of age (Harrell, Pearce, & Hayman, 2003), and the number of sudden deaths from heart disease has increased in persons 15 to 34 years of age (Kavey, et al., 2006).

Epidemiological studies, such as the Framingham study, have been instrumental in identifying factors associated with the risk of developing cardiovascular disease (Dawber et al.,

1959). These cardiovascular risk factors generally are categorized into major independent risk factors and other risk factors for the development of CVD, as listed in Table 1 (Hayman et al., 2007).

The likelihood of developing CVD increases with the presence of risk factors, including such modifiable risk factors as smoking, overweight, physical inactivity, and poor dietary behavior. The Pathobiological Determinants of Atherosclerosis in Youth (PDAY) study examined individuals from ages 15 to 34 for risk factors and clinical evidence of CVD and confirmed the origin of atherosclerosis in childhood (World Health Organization et al., 1999). Progression toward clinically significant lesions was evident in young adulthood, especially among individuals with coronary heart disease (CHD) risk factors. Reduction of these modifiable risk factors through education and preventative activities can contribute to the reversal of subclinical atherosclerosis and can decrease CVD risk (Gluckman et al., 2004).

Table 1: Cardiovascular Risk Factors

Major Independent Risk Factors	Other Risk Factors
*Cigarette smoking	Predisposing risk factors:
Elevated blood pressure	*Obesity
Elevated serum total (and LDL) cholesterol	Abdominal obesity
Low serum HDL cholesterol	*Physical inactivity
Diabetes mellitus	Family history of premature coronary heart disease
Advancing age	Ethnic characteristics
*Dietary behavior	Psychosocial factors:
	Stress
	Conditional risk factors:
	Elevated serum triglycerides
	Small LDL particles
	Elevated serum homocysteine
	Elevated serum lipoprotein (a)
	Prothrombotic factors (e.g., fibrinogen)
	Inflammatory markers

Note. *Targeted variables for this study. HDL = high-density lipoprotein; LDL = low-density lipoprotein. From "Cardiovascular Risk Factors and Atherosclerosis in Young Males: ARMY Study (Atherosclerosis Risk-Factors in Male Youngsters)," by M. Knoflach, S. Keichl, M. Kind, M. Said, R. Sief, M. Gisinger, et al., 2003, *Circulation, 108,* p. 1064.

Modifiable behaviors that impose a cardiovascular health risk are adopted at various points in a person's life; however, adolescence is a developmental stage that prompts particular concern. Adolescence is a common time for experimentation with such behaviors as cigarette use, and it is a time when diet and activity are less regulated by parents and structured programs in school than they were during childhood. Early adolescence, the developmental stage of particular interest, is understudied and has been poorly addressed with regard to behaviors associated with cardiovascular health risk. If these risky behaviors are present in early adolescents, prevention strategies must start in elementary school and with parents.

Despite these opportunities for risk identification and reduction interventions, no standard assessment tool for these modifiable CVD risk factors in adolescents is available for use in clinical practice and research (Reis et al., 2006). National programs from the Centers for Disease Control (CDC) and the American Heart Association (AHA) are seeking to promote such a focus. The CDC has put forth a strategy called the Logic Model for State Health and Stroke Prevention Program. Through this approach, the complexity of the CVD burden is acknowledged and comprehensive programs are called upon to reduce CVD rates, eliminate disparities, and achieve the long-term goals of *Healthy People 2010*. It has been suggested that a socioecological approach, which accounts for the social and environmental setting of the individual and the community, as well as policy and environmental changes in multiple settings, such as health care sites, work sites, schools, and communities, are effective in reaching people throughout their lives with a variety of messages and interventions (USDHHS, 2003).

In addition to providing a structure for state programs, the CDC, through the Youth Risk Behavior Surveillance System, monitors priority health-risk behaviors (these are defined as

"behaviors that contribute substantially to the leading causes of death, disability, and social problems among youth and adults in the US" [Brener et al., pg. 6, 2004]) among youth and young adults in six major categories, including behaviors that contribute to unintentional injury and violence; tobacco use; use of alcohol and other drugs; sexual behaviors that contribute to unintended pregnancy and STDs, including HIV infection; unhealthy dietary behavior, physical inactivity, and overweight; and asthma. Since 1991, the Youth Risk Behavior Surveillance System has conducted national, state, and local school-based biennial surveys of students in grades 9 through 12. These data are used (1) to measure progress toward achieving 15 national health objectives of *Healthy People 2010* and 3 of the 10 leading health indicators, (2) to assess trends in priority health-risk behaviors among high school students, and (3) to evaluate the impact of broad school and community interventions initiated at national, state, and local levels. Findings based on these data are used to develop more effective school health programs and other policy and programmatic interventions that seek to reduce risk and improve health outcomes among youth.

A secondary analysis of these data was conducted to explore modifiable cardiovascular risk factors in 9th-grade students. The following conceptual framework, shown as in Figure 1, is based on knowledge of cardiovascular risk factors and availability of self-reported behavioral data through the YRBS, was used to guide this analysis of modifiable cardiovascular risk factors in 9th-grade students.

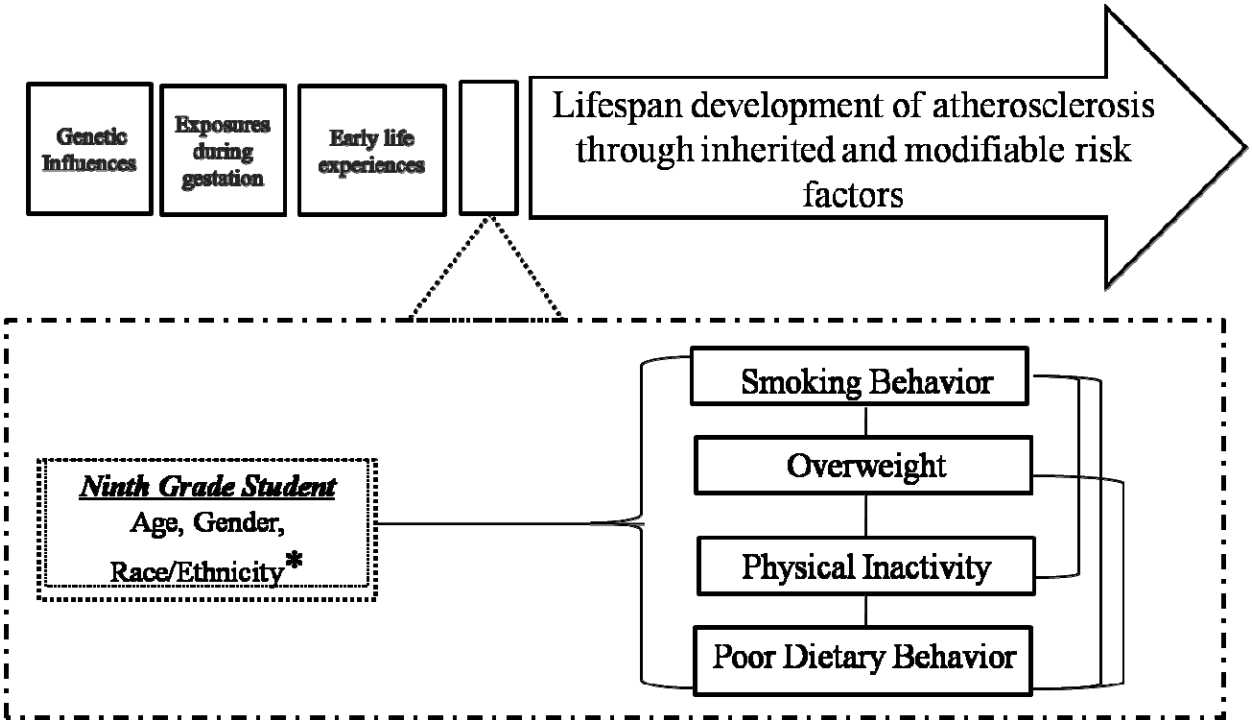

Figure 1: Conceptual framework for the study of selected modifiable risk factors in early adolescence within the continuum of a lifespan for the development of CVD.

The large arrow at the top of the framework reflects the developmental lifespan of an individual, from genetic predisposition to exposure during fetal life to early life experiences. It has been suggested that these genetic and experiential exposures serve as the roots of atherosclerosis (ADA, 2007). These three aspects of early life influence the cardiovascular health of the population of interest, specifically, 9th-grade students. The line leading to the 9th-grade student, therefore, is intentionally placed at an early point on the lifespan arrow. The 9th-grade student is described in terms of age, gender, and race—all of these represent non-modifiable risk factors for the development of CVD. The dotted line around the ninth grader and the risk factor boxes symbolizes that these variables are within the lifespan arrow.

Thus, the model depicts adolescence as a unique period in the life cycle that brings with it special challenges and opportunities. Adolescents make significant choices that may have far reaching effects, especially health effects that are carried forward into adulthood. These choices and habits may involve injury-related behaviors, violence, tobacco and drug use, unsafe sexual activity, poor dietary habits, and inadequate physical exercise (Kann, Brener, Warren, Collins, & Giovino, 2002). A vast majority of adolescents navigate this path successfully and progress into adulthood, while resolving the tasks set before them, such as succeeding in school, having positive relationships with peers and parents, and avoiding addiction to drugs or alcohol (Dahl, 2004). Unhealthy behaviors, which often are interrelated and preventable, contribute to the leading causes of adult morbidity and mortality (Grunbaum et al., 2002; Kolbe, Kann, & Collins, 1993). Thus, fostering healthy choices among adolescents may improve the health of adults.

In the conceptual framework, four separate lines connect the 9th-grade student to the four variables of interest. These variables, namely, smoking behavior, overweight, physical inactivity, and poor dietary behavior, are modifiable risk factors for CVD; solid connecting lines show the relationships between them. Although the precise time of onset and progression of CVD is not known, modifiable behavioral cardiovascular risks have been identified throughout the lifespan. For this reason, no arrows are used to infer direction, causality, or hierarchy.

Modifiable cardiovascular health-risk behaviors have been reported in adults, but these research findings are not necessarily transferable to children and youth. Recently, a newer term has emerged broadening CVD to include metabolic problems as well, namely cardio-metabolic risk. Historically, insulin resistance was considered a condition specific to adults. “However, the

increasing levels of obesity in children puts this population at risk for adult overweight and the concomitant conditions of diabetes and CVD" (ADA, pg. 14, 2007).

Smoking, the leading preventable cause of death in the United States (Lurie, 2000), has been long established as a risk factor for cardiovascular and respiratory diseases. The World Bank estimates that between 82,000 and 99,000 children and teenagers throughout the world begin to smoke every day. About half of these will become addicted smokers as adults, and half of adult smokers will die prematurely from smoking-related diseases (Jha, Ranson, Nguyen, & Yach, 2002).

Concern about the risk factor of obesity has intensified as the prevalence of obesity has increased. According to Robert Eckel, former President of the American Heart Association (2005-2006), "Paralleling the weight gain of U.S. adults, the prevalence of overweight children and adolescents has almost quadrupled from less than 5 percent in the 1980's to about 16 percent today" (Eckel, Daniels, Jacobs, & Robertson, 2005, p. 5). Several factors are known to contribute to weight gain or obesity; these include genetics, the environment, various psychosocial factors, and the two modifiable cardiovascular risk factors of physical inactivity and poor dietary behavior.

Physical inactivity is a matter of growing concern for children and adolescents. Although structured physical education classes and active play recesses were well integrated in school curricula of the past, many schools have decreased the number and length of physical education classes or have limited them to specific age groups. Many schools have not reached the national goal of requiring physical education classes for students (Pate, Heath, Dowda, & Trost, 1996).

Often, when physical education classes are required, the program is not sufficient to meet the recommendation for 30 minutes per day of moderate to vigorous activity.

The freedom to make individual food choices combined with an emphasis on body image among adolescents can lead to inconsistent nutrition or poor food choices. School officials support the concept of healthy eating, but when they devise menus and purchase food, their food choices are largely driven by cost. Dietary behavior includes more than diet consumption. *Dietary behavior* refers to conscious behaviors exhibited by individuals that can affect their weight, including dieting, exercising, purging, smoking, taking drugs, or any combination thereof.

Most individuals who die or are impaired because of atherosclerosis exhibit one or more identifiable characteristics called *risk factors.* The increasing prevalence of overweight and obesity in younger populations suggests that heart healthy behaviors must be established early in life to offset the adverse long-term impact of risk factors. The emerging independence and dramatic changes in physiological functioning that accompany puberty allow adolescents to begin to make heart healthy lifelong choices.

1.2 PROBLEM STATEMENT

Primary prevention is aimed at preventing the development of risk factors for CVD early in life. The relationship between established risk factors and CVD is continuous and graded (Hayman et al., 2007). Evidence indicates that adolescents possess accurate knowledge of cardiovascular heart disease risk, although they do not apply this knowledge to their own lifestyles and

behaviors (Smalley, Wittler, & Oliverson, 2004). It has been hypothesized that lack of motivation may be the number one barrier to adoption of healthy lifestyles by adolescents (Story et al., 2002). A paucity of studies has examined the relationship among CVD risk factors identified early in adolescence. Additional studies should be conducted to explore individual and combined CVD risk factors in adolescence, with a focus on specific grade levels, because diverse behavioral experiences are known to occur throughout adolescence.

1.3 PURPOSE

The purpose of this study is to describe patterns and relationships among the modifiable cardiovascular risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior within a 9th-grade population of male and female students, as identified by the 2003 Youth Risk Behavior Survey.

1.3.1 Research question

The following research question guided this study: What patterns and relationships are observed among smoking behavior, overweight, physical inactivity, and poor dietary behavior in 9th-grade students?

1.3.2 Specific aims of this study

On the basis of this question, the following aims were identified:

1. To conduct a factor analysis of questions selected from the 2003 YRBS that represent the following constructs:
    - Smoking behavior
    - Physical inactivity
    - Poor dietary behavior
2. To describe the modifiable risk factors of smoking, overweight, physical inactivity, and poor dietary behavior in a population of 9th-grade students who completed the 2003 YRBS.
3. To examine relationships among the risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior for the total sample.
4. To examine relationships among the risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior for subgroups identified by race and gender.

1.4 DEFINITIONS OF TERMS

Adolescent: Broadly defined as a young person between 10 and 19 years of age. In this study, the term is used specifically to refer to a person enrolled in 9th-grade at a school that participated in the Youth Risk Behavior Survey of 2003.

Cardiovascular Risk Factors: Those behaviors or factors that increase the likelihood of cardiovascular disease. They may be nonmodifiable, modifiable, or both.

Modifiable Cardiovascular Risk Factors: Several cardiovascular risk factors are modifiable, that is, they are reversible with behavior change; these include **cigarette smoking, overweight, physical inactivity,** and **poor dietary behavior**. Other modifiable risk factors that have not been selected for this study because of limitations of the dataset include high blood cholesterol, high blood pressure, and diabetes mellitus.

Nonmodifiable Cardiovascular Risk Factors: Those factors that cannot be changed by the individual. These include age, gender, and race/ethnicity. With increasing age, the risk of CVD increases. Males are at greater risk than females, particularly before the age of 55 years. Finally, Blacks are at greater risk for CVD than are members of all other races.

Another cardiovascular risk factor that can be classified as either modifiable or nonmodifiable is stress. Although this variable was not examined in this study because of data limitations, it is important to note that stress refers to force or pressure placed on an individual to perform well. It can be self-induced or may be externally imposed. Consequences of stress overload can culminate in the breakdown of physiological domains of the body, which may occur in unique ways among individuals. One individual may respond with a headache, another may describe abdominal pain, and yet another may not feel stressed and thus will project no physiological response to stress.

Because the YRBS measures self-reported behaviors, modifiable factors that require direct measurement, such as blood pressure, high cholesterol, lipid levels, and triglycerides,

cannot be assessed. Modifiable factors examined in this study include smoking behavior, overweight, physical inactivity, and poor dietary behavior.

Overweight: Overweight is determined by comparing the weight of an individual with that of the age-specific population. The reference criterion for the classification of overweight is body mass index (BMI) for age and sex based on reference data from the CDC. BMI represents an expression of weight relative to height. It is calculated as weight (in kilograms) divided by the square of height (in meters) or weight (in pounds) divided by the square of height (in inches) times 704.5. Because it is readily calculated, BMI is the measurement of choice as an indicator of healthy weight, overweight, and obesity (Resolution WHA 57.19, World Health Assembly, Geneva, May 2004). Adolescents are classified as overweight when their BMI is at or above the 85th percentile. Those at the 95th percentile are classified as at risk for obesity.

Physical Inactivity: Physical activity refers to any movement of the body that uses energy. For health benefits to be derived, physical activity should be moderate or vigorous and should occur for 30 minutes per day at least five times per week. Recommendations intended to maintain health call for a total of 20 minutes or more of physical activity per day on 3 or more of 7 days (Grunbaum, et al., 2004). Walking, climbing the stairs, playing soccer, and dancing are good examples of physical activity. Physical inactivity refers to reduced activity among students who do not meet these minimum physical activity requirements.

Poor Dietary Behavior: The food pyramid is the standard for a nutritional diet that will sustain health. Self-reported responses to questions about the frequency of intake of specific food items will be reviewed to determine adherence to suggested requirements. Those adolescents whose behaviors are inconsistent with the standard will be identified as exhibiting poor dietary

behavior. This judgment will be made on the basis of food groups rather than caloric consumption. A recognized limitation of this study is the small selection of food groups offered to participants. However, the CDC has evaluated the major food categories (i.e., fruits, vegetables, and milk) and has included them in the YRBS screening device. Therefore, the self-reported food histories of respondents served as the primary source of this information.

Smoking Behavior: For the purposes of this study, smoking is broadly defined as the inhalation of nicotine and tar into the depths of the bronchial tree. Smoking behavior is specific to cigarette smoking and is reported as the number of cigarettes smoked, ranging from just a puff to upward of 20 cigarettes per day per individual.

1.5 SIGNIFICANCE FOR NURSING

Atherosclerosis, an acquired cardiovascular disorder, is a chronic disease. Although the complexity and cumulative process of atherosclerosis make the identification of a single causative factor difficult, research has shown that both modifiable and nonmodifiable cardiovascular risk factors are associated with the development of disease (Young, 1998). Chronic diseases and noncommunicable diseases in adults, such as obesity, diabetes mellitus, hypertension, coronary artery disease, and stroke, have been related to the prevalence of risk factors in childhood (Freedman, Dietz, Srinivasan, & Berenson, 1999). One of the most significant associations between chronic disease and factors in the lifespan that contribute to

disease in the adult population is the clustering of tobacco use, physical inactivity, and excessive food consumption (Godlee, Smith, & Goldmann, 1999).

Unhealthy behaviors such as these do not occur only in adulthood but are established early in life during childhood and adolescence, as was shown by the Bogalusa Heart Study (Berenson et al., 1998; Freedman et al., 1999). Adult obesity has been tracked from childhood and has been shown to be influenced by parental physical inactivity and food choices within the home environment (Campbell et al., 2007; Casey, Dwyer, Coleman, & Valadian, 1992; Daniels et al., 2005). The availability of fast food has had an adverse effect on youth (French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001), and unhealthy behaviors often are acquired by adolescents through role modeling, learning, and media influences, as well as through peers and social networks (Fidler, West, Jarvis, & Wardle, 2006; Finkelstein, Kubzansky, & Goodman, 2006). Parental smoking and peer influence have been shown to significantly influence smoking in early adolescence (Fidler, West, Jarvis, & Wardel, 2006; Flay, d'Avernas, Best, Kersell, & Ryan, 1983; Huang, Norman, Zabinski, Calfas, & Patrick, 2007; Neumark-Sztainer, Story, Hannan & Croll, 2002).

Each risk factor is important for its independent negative influence on health; however, the clustering of lifestyle risk factors should be examined for assessment of the possibility of synergistic effects (Poortinga, 2007). Certain combinations of lifestyle risk factors are more detrimental than individual effects alone (McGinnis & Foege, 1993; Slattery, & Potter, 2002). Researchers have suggested that their effect on the body may be additive and insidious (Nissen, 2006; Querfield, 2002; Stice & Martinez, 2005); others have indicated that their effect may be multiplicative (Juonala, Raitakare, Vilkare, Raitakare, 2006). Epidemiologists have expressed

concern that causation often is wrongly attributed when associations are detected. This can be seen with antioxidant vitamins, for which observational studies have suggested a protective effect while randomized controlled trials have shown harmful effects (Egger, Schneider, & Davey Smith, 1998). Similar concerns have surfaced regarding hormone replacement therapy (HRT), which initially was posited to confer a protective effect, although randomized controlled trials have reported adverse effects (Beral, Banks, & Reeves, 2002). As in other clinical areas, studies of clusters of risk factors and misattributed causation have focused on adult populations. In spite of the inherent limitations of self-report surveys, the present study provides robust evidence of findings that are accurately representative of the early adolescent in 9th-grade. It is imperative that members of the scientific community quantify the significance of this cluster of behaviors and the risk factors related to morbidity and mortality that they impart for the adolescent population.

This investigation focuses on 9th-grade students because it is during this developmental phase that adolescents begin to make their own decisions. Health care personnel, especially nurses, work with today's youth in the community. Nurses can influence this age group by facilitating healthy choices and behaviors and by fostering healthy development. Nurses can promote healthy development in the psychological and physiological domains of youth. This goal can be accomplished through education, policy development, and various strategies that target cognitive, emotional, and physiological development in youth. If healthy lifestyle choices and therapeutic lifestyle changes are to be implemented, scientists must fully investigate this vulnerable age group. The study described in this report was conducted as an initial step toward enhancing our understanding of early adolescent behaviors.

Finally, risk reduction strategies should be based on identification of risk factors and adoption of healthy lifestyle behaviors. According to a panel of experts from the American Heart Association, these interventions can be implemented at both individual and group levels and should emphasize healthy lifestyle training that promotes cardiovascular health in childhood; they should seek to normalize levels of identified, modifiable risk factors and to reduce the risk and burden of CVD in adult life. Thus, lifestyle modification interventions can be taught early and promoted throughout the lifespan (Hayman et al., 2007).

2.0 REVIEW OF THE LITERATURE

The review of literature pertinent to this study is divided into sections relevant to the variables of interest. In the first section, the development of atherosclerosis is presented; this is followed by a section that describes the developmental characteristics of adolescence. The next four sections focus on the modifiable cardiovascular risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behaviors. The seventh section is concerned with the literature that discusses interactions of all designated variables. This chapter concludes with a synthesis of knowledge, trends, and gaps as they relate to the variables of interest, namely, smoking behavior, overweight, physical inactivity, and poor dietary behaviors.

2.1 LIFESPAN DEVELOPMENT OF ATHEROSCLEROSIS AND TARGETED RISK FACTORS OF CVD IN ADOLESCENTS

Atherosclerotic cardiovascular disease (CVD) refers to an acquired, insidious disease process that targets the heart and blood vessels; heart attack and stroke are the most common forms. Typically, these consequences are not manifested until the fifth or sixth decade of life; thus, most treatment and prevention research has focused on the adult, particularly the male adult, as the subject (Gotto, Robertson, Epstein, DeBakey, & McCollum, 1985).

The major cause of CVD is atherosclerosis, defined as an acquired and progressive process of thickening and hardening of the large and intermediate-sized arteries of the body (Gotto, Robertson, Epstein, DeBakey, & McCollum, 1985). Atherosclerosis is a process that begins in an area of the arterial wall that has been damaged in some way. The small variation from normal allows focal increases in permeability to circulating macromolecules, thickening of the subendothelial space, and proliferation of intimal smooth muscle cells. These changes are accompanied by significant alterations in arterial cell metabolism, which result in the appearance of intracellular lipid vacuoles rich in cholesteryl esters. The intimacytes then become "foam" cells, which serve as precursors to degenerative changes that lead to necrosis. Irreversible cell damage, with lysis and release of intracellular contents, causes large accumulations of extracellular lipids and connective tissue changes. Collagen and elastin fibers and scattered fibroblastic elements are deposited into the vessel wall, leading to the characteristic connective tissue changes described as fibrous plaques. A fibrous plaque is a permanent and severe lesion that usually appears in later life. In contrast to fatty streaks, fibrous plaques closely follow the development of clinical atherosclerosis in terms of distribution and severity. In susceptible populations, fibrous plaques first appear at sites of branching in the abdominal aorta in young adults and in the coronary arteries by the end of the third decade (Gotto, Robertson, Epstein, DeBakey, & McCollum, 1985).

This insidious process usually develops over several decades Development of atherosclerotic plaques leads to thickening and hardening of the arterial wall, and interferes with the basic functions of phospholipids and cholesterol by altering the fluidity of the cell membranes.

The need to consider atherosclerosis as a health concern in children and adolescents has received attention only recently. Evidence of fatty streaks and atherosclerotic lesions has been found postmortem in the aorta and coronary vessels of children as young as 6 years of age (Harrell, et al., 2003), and the number of sudden deaths from heart disease has increased in persons 15 to 34 years of age (Ogden, et al., 2006). It is uncertain when the process of atherosclerosis may begin, although increases in blood lipids, especially cholesterol, probably play an important role (Ferin, & Warren, 1993).

Cholesterol is a waxy substance that aids in the production of cell membranes, some hormones, and vitamin D. Cholesterol is a physiological necessity during all stages of life; however, specific concerns have been expressed about the fact that cholesterol is adequate in childhood and adolescence (e.g., cholesterol may be linked to height, thus shorter individuals may have a greater risk of CVD; (Hardy & Langenberg, 2003), the interaction of cholesterol with other hormones may influence the timing of maturation (Guyton & Hall, 2006). The most abundant nonmembranous way that cholesterol is used in the body is to form cholic acid within the liver. This acid is conjugated with other substances to form bile salts, which play a role in digestion and absorption of fats. Cholesterol is critical to neurodevelopment. In addition, cholesterol is the precursor to steroid hormones, which are secreted by the adrenal cortex, the ovaries, and the testes and are necessary for the initiation of puberty. The exact reason for interaction of cholesterol with these hormones is not clearly understood at this time, although it has been suggested that this may be associated with puberty (Guyton, & Hall, 2006).

Cholesterol in the body comes from two sources: from the foods one ingests, called *exogenous cholesterol*, and from the liver, called *endogenous cholesterol.* The liver makes

adequate amounts of cholesterol for usual body functions, so if excess cholesterol is ingested, negative consequences may ensue.

Cholesterol in the form of low-density lipoprotein (LDL) is an important factor in the development of atherosclerosis in high blood plasma concentrations. Plasma concentrations may be increased by many factors, including eating highly saturated fats, obesity, and physical inactivity (Guyton, & Hall, 2006). Except in the case of specific familial hypercholesterolemias, children and adolescents historically have been identified as being at low risk for developing high cholesterol and other risk factors for heart disease, as evidenced by the recommendation for initiation of screening for cholesterol at age 20. New information has emerged that shows that adolescents are at increasing risk for having high cholesterol as a result of increased sedentary behaviors, high consumption of calorie-laden foods, obesity, and a recognized family history of elevated cholesterol levels (Hayman et al., 2007)

The increased incidence of clinical atherosclerosis is associated with elevated serum cholesterol concentrations. Cholesterol and other plasma lipids are carried in the blood in emulsified, water-soluble forms called plasma lipoproteins. These macromolecules contain cholesterol, cholesteryl ester, triglycerides, and phospholipids (Dawber et al., 1959). High blood cholesterol then reflects the tracking of total cholesterol (TC) and LDL cholesterol (LDL-C) levels from childhood into adulthood. Elevated triglycerides (TGs) and low levels of high-density lipoprotein cholesterol (HDL-C) are markers of atherogenic dyslipidemia (Austin, Hokanson, & Edwards, 1998). Specifically, a low level of HDL-C is an independent risk factor for coronary heart disease (CHD) (Gordon et al., 1989). Non-HDL cholesterol also shows a strong correlation with CHD mortality (Cui et al., 2001).

As depicted in the conceptual framework for this study, the process of atherosclerosis may begin at any point in a person's lifespan. Evidence of atherosclerosis has been noted in early life, as have inherited and modifiable risk factors that can affect the initiation and progression of atherosclerosis. From this life continuum, students who are at the 9th-grade level have been selected for an analysis of modifiable risk factors.

2.2 ADOLESCENCE

Adolescence is a developmental stage that begins with puberty and lasts 8 to 10 years (Hayman et al., 2007). A time of dramatic transformation, adolescence begins in the domain of the physical and culminates in the realm of the social (Ross & Hoemann, 1975). Puberty, the physical event that marks the beginning of adolescence, starts between the ages of 8 and 14 (Pinyerd & Zipf, 2005). The timing of puberty is different for girls than for boys. Girls tend to enter puberty 18 months before boys do (Wagner, 2005), and within each gender, the timing of onset of puberty varies (Stang, & Story, 2005). This variation in onset has implications for the psychosocial transition of adolescence. Scientists affiliated with the Adolescent Development Affect-Regulation and the Pubertal Transition Research Network (ADAPT) program of the National Institute of Mental Health (NIMH) define adolescence as that "awkward period between sexual maturation and the attainment of adult roles and responsibilities" (Dahl, 2004).

Puberty, the hallmark of the transition from childhood to adulthood, is an integral part of growth and development. It is a complex biological process that is recognized as the last developmental phase in childhood development, and it most likely is programmed early in life (Foster, Jackson, & Padmanabhan, 2006). This highly ordered process may be influenced by inherent internal and external variations (Himes, 2006). The complete interactions of metabolic hormones that influence puberty have yet to be fully elucidated (Banerjee, 2007), although distinct and well-characterized alterations in sex hormones occur with the onset of puberty (Shils, Olson, & Shike, 1994). These hormonal changes manifest as an increase in gonadotropin-releasing hormone (GnRH), which initiates increases in lutenizing hormone (LH) and follicle-

stimulating hormone (FSH). These hormones are responsible for the development of secondary sex characteristics. In males, LH stimulates testosterone production and FSH stimulates gametogenesis. In females, LH stimulates ovarian cells to produce androgens and progesterone and stimulates ovulation, and FSH increases estrogen production (Neinstein, 1996). As the age of onset varies, so does the duration of each stage. Male pubertal development is noted first as the testes enlarge. Simultaneously, pubic hair sprouts and the testes, scrotum, and penis develop. The average time required for completion of puberty in male persons is about 3 years. Female puberty typically spans 4 years. It is heralded first by breast budding. Pubic hair growth can develop at varying rates. Typically, the growth spurt of female adolescents starts about 1 year before breast budding begins. Peak height is reached at about 1 year and 1 month after the start of breast budding. Menarche usually occurs about 1 year after peak height is reached. Sexual maturation has been shown to correlate closely with linear growth, changes in weight and body composition, and hormonal changes (Shils, Olson, & Shike, 1994).

A growing body of research shows that the brain is transformed in significant ways during adolescence (Keating, 2004); these changes have implication for cognition and for recognition of consequences. Noted developmental psychologist Piaget (Wadsworth, 1989) postulated numerous stages of cognitive development based on observations of children of various ages. For the years preceding adolescence, Piaget described development in terms of sensorimotor (0 to 4 years), preoperational (2 to 7 years), concrete (7 to 11 years), and formal operations (11 to 15 years). Passage from concrete to formal operations, which occurs at between 11 and 15 years, involves a shift from reasoning that is based on the most obvious variables to reasoning that results from full awareness of all possible variables and the relations between

them (Guerra, 1993). Adolescents who have achieved formal operations can imagine hypothetical events and can draw hypotheses and inferences while using both deductive and inductive reasoning to explore existing and potential relationships (Guerra, 1993). This sequential development of formal operations is summarized in Table 2.

Table 2: Substages of Formal Operational Stage*

Stage	Age, years	Characteristics
Substage 1	10 to 12	Capable of inverting relations but not able to consider all abstract possibilities
Substage 2	13 to 14	Capable of ordering triads of propositions or relations
Substage 3	15 to adult	True formal thought. Construction of all possible combinations or relations, systematic isolation of variables, and deductive hypothesis testing

*As identified by Guerra (1993).

New technologies provide a means of studying adolescent brain development. Using imaging techniques such as functional magnetic resonance imaging (MRI), researchers have noted a reorganization of synaptic connections which may enhance information processing. Changes also have been seen in the levels of various neurotransmitters in areas of the brain that control emotional functioning and these may help to explain the labile mood swings for which adolescents are known (Keating, 2004). However, cognition and behavior are related, and this relationship is not well understood at this time (Byrnes, 2001). A hallmark of healthy development is the attainment of formal operations. It is noteworthy that not all adolescents or adults fully develop formal operations (Wadsworth, 1989).

Variations in physical and psychosocial development have been reported. Transitioning from prepubescence to adolescence involves the accomplishment of numerous and varied developmental tasks, including developing relationships, preparing for a career, and participating in family and social life. According to Erickson, the central task for adolescents is to develop a sense of identity. This is typically a confusing time during which adolescents "experiment" to find out who they truly are. This identity awakening refers to the many physical, cognitive, and social changes that youngsters experience and internalize as they learn about themselves (Scriven, & Stevenson, 1998).

These many developmental changes can result in confusion and uncertainty in both family and social environments. Confusion may manifest as rebellious behavior, if it is acted upon, or family relationships may become strained. These trying times typically are not an indicator of lack of family connectedness but rather reflect the adolescent's need to develop an identify that is separate from that of the family. At this point, peers become central in the sphere of decision making (Coleman, 1990; Seidman, Allen, Aber, Michell, & Feinman, 1994). Peer relationships primarily involve the same sex, and strong solidarity and friendships often develop. As the body matures and cognitive processes become increasingly developed, a new sense of identity of self is established. Erikson believed that the key to achievement of identity lies in the social component of healthy interaction with others. Consistent with the adolescent's identity affirmation is experimentation with various behaviors and lifestyles, which occurs as part of the process of acquiring a sense of autonomy and independence, along with social skills. These skills are a necessary prerequisite for entering the adult world (Scriven, 1998). Thus, experimentation is an important step in the adolescent's attainment of identity of self (Scriven, 1998). Feelings of

omnipotence and immortality peak in this group, leading to risk-taking behaviors (Erickson, 1968). Individuality, rather than social and image constructs, appears to be a strong predictor of health behavior for teens. In fact, individuality was found to have a far greater significance to choices about smoking by adolescents than literature would suggest (Lynch, 1995).

Because of the broad range of physical changes and experiences that characterize adolescence, those who study this developmental period often depict adolescence in stages. However, inconsistency is evident in such groupings. For example, Pinyerd describes three stages that occur after the start of puberty: early adolescence, which typically covers ages 10 to 15; middle to late adolescence, which extends from the age of 16 to the early 20s; and early or young adulthood. Population-based studies such as the National Initiative, which was reported in Section 1, Building National Efforts to Improve Adolescent Health, define adolescence as the period from 10 to 19 years of age. However, *Healthy People 2010* classify adolescents into three age groups: 10 to 14 years, 15 to 19 years, and 20 to 24 years (Ozer, Brindis, Millstein, Knopt, & Irwin, 1998). This age classification is consistent with surveys used by the Centers for Disease Control and Prevention (CDC). Other national surveys may classify children into varied age groups such as children younger than 15 or 18 years, young adults 15 to 24 years, and older adults 25 to 44 years (Ozer, Brindis, Millstein, Knopt, & Irwin, 1998).

Early mother/child literature relied on the groupings of early/middle/late separation, which were derived from tasks from the developmental spectrum that had been accomplished (Affonso & Sheptak, 1989). Much of the medical research focuses on various age classifications. Independent researchers often use alternate age groupings that are not consistent with national surveys.

In lieu of the use of specific age groupings as a basis for study, the year of schooling that a student has attained has implications in terms of social milieu and cognitive challenges. Adolescence can vary from culture to culture and between socioeconomic classes within the same cultural setting (Fletcher et al., 2005). Seidman et al. (1994) investigated the impact of school transition in early adolescence and found that self-esteem is decreased when stressors in the child's environment, such as transferring to a new school or developing pubertal changes, accumulate (Seidman, Mosher, & Aral, 1994). Research has shown that adolescent development, transitioning of schools, and school organization are critical elements in the first year of high school (Hertzog, 1998). Ninth grade has proved to be pivotal in terms of adjustment and achievement (Alspaugh, 2000). More 9th-graders fail out of school than students of any other grade (Taylor, et al., 2002).

The public educational system has been used as a common milieu to effect change among youth en mass. Scientists recognize that targeting specific subgroups leads to a more accurate view of the adolescent because through this approach, vast differences between early and late adolescence are acknowledged (Ozer, Park, Paul, Brindis, & Irwin, 2003). For example, in a study by Edelen, Tucker, and Ellickson (2007), this "arbitrary" age segregation was supported in a discrete time hazards model of smoking initiation among West Coast youth. From a cohort of 6,255 youth, ages 5 to 23 years, who completed six assessments over a 10-year period, it was determined that only 17% did not initiate smoking during the study period, and more than half of the sample had initiated smoking by age 13 years. More profound was the finding that the hazard for initiation was greatest between the ages of 13 and 15 years, which points to the importance of early adolescence as a time of intervention.

In an effort to target those most critically at risk, this study addresses the 9th-grade student within the public school system. The premise for the adolescent is that conversion from risk taking to maintaining problem behavior starts at around 15 years of age, the median age of the traditional 9th-grader (Baker, Brandon, & Chassin, 2004; Johnston, O'Malley, Bachman, & Schulenberg, 2002; Prabhat, Ranson, Nguyer, & Yach, 2002). This critical point in an adolescent's development underscores the importance of a study of modifiable risk factors in this age group.

2.3 SMOKING BEHAVIOR

2.3.1 Smoking as a CVD risk factor

Cigarette smoking continues to be a leading modifiable risk factor for CVD (Rehill, Beck, Yeo, & Yeo, 2006), contributing to all phases of atherosclerosis from endothelial dysfunction to acute clinical events; the latter are largely thrombotic. Whether a distinct direct dose-dependent correlation can be made between cigarette smoke exposure and risk is debatable because recent clinical studies have shown a nonlinear relation to cigarette smoke exposure. The exact toxic components of cigarette smoke in relation to cardiovascular dysfunction are largely unknown, but it has been shown to enhance inflammation, thrombosis, and oxidation of LDL-C. Recent experimental and clinical data support the hypothesis that exposure to cigarette smoke increases oxidative stress as a potential mechanism for initiating cardiovascular dysfunction (Ambrose & Barua, 2004; Rehill, 2006). A large portion of the increased CVD risk caused by smoking may

be due to adverse effects on the vascular endothelium, induction of coronary vasoconstriction, and changes in production of basal nitric oxide or endothelial nitric oxide synthase protein (Barua et al., 2002; Gottlieb, & Weinberg, 1992; Holbrook, Grundy, Hennekens, Kannel, & Strong, 1984).

The physiological response to nicotine has been well characterized (Moolchan, Ernst, & Henningfield, 2000). Nicotine activates nicotinic cholinergic receptors (nAChRs), which demonstrate diversity in subunit structure, function, and distribution (McGehee & Role, 1995). It is known that nAChRs exist in different functional states, depending on nicotine exposure. These states—resting, activated, and the two desensitized states (Lena & Changeux, 1993)—have unclear implications for nicotine dependence. Nicotine initially depolarizes cholinergic receptors (thereby initiating neural stimulation), then blocks them (desensitization). In addition, it releases catecholamines from adrenals and nerve cells, thereby producing vasoconstriction, hypoglycemia, and increases in heart rate, oxygen consumption, and utilization of free fatty acids (Hellerstein et al., 1994). Nicotine-induced release of dopamine contributes to self-reinforcing behavior and dependence (Corrigall, Coen, & Adamson, 1994).

2.3.2 Prevalence of smoking

When classified by current smoking status, 10% of middle school students and 23% of high school students smoke (Grunbaum et al., 2002). According to recent data, initiation of smoking behavior is greatest between the ages of 10 and 18 years, with more than 75% of initiators having started by age 16 (Edelen, Tucker, & Ellickson, 2007). In spite of recent declines in the overall rate of adolescent cigarette smoking, almost one third of adolescents currently smoke cigarettes

(Grunbaum et al., 2004). The prevalence of ever smoking among high school students in recent years has decreased from a high prevalence of 70.1% in 1991 to 54.3% in 2005. However, from 2003 to 2005, this decline leveled, decreasing only from 58.4% to 54.3%. Reports of smoking behavior in adolescents are based on the findings of three major national studies that historically have targeted youth health behaviors, especially smoking behaviors. These studies vary in terms of their definitions of smoking status and the nature of the information included in their surveys.

The primary survey, the Youth Risk Behavior Survey (YRBS), is conducted every other year by the CDC; the most recent survey was completed in 2005. The YRBS asks several questions regarding smoking, including how old students were when they began to smoke, how many times students smoke each day, where they purchase their cigarettes, and whether they smoke on school property. The analysis section then classifies student responses into the categories of "never smoked" or "lifetime smoker." For this reason, reported prevalence rates from this survey are higher than those of the other two surveys.

In the 2005 survey, 13,917 9th through 12th graders (54.3% of respondents) self-reported that they had tried cigarette smoking (even one or two puffs). An individual who has "tried a cigarette, even one or two puffs" is considered a "lifetime cigarette user." The current (2005) lifetime daily cigarette rate for males (13.3%) is slightly lower than the current rate for females (13.5%). This compares with the 2003 lifetime daily cigarette rates of 15.7% for males and 15.8% for females. When reported by the reference group of students who smoked at least one cigarette over the past 30 days, the data from 2003 and 2005 are similar between genders and various race categories. The prevalence rates of current cigarette use for 2005 were 22.9% for

males and 23.0% for females. Consistent with historical data, prevalence rates were higher for Whites (25.9%) than for Blacks (12.5%) and Hispanics (22.0%) (Mermelstein, 1999).

Another national survey, conducted by the American Legacy Foundation, targets high school students across the country of varying ethnic and socioeconomic backgrounds. This report focuses on recent or current use of cigarettes to a greater degree than lifetime use; data are collected at undetermined intervals. Consistent with findings from the other two major national studies, the American Legacy Foundation reported that more than one third of high school students had used tobacco in the past month (34.8%), and more than one quarter reported that they currently were cigarette smokers (28.4%). In terms of cigarette prevalence by racial ethnic group, the highest rates were reported for Whites (32.8%), followed by Hispanics (25.8%) and African Americans (15.8%) (Grunbaum et al., 2000).

The Monitoring the Future survey is an annual study of the behaviors, attitudes, and values of American secondary school students, college students, and young adults. Each year, approximately 50,000 8th-, 10th-, and 12th-grade students are surveyed (12th graders since 1975, and 8th and 10th graders since 1991). Follow-up questionnaires are mailed to a sample of each graduating class, thus this study has a longitudinal component. The study documented trends such as a 50% increase in smoking rate for high school students in the early 1990s that peaked in 1996. In recent years, the prevalence rate according to this survey was 29%.

Although differences can be seen in specific items and classifications among these reports, trend and subgroup data from these reports are consistent (Johnston, O'Maley, Bachman, & Schulenberg, 2006). However, lack of substantial change among middle and high school students over the preceding 2 years emphasizes the need for sustained, comprehensive, evidence-

based programs that are effective in reducing adolescent smoking. A significant decline in smoking rates among adults has been noted over the past few years; however, only a slight decline has been seen in adolescent rates.

2.3.3. Research on smoking and CVD risk in adolescents

The literature on smoking and adolescents has focused primarily on factors related to smoking initiation and on interventions provided to support cessation. As noted in Table 3, numerous predictors of smoking have been identified; however, six common factors appear to be consistently related to smoking initiation: friends/family, adolescent perception, adolescent persona of maturity, value of smoking to the adolescent, self-esteem, and physiological factors (Camp, Klesges, & Relyea, 1993; Cottrell et al., 2007; Flay et al., 1994; French, Perry, Leon, & Fulkerson, 1994; Wilson, Serdula, Kendrick, & Binkin, 1989). These six variables have been studied extensively (Presson, Chassin, Sherman, Olshavsky, & Bensenberg, 1984; Flay, d'Avernas, Best, Kersell, & Ryan, 1983; Leventhal, & Cleary, 1980). It has been found that the most common factors are related to family and friends within the adolescent's environment (Chassin, Presson, & Sherman, 1984; Costa, Jessor, & Turbin, 2007; Ellickson, McGuigan, & Klein, 2001; Flay et al., 1994). The second most common factor is the adolescent's perception of others who smoke (Flay et al., 1994). A third factor is the perceived instrumental value of smoking (Chassin, Presson, Sherman, Corty, & Olshavsky, 1984). The adolescent perceives the persona of adulthood and maturity that smoking projects to others. A fourth factor is that of low self-esteem—individuals who have lower self-esteem or are demoralized view smoking as a way to self-medicate their self-esteem (Leventhal, & Cleary, 1980). How this therapeutic effect works

is not clearly understood. Emerging research has reported a physiological component that may be associated with what historically were thought to be purely behavioral associations (McGilligan, Wallace, Heavey, Ridley, & Rowland, 2007). Finally, a sixth factor involves the pharmacological or emotional effects of smoking. For some, the first experience has negative associations and acts as a deterrent to smoking (Flay, d'Avernas, Best, Kersell, & Ryan, 1983), whereas for others, it produces physiological and positive emotional sensations. Smoking cessation appears to be affected by such factors as gender, age, race, and educational attainment, although scientists have yet to unravel how or why these factors are so critical (Perkins, Epstein, & Pastor, 1990). Current research suggests that genetic linkages may influence the rate of metabolism (Tyndale & Sellers, 2001).

Table 3: Predictors of Smoking: Modifiable Adolescent Personal Factors

Personal factors
View smoking as mature*
Peer acceptance*
Having fun*
Coping with personal problems*
Coping with boredom*
Weight concerns†
Improved self-image
Low self-esteem
Low self-efficacy
Psychological problems
Other factors
Early puberty‡

From *Cottrell et al., 2007; Flay et al., 1994; †French, Perry, Leon, & Fulkerson, 1994; ‡Wilson, Serdula, Kendrick, & Binkin, 1989.

2.4 OVERWEIGHT

2.4.1 Overweight as a CVD risk factor

Overweight and obesity are labels for ranges of weight that are greater than what is generally considered healthy for a given height. These terms also identify ranges of weight that have been shown to increase the likelihood of certain diseases and other health problems. The states of overweight and obesity are determined through the use of weight and height measurements to calculate body mass index (BMI), a numerical value that indicates weight relative to height. BMI is used because, for most individuals, it correlates with their amount of body fat.

For children and teens, BMI that ranges above normal is given different labels (i.e., at risk of overweight and overweight). Additionally, BMI ranges for children and teens are defined in such a way that they take into account normal differences in body fat between boys and girls

and differences in body fat at various ages. BMI (also called *BMI-for-age*) has been the measure of choice in national surveys since the year 2000, when a standardized definition for BMI that was specific for age and gender was published by the CDC to define overweight in children; this definition has been recommended by health experts for use in clinical settings (Dietz & Robinson, 2005; Thompson et al., 2007).

Measurements for adiposity have not been standardized and remain impractical, yet components of BMI can be obtained easily with a high degree of accuracy and reliability and have been correlated with body fatness in children and adolescents (Frontini, Bao, Elkasabany, Srinivasan, & Berenson, 2001). The most prevalent definition of overweight in adolescents is the age- and sex-specific 95th percentile for BMI as defined by the CDC (van Strien & Oosterveld, 2007). For more than 75 years, height and weight tables developed by the Metropolitan Life Insurance Company have been used to assess risk and assign costs for insurance policies—a visible example of the now well-established expectation that overweight is associated with a shorter lifespan (Daniels et al., 2005).

The precise mechanism by which excess weight contributes to CVD is not fully understood (Jelic et al., 2002; Onwuanyi, Clarke, & Vanderbush, 2003). Excess weight has been considered by some researchers to be an independent risk factor for CVD and is associated with several comorbidities that themselves are risk factors for CVD, including dyslipidemia, elevated blood pressure, and hyperinsulinemia (Barter, 2005). Insulin may stimulate the sympathetic nervous system and promote vascular smooth muscle cell growth, thereby contributing to CVD and the development of atherosclerosis (Begum, Song, Rienzie, & Ragolia, 1998; Young, 1988). Excessive weight may contribute to CVD risk by impairing function of the large arteries. One

possible hypothesis is that total and central adiposity increases the risk of atherothrombolytic events or contributes to hypertension, left ventricular hypertrophy, and impaired coronary perfusion (O'Rourke, & Mancia, 1997; Ross, 1999). Obesity, which is influenced by genetics, physical activity, dietary behavior, and environment, is a major contributor to CVD and to the increased prevalence of comorbid conditions such as type 2 diabetes, metabolic syndrome, cardiovascular abnormalities, and psychosocial abnormalities (Daniels et al., 2005). During youth, obesity has been linked to teasing and bullying behavior, poor self-esteem, depression, poor family associations, and poor school performance (Troiano, Flegal, Kucymarski, Cmpbell, & Johnson, 1995).

Obesity has been shown to track from adolescence, especially later adolescence, into adulthood (Casey et al., 1992). Being overweight during adolescence and early life may be associated with CVD into the adult years, as manifested by increased artery intima media thickness (IMT) and coronary artery calcification (Must, Jacques, Dallal, Bajema, & Dietz, 1992).

The short- and long-term association of obesity with morbid outcomes raises the level of importance of understanding obesity as a contributor to CVD in children and adolescents. Excess adipose tissue is associated with free fatty acids, hyperinsulinemia, insulin resistance, hypertension, and dyslipidemia (Wajchenberg, 2000). It has been shown in adults that the effects of increased blood cholesterol and decreased HDL-C remain independently associated with risk after adjustments are made for other major risk factors, whereas weight and risk tend to lose significance (Wajchenberg, 2000). This does not suggest that increased weight is not important,

but rather that it may act as a confounder, moderator, or mediator for other risk factors. It is questionable whether this finding in adults is transferable to adolescents.

2.4.2. Prevalence of overweight

The prevalence and severity of overweight are increasing in children and adolescents, both globally and nationally (Aboderin, et al., 2002). When a standard definition of overweight as greater than the 85th percentile for age and height is used, it is noted that the prevalence of overweight in adolescents was relatively stable from 1960 through 1980. According to the National Health and Nutrition Examination Survey II (NHANES-II), the prevalence of overweight nearly doubled from 1976 (5%) to 1980 (11%), and in the subsequent NHANES-III study, the rate nearly doubled from 1988 (11%) to 2002 (17%). If the current rate, as noted in Table 4, is not arrested within this generation, it is suggested that these adolescents will be at risk for subsequent weight and obesity morbidities (Ogden, Flegal, Carroll, & Johnson, 2002; Ogden et al., 2006).

Table 4: Prevalence of Overweight Among Adolescents from Ages 12 to 19 for Selected Years 1963 to 1965 through 2004

Age, years	NHANES 1966-1970	NHANES 1971-1974	NHANES 1976-1980	NHANES 1988-1994	NHANES 1999-2000	NHANES 2001-2002	NHANES 2003-2004
12 to19	4.6	6.1	5	10.5	14.8	16.7	17.4

Note. Data for 1966-1970 for adolescents include those between the ages of 12 and 17 years, not between 12 and 19 years (Ogden, Flegal, Carroll, & Johnson, 2002; Ogden et al., 2006).

2.4.3. Research regarding overweight or obesity and CVD risk in adolescents

Because obesity is considered a complex disorder, it may not be an independent predictor but rather may be influenced by genetics, environment, or as yet other unidentified confounders (Wyatt, Winters, & Dubbert, 2006). In the longitudinal Cardiovascular Risk in Young Finns Study (2003), obesity was studied in relation to IMT, a marker of early atherosclerosis. It was shown that obesity was not an independent predictor of carotid IMT in adulthood. This cross-sectional study examined 4,320 youth in six age cohorts (3, 6, 9, 12, 15, and 18 years) at two time points. BMI as measured in youth was significantly associated with BMI as measured in adulthood. The correlation coefficient ranged between $r = 0.03$ and $r = 0.65$ in the six age cohorts ($p < .001$). In this study, being overweight during adolescence carried about a fourfold increased risk of obesity in adulthood. BMI as measured in adolescents correlated with adult IMT, but this correlation became nonsignificant when adjustments were made for adult BMI.

Thus, BMI from youth is not shown to be directly correlated with increased IMT in adults. These results are consistent with those of other researchers who found that significant associations between adolescent BMI and adult IMT were attenuated after adjustments were made for adult BMI (Oren, Vos, Uiterwaal, Grobbee, & Bots, 2003).

In the Amsterdam Growth and Health Longitudinal Study, Ferreira and colleagues compared body fatness and fat distribution versus carotid IMT and large artery stiffness in 175 women and 161 men at age 36 and in 84 females and 75 males during adolescence (between the ages of 13 and 16 years). It is interesting to note that at age 36, total body fat and central adiposity as assessed during adolescence were positively and independently associated with carotid IMT, adolescent central adiposity was associated with increased arterial stiffness, both abdominal and central adiposity were associated with arterial stiffness, and the effects of fatness on arterial stiffness were not uniform along the arterial tree.

In addition to IMT, arterial stiffness increases with age and in certain disease states that are associated with cardiovascular risk, including hypertension, diabetes mellitus, hypercholesterolemia, and end-stage renal failure (Baumgartner, 1995; Berenson & Srinivasan, 2001). Because these changes can be detected before clinically apparent vascular disease is seen, arterial stiffness may act as a marker for the development of future atherosclerotic disease, or it may be more directly involved in the process of atherosclerosis (De Franco, & Nissen, 2001). A recent study included obese and nonobese adolescents in the sample, and findings indicated that cardiovascular changes are associated with obesity in youth. Zebekakis and others conducted a cross-sectional study of the association of arterial stiffness with obesity that included subjects between 10 and 86 years of age. In females between the ages of 10 and 86, diameter and stiffness

of brachial and femoral arteries consistently increased as BMI increased. Age did not show a significant effect. In males and females, stiffening of the carotid was more pronounced at a younger age as BMI increased (Zebekakis et al., 2005).

Overweight adolescents are at risk for many physical and psychosocial consequences. Although the physical consequences often are not realized until adulthood, the psychosocial implications can be immediate and difficult to manage. Empirical research has shown that overweight children are mocked and rejected more often compared with children with any other handicap or blatant disability (LeBow, 1984). Overweight individuals have a greater risk of developing dissatisfaction with their bodies (Vander Wal & Thelen, 2000) and lowered self-esteem (Pesa, Syre, & Jones, 2000), and they are more likely to endure teasing from friends and peers (Jackson, Grilo, & Masheb, 2000).

2.5 PHYSICAL INACTIVITY

2.5.1 Physical inactivity as a CVD risk factor

The International Consensus Conference on Physical Activity Guidelines for Adolescents recommend that "all adolescents…be physically active daily, or nearly every day, as part of play, games, sports, work, transportation, recreation, physical education, or planned exercise, in the context of family, school, and community activities," and that "adolescents engage in three or more sessions per week of activities that last 20 minutes or more at a time and that require moderate to vigorous levels of exertion" (CDC, pg.3, 1997). Others have recommended 60

minutes per day of moderate to vigorous physical activity for youth (Cavill, 2001; Strong et al., 2005). Although research is inconsistent regarding amount, duration, and intensity, a general consensus has been reached among experts that physical activity does provide protection from CVD (Twisk, 2001). Regular physical activity provides additional health benefits, including improvements in aerobic endurance and muscular strength, reduction in risk factors for other chronic diseases, increased bone mass density, higher levels of self-esteem and self-concept, and lower levels of anxiety and stress (Lowrey, Brener, Lee, Fulton & Eppi, 2004).

The importance of physical activity for reducing rates of disease and death from chronic disease has been well established (Hahn, Teutsch, Rothenberg, & Marks, 1990; McGinnis & Foege, 1993). In contrast, physically inactive persons are almost twice as likely to develop CHD as are those who engage in regular physical activity (USDHHS, 1994). Thus, physical inactivity poses almost as much risk for heart disease as does cigarette smoking, high blood pressure, or a high cholesterol level, but it is more prevalent than any of these other risk factors (CDC, 1993).

Distinctions between physical activity, exercise, and physical fitness are useful for an understanding of health research. Physical activity is "any bodily movement produced by skeletal muscles that results in energy expenditure…". Exercise is a subset of physical activity that is planned, structured and repetitive" and is done to improve or maintain physical fitness. Physical fitness is "a set of attributes that are either health or skill related" (CDC, pg. 2, 1997).

Demographic, individual, interpersonal, and environmental factors all are associated with physical activity among children and adolescents. Demographic factors include gender, age, and race or ethnicity. Girls are less active than boys; older children and adolescents are less active than younger children; and among girls, Blacks are less active than Whites (Burgeson, Weschler,

Brener, Young, & Spain, 2001). The benefits of regular physical activity and the need to encourage participation through informed intervention have stimulated research into factors that encourage participation.

As a result of extensive research, the School Health Policies and Programs Study (SHPPS) adopted the objective to encourage physical education courses at elementary, middle/junior high, and secondary levels of education. Findings from the most recent survey report (2000) show that only 6.4% of middle/junior high schools and 5.8% of senior high schools provide daily physical education or its equivalent (150 minutes per week for elementary schools; 225 minutes per week for middle/junior and senior high schools) for the entire school year for students in all grades (Lowry, Wechsler, Kann, & Collins, 2001).

2.5.2 Prevalence of physical inactivity among adolescents

Although children and adolescents are more physically active than adults, many young people do not engage in moderate or vigorous physical activity at least 3 days a week (Burgeson, et al., 2001). Current data suggest that only 30% of teenagers meet this guideline (Grunbaum et al., 2000). Data have shown that this decrease is more profound for girls than for boys.

Physical education (PE) classes in public schools were once a source of regular physical activity for adolescents. Lowrey reported on the participation of high school students in daily PE classes. Overall, the prevalence of attending PE class daily declined significantly from 1991 (41.6%) to 1995 (25.4%), and this level of participation was consistent through 2003 (28.4%). These rates are similar when reported by gender; however, differences are noted between certain grade levels and between races. For Black and 10th-grade students, a significant decline was

noted from 1991 to 1999. For 9th-grade students, a significant decline was noted from 1991 to 1995, and this was followed by a significant increase from 1995 to 2003, which was detected among 9th-grade students (Lowrey, Brener, Lee, Fulton & Eppi, 2004). During the years from 1991 to 2003, the prevalence of students enrolled in PE class overall and among female, male, White, and Hispanic 9th to 12th graders did not change significantly. Among Black students, however, student numbers declined significantly from 1991 to 1997, and they have not changed since.

One should not confuse PE class attendance with physical activity. PE curricula have shifted focus from competitive games to learning activities. Many PE teachers have incorporated into their curriculum the shift from participating in competitive games to learning lifelong skills, such as golf, fly fishing, and the like.

2.5.3 Research related to physical inactivity and risk of CVD in adolescents

Research in adults has shown that weight reduction and physical exercise can decrease LDL-C and limit the reduction in HDL-C that occurs when dietary saturated fat is decreased (Stefanick et al., 1998). The degree of exercise effect is influenced by numerous factors, such as characteristics of the exercise program, level of commitment and intensity of the individual, and whether weight loss is involved. According to the American Heart Association (AHA), the effect of exercise on CVD risk factors is significantly less than that associated with pharmacological intervention (Thompson et al., 2003). The effects of physical activity on CVD risk factors in adults are evidenced by reductions in insulin resistance, glucose intolerance, postprandial hyperglycemia, and possibly hepatic glucose output (Thompson et al., 2003). Vigorous physical

activity has been shown to decrease serum triglycerides and reduce systolic blood pressure (Thompson et al., 2003).

Current descriptions of physical activity levels and dietary behaviors among adolescents are troubling because they reveal insufficient exercise and overconsumption of foods high in sugars and fats (French et al., 2001; Janssen, Katzmarzyk, Boyce, King, & Pickett, 2004). Research on adolescent attitudes shows that weight control is implicated in adolescent dietary behaviors and weight concerns (Carper, Orlet-Fischer, & Birch, 2000; Davison, Markey, & Birch, 2003; Fisher, & Birch, 2002).

In a cross-sectional study of 4,599 students aged 12 to 15 years, Bovet, Auguste, and Burdette (2007) detected a strong inverse relationship between fitness and excess body weight. However, how these two factors influence CVD risk has not been assessed. Because physical activity is a behavior with numerous variables that influence outcome and measurement, it has been suggested that cardiorespiratory fitness is more strongly predictive of health outcomes (Blair, Cheng, & Holder, 2001; Williams, 2001).

2.6 DIETARY BEHAVIORS

2.6.1 Poor dietary behavior as a CVD risk factor

A major contributor to excess weight is excess dietary consumption. Dietary intervention may be a key factor in the primordial prevention of dyslipidemia, hyperinsulinemia, and elevated blood cholesterol, all of which are risk factors for CVD (Daniels, 2007).

Adolescence is a nutritionally vulnerable time for youth, as is evidenced by growth spurts and altered recreational sports involvement. The quality and quantity of food selection influence weight and general health. However, the dietary patterns of adolescents have changed rapidly during this past decade because of increased snacking, greater fast food availability, and increased frequency of eating foods outside the home (Lee, Novotny, Daida, Vijayadeva, & Gittelsohn, 2007; Nielson, Siega-Riz, & Popkin, 2003). Media in the forms of television, video games, and magazines hold a strong attraction for promoting what sells, not necessarily what is healthy. Such media can be significant contributors to fad diets that adolescents undertake and the images they have of a model adolescent shape. All of these cultural, sociological, and social pressures can contribute to excess weight among adolescents.

In recent years, excess weight and obesity have significantly increased in prevalence in adults and youth. Obesity (excess fat storage) results from an imbalance between energy intake (food) and energy output (exercise) (Barter, 2005). Ironically enough, the awareness of the public also has increased regarding intake of saturated fats, cholesterol, HDLs and LDLs, *trans*-fats, and caloric consumption. This has been seen in the revamping of the food pyramid and in the restructuring of U.S. Food and Drug Administration (FDA) guidelines in that they describe narrow age groupings and are more specific in their stated objectives. On a national level, modest progress has been made in our understanding of how significant the role of nutrition is in weight and obesity, hypertension, and dyslipidemia. However, these relationships are not clear in part because scientific evidence-based research into physiological and behavioral realms is lacking. Research on diverse subpopulations such as infants, children, and youth, as well as various cultural groups, also is lacking; nonstandardization of operational terms such as weight,

eating, and dieting has been noted, and in most studies, statistical power and generalizability are reduced by small sample sizes.

Primordial prevention is aimed at preventing the development of risk factors for CVD early in life. Dietary intervention may be a key factor in the primordial prevention of dyslipidemia, hyperinsulinemia, and elevated blood cholesterol, all of which are risk factors for CVD (Daniels, 2007). Yet, before dietary intervention is warranted, current trends and dietary patterns in adolescents must be investigated.

2.6.2. Prevalence of poor dietary behaviors and CVD risk in adolescents

The health and nutrition of adolescents are important because their eating behaviors and nutrition do affect their future health. However, little research is available on dietary patterns of the essentially healthy adolescent. A plethora of research is related to the aberrant eating patterns of those with acute and chronic illness. Emerging research is focused on recognition of the link between eating habits and healthy outcomes.

Dietary intake in adolescents has been described with an eye toward heart healthy behaviors and lifestyle modifications. Limited research has explored the "normal" eating patterns of adolescents. The data from the 2003 YRBS report that nationwide, about 20% of students had eaten fruits and vegetables more than five times per day during the 7 days preceding the survey. Overall, the prevalence of having eaten fruits and vegetables was greater among males (21.4%) than among females (18.7%) and was greater among Black males (24.3%) than among Black females (19.9%). The prevalence of eating fruits and vegetables was higher among Hispanics

(23.2%) than among Blacks (22.1%) and Whites (18.6%). Overall, the prevalence of students who had eaten fruits and vegetables more than five times per day before participating in the survey declined with grade advancement: 9th-graders—21.3%, 11th grade—18.8%, and 12th grade—18.3%.

In the nationwide sample for the 2003 YRBS, it was reported that about 16.2% of students had drunk three or more glasses of milk per day during the 7 days before survey participation. Overall, the prevalence of having drunk three or more glasses per day of milk during the 7 days preceding the survey was higher among males (20.8%) than among females (11.6%) and was higher among White males (24.0%) than among Black males (11.7%). The prevalence of having drunk three or more glasses per day of milk was higher among Whites (18.7%) than among Blacks (8.6%) and Hispanics (13.9%). Overall, the prevalence of students who had drunk three or more glasses per day of milk per day for 7 days preceding the survey was higher among 9th-graders (18.7%) than among 10th graders (15.5%) and 12th graders (13.5%), and it was higher among 11th graders (16.5%) than among 12th graders (13.5%).

2.6.3 Research regarding poor dietary behavior and CVD risk in adolescents

To gain an understanding of the relationships between dieting, weight perception, and body composition, normal weight, overweight, and obese college females were compared by Malinauskas, Raedeke, Aeby, Smith, and Dallas (Malinauskas, Raedeke, Aeby, Smith, & Dallas, 2006). The purpose of this study was to investigate whether normal weight individuals diet differently from those who are overweight or obese. Findings from this study support the general belief that dieting by college women is a common weight management strategy, irrespective of

weight status. Noteworthy are findings from this study that reveal that 80% of participants reported using physical activity to control weight, although only 19% exercised at a sufficient level to promote weight loss. In addition, the most prevalent explicit maladaptive weight loss behavior was smoking cigarettes (9% of participants). Despite the finding that dieting to control weight is ineffective, children as young as age 10 have been noted to use this strategy, and it is most prevalent at 13 and 14 years of age (Huon & Lim, 2000).

Intentional weight loss in obese patients can improve or prevent many obesity-related risk factors for CVD (Graham, Stewart, & Hertog, 2006). The beneficial effects on health in adults have been well documented (Klein et al., 2004). These systemic effects include decreases in blood volume, stroke volume, cardiac output, pulmonary capillary wedge pressure, left ventricular mass, resting oxygen consumption, systemic arterial pressure, resting heart rate, and QTc interval. Other beneficial effects include improvement in left ventricular diastolic and systolic dysfunction (Graham, Stewart, & Hertog, 2006), yet little research on the adolescent population substantiates these effects.

Scientists suggest that the development of atherosclerosis may be delayed or prevented by dietary measures; one sentinel study has been documented. In this randomized, prospective Special Turku Coronary Risk Factor Intervention Project (STRIP), a low–saturated fat, low-cholesterol diet combined with dietary counseling was shown to be effective in decreasing CVD development in children age 7 months through 14 years, or until the onset of puberty (Niinikoski et al., 2007). This study provided evidence of what may be the "perfect" diet. However, many other sanctioned diets and behavioral modification approaches have been proposed for the treatment of excess weight. Retaining excess weight is dependent on successfully achieving the

balance between energy intake and expenditure. Dietary approaches differ in their total energy expenditure, macronutrient and micronutrient composition, energy density, and glycemic index (Klein et al., 2004). The most widely accepted approach is the low-fat diet (Howard et al., 2006). Another popular approach is the low-carbohydrate diet (Nordmann et al., 2006). Other popular dietary approaches undertaken by adolescents have demonstrated adverse health implications. Some of these dietary patterns include vegetarianism, fast food consumption, and intake of junk foods, solitary health foods, and megavitamins (Hanning & Zlotkin, 1985). Research has shown that eating disorders such as anorexia nervosa and bulimia have the highest mortality rate of any psychiatric disorder. Morbidity and mortality are directly related to cardiovascular involvement (Casiero & Frishman, 2006).

Compared with those of younger children, the dietary behaviors of early adolescents are influenced by peers, weight concerns, and body image (Cusatis et al., 2000; Cusatis & Shannon, 1996). Current research findings reveal a decrease in fruit and vegetable consumption and an increase in consumption of simple sugars, especially among girls (Cusatis et al., 2000; Lytle, Seifert, Greenstein, & McGovern, 2000). Research also has shown that dietary patterns are associated with more frequent fast food consumption in this age group than in most others (Bisset, Gauvin, Potvin, & Paradis, 2005).

2.7 INTERRELATEDNESS OF SMOKING BEHAVIOR, WEIGHT STATUS, PHYSICAL ACTIVITY, AND POOR DIETARY BEHAVIOR IN EARLY ADOLESCENCE

Recent literature calls for a focus on prevention of all major risk factors simultaneously, using lifestyle approaches from early ages onward to reduce population CVD risk (Daviglus, Lloyd-Jones & Pirzada, 2006). However, longitudinal and intervention studies to explore the prevalence of such risk factors in adolescents is limited to the risk factors of blood pressure, lipids, and overweight, and have been conducted outside of the United States (Rozanov, Aleksandov, Shugaeva, Perova, Maslinnikova, Smirnova & Olfer'ev, 2007). Smoking, excess weight, physical inactivity, and dietary behaviors as four modifiable cardiovascular risk factors in adolescents have been understudied as a cluster of behavioral risk factors, as has their impact on CVD.

The literature reveals complex interactions between these behaviors. For example, the drive for weight control has an effect on initiation, maintenance, cessation, and relapse of smoking. Further, those early adolescents who report weight concerns as central to their smoking behavior are more likely to use weight as a motivation for smoking (Klesges, Hanson, Eck, & Durff, 1988). Smoking behaviors, physical activity, and dietary behaviors in adolescents vary, depending on weight management goals and practices (Boutelle, Neumark-Sztainer, Story, & Resnick, 2002; Lowry, Galuska, Fulton, Wechsler, & Kann, 2002; Malinauskas, Raedeke, Aeby, Smith, & Dallas, 2006; Story, Neumark-Sztainer, 1998). Smoking has been shown to be significantly associated with body weight, especially in girls who begin to smoke cigarettes

(French, Perry, Leon, & Fulkerson, 1994; Klesges, Meyers, Klesges, & Vasque, 1989). Smoking influences body weight by enhancing performance effects for the individual and by acting as an appetite suppressant.

In addition, gender differences have been reported, primarily as post-cessation changes in food intake and weight gain (Ogden, & Fox, 1993). However, the literature suggests that both male and female subjects of normal weight report a relationship between smoking and weight control (Klesges & Klesges, 1988). Several studies have identified links between weight concerns and psychosocial maladaptive behaviors such as depression and low self-esteem (French et al., 1994; French, Perry, Leon, & Fulkerson, 1995); others have identified family and individual characteristics as "predictors" of weight concerns (McHale, Corneal, Crouter, & Birch, 2001). Yet, the bulk of previous research in fact is focused on the adult, and these relationships remain relatively unexplored in the adolescent.

It is a widely held perception that adults who choose to be regular exercisers tend to adopt other positive health habits. Although the validity of this perception has not always been supported by scientific investigation, evidence suggests that physically active adults tend to smoke less, consume healthier diets, and maintain a more favorable body composition (Simoes, 1995). This same perception, that physical activity has been linked with other positive health behaviors, has been applied to teenagers (Nelson & Gordon-Larsen, 2006; Pate, Heath, Dowda, & Trost, 1996). In a study by Audrain-McGovern, Rodriguez, and Moss (2003), it was shown that an increase in overall physical activity across the first 3 years of high school was associated with a 44% decrease in the odds of smoking progression. In another study, Abrams, Skolnik, and Diamond (1999) reported that students who played three or more sports had only a 3% chance of

being current smokers, whereas students who played two or fewer sports had a 22% chance of being current smokers. This literature review is presented to convey to the reader an understanding of previous research as it relates to smoking behavior, weight status, dietary behaviors, and physical activity.

Body image concerns, eating problems, and obesity among children and adolescents are increasingly targeted for preventative health education and health promotion programs. It is important that educators present suitable strategies, so adolescents can select healthy options. Body image and weight concerns have been consistently more common among girls than among boys, but recent reports show that boys and young men are increasingly reporting these problems (Bener, Kamal, Tewfik, Sabuncuoglu, 2006; McCreary & Sasse, 2000; O'Dea & Rawstorne, 2001). It is known that adults, especially women, have used cigarette smoking as a method of preventing weight gain; research findings suggest that adolescents are using smoking as a method of losing weight (French et al., 1994).

It is becoming clear that smoking status may be associated with dietary intake and physical activity in adults and in adolescents. However, it is apparent that youth are more likely than adults to employ unhealthy weight management practices. It is speculated that this association may be influenced by such factors as exposure to television and media that reflect unrealistic expectations of perfect body measurements. Youth may be creating an unrealistic goal for body shape. Youth who employ unhealthy weight management strategies may not realize the consequences of continued exposure to unhealthy behaviors on body systems because these effects are not noted until well into adulthood.

A study was undertaken by Boutelle, Neumark-Sztainer, Story, and Resnick (Boutelle, Neumark-Sztainer, Story, & Resnick, 2002) to evaluate weight control behaviors, eating, and physical activity behaviors among a nationally representative sample of 8,330 youth in public school grades seven, eight, and eleven. A 225-item survey was administered to students after institutional review board (IRB) approval was obtained and appropriate piloting was undertaken. Dieting behaviors, eating behaviors, and exercise behaviors were the targeted variables of interest. Analysis was conducted with use of the generalized linear mixed model. Before application, the model was adjusted to include sociodemographic factors (parents' social economic status, race, and grade) and school as random effects. Findings suggest that compared with nonoverweight youths, overweight adolescents are less likely to eat breakfast and are less likely to engage in vigorous physical activity (Boutelle, Neumark-Sztainer, Story, & Resnick, 2002). Another study by Wilson et al. (2005) looked at differences in food intake and exercise by smoking status in adolescents. This study was undertaken as part of a comprehensive evaluation of youth prevention programs from the Commonwealth of Virginia. Participants from middle school (n = 8,022) and high school (n = 2,613) were included. Analysis was based on the chi-square bivariate test and multivariate regression models. Findings suggest a fairly equal distribution between males and females in both middle school and high school. Race and ethnicity were equally distributed among middle school and high school students. Findings revealed that smoking status for nonsmokers was significantly less among middle school students than among high school students.

Findings of chi-square bivariate analysis revealed that among middle school youth, female smokers were less likely to report that they consumed ≥1 serving of vegetables/day ($p <$

.01), and both female and total sample smokers were less likely than nonsmokers to exercise ≥3 times/week. No association was noted between smoking status and either fruit intake or milk/dairy intake among middle school students.

Among high school girls, smoking was significantly associated with three outcome variables: reduced likelihood of consuming vegetables ($p < .01$), intake of milk/dairy products ≥1 serving/day ($p < .01$), and exercise ≥3 times/week ($p < .01$). High school boys who smoked were significantly less likely than nonsmokers to consume milk/dairy products ≥1 time/day ($p < .01$). No association was detected between smoking and fruit consumption in any high school group.

Results of logistic regression revealed that when each outcome was modeled separately with smoking as an independent variable, with controls for gender, grade, race/ethnicity, weight goals, and BMI among middle school female students, smoking was significantly associated with a decreased odds ratio (OR) for consuming vegetables (OR = .75; 95% confidence interval [CI], 0.55 to 0.96) and for exercising (OR = .66; 95% CI, 0.49 to 0.90). Smoking and exercise also were significant in the total middle school sample (OR= .70; 95% CI, 0.58 to 0.91).

Among high school girls, smoking was significantly associated with decreases in odds of consuming vegetables (.70; 95% CI, 0.58 to 0.91), intake of milk/dairy products ≥1 serving per day (OR = .64; 95% CI, 0.51 to 0.88), and exercise (OR = .58; 95% CI, 0.44 to 0.71). Among boys, smoking was significantly associated with consuming milk/dairy products (OR = .62; 95% CI, 0.46 to 0.82) and with exercise (OR= .72; 95% CI, 0.52 to 0.99). In the total high school sample, smoking was significantly associated with decreased odds of eating vegetables (OR = .75; 95% CI, 0.62 to 0.91), with decreased milk/dairy intake (OR = 0.64; 95% CI, 0.53 to 0.78),

and with reduced exercise frequency (OR = 0.66; 95% CI, 0.53 to 0.81). No association was reported for fruit intake (Wilson et al., 2005).

Another relevant study by Winter, de Guia, Ferrence, and Cohen (2002) focused on adolescents in Canada. The relationship of smoking status to body weight perception and weight control behavior was explored. This secondary analysis used logistic regression to evaluate associations in a sample of 3,990 students from grades 7, 9, 11, and 13 in public and Catholic schools. Total sample characteristics were missing; however, almost one third (31%) of females considered themselves overweight compared with only 14% of males. More than one quarter of females and males had smoked a cigarette in the past 12 months (29% and 26%). Weight perception was positively associated with smoking among females but not among males (females, OR = 1.47; 95% CI, 0.76 to 2.05). Females were more likely to smoke if they exercised to lose weight (OR = 2.60; $p < .001$), skipped meals (OR = 2.72; $p < .001$), vomited (OR = 4.16; $p < .001$), or used diet pills (OR = 6.52; $p < .001$). When financial situation and age were controlled, all odds ratios decreased slightly but remained statistically significant. Males demonstrated no statistically significant associations (Winter, de Guia, Ferrence, & Cohen, 2002).

A more recent study by Stice and Shaw (2003) investigated the prospective relationship of body image and eating and affective disturbance to smoking onset in a population of adolescent girls. This prospective study comprised 496 adolescent girls from middle schools in the urban Southwest of the United States. Researchers suggested that body image and eating disturbances increase the risk for cigarette smoking in adolescent girls because of the belief that smoking is an effective weight control strategy (Stice & Shaw, 2003). Ideally, this analysis

would have examined predictors of the transition from nonsmoker to experimental smoker or regular smoker. However, because of small cell size, this analysis could not be performed. This in itself may be an ominous indicator, and further research is warranted. The aim of this study was to use logistic regression analysis to explore whether body image, eating, and affective disturbances would predict onset of smoking. Consistent with expectations, increases in body dissatisfaction were noted for both experimental and regular smokers (OR = 5.60; $p < .001$; 95% CI, 2.34 to 13.38) (Stice & Shaw, 2003).

Many studies have explored relationships between smoking and body weight. In a review of literature conducted by Klesges et al. (1989), 29 relevant studies were extracted. Two design approaches—cross-sectional and epidemiological—were used in these studies. Overwhelming agreement indicates that smoking status does affect body weight. Of 29 studies, 24 (83%) reported that smokers weighed less than nonsmokers, 3 (10%) reported that smokers weighed less than nonsmokers in a single group of individuals but not in another, and only 2 (7%) described no differences between smokers and nonsmokers. Among the three studies that provided partial support for the argument that smoking and weight are related, the most relevant finding was that this association was supported for women but not for men. This would lead one to question the role of gender in the association of smoking with weight across the lifespan (Klesges, Meyers, Klesges, & Vasque, 1989).

The single most relevant study was conducted by Lowry, Galluska, Fulton, Wechsler, and Kann (2001) to explore associations of physical activity, fruit and vegetable consumption, and cigarette smoking with weight management goals and practices of high school students. A secondary analysis examined data from the 1999 YRBS on 15,349 9th to 12th graders. Adjusted

odds ratios were used to describe associations with control for demographics. Findings revealed that 25% of students were overweight (11%) or were at risk of becoming overweight (14%). However, a large proportion of students (43%) were trying to lose weight, and 19% were trying to maintain their weight. Trying to lose weight was associated with vigorous physical activity (OR = 1.5), strengthening exercises (OR = 2.2), and cigarette smoking (OR = 1.4) among female students; and with vigorous physical activity (OR = 1.6), strengthening exercises (OR = 1.8), and eating more than five servings per day of fruits and vegetables (OR = 1.5) among male students. Among students who tried to lose weight or maintain their weight, 62% of females and 41% of males combined exercise with caloric modification, and 32% of females and 17% of males used unhealthy weight control methods, such as fasting, diet pills, vomiting, and laxatives (Grunbaum et al., 2002). Table 5 presents a summary of pertinent articles that relate to exploration into the associations between smoking and weight status, physical activity, and dietary behaviors.

Research suggests that cigarette smoking in adolescence results in appetite suppression and weight loss, thus affecting growth (Camp, Klesges, & Relyea, 1993). This finding supports the premise that cigarette smoking retards physical development during adolescence—a period of significant physical growth (Stice & Martinez, 2005).

Sedentary lifestyle and excessive weight are important lifestyle factors that adversely affect individuals worldwide. Physical inactivity and excess body mass are associated with a number of health-related risk factors and are independent risk factors for CVD in the adult (Haapanen-Niemi et al., 2000). In a study by Hu et al. (2005), it was demonstrated that increased physical activity and decreased body mass in adults had a positive relationship on CVD mortality (Hu, et al., 2005). This finding that regular physical activity has an important impact on CVD

mortality in adolescents has not yet been demonstrated for this population. Other research has consistently demonstrated a negative relationship between physical activity and cigarette smoking in adolescents (Audrain-McGovern, Rodriguez, & Moss, 2003; Rainey, McKeown, Sargent, & Valois, 1996). These findings support the protective effects that physical activity provides to adolescent smokers. However, how these protective factors affect the underlying physiology remains unclear. Thus, the relationship between physical activity, smoking, and CVD risks in the adolescent population remains unknown.

2.7.1 Smoking, dietary habits, and CVD risk factors in the adolescent

Research supports the relationship between the social/cognitive construction of the adolescent self and health-related behaviors (Crocker et al., 2001; Crocker et al., 2003; Davis, 1997; Fox, 1997). Tomeo et al. (1999) found that contemplation of smoking initiation was associated with appearance, whereas experimentation with smoking was associated with daily dieting. Research supports the relationship between smoking and dieting as a weight control mechanism (Friestad & Klepp, 1997; Tomeo et al., 1999). However, no longitudinal studies have examined the causal relationships among smoking, dietary behaviors, and CVD risks in adolescents.

As noted throughout this review of literature, there are many studies that explored the relationship of one of the modifiable risk factors to another in the adolescent population. However, studies that look at relationships among all four of the modifiable risk factors of interest are limited. Table 5 provides a summary of 5 studies that have looked at one or more of the risk factors of interest to this study in the adolescent population. Further, 4 of the 5 studies have employed analytic techniques to assess associations from data collected in larger studies.

The overarching framework for these studies was primarily on weight management or obesity, with physical activity, dietary behavior, or smoking as intentional choices related to weight management. Thus the context of these studies is not one of disease prevention, but behavior management. All studies had a survey design with large sample sizes, ranging from 496 to 15,349 subjects. In these studies, the developmental period for participants was identified by grade level, and varied among the studies. In some, the population of interest was grades 9-12, while others focused on students as young as 6th grade. However, the range of grade levels studied was as broad as 7th through 13th grades. None of these studies focused on a single grade, nor did they identify the developmental concerns of the various stages in this broad range of grades, that is early, middle, and late adolescence, as these stages influenced findings.

Four of the five studies were secondary analyses, while only one was a prospective study involving a primary data collection. For the four studies employing secondary analysis (Lowry, Galuska, Fulton, Wechsler, & Kann, 2002; Winter, de Guia, Ferrence & Cohen, 2002; Boutelle, Neumark-sztainer, Story, & Resnick, 2002; and Wilson, Smith, & Steizer, 2005) students of both genders were included in the study. The prospective study by Stice and Shaw (2003) recruited only girls. In addition to being a gender specific study, there are other demographic concerns and variables usage that differentiate the study. First, the study included girls in private and public school venues, and analyzed behaviors in relation to those settings. Specific to this study is the finding that girls that attended private school were less likely to show smoking onset relative to girls attending public high school, introducing socioeconomic status as a factor to consider in behavior. Also, this prospective study was the only study that examined mood disturbances and

body image as a variable of interest. Finally, risk behaviors were limited to those related to eating and smoking.

Thus, the studies summarized in table 5 point to a pattern of adopting more than one behavior that imposes health risk among adolescents, particularly for those who are overweight or perceive a weight concern. This is especially true for girls, who increase physical activity and smoke as a means of addressing weight concerns.

Table 5: Studies on Smoking, Weight Status, Physical Activity, and Dietary Behaviors in Adolescents

Citation	Study Participants	Purpose and Means of Analysis	Findings Pertinent to this Study
Boutelle, Neumark-Sztainer, Story & Resnick (2002) Weight Control Behaviors Among Obese, Overweight, and Non-overweight Adolescents	8,330 male and female students in grades 7, 9 and 11 from the Voice of Connecticut Youth Survey	Secondary analysis to assess the associations between overweight status and weight control, eating and physical activity in female and male adolescents.	**Findings**: Overweight students were less likely to report vigorous physical activity or report heathy eating patterns. High percentages of both overweight and non-overweight adolescents seem to be consuming low levels of fruits and vegetables and not getting adequate exercise.

Table 5: (Continued)

Citation	Study Participants	Purpose and Means of Analysis	**Findings Pertinent to this Study**
Wilson, et al. (2005) Differences in Food Intake and Exercise by Smoking Status in Adolescents	2613 high school and 8022 middle school male and female students participating in Youth Tobacco Prevention/Cessation Programs in Virginia (only baseline data used)	Secondary analysis to examine the relationship between smoking and the consumption of fruit/vegetables, milk/dairy products and the frequency of exercise in youth.	**Findings:** In high school females, smoking was significantly associated with three outcome variables: less likelihood of consuming vegetables, milk/dairy products ≥1 serving/day, and of exercising ≥3X/week (each at $p<.01$). For males, smokers were less likely than nonsmokers to consume milk/dairy and to exercise ($p<.01$). As smoking behavior increased, consumption of vegetables and milk and dairy products and exercise decreased. Ethnicity was a significant covariate in models for smoking and diet, and smoking and exercise, with African American HS students being less likely to eat milk/dairy products and to exercise as frequently as compared to White and Hispanic students. **Implications for this study:** Teens who smoke may be at greater risk than nonsmokers for compromised consumption of vegetables and milk/dairy products and less frequent physical activity

Table 5: (Continued)

Citation	Study Participants	Purpose and Means of Analysis	Findings Pertinent to this Study
Winter, de Guia, Ferrence, & Cohen (2002) The Relationship Between Body Weight Perceptions, Weight Control Behaviors and Smoking Status Among Adolescents	3,990 male and female public and Catholic school students, grades, 7,9,11, and 13 who completed the 1997 Ontario Student Drug Use Survey	Secondary Analysis to assess the association of students self-rating of being too thin, about right, or too fat and smoking and weight control behaviors, including exercise, skipping meals, using diet pills or vomiting.	**Findings:** Females are more likely to smoke if they exercised to lose weight (OR=2.6), skipped meals (OR = 2.72) vomited (OR 4.16) or used diet pills (OR 6.52) (all significant at $p<.001$). Males who skipped meals to control or maintain weight were more likely to smoke than those who did not skip meals OR=2.36, $p<.05$). **Implication for this study**: Smoking may be linked to more exercise or poor dietary behavior. Data were not available for actual weight assessment, thus perception may not be realistic assessment of weight. One motivation for smoking may be weight reduction.

Table 5: (Continued)

Citation	Study Participants	Purpose and Means of Analysis	Findings Pertinent to this Study
Stice & Shaw (2003) Prospective Relations of Body Image, Eating, and Affective Disturbances to Smoking Onset in Adolescent Girls: How Virginia Slims	496 adolescent girls, ages 11 to 15 years from public and private middle school in the Southwestern US	Prospective Study to assess if body image, eating, and affective disturbances predicted onset of smoking in adolescent girls from baseline to a one year follow-up interview.	Findings: At baseline assessment, girls attending private schools were less likely to show smoking onset relative to girls in public school (OR=0.16, 95% CI 0.4-.67), however prospective effects were not different for private versus public. Body dissatisfaction and eating pathology showed a unique effect for onset of smoking while controlling for the effects of negative affect (OR 4.33, 95% CI 1.71-10.95), however negative affect did not show a significant effect when controlling for the effects of body dissatisfaction. Implications for this study: Confirms that early adolescence is a high-risk period for increases in smoking behavior, particularly in girls. Smoking is perceived as a weight loss strategy, especially for girls with body dissatisfaction and unhealthy eating behaviors.

Table 5: (Continued)

Citation	Study Participants	Purpose and Means of Analysis	Findings Pertinent to this Study
Lowry, Galuska, Fulton, Wechsler & Kann (2002) Weight Management Goals and Practices Among U.S. High School Students: Associations With Physical Activity, Diet, and Smoking	15,349 male and female High school students (9th to 12th grade) from the 1999 YRBS	Secondary Analysis to assess the association of physical activity, diet and smoking as weight management strategies by gender, race, and perception of weight status	Findings: 21.45 of female students were overweight or at risk for becoming so, 36.3% considered themselves slightly or very overweight, and 59.4% were trying to lose weight. For male students, 28.3% were overweight or at risk of becoming so, 23.7% considered themselves to be slightly or very overweight, and 26.1% were trying to lose weight. Black and Hispanic students were more likely to be overweight or at risk of overweight. 9th grade males were more likely than 12th grade males to be trying to lose weight or stay the same. Using exercise for weight control is associated with a pattern of healthy behaviors, especially increased fruit and vegetable consumption, but reduced smoking only for males. Implication for this study: Current smoking among males, but not among females, was associated with extreme weight loss strategies.

Of students who were involved in one unhealthy behavior, especially smoking or overweight, students were likely to engage in other unhealthy behaviors as a means of addressing the smoking or overweight, pointing to the failure to identify with health behavior as a positive contributor to long term health.

This literature informs this study in a number of ways. First, the focus of this study is to understand the association of these four important lifestyle concerns that influence long term cardiometabolic health. The population of interest will be limited to the 9th-grader. The choice of this population is based in specific developmental characteristics of the 9th-grade student, particularly as independent decision makers regarding health behavior. An understanding of the prevalence and association of these factors will assist in identifying an appropriate developmental period for intervention to prevent smoking, overweight, physical inactivity, and poor dietary behavior These four important modifiable risk factors contribute to the development of cardio-metabolic risk, thus this study will provide important information about timing of possible interventions, as well as the appropriate target behaviors.

A recent consensus document (ADA, 2007) urges preventive strategies to address cardiovascular and metabolic disease, and points to early life as an important time for such intervention. However, the age and circumstances of such intervention is not established. We do not know how early these behavioral risk factors in children begin to exert a cumulative effect on the cardiovascular system. Thus, further investigation is necessary to determine how early these risk factors co-exist, and the best time for intervention.

3.0 METHODS

The purpose of this study was to describe patterns and relationships among the modifiable cardiovascular risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior within a 9th-grade population of male and female students, as identified by the 2003 Youth Risk Behavior Survey (YRBS). This chapter describes the methods used to conduct this study. Research design, sample selection, variable descriptions and levels of measurement, sampling and data collection, data management, data processing, and statistical analysis of data are discussed. Human subject protection also is addressed.

3.1 RESEARCH DESIGN

This study examined the relationships among smoking behavior, overweight, physical inactivity, and poor dietary behavior via secondary analysis of data from a large cross-sectional national study. Secondary analysis taps into existing data so that the richness of data obtained can be used to generate findings, most specifically, so that results can be used to promote evidence-based practice. The most obvious reason for this is that it permits examination of relationships between variables that previously remained unanalyzed. More generic reasons include the fact that data that have been collected for nonresearch purposes may be used to answer research questions. The use of a secondary data analysis makes it possible for investigators to bypass time-consuming and costly steps of the research process. The investigator is able to save money, time, and resources when pursuing an exploratory question when using a secondary analysis instead of a primary data collection. The strengths of a secondary data analysis include its expediency for generating results; thus this rapid method of conducting research can be readily used as a training tool. As applied to the present study, this approach is especially valuable because studies on adolescents that focus on cardiovascular risk factors in this subgroup are lacking. However, this technique does have its limitations. One of the prime limitations of a secondary dataset is that it allows less room for manipulation of scales of measurement (e.g., moving from ordinal to ratio). Most notably, the question generated by the researcher may remain unanswered. According to Polit and Beck, (2004) this type of analysis may be deficient in many ways (e.g., samples used,

variables measured, theories applied, and perspectives on insight). Measures for this study include baseline data and select reported responses reflective of the factors of interest, namely, smoking behavior, overweight, physical inactivity, and poor dietary behavior, as documented in the YRBS of 2003.

3.2 POPULATION AND SAMPLE

3.2.1 Description of the parent study

The Youth Risk Behavior Surveillance System is an epidemiologic surveillance system that was established by the Centers for Disease Control and Prevention (CDC) to monitor the prevalence of youth behaviors that most strongly influence health. The YRBS is conducted every other year and is one component of this surveillance system. For the first survey items were selected to provide assistance for addressing the human immunodeficiency virus (HIV) prevention programs for youth and were added to supplement the established Behavioral Risk Factor Surveillance System (BRFSS). Then, epidemiologists determined that there was not a mechanism available that provided adequate monitoring and tracking of key behaviors that influenced health for youth. The YRBS was established and has grown to accommodate national, state and local agencies that monitor behaviors for youth, and has been administered biennially since 1991. The YRBS focuses on priority health-risk behaviors established during youth that result in the most significant mortality, morbidity, disability, and social problems that may occur during both youth and adulthood (Everett, Kann, & McReynolds, 1997). These include tobacco use, sexual

behaviors that may result in HIV infection or other sexually transmitted diseases, unintended pregnancies, and behaviors that may lead to violence and unintentional injury or adverse health outcomes (McKean, & Card, 2005). The YRBS was developed through extensive research and evaluation (Kolbe, Kann, & Collins, 1993).

3.2.2 Data collection protocols

The study entitled *2003 National School-Based Youth Risk Behavior Survey* was conducted by the CDC. Funding for the parent study was provided to Sociometrics Corporation (Los Altos, California) by the National Institute for Child Health and Human Development (NICHD) under Contract No. N01-4-4487. The data used in this study were made available by the Data Archive on Adolescent Pregnancy and Pregnancy Prevention (DAAPPP) at Sociometrics Corporation. The original investigators, the funding agency, and DAAPPP are not responsible for the analyses or interpretations presented here. Data supplied by DAAPPP were de-identified in adherence with the Public Health Services Act, which prohibits any effort to determine the identity of any reported case (Grunbaum et al., 2004). The parent study survey procedures were designed to protect students' privacy by allowing anonymous and voluntary participation. Local procedures for obtaining parental permission were followed before the YRBS was administered at any school. Certain schools used active permission, in which parents sent back to the school a signed form indicating their approval before their child could participate in the study. Other schools used passive permission, in which parents sent back a signed form only if they did not want their child to participate in the survey. In the 2003 survey, 3 of 43 participating states used state-wide

active permission procedures, and 5 of 22 districts used district-wide active permission. In 2003, 38% of schools used active permission, and 62% used passive permission.

Data collection and processing of data from a national survey represent a comprehensive effort that requires the collaboration of all parties if quality data are to be ensured. The parent study was overseen by the CDC in Atlanta, Georgia. For the 2003 YRBS, 225 logical edits were performed on each questionnaire. Responses that conflict in logical terms are set to missing, and data are not imputed. Questionnaires that include fewer than 20 valid responses after editing are deleted from the dataset. In 2003, the number of completed questionnaires in state surveys that failed quality control checks and were excluded from analysis ranged from 0 to 86 per state, with a median of 4. In local surveys, the range was 0 to 35 per site, with a median of 8 (Grunbaum, et al., 2004). Data processing at the national level is similar to that performed for state and local surveys. In 2003, a total of 26 questionnaires in the national survey failed quality control checks and were excluded from analysis.

The population for YRBS consists of high school students in grades 9 through 12. The following methods, reported in the Codebook for the 2003 YRBS, are summarized as follows:

> For national, state, and local YRBS samples, schools are selected with probability proportional to the size of student enrollment in grades 9 through 12; a class that is a curriculum requirement for all students, (e.g., English classes) is identified, and specific classes then are randomly selected to participate. Within the randomly selected classes, all students are eligible to participate. One class period is needed. It takes approximately 10 minutes for the survey administrator to distribute survey materials and read directions to the students. Approximately 35 minutes is needed for students to record their responses. No physical test or

examination is involved. Participation in the YRBS is voluntary. Local parental permission procedures are followed. Students complete the self-administered questionnaire during a single class period and record their responses on a computer-scannable questionnaire booklet or a separate answer sheet.

For the national survey and for most state and local surveys, trained data collectors travel to each participating school to administer the questionnaire to students. These data collectors read a scripted standardized introduction of the survey to students. Data collectors also record information regarding schools and classrooms, which is used later in the survey process to verify sample selection and to weight data. In certain state and local surveys, questionnaires were sent to the schools, and teachers administered them and completed the accompanying documentation. Students then completed the self-administered questionnaire in their classrooms during a regular class period and recorded their responses directly on a computer-scannable booklet or answer sheet. YRBS procedures are designed to protect student privacy by allowing for anonymous and voluntary participation. If possible, space was allocated between students, papers were offered to cover student responses, and, in the case of the national survey, students were asked to seal their questionnaire in a sealed envelope after completing it and before placing it into a box (CDC, 2005).

Investigator confidence in the reliability of these data is important if they are to be used in findings that may have a serious impact, for example, findings that lead to interventions to prevent CVD in all 9th-graders. Attempts have been made to demonstrate reliability and validity for specific health behaviors, but these studies primarily have been done on a much smaller scale

and with fewer participants (Aaron et al., 1995; Davoli, Perucci, Sangalli, Brancato, & Dell'Uomo, 1992; French, Peterson, Story, Anderson, Mussell, & Mitchell, 1998; Needle, McCubbin, Lorence, & Hochhauser, 1983). Assessments of reliability and validity published prior to the 2003 YRBS included an examination of specific health-risk behaviors (Brener, Billy, & Grady, 2003). There were two main theoretical approaches to threats of validity that emerge from self-reported data. They were identified as stemming from the cognitive approach and from the situational perspective. The cognitive approach suggests that there are four basic processes that may be influenced. They are comprehension, retrieval, decision-making and response generation. Because the error may be introduced through any and/or all of the stages, the influence is not static. The second major contributor to undue influence on validity relates to the situational perspective. That situational perspective arises out of the characteristics of the environment. Such influences are setting, presence of others when responding, social desirability, confidentiality, anonymity or privacy. The two perspectives are not necessarily independent of one another.

The threats to smoking behavior included cognitive factors that were identified as recall, where time greater than a year tends to be blurred for adolescents. In addition, amount of smoking, since it is habitual and addictive, may influence accuracy of age of use, or amount of use. Thus, there exists the possibility of underreporting on smoking behavior as relates to retrieval and in describing their use and patterns as they may not see themselves as regular users. The situational factors influencing smoking behavior meets with more social undesirability today than in times past. Given the laws that prohibit sale of tobacco products and the attention garnered from the Master's Tobacco settlement, researchers generally anticipate tobacco usage to be underreported. Ways to compensate for this have to do with environment for performing a

test-retest, which is not possible in the current structure of the YRBS. Another method to validate smoking behavior is with biochemical measures. This method has met with controversial output in different studies (Brener, Billy, & Grady, 2003).

Dietary behavior can also be influenced by both cognitive and situational factors. For recall purposes, validity was found to be good for short-term recall, and dropped off as time of event to recall occurred. Assessment of weight was also included with dietary as it related to weight control behaviors. Those adolescents who were engaged in weight control behaviors tended to have better recall than those not trying to lose weight. For individuals that engaged in unhealthy behaviors a larger disparity was noted between self-reports and diary reports. This may be an influence of social desirability more than recall. Because researchers tend to view dietary behavior as a non-sensitive behavior, the literature did not focus on the situational barriers. However, in research that addressed unhealthy behaviors such as purging, bingeing and the like, there is the suggestion that privacy and confidentiality may be a consideration to the threat of validity for dietary behavior. With respect to self-reports of weight control Brener et al., found moderate reliability among adolescents as relates to dietary behaviors (Brener, Billy, & Grady, 2003).

Physical activity behavior was noted to be one of the more challenging behaviors to identify threats to validity due to non-standardized type, timing, and occurrences of such behaviors. The prime threat to validity was noted to be recall, and was influenced by rigorousness of exercise and time to recall. Behaviors related to physical activity are not sensitive, thus one would anticipate a small to negligible impact on self-reported data. As physical prowess is valued in the society there may be some degree of social desirability attached to the validity. Studies that have reported on the validity have noted moderate to substantial

reliability. There was also noted reliability among the measures that were used in the reporting of physical activity behaviors. Surprisingly, some of the most mechanical methods, such as use of accelerometers, and heart rate monitors to quantify physical activity has not been found to be as accurate in correlating self-report with actual findings. It has been suggested that this low correlation has more to do with the data capturing capability of the device than the actual energy expenditure from the individual (Brener, Billy, and Grady, 2003). While the study addressed the prime six health risk behaviors addressed in the YRBS, the findings here are only reflective of the variables addressed in the current study.

A comprehensive assessment if test-retest reliability was completed by Brener and colleagues in 2002. The purpose of the study was to assess the test-retest reliability of school students from White, Black, Hispanic, and other racial/ethnic groups who completed the YRBS questionnaire on two occasions approximately 2 weeks apart. The Brener study used a protocol that maintained anonymity yet allowed matching of Time-1 and Time-2 responses. A κ statistic for the 72 items was computed and compared with group prevalence estimates on two testing occasions. A κ statistic provides a measure of agreement that corrects for what would be expected to occur by chance. Prevalence rates were considered significantly different if their 95% confidence intervals (CIs) did not overlap. This is the same criterion that was used to assess the statistical significance of subgroup differences in reports of YRBS data (Kann, et al., 2000). Values for κ ranged from 23.6% to 90.5%, with a mean of 60.7% and a median of 60.0%. These values did not differ by gender, grade, or race/ethnicity of the respondent; 47.2% of items had at least "substantial" reliability ($\kappa \geq 61\%$), and 93.1% had at least "moderate" reliability ($\kappa \geq 41\%$). About one in five items (22.2%) had significantly different prevalence estimates at Time-1 versus Time-2. In 10 items, or 13.9%, both κ values were below 61%, and Time-1 and Time-2

prevalence estimates were significantly different. Examination of reliability by risk behavior category revealed significant differences. Specifically, items related to tobacco use exhibited significantly higher reliability (mean κ = 68.8%) than items related to unintentional injury and violence (mean κ = 59.0%), dietary behavior (mean κ = 50%), physical activity (mean κ = 55.2%), and other health-related topics (mean κ = 49.7%). In addition, items related to the use of alcohol and other drugs (mean κ = 63.4%) and those related to sexual behavior (mean κ = 62.7%) showed greater reliability than items related to dietary behavior, physical activity, and other health-related topics. This pattern of results is parallel to that seen when investigators sought to determine which risk behavior categories were more likely to include items that had significantly different Time-1 and Time-2 prevalence estimates. For example, although none of the 13 items related to tobacco use had significantly different Time-1 and Time-2 prevalence estimates, four of seven dietary behavior items, two of five physical activity items, and 6 of 20 injury-related items demonstrated significant differences between Time-1 and Time-2 (Brener, et al., 2002). The limitation of this study was that responses that differed between Time-1 and Time-2 were considered to reflect response error, although these differences truly could indicate a change in behavior. However, because of time constraints, this was highly improbable. Therefore, the κ values reflected in this study must be regarded as conservative estimates. Finally, the last limitation is that this study investigated reliability, not validity, and consequently cannot address the validity of this instrument.

In 1997 an extensive review of face validity and content validity of the YRBS was undertaken by approximately 800 experts from academia and agencies germane to the process (Brener, et al., 2004). Currently, the questionnaire is reviewed biennially by a limited number of experts prior to dissemination within the CDC (Brener, et al., 2004). Research has demonstrated

the validity of self-reported tobacco use (Akers, et al., 1983; Wills, & Cleary, 1997), dietary behavior (Rockett et al., 1997; Rosen, & Poplawski, 1987), and physical activity (Weston, Petosa, & Pate, 1997) outside the context of the YRBS.

3.2.3 Inclusion and exclusion criteria for the proposed study

The dataset was procured from Sociometrics Corporation after data had been screened, cleaned, and edited. Because this study was exploratory in nature and sought to capture the essence of the targeted variables, no exclusions were incorporated. From 15,214 high school participants included in the 2003 data collection, a subset of 3,674 records was selected for this study, based on identification of students as being in the ninth grade. This weighted sample is equivalent to 4,448 9th-grade students from 2003. All data are presented at the weighted sample number. Weighting is a statistical procedure that is applied when units are selected with nonequal probabilities. It often is applied as the result of disproportionate sampling. Weights are calculated in ratio to the inverse of the probability of selection (Tabachnick, 2001). Inclusion criteria are aimed at maximizing the data; thus, if a respondent contributed data, his or her selection is included. Missing data were identified for all variables that had values to be coded as missing. For numeric variables, a blank in the data file was automatically treated as a system missing value (CDC, 2004).

The sample for this study comprised 4,448 students. Age was categorized by years of age, however, the lowest age category was specified as 12 years old or younger, and the highest was specified as 18 years old or older. Data regarding the 9th-grade students ages is noted in Table 6.

The mode for age was 15 years at 49.6%, and the number of 14-year-olds (41.4%) was significant.

Table 6: Frequency Distribution of Age Categories

Age	Frequency	Percent
12 years old or younger	5	.1
13 years old	7	.2
14 years old	1,842	41.4
15 years old	2,207	49.6
16 years old	343	7.7
17 years old	28	.6
18 years old or older	15	.3
Total	4,447	100.0

The sample was fairly balanced for gender as noted in Table 7; 2,123 participants were female (47.7%), and the remaining 2,322 participants were male (52.2%).

Table 7: Frequency Distribution of Gender Categories

Gender	Frequency	Percent
Female	2,123	47.7
Male	2,322	52.2
Total	4,446	99.9

The distribution of race/ethnicity was consistent with national data from the census bureau; as noted in Table 8, most participants were White (56.1%), Black (16%), Hispanic-Latino (18.6%), and Native American (1%). The remaining 8.3% classified themselves as Asian, Native Hawaiian, or Multiethnic/Non-Hispanic.

Table 8**:** Frequency Distribution of Race/Ethnicity Categories

Race/Ethnicity	Frequency	Percent
Black or African American	713	16.0
Hispanic or Latino	826	18.6
White	2,495	56.1
Other	388	8.7
Total	4,423	99.4

Height for students ranged from 4.16 to 6.92 feet, with mean ± standard deviation (SD) height being 5.51 feet ± .295 *feet.* Weight for students ranged from 71.01 to 350.00 lb; mean ± SD weight was 142.39 lbs ± 34.39 *lbs.* These values were used to calculate body mass index using the formula weight (kg) divided by height (in meters squared). Students were then identified as overweight or not overweight by the definition used by the CDC: 85th percentile and greater according to the CDC BMI-for-age growth charts.

Table 9: Weight Status of 9th-Graders Determined from BMI Calculations and According to CDC Guidelines

Weight Status	Frequency	Percent
Not overweight	2,674	60.1
Overweight	1,215	27.3
Height, weight, or both not reported	559	12.6
Total	4,448	100.0

3.3 DATA PROCESSING PROCEDURES

Data processing and cleaning at local, state, and national levels was completed by the Sociometrics Corporation in accordance with codebook guidelines, thus all data provided for use in this study was eligible for analysis (CDC, 2005). For the purposes of this study, data for 9th-grade students only were included in the analysis. Although only 3,674 records were reviewed, these records represent 4,448 cases after sample weighting to adjust for disproportionate sampling. To address the specific aims of this study, demographic data on gender, race, and age and items based on their pertinence to the modifiable risk factors of interest were selected for study.

3.3.1. Missing Data

There is a great variation in the level of missing data across variables. The portion of missing data per item ranged from 1.9% (85 responses) to 19.8% (879 responses) for the individual items that were incorporated into the factor analysis. Five hundred fifty nine students of 4,448 (12.6%) did not report data needed for the BMI calculation. Missing data were handled in a list-wise manner. As this study was exploratory in nature, taking a list-wise approach optimized the data set.

3.4 VARIABLE DESCRIPTIONS, MEASURES, AND LEVELS OF MEASUREMENT

Variables for this study, that is, smoking behavior, overweight, physical inactivity, and poor dietary behavior, were measured with the use of specific items from the YRBS.

Smoking behavior was measured with the use of items numbered 28 through 31 and item number 34. The selected items and the responses from the ninth grade students can be found in Appendix A. These selected questions refer to cigarette smoking and exclude other forms of tobacco use. The questions address such smoking behaviors as the number of cigarettes smoked per day over the past 30 days, the frequency of attaining one's cigarettes, smoking on school property, and the number of days of continuous smoking.

Overweight was determined by categorizing a body mass index (BMI) that was calculated on the basis of adolescent self-reported heights and weights. This variable was reported as a categorical variable of overweight or not overweight as determined by body mass

indicator established by the Centers for Disease Prevention and Control http://apps.nccd.cdc.gov/dnpabmi/Calculator.aspx, accessed July 16, 2008.

Physical inactivity for this study was measured with the use of items numbered 83 through 86, as well as item number 93, from the 2003 YRBS. These questions were selected because they address energy expenditure for various activities. Question 83 asks, "How many hours do you watch TV?" This item captures sedentariness rather than energy expenditure, as noted by a response of increased television viewing captures increased inactivity levels. Responses are ordinal data ranges where response 1 equals not engage in watching TV (least amount of sedentariness), and 7 equals watch TV for 5 hours or longer per day (greatest amount of sedentariness). Question 84 addresses an average week for the student and asks about physical education class attendance. Responses range from 0 days to 5 days. Question 85 inquires about average physical education attendance and class participation and asks "How many minutes do you spend actually exercising or playing sports?" Again, responses are provided as ordinal data, ranging from 1 to 8 in 10 minute increments. Question 86 attempts to capture community or extracurricular activity engagement. The target item asks, "During the past 12 months, on how many sports teams did you play?" Responses ranged from 0 to 3, where 3 means played on 3 or more teams. Question 93 inquires about injuries that occurred while the respondent was playing or participating in a sports activity. Answers are dichotomous in that response 1 is used for individuals who did not engage or play in the past 30 days, and responses 3 and 4 are dichotomized to Yes or No, respectively.

Poor dietary behavior was measured via items 73 through 79 from the YRBS, which used an ordinal level of measurement, then reduced its dimensionality by means of factor analysis, thus allowing for conversion to interval data. Diet is addressed in the YRBS through questions

specific to fruit, vegetable, and milk consumption. Again, the self-reported information used a look-back method for the previous 7 days for the responder. Questions 73 and 74 refer to fruits by asking how many times one drank 100% fruit juices such as orange juice, apple juice, or grape juice. Question 75 captures the concept of salad consumption, and again, response categories are similar to those in questions 73 and 74. Question 76 addresses how many times a respondent eats potatoes, and question 77 refers to intake of carrots, leaving question 78 to refer to the intake of any other vegetables. Question 79 asks how many glasses of milk a respondent consumed in the past 7 days. The responses for questions 77 through 79 are consistent with previous categories for questions regarding fruit and food consumption.

Demographic data include descriptors of the 9th-grade population, including gender, race/ethnicity, and age. Age was reported by year of age, gender was categorized as male and female, and race/ethnicity was categorized as White, Black, Hispanic or Other.

3.5 STATISTICAL ANALYSIS OF THE DATA

The purpose of this study is to describe patterns and relationships among the modifiable cardiovascular risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior. A descriptive, correlational design was used to determine the relationships among designated variables for the 9th-grade participants. Factor analysis was performed to reduce the dimensionality of the information on each variable and to compress the data while removing collinearity within the variables from the 2003 YRBS, thus allowing correlations to be examined

and interpreted. Pearson correlation's *r* was used to determine the correlations among designated variables.

Descriptive statistics summarize, organize, synthesize, describe, and communicate numerical information (Burns, 1999). Numerical data were obtained from the dataset, which consists of self-report data from high school students. Frequency distributions, measures of central tendency, variability, and correlations are used to communicate information obtained from the dataset.

Pearson's *r* is the correlation coefficient that is widely used for quantifying the magnitude of correlation when correlated variables are measured on an interval or ratio scale. A perfect correlation is +1 or -1, which is rarely seen. A significance level of $< .05$ is used. Because this is an exploratory study, it is least restrictive. This is also the most common significance level noted in scientific research and thus allows for generalizability.

Logistic regression is a part of a category of statistical models called generalized linear models. This broad class of models includes ordinary regression, analysis of variance, log-linear regression, sequential regression, stepwise regression and chi-square analysis (Tabachnick, 2001). Logistic regression allows one to predict a discrete outcome from a set of variables that may be continuous, discrete, dichotomous, or a combination of these. Typically, the dependent variable is dichotomous and the independent variables are either categorical or continuous. Chi-square (χ^2) test of independence is used to examine the relationship between two discrete variables (Tabachnick, & Fidell, 2001). For this study χ^2 was used to examine the expected and observed frequency of overweight in a sample of ninth grade students.

3.5.1 Specific aim 1

To conduct a factor analysis of questions selected from the 2003 YRBS to represent the constructs of smoking behavior, physical inactivity, and poor dietary behavior.

Factor analysis is a method that is used to reduce a myriad of variables to a few constructs, or a way of determining the nature of underlying variables from a set of variables (Burns, & Grove, 1999). Factor analysis has two purposes: to explore the variables used to identify factors that underlie variables and to identify the simplest patterns noted in relationships among variables, as demonstrated by eigenvalues. In particular, it seeks to unveil how the observed variables explain relationships largely or entirely in terms of a much smaller number of variables called *factors*. However, it disentangles the complexity of relationships among various variables and pairs the variables that can be combined together. A factor is a hypothetical entity that underlies a variable. Factors are unobserved; however, they can be inferred from a set of observed variables. An instrument that measures only one factor is considered factorially pure. On the other hand, when numerous components are latent within a variable, it is loaded with factors. Factor analysis generates a factor matrix that represents a table of coefficients of correlation between the instrument and the underlying factors. Theoretically, factor analysis is based on the variance of components that are not shared with any other component (Tabachnik & Fidell, 2001).

Principal component analysis (PCA) is the method most commonly used to perform factor analysis (Stat Soft, 2007). The correlation matrix, with 1.0s down the main diagonal, is submitted for analysis. In the PCA method, consecutive factors that account for less variability are extracted. In the correlation matrix, variances of all variables are equal to 1.0, thus making the total variance in that matrix equal to the number of variables.

The extraction of principal components is based on the principle of a variance maximizing (varimax) rotation of the original variable space. The fundamental theory of factor analysis is invariant within rotations. Orthogonal rotations are used most commonly. The original *x*-axis of a scatterplot is rotated in such a way that it approximates the regression line and maximizes variability.

Factor loadings are the correlation coefficients between variables and factors. Analogous to Pearson's *r,* the squared factor loading is the percent of variance in all variables accounted for by the number of variables. Factor loadings are found in a component matrix. They then are subjected to rotation—a process by which the solution is made more interpretable, making high correlations higher and low correlations lower. This process is important in the interpretation of factors. Variances extracted by these factors are called *eigenvalues.* An eigenvalue is the value that is equal to the sum of the squared weights for all factors. Many researchers establish as their cutoff point for factor extraction eigenvalues greater than 1.00. Others may use the cutoff rule of factors with a minimum of 5% explained variance; yet another criterion is based on the principle of discontinuity: A sharp drop in the percentage of explained variance indicates the appropriate termination point. Determining the optimal number of factors is subjective in nature. However, this study used an eigenvalue greater than 1 and a notably sharp drop in explained variance to determine a factor. Whichever criterion is selected, the general consensus is that it is better to extract too many factors than too few (Polit, & Beck, 2004).

3.5.2 Specific aim 2

To describe the modifiable risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior in a population of 9th-grade students who completed the 2003 YRBS.

Descriptive statistics were used to report the composite factor scores for each CV risk behavior, as developed in specific aim 1, as well as individual item responses associated with each risk factors. Descriptive statistics include frequencies and percentages and means and standard deviations for individual items from the YRBS.

3.5.3 Specific aim 3

To examine relationships among the risk behavior factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior for the total sample.

Pairwise associations, using Pearson r correlations between variables are used to yield a numerical response. Empirical associations are noted for those pairs that have statistically significant values with a p value < .05.

3.5.4 Specific aim 4

To examine relationships among the risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior for subgroups identified by race and gender.

The demographic subgroups of gender and race are analyzed. Gender is dichotomized, and frequencies and percentages then are used to describe this characteristic. Race is categorized as White, Black, Hispanic, or Other based on the self-report of participants. Individuals who identify themselves as Black or African American are categorized as Black, and those who select the racial category of Hispanic or Latino or Multiple Hispanic are categorized as Hispanic. The remaining descriptor of Other encompasses those respondents who select American Indian or Alaskan Native, Asian, Native Hawaiian/Pacific Islander, or Multiple/Non-Hispanic as their

racial/ethnic identity. For each of these gender and racial/ethnic identities, Pearson r correlations are reported for the factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior.

A post hoc power analysis is performed to validate power from this dataset. This is accomplished with the use of Russ Lenth's power and sample size applet (Lenth, 2006). The alpha is set at .05 because this is the most commonly used and least restrictive level of significance. This allows the majority of statistical significance to be identified, thus leading to further exploration. This sample size of approximately 4,000 records makes it possible to detect correlations as small as .045 with 80% power.

3.6 HUMAN SUBJECT PROTECTION

The University of Pittsburgh Institutional Review Board determined this study to be exempt from human subject concerns (Letter of Approval, Appendix B). Data were procured from an intermediary source after cleaning and sanitizing had occurred. Data provided to the investigator were de-identified, thus confidentiality and the anonymity of subjects were assured.

4.0 PRESENTATION OF FINDINGS

The purpose of this study is to describe patterns and relationships among the modifiable cardiovascular risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior within a sample of 9th-grade male and female students, as identified from the 2003 Youth Risk Behavior Survey (YRBS). This section presents analytical findings based on the specific aims for this study, as well as a summary of results. Specific aims for this study are as follows:

1. To conduct a factor analysis of questions selected from the 2003 YRBS to represent the constructs of smoking behavior, physical inactivity, and poor dietary behavior.
2. To describe the modifiable risk factors of smoking, overweight, physical inactivity, and poor dietary behavior in a population of 9th-grade students who completed the 2003 YRBS.
3. To examine relationships among the risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior for the total sample.
4. To examine relationships among the risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behavior for subgroups identified by race and gender.

Specific questions were selected from the 2003 YRBS codebook for their representativeness of the modifiable risk factors of interest as guided by the conceptual framework for this dissertation; they were directed at answering the following research question: What are the patterns and relationships among smoking behavior, overweight, physical inactivity, and poor dietary behavior in 9th-grade students? The analysis follows from the

aforementioned specific aims. Data were analyzed with the use of Pearson correlations and logistic regression.

4.1 ANALYSES

4.1.1 Analysis of specific aim 1

The first specific aim of this study was to conduct a factor analysis of questions selected from the 2003 YRBS to represent the constructs of smoking behavior, physical inactivity, and poor dietary behavior. The principal component analysis (PCA) method was used to accomplish this goal. Analysis was performed for each specific modifiable cardiovascular risk factor for which interval level data were available, namely, smoking behavior, physical inactivity, and poor dietary behavior.

Smoking behavior

The five items from the YRBS that were selected as representative of smoking behavior were entered into the PCA model for smoking behavior. These items addressed behaviors such as the age at which a person tried the first cigarette, the number of cigarettes smoked per day, and regularity of the smoking behavior. Table 10 lists the specific items and depicts the factor pattern matrix for smoking behavior. To minimize communality, or the proportion of shared variance to each factor, it is necessary to rotate the matrix. Rotation allows for meaningful interpretation of the factor loadings (Kim & Mueller, 1978). For the construct of smoking behavior, rotation convergence appeared after three iterations.

Table 10: Final Rotated Component Matrix for Smoking Behavior

Extraction method: Principal component analysis
Rotation method: Varimax with Kaiser normalization
Rotation converged in three iterations

Item	Question	Factor 1	Factor 2
30	Number of days smoked cigarettes in the past 30 days	**.935**	.240
31	Number of cigarettes smoked per day in the past 30 days	**.907**	.268
34	Ever smoked cigarettes daily for 30 days	**-.870**	-.155
28	Ever tried cigarette smoking, even one or two puffs	-.205	**-.893**
29	Age smoked whole cigarette for the first time, years	.221	**.890**

The final component transformation matrix for smoking behavior is identified in Table 11; it demonstrates successful data reduction of smoking behavior to only two factors. Thematic consistency was reviewed for each factor to obtain an appropriate factor label. Items 30, 31, and 34, loaded as factor one, were descriptive of smoking activity within the past 30 days. Items 28 and 29, loaded as factor two, were descriptive of past attempts at smoking. Factor one was labeled as *recent smoking* and factor two was labeled as *tried smoking*. PCA revealed the presence of two components with an eigenvalue exceeding 1, explaining a total of 85.7% of the variance for the construct of smoking behavior. *Recent smoking* accounted for 64.114% of the

variance, and *tried smoking* added 21.659% to the variance. Thus, conceptualization of smoking behavior was depicted by two factors: *recent smoking* and *tried smoking*.

Table 11: Total Variance Explained for CVD by Smoking Behavior

Factor	Eigenvalue	Percent of Variance Explained	Cumulative Percent of Variance Explained
Recent smoking	3.206	64.114	64.114
Tried smoking	1.083	21.659	85.772
	.363	7.250	93.022
	.284	5.686	98.703
	.065	1.291	100.00

Extraction method: PCA.

CVD = cardiovascular disease; PCA = principal component analysis.

Physical inactivity

The eight items selected to represent the modifiable risk factor of physical inactivity were entered into the PCA model. These eight items addressed such concerns as the number of times the student exercised in the past 7 days, the number of sports played, the number of days of light activity, and the number of hours per day spent watching TV. Table 12 lists the specific items and depicts the factor pattern matrix that emerged from the analysis. Factor loadings revealed three distinct factors, with convergence after three iterations. These three factors then were assessed for the percent of variance explained, as evidenced by eigenvalues that approximated or exceeded the value of 1. Questions 82, 80, 81 and 83 loaded on factor one and centered on

exercise and level of activity; thus, factor one was labeled *exercise*. Items 84, 85 and 93 loaded on factor two, and addressed participation in and activity associated with physical education class, as well as potential limitations imposed by injury; therefore, the label *phys ed class* was assigned. The only item that loaded on the third factor, item 83 was related to sedentary activities, primarily TV, thus the label *TV* was assigned. As depicted in Table 13, only two factors have eigenvalues in excess of 1; however, the third factor approximated 1, at 0.985, and accounted for 12.31% of the variance for the construct, thus both the Kaiser criterion and the concept of comprehensibility were employed to determine inclusion of a factor in the final explanation of the construct (Hu, 2003). This decision is supported by the percent of variance for physical inactivity explained by the three chosen factors, specifically *exercise* explained 32.352%, *physical education class* explained 16.449%, and *television* explained 12.310%, for a total of 61.110% of variance on the construct of physical inactivity.

Table 12: Final Rotated Component Matrix for Physical Inactivity

Extraction method: Principal component analysis
Rotation method: Varimax with Kaiser normalization
Rotation converged in three iterations

Item	Question	Factor 1	Factor 2	Factor 3
82	Number of times exercised at least 20 minutes in the past 7 days	**.771**	.172	.001
80	Number of days strengthening/toning muscles in the past 7 days	**.770**	.260	.088
81	Number of sports teams played on in the past 12 months	**.639**	-.030	.021
86	Number of days participated in light physical activity in the past 7 days	**.527**	.110	-.395
84	Number of minutes in actual exercise/sports in an average physical education class	.084	**.898**	.047
85	Number of days of physical education class in an average school week	.141	**.869**	.027
93	See MD/nurse for exercise/sports injury	.178	**.422**	-.359
83	Number of hours spent watching TV on an average school day	.034	.084	**.896**

Table 13: Total Variance Explained for CVD by Physical Inactivity

Factor	Eigenvalue	Percent of Variance Explained	Cumulative Percent of Variance Explained
Exercise	2.588	32.352	32.352
Phys ed class	1.316	16.449	48.801
TV	.985	12.310	61.110
	.859	10.743	71.854
	.836	10.447	82.301
	.658	8.231	90.531
	.449	5.609	96.141
	.309	3.859	100.00

Poor dietary behavior

The seven items that were selected to represent poor dietary behavior addressed information such as the number of times certain food items such as potatoes, carrots, fruits, and milk were ingested in the past 7 days. Table 14 lists the items and depicts the factor pattern matrix that emerged from the analysis. Factor loadings revealed three distinct factors, with convergence after five iterations. These three factors then were assessed for the percent of variance explained as evidenced by an eigenvalue that approximated or exceeded the value of 1. Questions that were loaded on factor one were centered on vegetable intake; thus, factor one was labeled *vegetables*. Items that were loaded on factor two addressed fruit intake; therefore, the label *fruit* was assigned. Items that were loaded on the third factor were related to intake of milk; thus, the label

milk was assigned. As is depicted in Table 15, only two factors had eigenvalues in excess of 1. However, the third factor, *milk*, had an eigenvalue of (λ = .865), and explained 12.354% of the variance for the construct. Conceptually, the inclusion of milk in the diet is important in terms of dietary standards, thus although the eigenvalue for this factor is similar to some eigenvalues not included in previous factors, the percent of the variance explained is quite similar to factors included in other factors. The concept of comprehensibility was used to determine inclusion of a factor in the final explanation of the construct (Hu, 2003). This decision is supported by the percent of variance for poor dietary behavior explained by the three chosen factors, specifically *vegetables* explained 39.780%, *fruit* explained 14.920%, and m*ilk* explained 12.354%, for a total of 67.054% of variance on the construct of poor dietary behavior.

Table 14**:** Final Rotated Component Matrix for Poor Dietary Behavior

Extraction method: Principal component analysis
Rotation method: Varimax with Kaiser normalization
Rotation converged in five iterations

Item	Question	Factor 1	Factor 2	Factor 3
76	Number of times ate potatoes in the past 7 days	**.780**	-.059	.134
77	Number of times ate carrots in the past 7 days	**.759**	.125	.105
78	Number of times ate other vegetables in the past 7 days	**.617**	.445	.059
75	Number of times ate green salad in the past 7 days	**.613**	.380	-.048
73	Number of times drank 100% fruit juices in the past 7 days	.013	**.831**	.102
74	Number of times ate fruit in the past 7 days	.264	**.759**	.104
79	Number of glasses of milk drunk in the past 7 days	.130	.151	**.971**

Table 15: Total Variance Explained for CVD by Poor Dietary Behavior

Factor	Eigenvalue	Percent of Variance Explained	Cumulative Percent of Variance Explained
Vegetables	2.785	39.780	39.780
Fruits	1.044	14.920	54.699
Milk	.865	12.354	67.054
	.669	9.556	76.610
	.581	8.307	84.917
	.552	7.888	92.805
	.504	7.195	100.00

Extraction method: Principal component analysis

In summary, the PCA method of factor analysis was used to reduce selected items from the 2003 YRBS to those that best represented the constructs of smoking behavior, physical inactivity, and poor dietary behavior. The construct of smoking was represented by two factors, namely, *recent smoking* and *tried smoking*. The construct of physical inactivity was represented by three factors: titled *exercise, physical education classes,* and *television*. The final construct, poor dietary behavior, was represented by three factors, specifically, *vegetables, fruit*, and *milk*. These eight factors were used in all descriptive and correlation analyses for specific aims 2, 3, and 4.

4.1.2 Analysis of specific aim 2

The second aim of this study was to describe patterns of smoking behavior, overweight, physical inactivity, and poor dietary behavior in a population of 9th-grade students. Descriptive statistics were employed to describe the eight factors identified in the Principal Component Analysis of Aim 1. In addition, the variable of overweight, calculated from self-reported height and weight on the YRBS, is described.

Smoking behavior

The factors that represent smoking behavior were *recent smoking* and *tried smoking* as identied in specific aim 1. Table 15 summarizes the factor loadings, minimum and maximum factor scores, and percent of variance attributable to the two factors of the construct of smoking behavior. Five items on two factors account for 85.772 percent of the variance for the variable of smoking behavior, with *recent smoking* contributing 64.114 percent of variance, and *tried smoking* contributing 21.659 percent of variance. Factor scores were determined for each student response, with the range of scores of -.97 to 4.08 for *recent smoking* and -.86 to 2.33 for *tried smoking*. On either factor, a lower score is indicative of absent or minimal participation in smoking behavior, while a higher score is indicative of more frequent experimentation or a regularly established pattern of smoking.

Table 16: Factor Loadings, Minimum and Maximum Factor Scores, and Percent of Variance Attributable to the Two Factors of the Construct of Smoking Behavior, 2003 YRBS

Item Number from the 2003 YRBS	Factor label	Factor Loading	Percent of Variance	Minimum Factor Score	Maximum Factor Score
	Recent Smoking				
30		.935	64.114	-.97	4.08
31		.907			
34		-.870			
	Tried Smoking				
28		-.893	21.659	-.86	2.33
29		.890			
Total			85.772		

The factor of *recent smoking* describes a pattern of self-reported smoking that addresses the amount and frequency of cigarettes smoked and the number of days that the 9th-grader smoked over the 30 days preceding survey completion. Figure 2 is a bar graph that depicts the factor scores for the 9th-grade students who responded to the 2003 YRBS. Each bar of the graph represents the number of students with a factor score that falls within a range in intervals of 1, beginning with -2 and ending with 5. For example, 3,211 students had factor scores in the -1 to 0 range. The mean for any factor score is 0, and the standard deviation is 1. The lower the score in the range of possible score, the lower the participation of the student in a particular activity. The factor score is a reflection of the combined responses of the three items that load onto the factor. For the factor of recent *smoking*, the low incidence of reported smoking is reflected by the preponderance of factor scores below zero (n=3,211, 82.93%).

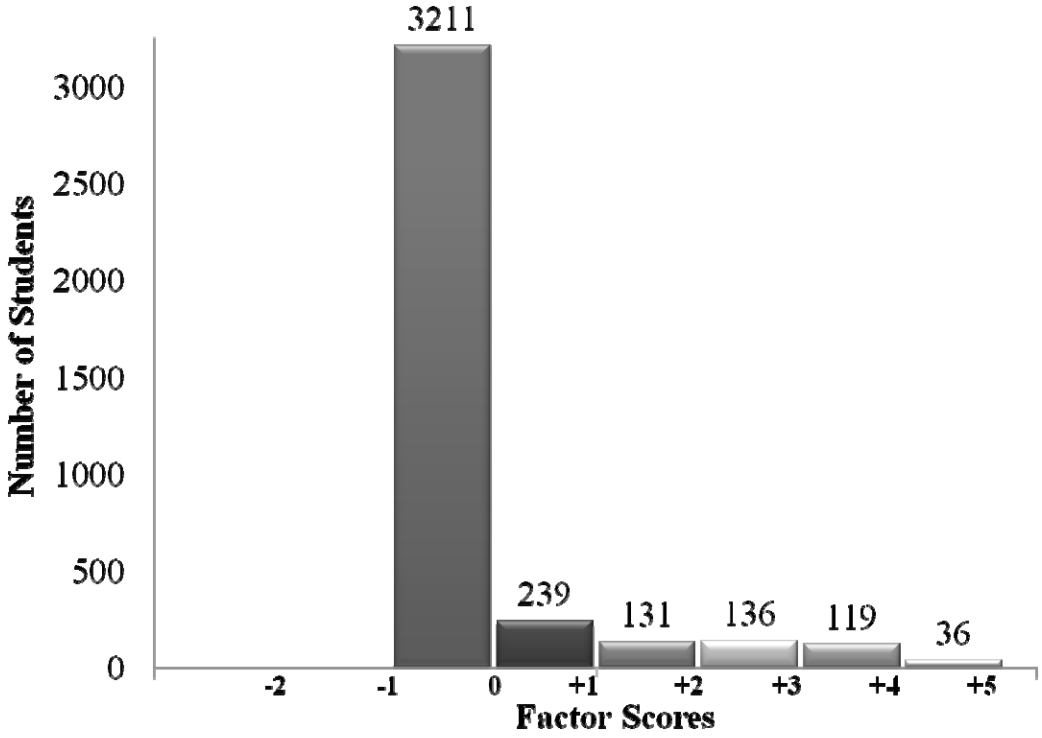

Figure 2: Bar graph of the distribution of factor scores for *Recent Smoking* for 9th-graders who completed the 2003 YRBS (n=3,872).

There were three items that contributed to the factor *recent smoking*, namely items 30, 31, and 34. Item 30, as noted in figure 3, asked students to categorize their smoking by the number of days they smoked according to the following categories: (a) did not smoke at all, or smoked for (b) 1 to 2 days, (c) 3 to 5 days, (d) 6 to 9 days, (e) 10 to 19 days, (f) 20 to 29 days, or (g) all 30 days. Of students who responded to this item, 732 (17.3%) of 9th-graders admitted to smoking on at least some of the past 30 days. Of 732 recent smokers, nearly one-fourth of students (n=208, 28.4% of those reporting smoking, 5.0% of the total sample) who smoked in the past 30 days indicated that they had smoked on all 30 days However, 181 students (4.3% of those reporting smoking, 17.4% of total sample) reported smoking only 1 to 2 days, and an additional 13.9% of those who reported smoking (2.4% of the total sample), or 102 students, reported

smoking on 3 to 5 days. Item 30 loaded heavily onto the factor *recent smoking* with a factor loading of .935.

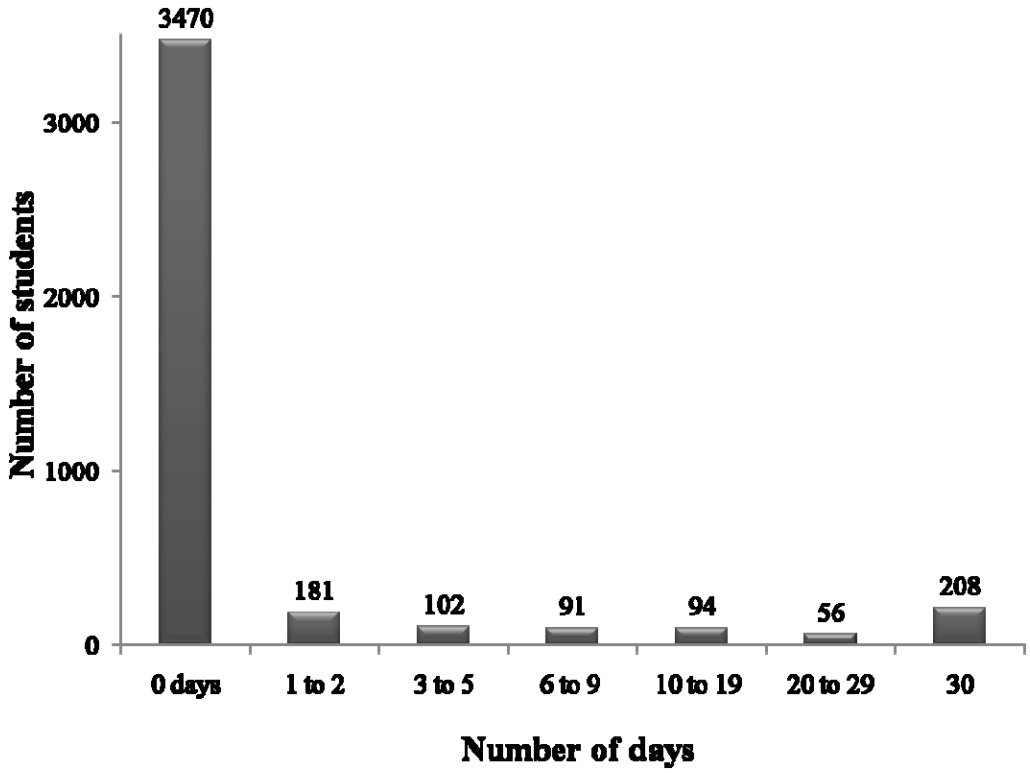

Figure 3: Bar graph of responses to Item 30 from the 2003 YRBS "During the past 30 days, on how many days did you smoke cigarettes?" (n=732).

Item 31 asked the student to respond to the number of cigarettes that the student smoked per day. As noted in figure 14, of the students who responded to this item (N=726), 165, (4.0%) acknowledge that they smoked less than 1 cigarette per day within the past 30 days, 139 (3.4%) admitted to smoking 1 cigarette per day, 260 (6.3%) reported smoking 2 to 5 cigarettes, 84 students (2.0%) reported smoking 6 to 10 cigarettes, and 39 students (.9%) reported smoking 11 to 20 cigarettes per day. Less than 1% (.9%) indicated that they smoked more than 20 cigarettes

in the last 30 days. Item 31 loaded highly onto the factor *recent smoking* with a factor loading of .907.

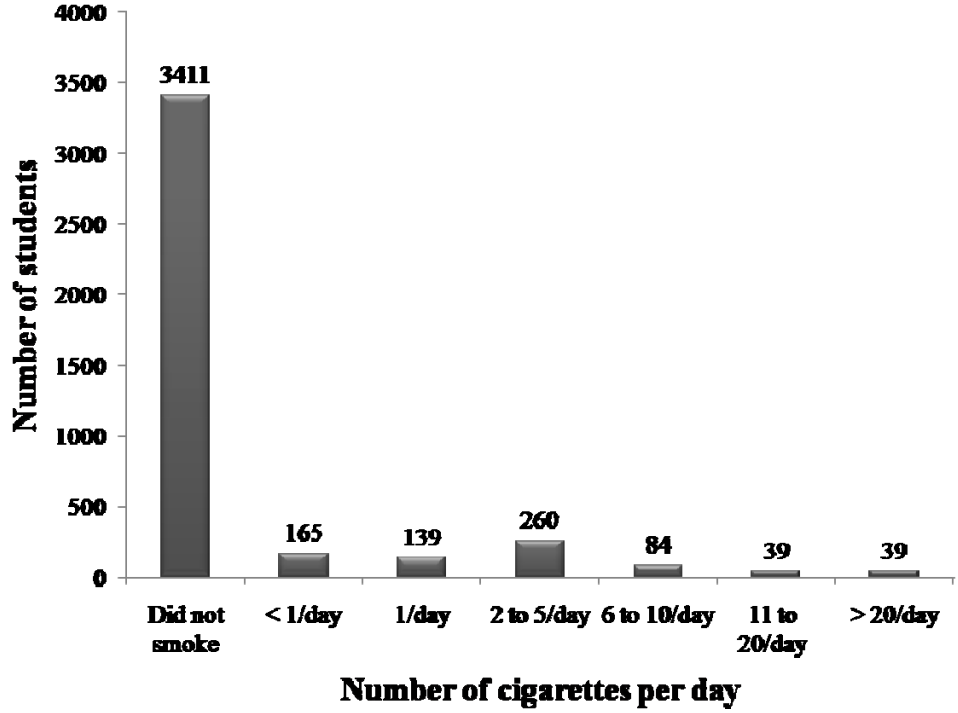

Figure 4: Bar graph of responses to Item 31 from the 2003 YRBS, "During the past 30 days, on the days you smoked, how many cigarettes did you smoke per day?" (n=726).

The third item to load onto the factor of *recent smoking* was item 34, which addressed the consistency of the smoking behavior by asking "Have you ever smoked cigarettes daily, that is, at least one cigarette every day for 30 days?" This item had a factor loading of -.870. Loading scores or components are the correlation between the item and the factor, and a negative sign is an indicator of the direction of the correlation. That is, negative loadings are caused by questions that are negatively oriented to the factor. In this instance, a response that a student did smoke one cigarette a day for 30 days would yield a positive factor loading, and a denial of consistent smoking would yield a negative factor loading. Figure 5 is a pie chart that reports total responses to this item by number and percent of "yes" and "no" responses. A yes response indicates the

student is engaged in regular smoking, that is, at least one cigarette every day for 30 days. Eighty-eight percent of respondents (n=3660) denied having one cigarette every day for 30 days. Only 476 9th-grade students indicated they smoked at least one cigarette every day for 30 days.

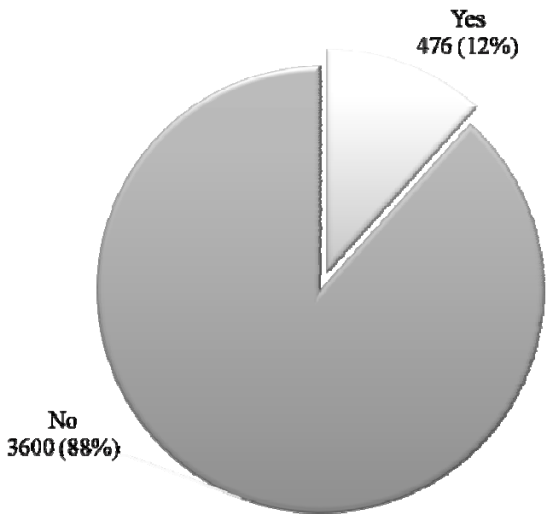

Figure 5: Pie chart of 9th-grade responses to Item 34 from the 2003 YRBS, "Have you ever smoked cigarettes daily, that is, at least one cigarette every day for 30 days?" (n=4,076).

Taken together, these three items illustrate that a small percentage of students are participating in regular smoking, if partaking of cigarettes at all. The factor scores for *recent smoking* confirm these per item observations, as of the 3882 students for whom data were available for the calculation of factor scores, 3211 9th-grade students 82.7% have factor scores between -1 and 0, indicative of participation in *recent smoking* that is quite limited or absent.

Two items loaded on the second factor for the construct of smoking behavior, labeled *tried smoking*. Though obvious from the data presented on *recent smoking*, the majority of students in ninth grade do not smoke. However, there are more students who have experimented with smoking behavior as evidenced by the factor *tried smoking.* The range for the factor *tried smoking* was between -1.0 and 3.0 (see figure 6). Two thousand ninety-three of the 3,871

respondents had factor scores between -1 and 0, and thus had either no or quite limited experimentation with smoking. The remaining 1,758 students had factor scores greater than 0, scores that are representative of more frequent experimentation.

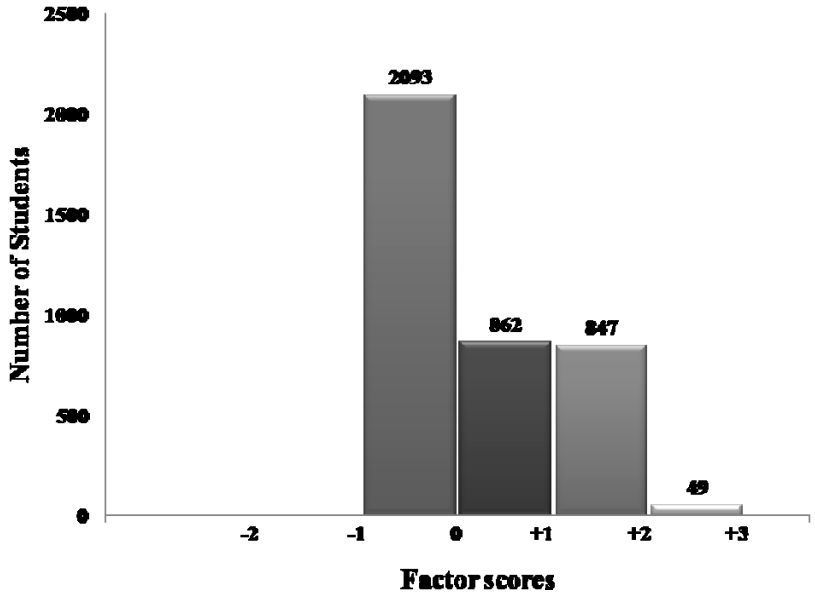

Figure 6: Bar graph of the distribution of factor scores for *Tried Smoking* for 9th-graders who completed the 2003 YRBS (n=3,851).

Item 28 had a factor loading of -.893. Specifically, item 28 asked students to respond by answering yes or no to the question "Have you ever tried cigarette smoking, even one or two puffs?" As noted in figure 7, to this question, 2,222 9th-grade students (52%) responded in the affirmative, while 2,051 students (48%) denied trying cigarettes.

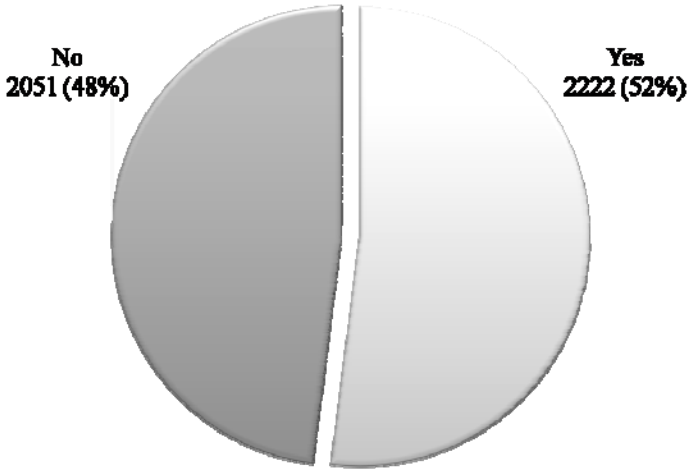

Figure 7: Pie chart of 9th-grade student responses to Item 28 from the 2003 YRBS "Have you ever tried smoking, even one or two puffs?" (n=4,273)

Item 29 provides additional information about these smoking attempts, by asking the student to report the age at which the student smoked a whole cigarette for the first time. Sixty-three percent of students (n=2638) reported that they had never smoked a whole cigarette. For the remaining 1530 9th-grade students (37%), age 13 to 14 was the most common age for students to have smoked a whole cigarette (n=616, 40.2%), followed in percent occurrence at these earlier ages: age 11 to 12 (n=377, 24.6%), ages 9 to 10 (n=242, 15.8%), 8 years of age and younger (n=186, 12.1%), and then these older ages 15 to 16 (n=107, 6.9%) and 17 years or older (n=2, .1%).

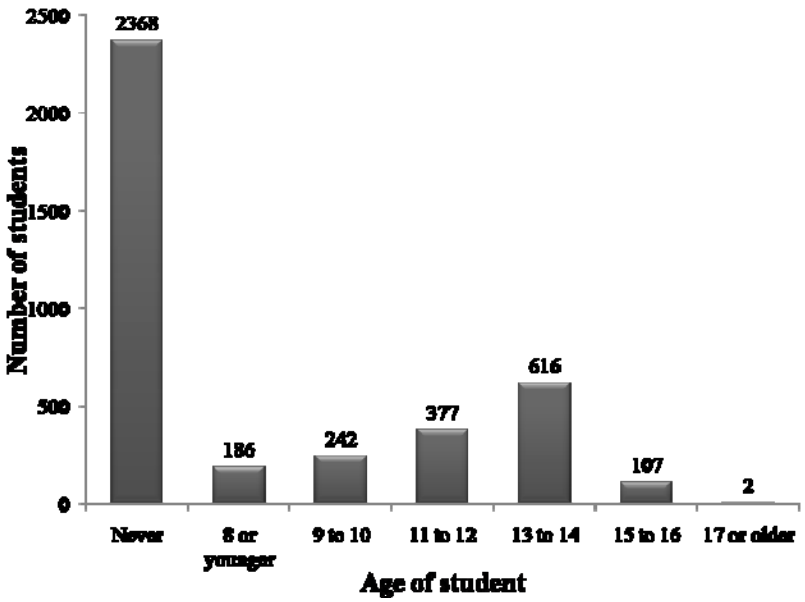

Figure 8: Bar graph of responses to Item 29 from the 2003 YRBS "How old were you when you smoked a whole cigarette for the first time?" (n=3,898)

Thus, these two items taken together in the form of a factor score illustrate the 9th-grade involvement with experimental cigarette smoking behavior. The factor scores confirm these per item observations of the 3,851 students for whom data were available for the calculation of factor scores, reveal the combined influence of age and experimental smoking behavior and range from -1 to +3. Therefore, it can be concluded that the factor scores of *tried smoking* demonstrate that there are very few 9th-grade students who first experiment with smoking behavior, while the vast majority of 9th-grade students, those with a negative factor score, have either already tried this behavior and did not sustain it, or do not currently participate in smoking behavior.

Overweight

Overweight was determined through calculation of a body mass index (BMI) based on individual responses provided to questions regarding height and weight. Following this calculation, the BMI was categorized as overweight or non-overweight, in accordance with the Centers for Disease Control and Prevention (CDC) definition of overweight as a BMI greater than the 85th percentile. Table 16 displays the numerical findings that revealed that 1,213 9th-graders (31.2%) were identified as overweight. Five hundred fifty-nine students (12.6%) did not report data needed for the BMI calculation. Table 16 displays the frequency of overweight and non-overweight students classified by gender and race. When reported by gender and race, the rank order of percentage of male overweight students by race for was Hispanic (39.3%), Black (32.7%), Other (30.5%) and White (27.0%). For female overweight students, the rank order of percent of students was Black (47.4%), Hispanic (38.2%), Other (28.2%), and White (26.4%).

Table 17: Weight Disbursement of 9th-Graders from the 2003 YRBS: Overweight and Non-overweight Students (n = 3,874)

	Overweight (n=1,213, 31.3%)		Non-overweight (n=2,661, 68.7%)	
	Male	Female	Male	Female
White	311	275	839	765
Black	107	139	220	154
Hispanic	148	133	229	215
Other	58	42	132	107

Physical inactivity

The factors that represent physical inactivity were *exercise, physical education class* and *television* as identified in the analysis from specific aim 1. There were 3,301 students who provided responses for the factors. The factor of *exercise* represents type and quantity of exercise reported by 9th-grade students. As is noted in table 17, *exercise*, the first factor, contributed 32.352 percent of the variance to the construct of physical inactivity, and was represented by items 80 to 82 and 86. The factor labeled *physical education class* accounted for an additional 16.449 percent of the variance on the construct, and the factor television accounted for 12.310 percent of the variance.

The range for the factor exercise was from -2.34 to 2.55. As is noted in figure 10, this is a fairly normal distribution of factor scores demonstrating that exercise for 9th-grade students ranges from primarily sedentary behaviors, as indicated by lower factor scores, to behaviors reflective of regular engagement in activities, as indicated by higher factor scores.

Table 18: Factor Loadings, Minimum and Maximum Factor Scores, and Percent of Variance Attributable to the Three Factors of the Construct of Physical Inactivity, 2003 YRBS

Item Numbers from 2003 YRBS		Factor Loading	Percent of Variance	Minimum Score	Maximum Score
	Exercise				
82		.771	32.352	-2.34	2.55
80		.770			
81		.639			
86		.527			
	Physical Education Class				
84		.898	16.449	-2.04	1.73
85		.869			
93		.422			
	Television				
83		.896	12.310	-2.33	2.24
Total			61.110		

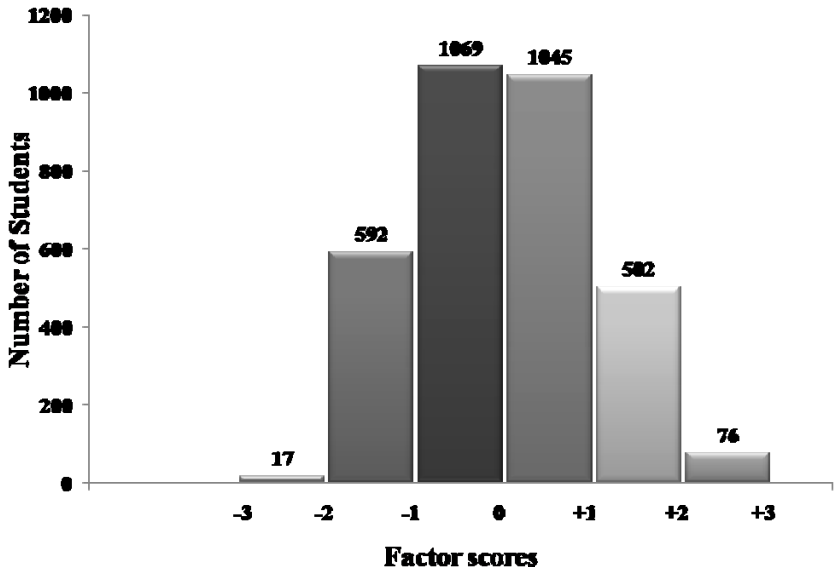

Figure 9: Bar graph of the distribution of factor scores for *Exercise* for 9th-graders who completed the 2003 YRBS (n=3,301).

The highest factor loading was .771 from item 82. In item 82, students were asked to respond with the number of days of the past 7 days that they engaged in exercises to strengthen or tone their muscles, such as push-ups, sit-ups, or weight-lifting. As noted in figure 10, the respondents indicated their participation in strengthening/toning muscles by the number of days of the past 7 days as follows: (a) 0 days, (b) 1 day, (c) 2 days, (d) 3 days, (e) 4 days, (f) 5 days, (g) 6 days and (h) 7 days. Of the 4,266 respondents, nearly one-fourth, 952 students (22.3%) indicated they had not done any strengthening/toning within the past 7 days. Yet, 785 students (18.4%) indicated they had engaged in strengthening/toning for each of the previous 7 days. The remainder of students who responded to this item was distributed across the categories of 1 day through 6 days by as little as 183 students (4.3%) and a maximum of 593 students (13.9%).

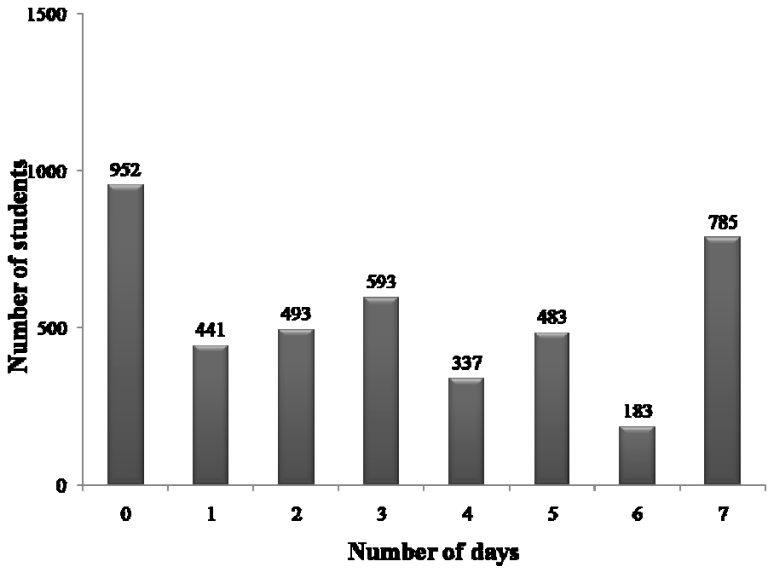

Figure 10: Bar graph of 9th-grade students responses to Item 82 "On how many of the past 7 days did you do exercises to strengthen or tone muscles, such as pushups, sit-ups, or weight training?" (n= 4,266).

Items 80 and 81 address the intensity of exercise in which the 9th-graders participated. The second highest factor loading (.770) was noted for item 80, which asks the number of days that the students participated in exercise or physical activity that made them sweat or breathe hard. As noted in figure 11, of the 4,305 students who responded to item 80 regarding the number of days they exercised for at least 20 minutes over the past 7 days, 628 9th-grade students (14.1%) did not exercise at all. Only 1,090 (25.3%) reported that they exercised on each of the 7 days, although an additional 21.2% reported that they adhered to exercise on 5 or 6 days.

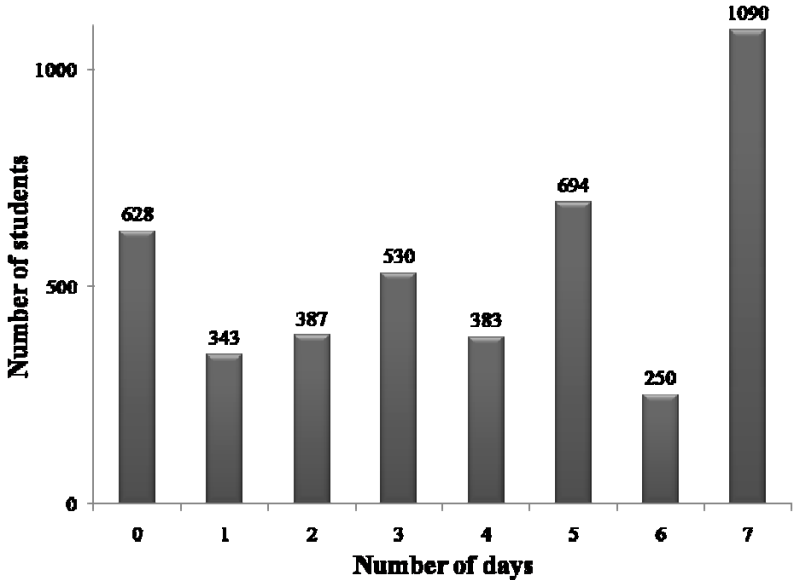

Figure 11: Bar chart of responses to Item 80 from the 2003 YRSB "On how many of the past 7 days did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard ...? (n=4,305).

Item 81 asks the number of days within the past 7 days the 9th-grade respondents engaged in physical activity for at least 30 minutes that did not make the student sweat or breathe hard. The respondents indicated their participation these less strenuous activities by selecting the number of days of the past 7 days as follows: (a) 0 days, (b) 1 day, (c) 2 days, (d) 3 days, (e) 4 days, (f) 5 days, (g) 6 days and (h) 7 days. Of the 4,310 respondents, nearly one-fourth, 1337 students (30.1%) indicated they had not done any activity within the past 7 days. Yet, 614 students (13.8%) indicated they had engaged in these less strenuous activities on each of the previous 7 days. The remainder of students who responded to this item was distributed across the categories of 1 day through 6 days by as little as 152 students (3.4%) and a maximum of 586 students (13.2%) (see figure 12).

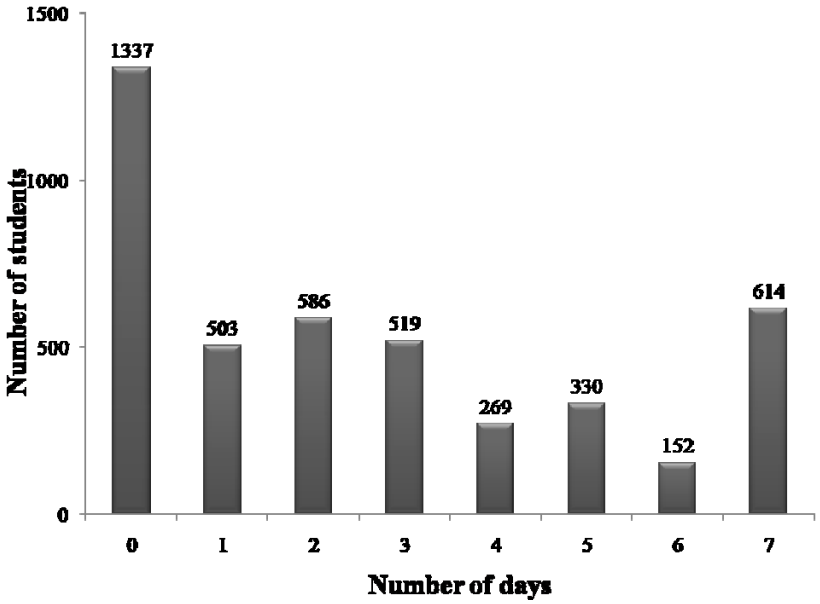

Figure 12: Bar graph of responses to Item 81 from the 2003 YRBS "On how many of the past 7 days did you participate in physical activity for at least 30 minutes that did not make you sweat or breathe hard ...? (n=4,305).

The lowest factor loading (.527) was noted for item 86, which addressed the number of sports teams a ninth grader has played on in the past 12 months, and had a factor loading of .639. The students selections ranged between not playing on any teams to playing on 3 or greater number of teams in the past 12 months. As noted in figure 13, of the 4,029 respondents to this item, 1,601 students (39.7%) reported that had not played on any team. However, 939 students (23.3%) indicated that they had played on at least 1 team, and 693 students (17.2%) indicated that they had played on two teams. There were 796 students (19.8%) who indicated that they played on 3 or more teams within the past 12 months.

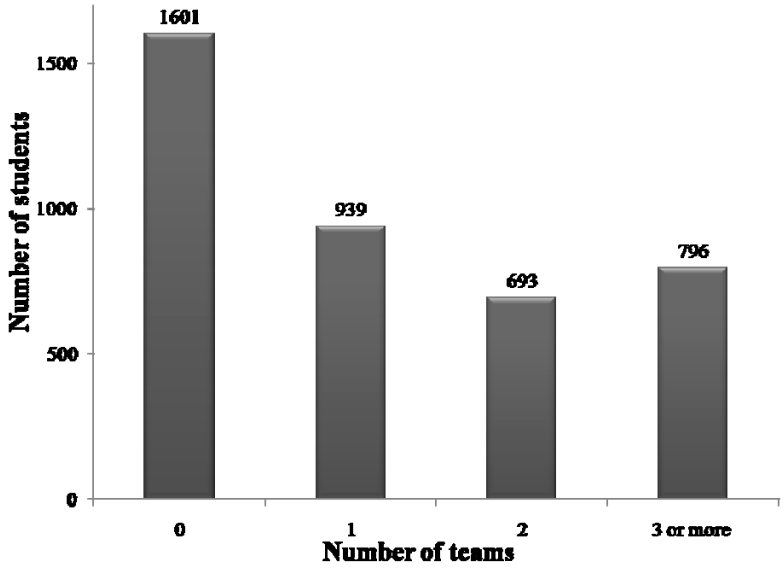

Figure 13: Bar graph of 9th-grade responses to Item 86 on the 2003 YRBS "During the past 12 months, on how many sports teams did you play?" (n=4,029)

In summary, these 4 items taken together in the form of a factor score portray the average 9th-graders involvement with exercise. The factor scores reveal a fairly normal distribution of activity involvement ranging from a score of -3 to +3, showing that about half of the students partake of some exercise.

The second factor that contributes to physical inactivity in 9th-grade students is represented by those items that refer to *physical education class*. This factor provides insight regarding a structure within the school system that encourages increased activity. *Physical education classes* had three items that contributed to the factor. Similar factor loadings, .898 and .869 were noted for items 84 and 85. Both items loaded fairly similarly reflecting not only the number of days engaged in physical education class, but also the time engaged while in the physical education class. *Physical education class* demonstrated a range of -2.04 to 1.73. As is noted in figure 14, the distribution for the factor *physical education* is clearly bimodal, demonstrating that there are clearly two distinct sectors for those involved with physical

education class. Twenty-nine percent of students indicated that the student was not engaged in a physical education class. Thus, the lower range reflects the students not involved in a physical education class or sports and exercise. These students display an approximate range from -2.10 to -.90. The remaining students that report participating in physical education class demonstrate an approximate range between -.90 to 2.0. These scores reflect a fairly normal distribution though slightly skewed to the right signifying that for students attending physical education class the factor physical education glass represents frequency and quantity of time engaged while in physical education class.

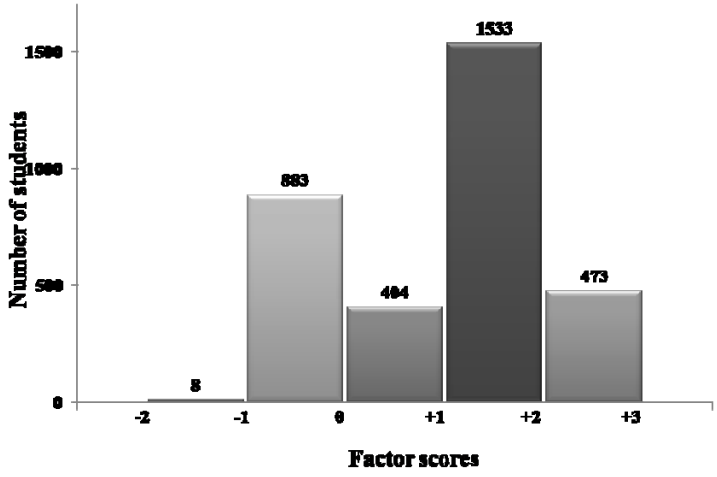

Figure 14: Bar graph of the factor score distribution for the factor *Physical Education Class* for 9th-grade students who completed the 2003 YRBS (n=3,301).

Item 84, factor loading of .898, asked for the number of days the 9th-grade student participated in physical education class in an average school week. The students selected between no days to 5 days per week. As noted in figure 15, for the 3,876 students who responded to this item, 1467 students (37.9%) reported that they participated in physical education classes on 5 days of the

week and 19.7% on 3 days of the week; 29.0% indicated no participation in physical education class.

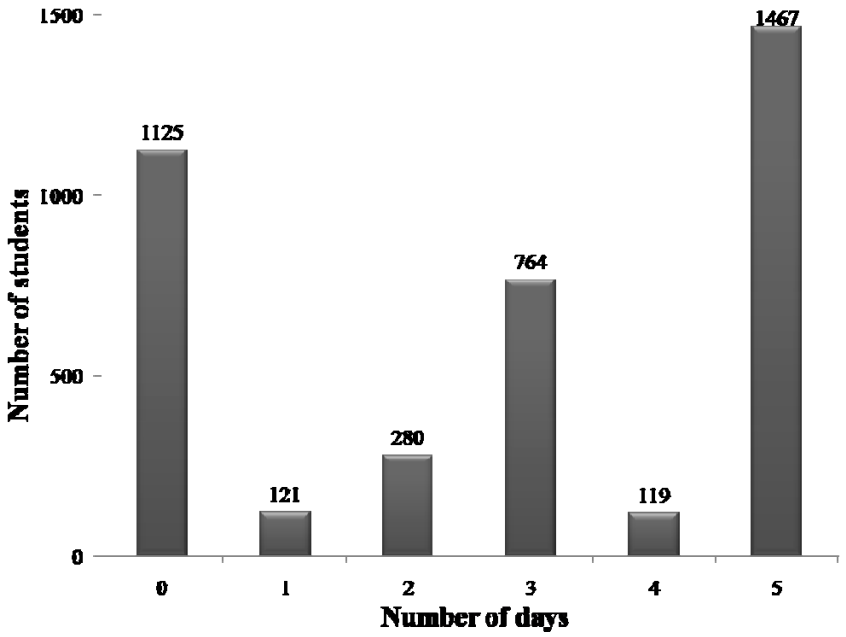

Figure 15: Bar graph of the 9th-grade responses to Item 84 of the 2003 YRBS "In an average week when you are in school, on how many days do you go to physical education (PE) classes?" (n=3,876).

Item 85 addressed the amount of time engaged in exercise while in physical education class and had a factor loading of .869. As noted in figure 16, there were 3,900 students that responded to this item, and 1,130 students (29.0%) reported that they do not take physical education class. For those who reported participation, 545 students (14.0%) are engaging in 20 minutes or less of activity during physical education class. There were 458 students (11.8%) who indicated that they spend 21 to 30 minutes in actual exercise during class, 526 students (13.5%) reported engaging in 31 to 40 minutes, 387 students (9.9%) reported engaging in 41 to 50 minutes, and 283 students (7.3%) reported engaging in 51 to 60 minutes per physical education class. There

were 570 students (14.6%) who reported engaging in more than 60 minutes of exercise in physical education class.

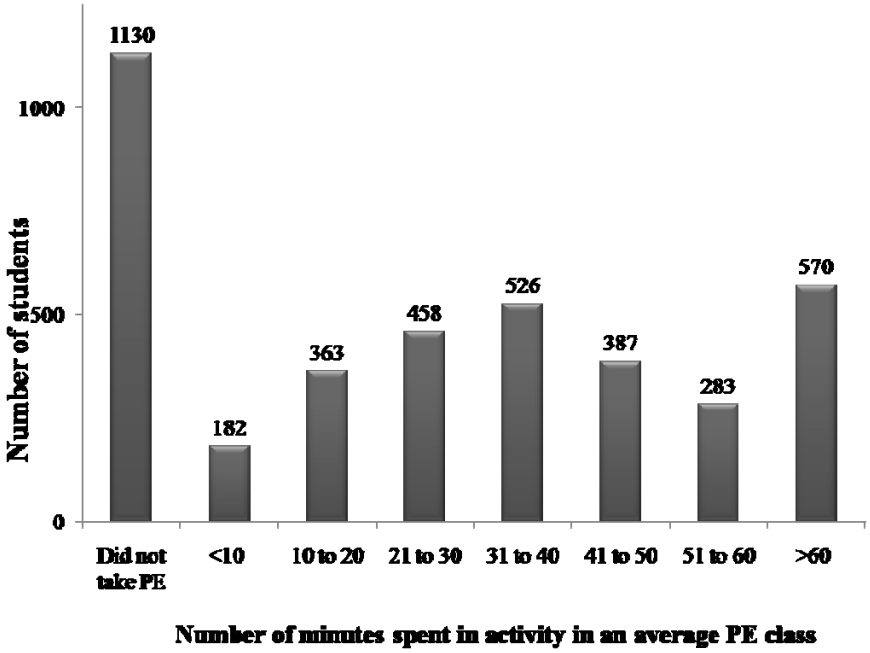

Figure 16: Bar graph of the 9th-grade students' responses to Item 85 "During an average PE class, how many minutes do you spend actually exercising or playing sports?" (n=3,900).

Item 93, as represented in figure 17, also loaded on the factor labeled *physical education class,* with a factor loading of .422. This item was "During the past 30 days, did you see a doctor or nurse for an injury that happened while exercising or playing sports?" and students responded to options that included "I did not exercise or play sports in the past 30 days", "yes" or "no". Thus, this item spoke to the student's choice to participate with activities, or to limitations imposed based on such participation.

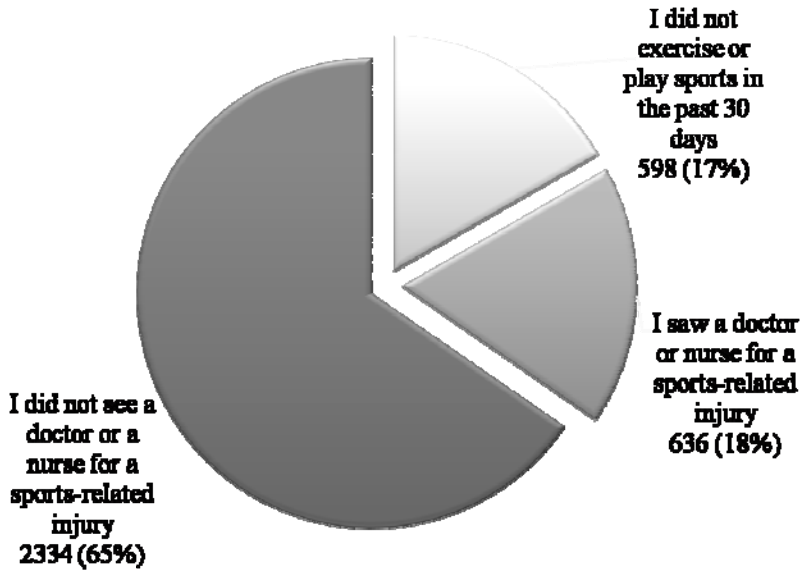

Figure 17: Pie chart representing 9th-grade responses to Item 93 "During the past 30 days, did you see a doctor or nurse for an injury that happened while exercising or playing sports?" (n=3,568).

Taken together, these three items address the frequency and intensity of physical education class, choice to participate in sports and exercise and of injury related to such participation and reveal that the majority of 9th-grade students are engaged in physical education class. This was reflected in the factor scores that ranged from a -2 to +3, where the +3 value represents the represents those adolescents who report an active lifestyle.

The third factor in the construct of physical inactivity was *television*. The sedentary activity was comprised of item 83, which reported the number of hours watching television per day. *Television* accounted for 12.310 percent of variance to the factor physical inactivity and had a range from -2.33 to 2.24. The distribution for the ninth grade students for the factor *television* is a normal distribution, as noted in figure 18. This distribution, labeled *television* demonstrates that there were about as many 9th-grade students engaged in sedentary activity primarily watching television as there were students who limited their sedentary time on an average day.

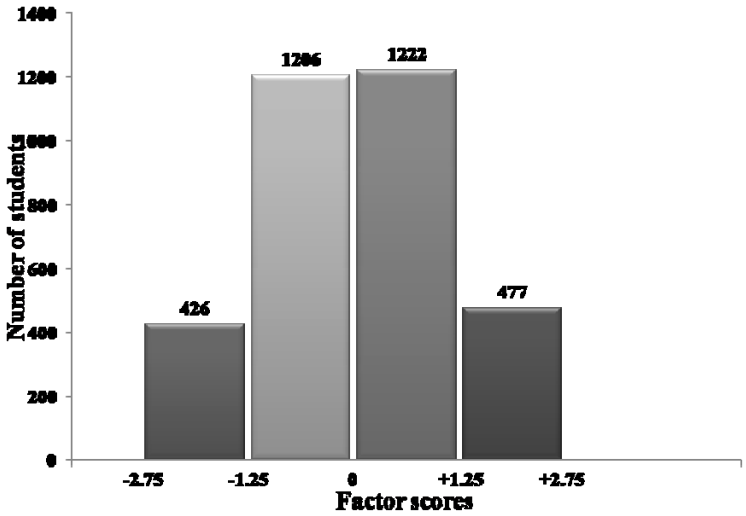

Figure 18: Bar graph of the distribution of factor scores for the factor *Television* on the 2003 YRBS (n=3,331).

Television had a fairly high loading factor of .896 which correlates highly with physical inactivity. For this item, students were asked to report the number of hours engaged in viewing television on an average school day. Figure 19 portrays item 83 which indicated that for the 4,238 students who responded, 2,784 students (65.6%) indicated that they engaged in television watching 2 hours or longer per day; 673 students (15.9%) admitted that they watched 5 or more hours of television per day. Only 8.6% reported no television time.

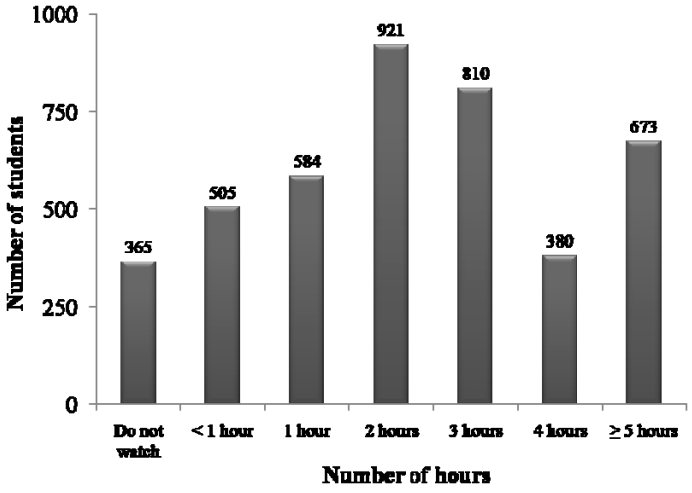

Figure 19: Bar chart of the 9th-grade responses to Item 83 on the 2003 YRBS "On an average school day, how many hours do you watch TV?" (n=4,238).

In summary, these three factors comprise the construct of physical inactivity. Factor scores on these three factors and for the items that comprise the factors describe the status of 9th-grade students' extent of participation in exercise and sports, in school structured activities, and in the sedentary activity of television watching.

The factors that represent poor dietary behavior were vegetables, fruits, and milk. Table 18 summarizes the descriptive data from the three factors of the construct of poor dietary behavior. Seven items on these three factors account for 67.054% of the variance for the construct, with vegetables accounting for 39.78 % of the variance, fruit accounting for 14.92% and milk accounting for 12.354%. Factor scores were determined for each student response, with the range of -2.0 to 5.99 for vegetables, -2.93 to 3.93 for fruits, and -2.35 to 2.33 for milk. For any of these three factors, a lower score was indicative of less frequent consumption of the food item.

Table 19: Factor Loadings, Minimum and Maximum Factor Scores, and Percent of Variance Attributable to the Three Factors of the Construct of Poor Dietary Behavior, 2003 YRBS

Item Numbers from 2003 YRBS		Factor Loading	Percent of Variance	Minimum Score	Maximum Score
	Vegetables				
76		.780	39.780	-2.07	5.99
77		.779			
78		.617			
75		.613			
	Fruit				
73		.831	14.920	-2.58	3.93
74		.759			
	Milk				
79		.971	12.354	-2.35	2.33
Total			67.054		

The range for the factor score of *vegetables* was between -2.07 to 5.99. As portrayed in figure 21, the distribution of factor scores for the factor *vegetables* was normal, with the range of scores extending from -2.07 to 5.99. While the distribution of factor scores appears to be a normal distribution, it should be noted that the preponderance of factor scores (n=3813 of 4182 responses or 91.17%) are below the mean of zero. As lower scores are indicative or a lower participation in the behavior, the factor scores from this analysis represent a low intake of vegetables, in general.

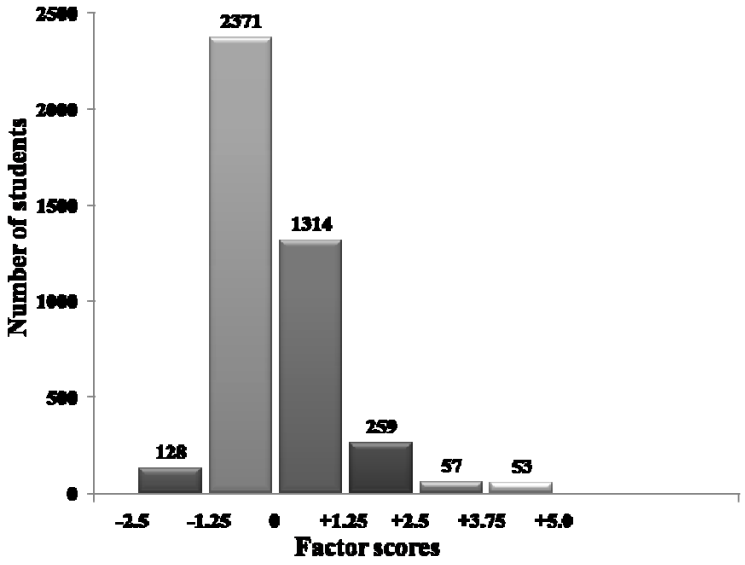

Figure 20: Bar graph of the distribution of factor score for *Vegetables* for 9th-grade students who complete the 2003 YRBS (n= 4,182).

The factor of *vegetables* is represented by items 75, 76, 77, and 78 from the 2003 YRBS. Item 76 addresses consumption of potatoes. As noted in Figure 21, a total of 2,942 students (66.2%) acknowledged that they ate some form of potatoes over the previous 7 days. One thousand nine hundred fifty-seven students (44.%) reported that they had eaten potatoes one to three times over the past 7 days, and 556 students (12.5%) acknowledged that they had eaten potatoes four to six times in the past 7 days. In all, 430 9th-graders (9.6%) reported that they ate potatoes a minimum of one time a day and some ate potatoes as many as four times a day.

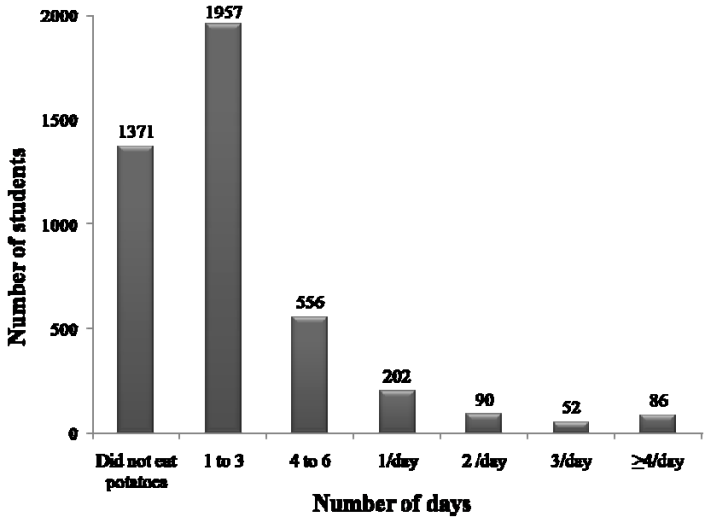

Figure 21: Bar graph of the 9th-grade student responses to Item 76 on the 2003 YRBS "During the past 7 days, how many times did you eat potatoes?" (n=4,238).

Item 77, as seen in figure 22, addresses carrot consumption for ninth graders. Of the 4,336 students who ate carrots, most students ate less than 6 servings within the previous 7 days. While 2,323 students (53.6%) indicated that they had not eaten any carrots within the past week, 1,414 students (32.6%) reported that they had consumed 1 to 3 servings in the past 7 days. There were 262 students (6.0%) who indicated that they had consumed carrots between 4 and 6 times within the last week. For the ninth grade student less than 5% reported that they ate carrots at least once a day or more often.

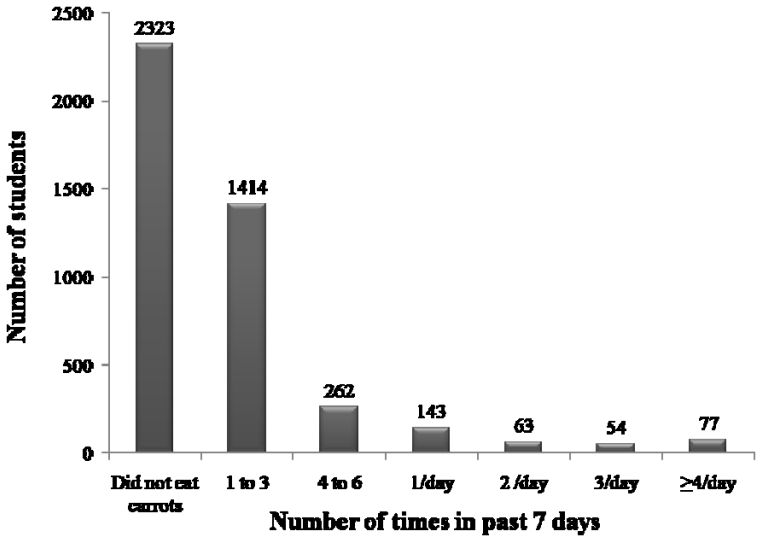

Figure 22: Bar graph of the 9th-grade student responses to Item 77 on the 2003 YRBS "During the past 7 days, how many times did you eat carrots?" (n=4,238).

Item 78, as portrayed in figure 23, asked students to report on the "other vegetables" that they consumed in the past 7 days. Of the 4,261 students who responded, only 752 students (17.6%) acknowledged that they had not eaten any other vegetables other than potatoes or carrots. There were 1,555 students (36.5%) who indicated that they ate 1 to 3 servings of vegetables during the past 7 days, and 972 students who indicated that they had eaten 4 to 6 servings in the past 7 days. Only 532 students (12.5%) reported eating a minimum of one serving of vegetables per day, 224 students (5.3%) reported eating 2 servings within the last 7 days, and 104 students (2.4%) reported eating 3 servings within the last 7 days. A small number of students, 121 (2.8%) reported eating 4 servings of an alternate vegetable within the past 7 days.

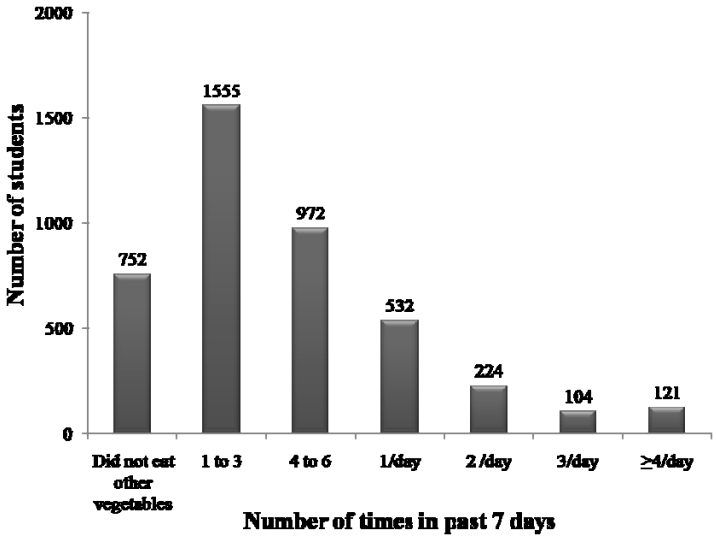

Figure 23: Bar graph of the 9th-grade student responses to Item 78 on the 2003 YRBS "During the past 7 days, how many times did you eat other vegetables?" (n=4,238).

Consumption of green salad was the topic of item 75, which loaded onto the factor vegetables at .613. As noted in figure 24, there were 4,361 (98.1%) who responded to this item. More than one quarter of the ninth graders, 1,708 students (39.2%) indicated that they had not had any salads within the past 7 days. There were 1,483 students (34.0%) who indicated that they had 1 to 3 servings of salad within the past 7 days, while 534 students (12.3%) reported that they had 4 to 6 servings within the past 7 days. Only 314 students (7.2%) reported eating salad at least once a day, and only 159 students (3.7%) reported eating salad twice a day. Those who ate salads frequently were in the minority with only 64 students (1.5%) report eating salad 3 times a day and 98 students (2.2%) report eating salad more than 4 times a day.

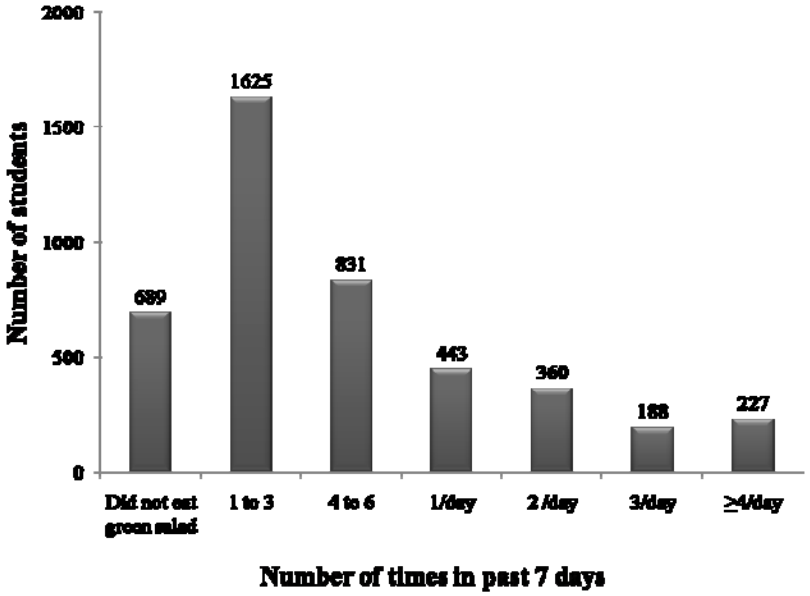

Figure 24: Bar graph of the 9th-grade student responses to Item 75 on the 2003 YRBS "During the past 7 days, how many times did you eat green vegetables?" (n=4,238).

The second factor to emerge for the variable poor dietary behavior was *fruit* and it contributed 14.990 percent of the variance. As is noted in figure 25, while the distribution is positively skewed it does reflect a fairly normal distribution. Two items; 73 and 74 loaded onto the factor *fruit*. Consumption of fruit juice was addressed in item 73, with a loading score of .831. Item 74, which asks students to report on their intake of whole fruits in the past 7 days, achieved a factor loading of .759. The range of factor scores for the factor *fruit* was -2.58 to 3.93.

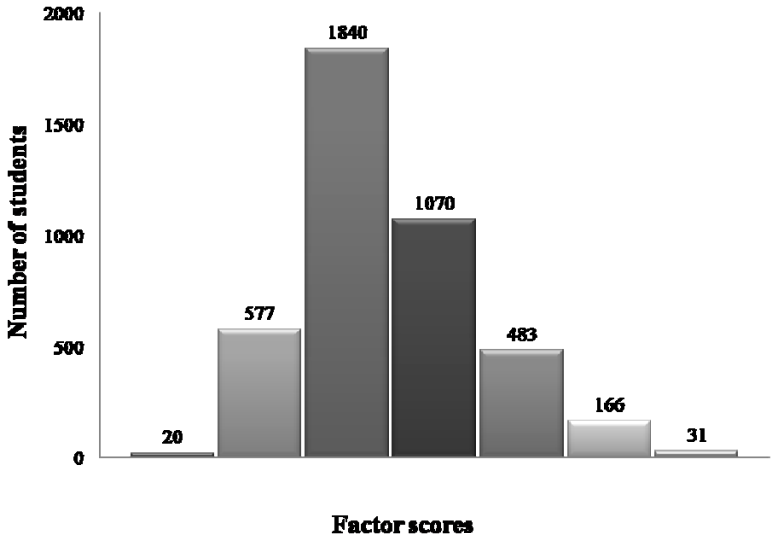

Figure 25: Bar graph of the distribution of factor scores for *fruit* for 9th-graders who completed the 2003 YRBS (n=4,187).

Item 73 addressed 100% fruit juice consumption. As noted in Figure 26, of 4,364 students who responded to this item, only 860 students (19.7%) denied that they had any juice in the past 7 days; however, students who reported that they had two or more servings of juice represented only 21.8% (952 students) of 9th-grade respondents.

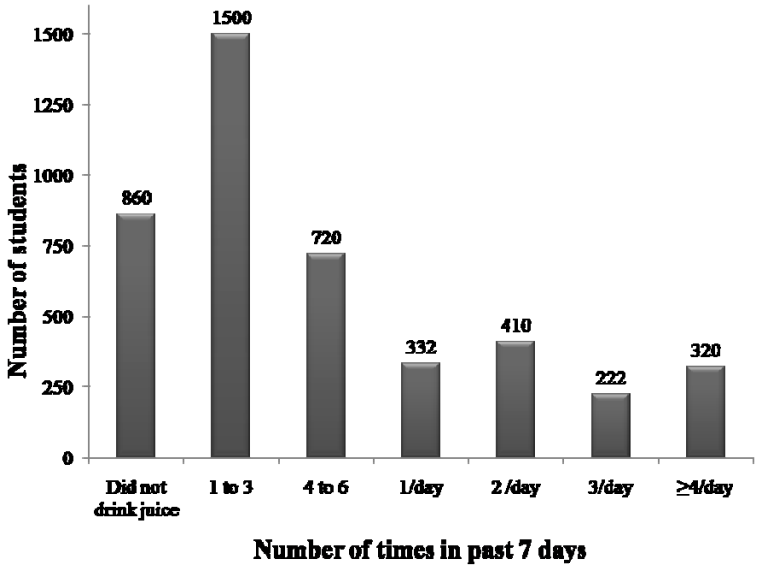

Figure 26: Bar graph of the 9th-grade student responses to item 73 on the 2003 YRBS "During the past 7 days, how many times did you drink 100% fruit juices such as orange juice, apple juice, or grape juice?" (n=4,364).

Item 74 asked students to respond to the number of times they ate fruit within the past 7 days. Figure 27 notes the responses to item 74. Of the 4,363 ninth graders who responded, only 689 students (15.8) reported no fruit consumption at all within the past week. There were 1,625 students (37.3%) who indicated they had 1 to 3 servings within the past 7 days, and only 831 students (19%) indicated that they had consumed 4 to 6 servings. There were only 775 students (17.7%) of the ninth graders who were meeting the minumum recommened amount of fruit intake of one to two cups for the average early adolescent, for the past 7 days.

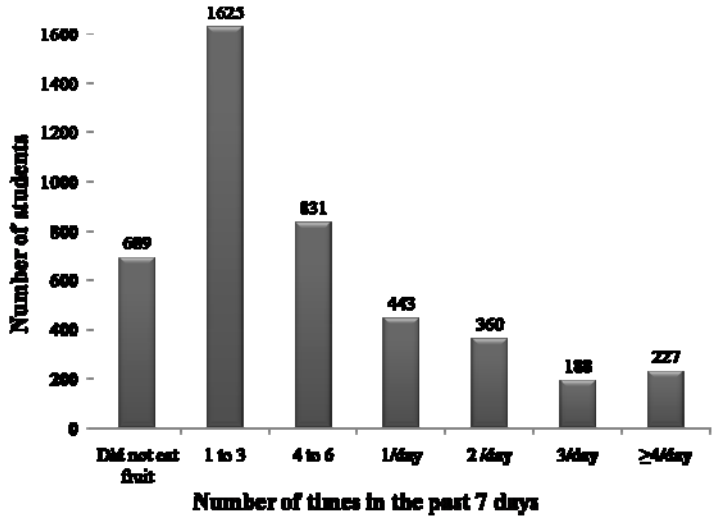

Figure 27: Bar graph of the 9th-grade student responses to item 74 on the 2003 YRBS "During the past 7 days, how many times did you eat fruit?" (n=4,363).

From the two items that comprise the factor fruits, the factor scores show a fairly normal distribution. While the range of scores is between -3 to +4 for the 4,187 who provided data, over half of the scores fall between -1 to +1. This indicates that over half of the students are consuming fruit through either consumption of fruits or fruit juices. Thus, while the factor score distribution was fairly normal for the factor fruits only a small portion of 9th-graders were consuming fruit on a daily basis.

The third and final factor that contributed to the variable poor dietary behavior was *milk* with a single, strong loading item that accounted for 12.354 percent of the variance for the construct poor dietary behavior. The range for the factor score of *milk* was noted to be between -2.35 and 2.33. Figure 28 demonstrates that there are more factor scores (n=2382, 56.89%) below 0, indicating the majority of 9th-grade students had limited or no inclusion of milk in the diet.

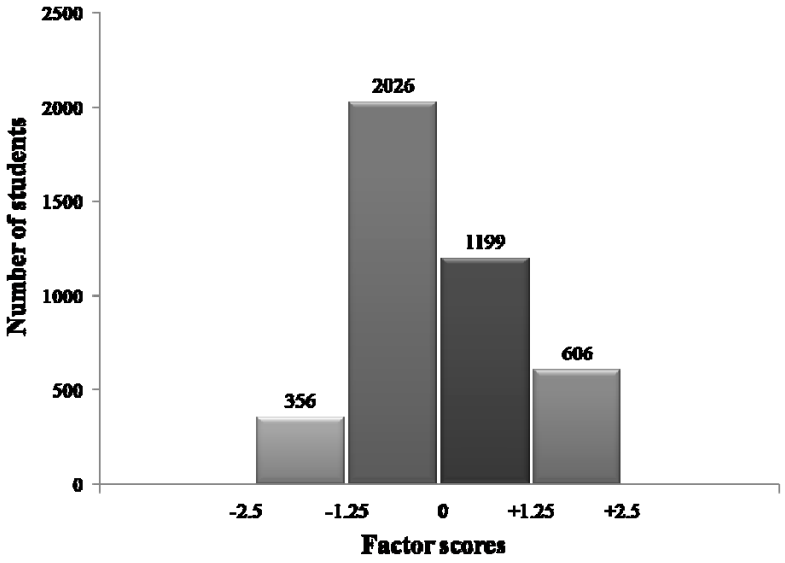

Figure 28: Bar graph of the distribution of factor scores for *Milk* for 9th-graders who completed the 2003 YRBS (n=4,187).

A total of 4,266 students responded to the question regarding milk intake. When the recommended three to four servings a day was used as a standard, only 831 students (19.479%) were found to meet or exceed the minimum standard for milk intake. As noted in Figure 29, seven hundred nine students (16.619%) reported that they did not drink milk at all.

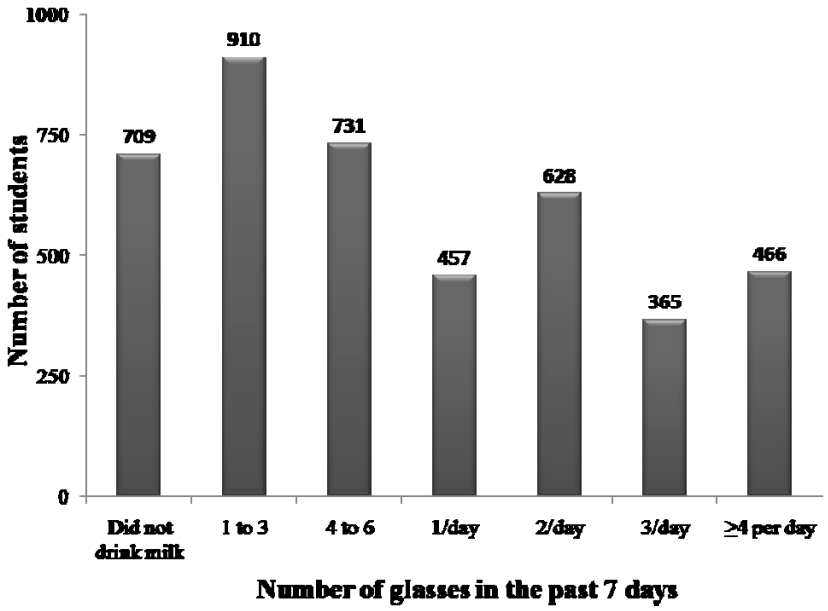

Figure 29: Bar graph of the 9th-grade student responses to item 79 on the 2003 YRBS During the past 7 days, how many glasses of milk did you drink?" (n=4,266).

In summary, it can be concluded that for the twenty items extracted from the 2003 YRBS, there were 8 factors that emerged; namely *recent* and *tried smoking*, *exercise, physical education class*, *television, vegetables, fruit*, and *milk* representing the constructs of smoking behavior, physical inactivity and poor dietary behavior.

4.1.3 Analysis of specific aim 3

Specific aim 3 was designed to examine the relationships among the risk behavior factors of smoking behavior, being overweight, physical inactivity, and poor dietary behavior for the total sample. For this aim, the factors were identified through a Principal Component Analysis for smoking behavior, physical inactivity, poor dietary behavior, and being overweight, as derived from self-reported height and weight, and analyzed. Significance probabilities (p-values) were examined for each measurement correlation.

Table 20 depicts the correlations for the total sample. There were several statistically significant correlations for the modifiable risk factors examined; however, all of the statistically significant correlations were of a magnitude less than 0.3, indicative of small, but definite relationships. Inverse relationships were found between exercise and *recent smoking* ($r=-0.056$, $p=0.004$), vegetables and television ($r=-0.072$, $p<0.01$), milk and tried smoking ($r=0.071$, $p<0.001$). As exercise increased, smoking decreased, as vegetable intake increased less time was spent watching television, and as milk intake increased tried smoking decreased. No other activity or dietary behavior was significantly related to recent or attempted smoking. As for positive correlations, exercise and consumption of vegetables ($r=0.118$), fruits ($r=0.232$), and milk ($r=0.161$) were related at the 0.01 level of significance. Consumption of fruits ($r=0.079$, $p<0.01$) and milk ($r=0.46$, $p<0.05$) were positively associated with physical education class.

Table 20: Pearson r Correlations for all Ninth Grade Participants of the 2003 YRBS for the Modifiable Risk Factors of Smoking Behavior, Physical Inactivity, and Poor Dietary Behavior

	Recent Smoking	Tried Smoking	Exercise	Phys Ed Classes	Television
Exercise	-0.056**	-0.021			
	(N=3110)	(N=3110)			
PE Classes	-0.022	0.019			
	(N=3110)	(N=3110)			
Television	0.006	0.032			
	(N=3110)	(N=3110)			
Vegetables	0.102**	0.007	0.118**	0.033	-0.072**
	(N=3755)	(N=3755)	(N=3270)	(N=3270)	(N=3270)
Fruits	-0.012	-0.001	0.232**	0.079**	-0.012
	(N=3755)	(N=3755	(N=3270)	(N=3270)	(N=3270)
Milk	-0.029	-0.071**	0.161**	0.046*	0.035
	(N=3755)	(N=3755)	(N=3270)	(N=3270)	(N=3270)

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The variable *overweight* was a dichotomous variable, and thus a methodology to explore the relationships among interval variables with a dichotomous variable was necessary. In order to assess the association between being overweight and the constructs of smoking behavior, physical inactivity, and poor dietary behavior, a logistic regression analysis was performed. Overweight was the defined dependent variable, whereas the eight factors that represented the three constructs of modifiable risk factors, i.e., smoking behavior, physical inactivity, and poor

dietary behavior were the independent variables. A backward stepwise logistic analysis revealed that of all the factors entered, only five factors, namely vegetables, television, tried smoking, milk and exercise were associated with being overweight (see Table 21).

Table 21: Initial Logistic Regression Model with Coefficients of Predictor Variables, Standard Error, and P-values

Variables	βeta	Standard Error	Degrees of Freedom	Sig. ($p<0.05$)	Exp(B)
Vegetables	0.110	0.047	1	0.019	1.116
Fruits	0.047	0.043	1	0.272	1.049
Milk	-0.097	0.043	1	0.024	0.908
Exercise	-0.183	0.045	1	0.001	0.833
Phys Ed Class	0.017	0.042	1	0.688	1.017
Television	0.213	0.043	1	0.001	1.238
Recent Smoking	-0.051	0.044	1	0.240	0.950
Tried Smoking	0.085	0.041	1	0.037	1.089
Constant	-0.811	0.042	1	0.001	0.444

These five factors were entered as a model of contributing factors. As depicted in Table 22, there was a significant association between overweight and the factors of vegetables, television, tried smoking, milk, and exercise. The analysis demonstrates that the factors of vegetables, television, and tried smoking are associated with a greater risk of being overweight, whereas milk and exercise are associated with a lower risk of being overweight.

Table 22: Final Logistic Regression Model with Coefficients of Predictor Variables, Standard Error, and P-values

Variables	βeta	Standard Error	Degrees of Freedom	Sig. (p<.05)	Exp(B)
Constant	-0.807	0.042	1	0.001	0.446
Television	0.213	0.043	1	0.001	1.237
Vegetables	0.108	0.047	1	0.021	1.114
Tried Smoking	0.086	0.041	1	0.036	1.090
Milk	-0.096	0.043	1	0.025	0.909
Exercise	-0.168	0.043	1	0.001	0.845

As revealed in Table 22, the strongest contributor to being overweight was television, with a beta (β) equal to 0.213. This finding means that for every single unit increase in television we expected a 0.213 increase in the log-odds of being overweight, holding all other independent variables constant. Similarly, the factor vegetables contributed to overweight by a log-odds of 0.108, meaning that for each unit increase in vegetable consumption we expect a .108 increase in the log-odds of being overweight. The weakest quantifiable contributor to being overweight was from tried smoking. That is, for every single unit increase in tried smoking, we expected a 0.086 increase in the log-odds of being overweight, holding all other independent variables constant. In this model, both milk and exercise were noted to have a negative beta (β) value. This means that for every single unit increase in milk or exercise we expect a -.096 and -.168 decrease respectively, in the log-odds of being overweight. In addition, the logistic regression model of television, vegetables, tried smoking, milk, and exercise has a sensitivity of 59.2% and a specificity of 57.6% (see Table 23).

Table 23: Sensitivity and Specificity of Current Regression Model using the Factors *Recent Smoking, Tried Smoking, Exercise, Physical Education Classes, Television, Vegetables, Fruits, & Milk*

		Observed	Predicted	Percentage Correct
		Not Overweight	Overweight	
	Not Overweight	1103	813	57.6 (specificity)
	Overweight	353	512	59.2 (sensitivity)
Overall Percentage				58.1

One issue of concern to the analysis was the non normal distribution of the factor scores of tried smoking and physical education classes. To assess for any effect of this bimodal distribution, the logistic regressions were conducted on those who did and did not try smoking and those who participated in physical education class and those who did not partake of physical education class.

While *recent smoking* and those who partook of physical education class was not noted to have a normal distribution further analysis was explored without transforming or altering the data. This was a limitation that was presented with the original data set. It can be suggested that if more data were procured, more of a normal distribution would reveal itself. While the majority of the factors portrayed a normal distribution analysis commenced without transformation such that the exploration of the data set would reveal the results pertinent to the early adolescents and not be attributed to alterations of the data.

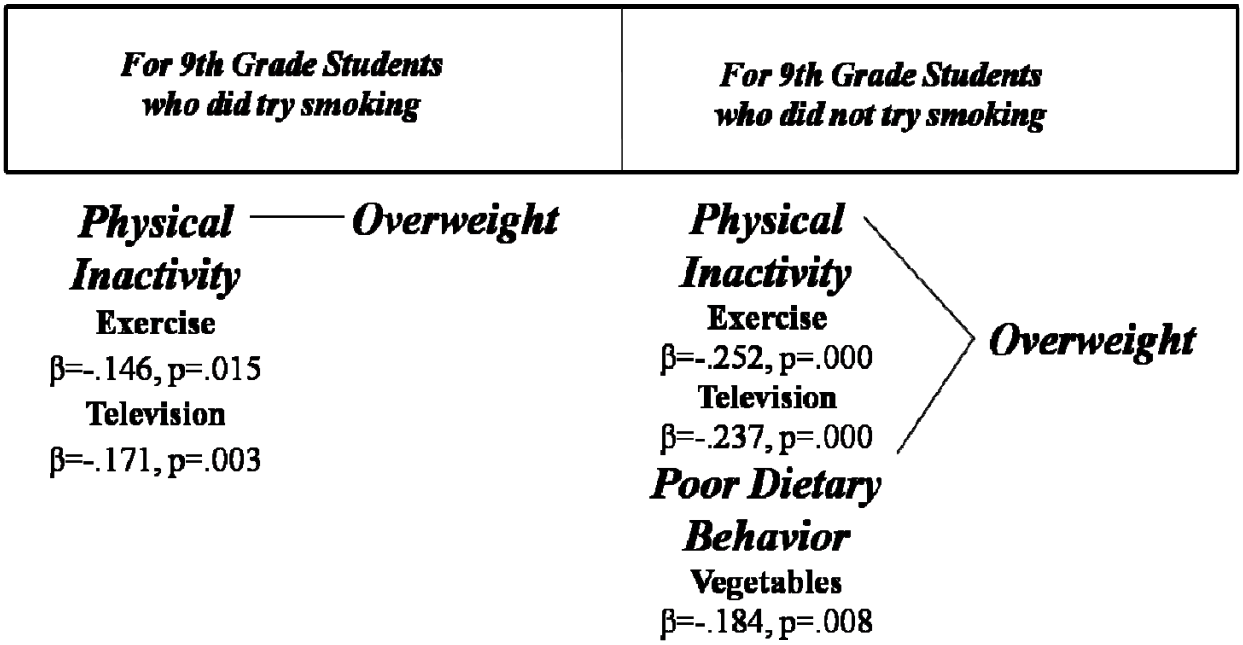

Figure 30: Logistic regression model for 9th Graders for the associations between the smokers and non-smokers.

Likewise, when the factor physical education classes was explored for those who did not engage in physical education class a clear bimodal distribution was noted. Therefore, a backward, stepwise logistic model run, which showed that for those overweight individuals who did not take physical education classes, of the 2,051 students analyzed, only vegetables, exercise, and television were statistically significant. This model was determined to have an overall sensitivity and specificity of 59.1%.

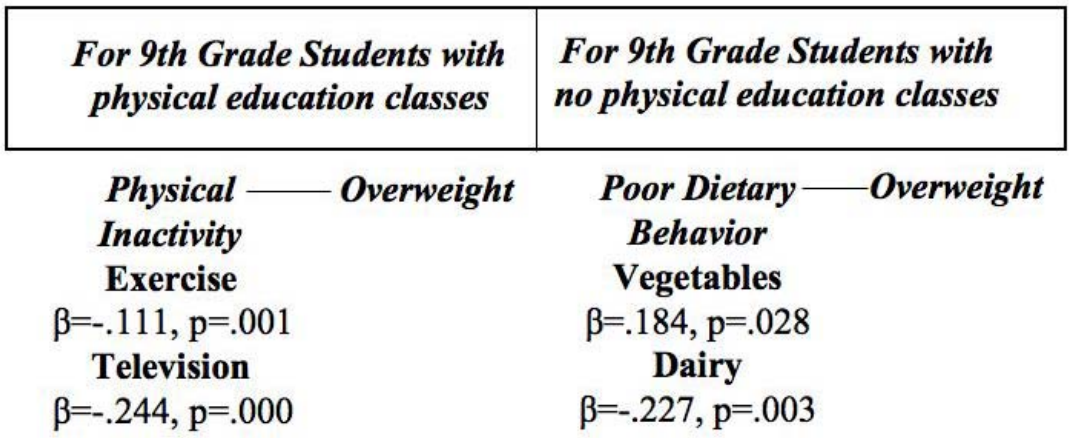

Figure 31: Logistic regression model for 9th Graders for the associations between the students in physical education classes and those with no physical education classes.

In conclusion, this exploratory analysis demonstrated several correlations among the modifiable cardiovascular risk factors as studied in the context of the ninth grade participants of the 2003 YRBS.

4.1.4 Analysis of specific aim 4

The purpose of specific aim 4 was to examine the relationships among the risk factors of smoking behavior, being overweight, physical inactivity, and poor dietary behavior for subgroups identified by race and gender. Pearson r correlations were used to gain insight into the behaviors specific to each subgroup. Gender and ethnicity/race were correlated to the factors from the targeted variables of smoking behavior, being overweight as represented by a BMI greater than the 85th percentile, physical inactivity, and poor dietary behavior.

4.1.4.1 Subgroup Analysis

The first demographic subgroup that was addressed was that of gender. As noted in the section which described the characteristics of the sample, 47.7% (2123) of this sample was female and 52.2% (2322) was male. To assess the gender-specific association between smoking behavior, physical inactivity, poor dietary behavior and overweight, a logistic regression analysis was conducted as in specific aim 3, adding the variable of gender to the model. As depicted in table 24, gender does not contribute to the model of the cardiovascular risk factors.

Table 24: Logistic Regression Model of Associations with the CVD Modifiable Risk Factors in 9th-Graders with Gender as a Variable in the Model

Variable	**Beta**	**Significance**
Constant	-.813	.000
Gender	*.001*	.987
Vegetables	*.110*	***.019***
Fruits	*.047*	.273
Milk	*-.097*	***.027***
Exercise	*-.183*	***.000***
Television	*.213*	***.000***
Recent Smoking	*-.051*	.241
Tried Smoking	*.085*	***.037***

** 1 degree of freedom for each variable.*

4.1.4.2 Ethnicity/Race

To assess the race-specific association between smoking behavior, physical inactivity, poor dietary behavior and overweight, a logistic regression analysis was conducted as in specific aim 3, adding the variable of race to the model. Of the students that provided data regarding ethnicity/race and body mass index, 561 were Black, 1,066 were White, 687 were Hispanic and 204 were classified as Other who were overweight. The referent group for the racial category was the Other race. The racial categories of White, Black and Hispanic were then entered. Race was determined to be a significant contributor to overweight. With the Other group as the comparison group (p=.000), the analysis revealed that being of White race did not contribute significantly to the model as compared to the referent Other group (β=-0.62, p=.671), however being of Hispanic (β=.400, p=.013) or Black (β=.358, p=.037) race did increase the likelihood of overweight as compared to the referent group.

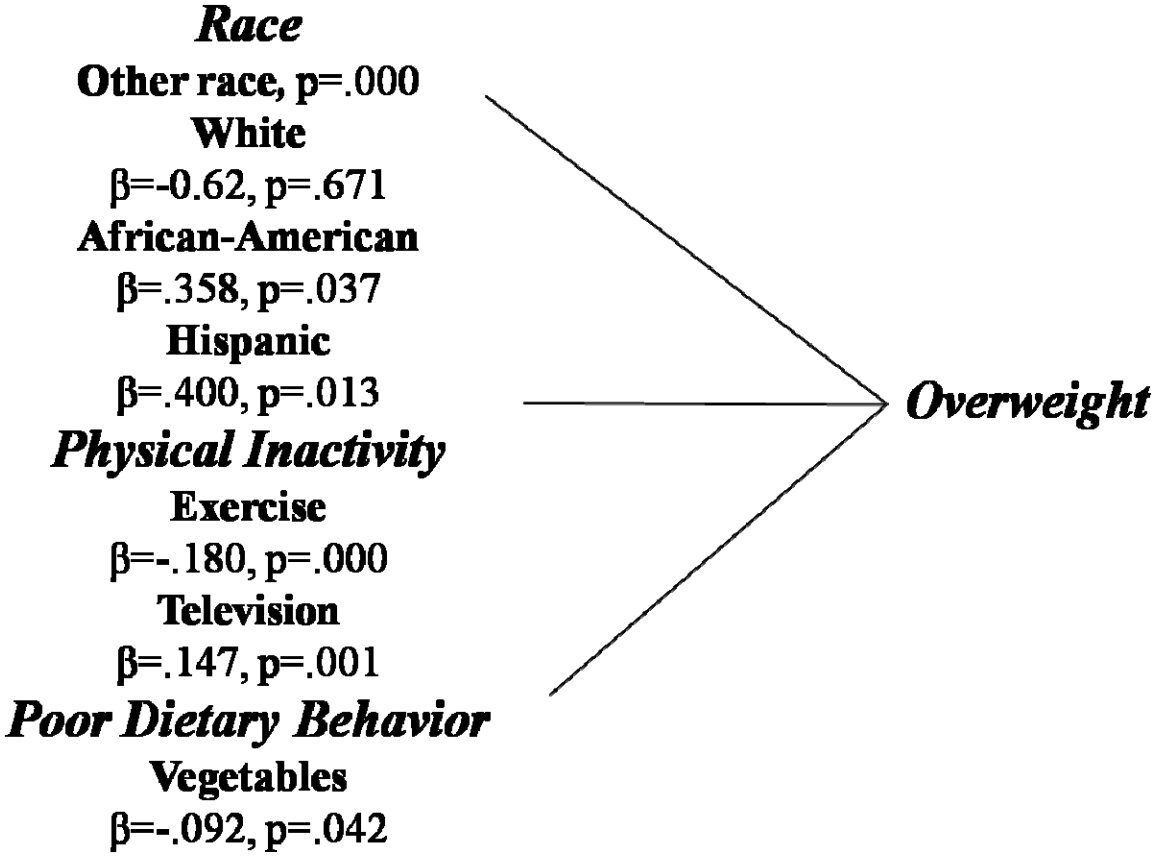

Figure 32: Logistic regression model by race for the variables of smoking behavior, physical inactivity and dietary behavior for 9th graders.

Subgroup analysis of ninth graders was further explored via the categorization of ethnicity/race toward a goal of identifying race specific interventions that would most likely affect positive change to the modifiable behaviors, as it relates to cardiovascular disease. In an effort to target the most impressionable subpopulations, analysis of the racial categories of Whites, Blacks, Hispanics, and Other was undertaken in accordance with the targeted variables of smoking behavior, physical inactivity, and poor dietary behavior. Very little difference was noted amongst the differing groups, though the differences merit mention.

Table 25: Correlates from Racial Subgroups for the Significant Associations between the Variables of Smoking Behavior, Physical Inactivity and Dietary Behavior for 9th Graders.

	Other	White	Black	Hispanic
Exercise and Vegetables	0.215** N=379	0.076** N=1900	0.098* N=457	0.150** N=523
Exercise and Fruit	0.331** N=379	0.267** N=1900	0.115* N=457	0.145** N=523
Exercise and Milk	0.270** N=379	0.105** N=1900	0.169** N=457	0.193** N=523
Exercise and physical education class		-0.057* N=1905		0.133** N=536
Physical education class and fruits		0.095** N=1900		
Physical education class and milk			0.153** N=457	0.098* N=523
Exercise and Recent Smoking		-0.104** N=1820	0.130** N=410	
Recent smoking and Vegetables	-0.097* N=428	0.159** N=2206		
Recent smoking and milk	-0.190** N=428			
Tried smoking and vegetables		0.049* N=2206		
TV and vegetables		-0.096** N=1900		
TV and Milk		0.073** N=1900		
TV and Fruits			0.106* N=457	
TV and tried smoking	0.131* N=365			

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

As noted in table 25, the Blacks demonstrated only 2 of the 5 associations to be significant with a p-value less than 0.05 levels, while the Hispanics were noted to have 2 of the 6 associations statistically significant with a p-value less than 0.05. Overall, all groups were noted to demonstrate a statistical difference between all of the dietary behaviors to exercise. The Hispanic sector was noted to have stronger correlations than either the Blacks or White subpopulations. In addition, recent smoking was statistically significant for both the White and Black groups, but not the Hispanics at this point in time. Blacks demonstrated a positive correlation (r=.130, p=.009) while the Whites showed an inverse relationship with that correlation (r=-.104, p=.000). Likewise, both Hispanics and Whites demonstrated a statistically significant relationship between physical education classes and exercise, although the Hispanics showed a positive correlation (r=.133, p=.002) while the White early adolescents demonstrated an inverse relationship (r=-.057, p=.013). Both the Blacks and the Hispanics demonstrated a statistically significant relationship between milk and physical education classes. As noted in table 26, the Blacks showed a correlation of (r=.153, p=.001) while the Hispanics noted a correlation of (r=.098, p=.098, p=.025).

Unique to the White early adolescents were the associations between milk and television (r=.073, p=.001), television and vegetables (r=-.096, p=.000), vegetables and recent smoking (r=.159, p=.000) and tried smoking with vegetables (r=.049, =.021). Unique to the Hispanic early adolescents was the association between milk and tried smoking (r=-.089, p=.037). The Black early adolescents did not have any associations unique to only their subgroup.

This analysis reveals a picture of the underlying behaviors that are indigenous to ninth grade students. It is suggested that these findings be taken cautiously until further scientific inquiry can validate these significant findings in populations that take into account all students of

this age, not just those students extracted from the public school setting. However, it does suggest that there are distinct differences between racial groups that may need to be considered when designing interventions that target the modifiable behaviors of early adolescent as a way to minimize the cardiovascular burden.

5.0 DISCUSSION

Our current understanding of cardiovascular disease (CVD) is based primarily on the manifestation of CVD and risk factors in adult populations. Although the origins of atherosclerosis are seen in early childhood with progression toward clinically significant lesions in young adulthood, minimal research has been conducted in the developmental period of early adolescence. Thus, CVD in early adolescence must be examined. Characteristics of risk factors that predispose individuals to CVD traditionally have been associated with biological and physiological markers; however, behavioral risk factors have been shown to influence biological risk factors and their outcomes.

This moment in time was selected because those in early adolescence are claiming their independence by self-selecting behaviors that may demonstrate lifelong negative sequelae. In addition, it is suggested that focusing on early adolescence, when behaviors that are difficult to change are acquired and adopted, is prudent in addressing the modifiable risk factors adopted by those in early adolescence. In an effort to identify the earliest emergence of modifiable behavioral risk factors, in order to target intervention, examining early adolescence was undertaken in a national parent study. This exploratory study was designed to describe patterns and relationships among the modifiable cardiovascular risk factors of smoking behavior, overweight, physical inactivity, and poor dietary behaviors within a 9th-grade population of male and female students, as identified by the 2003 Youth Risk Behavior Survey (YRBS). Specific aims for this study include the following:

1. To conduct a factor analysis that identifies variables from the YRBS that constitute the constructs of smoking behavior, physical inactivity, and poor dietary behavior.
2. To describe patterns of smoking behavior, the condition of being overweight, physical inactivity, and poor dietary behavior in 9th-grade students.
3. To examine the relationships among risk factors of smoking behavior, being overweight, physical inactivity, and poor dietary behavior.
4. To perform correlations within demographic subgroups and to descriptively compare these relationships across subgroups.

This exploratory study was undertaken to investigate the association of modifiable CVD risk factors in 9th-graders.

5.1 SPECIFIC AIM 1

To achieve the first specific aim, a factor analysis was conducted in which principal component analysis (PCA) was performed on items within the 2003 YRBS that made up the constructs of smoking behavior, physical inactivity, and poor dietary behavior. Factor analysis revealed that the main components of smoking behavior were explained by behaviors indicative of recent smoking activity and tried smoking behavior or experimentation with cigarette smoking. This behavior explained 85.772% of the cumulative variance for the variable, smoking behavior. Social scientists have directed many of their efforts toward identifying and understanding the cognitive factors that underlie smoking initiation, maintenance, and cessation. Many of these studies have found the cognitive factor, smoking expectancies, to be one of the consistent predictors of smoking-related behavior in adolescents (Lewis-Equerre, 2005; Myers, 2003). No studies could be found in which a factor analysis had been performed on smoking behavior.

Smoking prevalence typically is measured by report of smoking on any days in the last month (USDHHS, 1994). Research reports that the smoking uptake process is defined by categories from the committed never smoker through the current established smoker, with susceptible never smokers and experimenters sandwiched in between. If a smoker had not smoked in the past 30 days, he or she was classified as a former smoker (Gilpin, Emery, White, & Pierce, 2003). The smoking variable in most studies has been quantified by the number of cigarettes smoked, rather than by intention or motivation for smoking (Paavola, Vartiainen, & Haukkala, 2004; Strine, et al., 2005; Ward, et al., 2003). Numerous articles have addressed contributors to or motivators for smoking behavior (Asbridge, Tanner, & Wortley, 2005). Few studies have categorized smokers' actions into the phases of smoking lifestyle for adolescence, such as experimentation through maintenance smoker (Cortes, Marti, & Fernandez, 2005; Gilpin, Emery, White, & Pierce, 2003; Kaplan, Napoles-Springer, Stewart, & Perez-Stable, 2001; Ma, Tan, Toubbeh, & Su, 2003). Currently, five published tools that contain between two and seven dimensions can be used to assess adolescent smoking expectancies (Dalton, Sargent, Beach, Bernhardt, & Stevens, 1999; Lewis-Equerre, Rodridque, & Kahler, 2005; Myers, McCarthy, MacPherson, & Brown, 2003; Pallonen, Prochaska, Velicer, Prokhorov & Smith, 1998; Wahl, Turner, Mermelstein & Flay, 2005). Lack of standardization of dimensions makes it difficult to generalize findings and to apply findings from previous research. Therefore, future research is encouraged to promote scale development in such a way that research can be translational. Research that is translational is needed before interventions can be developed and implications can be suggested for policy promotion.

Further deconstruction with the use of PCA factor analysis determined that the variable, physical inactivity comprised three factors: (lack of) exercise, (insufficient participation in)

physical education class, and television. Previously, physical activity has been measured by energy expenditures. However, due to sedentary lifestyles, it became necessary to quantify physical inactivity or sedentary behavior (Barnes, & Schoenborn, 2000; CDC, 2003). Therefore, when placed on a continuum, the concept of physical activity quantifiable by kilocalorie expenditure, metabolic equivalents (METS), or some other classification system, sedentary lifestyle is represented by a lower factor score. The current study measured physical activity as exercise, physical education class, and television. This inactive lifestyle is linked to the obesity epidemic that faces early adolescents and is one of the driving forces for encouraging all early adolescents to participate in a minimum of 20 minutes of exercise a day.

The third modifiable variable was poor dietary behavior. Diet affects risks for obesity and CVD. Early adolescent dietary habits may persist over time to unduly influence risk for chronic disease. In an effort to capture the dietary patterns of early adolescence, PCA was applied to the variable, poor dietary behavior. This study determined that factors that made up the variable poor dietary behavior were limited to insufficient intake of vegetables, inadequate consumption of fruits, and insufficient intake of milk. Many studies have examined the dietary patterns of young people (Anderson, & Morris, 2000). None of these studies measured this construct using the factors we discussed. These studies have largely incorporated high fat content and elevated sugar consumption into the variable, "poor dietary behavior." A distinct limitation of this data set was that questions were not asked that would allow for a factor analysis of sugars or fats.

5.2 SPECIFIC AIM 2

Specific aim 2 of the present study was to describe patterns of smoking behavior, being overweight, physical inactivity, and poor dietary behavior in 9th-grade students. Overall, 10.7%

of 9th-grade students were regular smokers; 4.7% of these reported that they were daily cigarette smokers. Overall prevalence rates for regular smokers in the United States were reported by a study from Monitoring the Future, which noted a 4.0% prevalence rate (n = 16,800) for 8th-grade students (Johnston, O'Malley, Bachman, & Schulenberg, 2006). Almost 5% (4.1%) of 9th-graders reported that they had smoked at least one to two cigarettes within the past 30 days and 52% acknowledge previous attempts at smoking. This is consistent with the findings of another study, in which Singh, Kogan, & van Dyck (2007) noted that 2.4% of regular 8th-grade smokers were noted to smoke one to five cigarettes a day. Although no clear consensus has been reached on how much cigarette consumption predicts addiction, research suggests that individuals who are smoking at least two cigarettes per week by age 12 may be at greatest risk for addiction (Riggs, Chou, Li, & Pentz, 2007). Past decades have witnessed a concerted effort in relation to tobacco consumption by adolescents. In spite of education on and facilitation of smoking cessation during adolescence, early adolescents continue to smoke and to experiment with this risky behavior. The present study reports that the 13-and 14-year age group comprised the largest number of early adolescents who experimented with cigarettes. This is consistent with findings of previous literature, in which the mean age for experimentation by early adolescents was reported as 12.2 ± 1.34 years (Riggs, Chou, Li, & Pentz, 2007). Thus, although research suggests that those students other than 9th-grade could be better served by focused preventative efforts, the interaction of the early adolescent with societal forces is not clearly understood, and this topic requires further exploration before effective interventions can be provided or appropriate policies developed.

The diet and sedentary lifestyle of early adolescents reflect a pattern that puts their health at risk. Epidemic proportions of overweight are seen in all age groups. The present study reports

that 31.2% of 9th-graders were overweight based on body mass index (BMI) calculations. This compares with previous studies fairly closely. In the previous study by Wilson et al., (2005), where subjects were looked at from a middle school or a high school status; from the middle school, there were 10.0% (n=802) who were overweight and 4.5% (n=361) who were obese. While from the high school 15.2% (n=397) were classified as overweight and 7.9% (n=206) were classified as obese. In another study, looking at only high school students, Lowry et al., reported on self-reported data from the students that 25% (n=3,837 students) were either overweight or at-risk for becoming overweight. Similarly, in a Canadian study by Boutelle, et al., (2002) 45.6% (1,421 9th-grade students) were noted to be either overweight or at-risk for overweight. This is consistent with research suggesting that because of urbanization and lifestyle within Western culture, individuals are gaining weight at a rate that causes serious concern among clinicians. Investigations into unique contributions from specific constellations of modifiable risk behaviors have been targeted for inquiry in an effort to nurture healthy behaviors. This exploration is being undertaken in the hope of promoting healthy behaviors in early adolescents.

Overall, 14.1% of early adolescents reported that they had not engaged in any exercise within the past 7 days. This is consistent with previous research, which demonstrated a 13.30% prevalence rate of physical inactivity in a sample size of 46,286 subjects aged 10 to 17 years of age (Singh, Kogan, & van Dyck, 2007). This also is consistent with research on adolescents from other industrialized nations, which found that in England, 30% of males and 40% of females do not meet physical activity recommendations (DHHS for England, 2002).

A major contributor to physical inactivity is television viewing. Investigators in the current study noted that 75.5% of early adolescents reported watching TV 2 hours a day or

longer. This is consistent with a study by Vereecken, Todd, Roberts, Mulvihill, & Maes, (2006) which was a cross-sectional study on 11-15 year olds from 35 different countries. This study reported television viewing time for the average adolescent to be between 2.0 to 3.7 hours per day. These findings are supported by other literature, which shows that the amount of time engaged in television viewing tends to increase with age through adolescence (Vereecken, et al., (2006). Although it is notable that efforts have been targeted at increasing physical activity levels for all individuals as established by the *Healthy People 2010* initiative, the lack of standardization for quantifying physical activity makes measurement difficult. Activity is noted to be on a continuum that ranges from absent to 24-hour involvement. However, the language of quantifying energy expenditure, whether in kilocalories or METS, is not applied to all research activity. Some investigators opt to quantify activity on the basis of light, moderate, or vigorous engagement; others use a more specific measure. Although the present study reports that 77.6% of early adolescents are engaging in strengthening/toning exercise, and that 36% admit to participating in a team sport, it is difficult to generalize findings because leading indicators as specified in *Healthy People 2010* reflect no consensus on unit of measurement for physical activity, let alone whether it has been applied to unique subsets of participants, particularly early adolescents.

Overall, less than 10% of adolescents met the recommendation of eating a minimum of three servings a day of vegetables, and 15.5% of adolescents reported that they did not consume any fruit within the past 7 days. Thus, the minimally accepted recommendation for intake of both fruits and vegetables was not met. This is consistent with the literature, which reports that only about 30% of adolescents consume any fruit or vegetable on a daily basis (Vereecken, Todd, Roberts, Mulvihill, & Maes, 2006). Unfortunately, the foods that early adolescents tend to like

rarely have much nutritional value. Most of the research that addresses dietary behavior attends to it in relation to the "gold standard," known as the Food Pyramid. Oftentimes, dietary behavior is viewed with a bias to how much the participant is receiving, not to how lacking the participant is in relation to set standards. As early research on food patterns has noted, generally speaking, over time, if children were left to their own devices, proper consumption of vitamins and minerals would be self-regulated to expenditure of energy (Davies, 1928). Food consumption patterns for individuals are affected by numerous factors such as lifestyle, economics, marketing, culture, biology, media, and the like. However, recent factors have established that the historical milieu may not be as similar today as was believed historically. Such factors that affect adolescents include the increased incidence of single parents, the traditional family with two full-time employed parents that is stretched economically, and, the time wise availability of fast food restaurants. These factors all negatively affect the current environment of the adolescent as it relates to proper dietary behavior. Although parental support for role modeling or meal preparation is lacking in the home environment, another adverse finding for proper dietary behavior relates to milk consumption. The current study found that almost 80% of early adolescents were not meeting the recommendation for milk consumption. A study by Fischer et al. (2001) reported that mother's choice of drink between milk and soft drink was influential for children aged 5 to 7 years (Fischer, & Birch, 2002). Because the availability of soft drinks and energy drinks has grown exponentially in recent times, this finding suggests that adequate milk consumption requires numerous factors that could adversely influence attainment of the current recommendation.

Although poor dietary habits and inadequate amounts of physical activity contribute to poor health in individuals, it is notable that through logistic regression, investigators found the

factors vegetables, television viewing, tried smoking, milk, and exercise to be statistically significant in contributing to obesity. It is most notable that television viewing was found to be the strongest contributor, and tried smoking was the weakest contributor, based on the variables examined. The strongest contributor, television viewing, has been substantiated in previous research Vereecken, et al., (2006) because it is noted to be a sedentary activity that often is accompanied by snacking behavior. However, the tried smoking association warrants investigation in that no other research can be found that addresses this mechanism to explain its relationship to obesity. It is suggested that this behavior may be seen in a cluster that consists of other high-risk activities that have adverse implications for the health of individuals. Or, it may be suggested that early adolescents are trying to determine which behaviors they should commit to for the long term, because this is just an experimental phase. Further investigation is warranted that may enhance our understanding of motivators for experimental behaviors in early adolescents.

5.3 SPECIFIC AIM 3

Specific aim 3 was to examine the relationships among the risk factors of smoking behavior, being overweight, physical inactivity, and poor dietary behavior. Within this sample of 9th-graders, significant associations between BMI and factors from all three variables of smoking behavior, physical activity, and dietary behavior emerged. Findings of this study indicate that an association is evident between BMI and smoking behavior in early adolescents of both genders. Prior research had established an association in boys, but not in girls. A new association between dietary behaviors and smoking behaviors was revealed for male adolescents. Lastly, a new association between physical activity and dietary behavior was noted to be statistically

significant for boys; this had not been established in prior studies. Investigators in the present study also have confirmed associations between BMI and both dietary behavior and physical activity for both genders, and between BMI and smoking behavior in boys, as established in prior studies (Koh-Banerjee et al., 2003; Lowrey, et al., 2000; Winter, de Guia, Ferrence, & Cohen, 2002). While the logistic regression confirmed that associations between gender and the modifiable CVD risk factors were not significant, it may be postulated that the significance is attributable to the ever increasing numbers of both genders that are partaking in these activities.

Confirmation was noted between dietary behavior and physical activity in early adolescents, and between dietary behavior and smoking behavior in girls (Koh-Banerjee et al., 2003; Lowrey, 2000; Boutelle, Neumark-Sztainer, Story, & Resnick, 2002; Wilson et al., 2005). Study findings also validate what other researchers have shown in previous research—that associations can be found between physical activity and smoking behavior (Lowry, Galuska, Fulton, Wechsler, & Kann, 2002; Wilson et al., 2005).

Tried smoking was significantly associated with being overweight, but recent smoking was not. As tried smoking was noted to not be normally distributed, a logistic regression was performed with just the individuals who were overweight who attested to trying smoking. The correlations for the overweight individuals who tried smoking were statistically significant between *milk* and *fruits* (r=-.049, p=.027), *exercise* to *vegetables* (r=.136, p=.000), *fruits* (r=.187, p=.000), and *milk* (r=.177, p=.000) respectively. In addition, in the same sample of 9th-graders, physical education class was statistically significant with *vegetables* (r=.074, p=.003), and *fruits* (r=.102, p=.000). And finally, in this same sample *television* and *milk* were statistically significant (r=.081, p=.001). While numerous associations were revealed when examining just the overweight individuals who tried smoking it is suggested that while tried smoking was not

significant overall, possibly due to small sample sizes of those who acknowledge experimentation with cigarette behavior that further exploration into this phenomena be pursued.

Although poor dietary habits and inadequate amounts of physical activity contribute to poor health in individuals, it is notable that through logistic regression, investigators found the factors vegetables, television viewing, tried smoking, milk, and exercise to be statistically significant in contributing to obesity. It is most notable that television viewing was found to be the strongest contributor, and tried smoking was the weakest contributor, based on the variables examined. The strongest contributor, television viewing, has been substantiated in previous research Vereecken, et al., (2006) because it is noted to be a sedentary activity that often is accompanied by snacking behavior. However, the tried smoking association warrants investigation in that no other research can be found that addresses this mechanism to explain its relationship to obesity. It is suggested that this behavior may be seen in a cluster that consists of other high-risk activities that have adverse implications for the health of individuals. Or, it may be suggested that early adolescents are trying to determine which behaviors they should commit to for the long term, because this is just an experimental phase. Further investigation is warranted that may enhance our understanding of motivators for experimental behaviors in early adolescents.

This model was only a fair predictor of future outcomes just a bit more than half of the time. This could possibly be enhanced with more subjects entered into the study. Further analysis, revealed via logistic regression that there were statistical associations in the tried smoking sector with exercise (stat. significance=.004(1df)) and television (stat. significance=.005(1df)). It is not surprising as previous research has shown that for those

individuals who engage in one unhealthy behavior that they tend to partake in other unhealthy risk behaviors (Bovet, Auguste, & Burdette, 2007).

Self-perception of body image may play a role in the initiation and maintenance of smoking behavior. Among female adolescents, concerns about body image are pervasive (Gritz, & Crane, 1991), although these concerns among males are only starting to emerge. Research has shown that in adolescent girls, smoking has been applied as a method of weight control (Camp, Klesges, & Relyea, 1993). A distorted perception of body image among female early adolescents may assist in explaining the association of tried smoking with being overweight. This finding is consistent with reports of previous research done by Winter, de Giua, Ferrence, and Cohen (2002), which reported that weight perceptions were positively associated with smoking among females.

Overweight adolescents are at risk for a number of short- and long-term weight-related consequences. Overweight adolescents are at greater risk of developing overall body dissatisfaction (Vander Wal & Thelen, 2000) and low self-esteem (Pesa, Syre, & Jones, 2000), and of being teased and bullied (Jackson, Grilo, & Masheb, 2000). Inadequate amounts of exercise and television viewing were significantly associated with being overweight. Few studies have specifically focused in depth on overweight adolescents or on the application of weight control strategies (Boutelle, Neumark-Sztainer, Story, & Resnick, 2002). Thus, few data are available on the healthy application of such strategies as opposed to their application in a negative manner. Earlier literature shows that overweight adolescents were more likely to use exercise to lose weight (Neumark-Sztainer et al., 1999). This historical finding was not supported by the current study or by more recent research by Boutelle, Neumark-Sztainer, Story, and Resnick (2002). Research by Boutelle and colleagues revealed that overweight adolescents were

less likely to engage in vigorous physical activity and, furthermore, that overweight adolescents were not getting adequate exercise. Although overweight adolescents may engage in exercise as a strategy to manage their weight, the frequency and intensity of exercise may not be sufficient to meet minimal recommendations.

Statistical significance was noted between physical inactivity and poor dietary behavior. Most specifically, an inverse relationship was noted between television and vegetables ($r = -.072$; $p = .000$). Although statistical significance was remarkably low, it does lend support to the notion that 9th-graders, when allowed to make their own decisions, are not making healthy, wise choices, that is, those individuals who tend to watch television are not eating properly or exercise in sufficient amount and duration to lead healthy lifestyles. This is consistent with previous research, which showed that overweight adolescent girls were less likely to eat low-fat foods, dairy products or engage in healthy practices than their non-overweight peers (Boutelle, Neumark-Sztainer, Story, & Resnick, 2002). The association between fruits and physical education classes was noted to be statistically significant, although it too was very weak (.079; $p = .000$). Had the sample population not been so large, there is every reason to believe that this would not have been detected. Although statistical significance is markedly low, it does support the notion that those early adolescents who were captured through physical education classes are not eating appropriately, according to the established food pyramid. Again, the idea that 9th-graders are not making wise choices as they emerge into young adulthood, for which independent decision making is required, is cause for concern. This suggests that not only should health teaching be geared to what is healthy and what is not healthy, but selections of individuals should be intentional, with relevance to how they will affect the individual in both the short and the long term.

The most statistical significance was noted for the association between dietary behaviors and exercise. Although the association between fruits and exercise was most notable (.232; p = .000), another association was noted between both vegetable and milk and exercise. This is consistent with the findings of previous research, which demonstrated that among college students who use exercise for weight control, an association was found between vigorous strengthening and moderate physical activity (Lowrey, Galuska, & Fulton, 2000). Although one may think that this association reflects the norm, little research has addressed weight concerns from the perspective of early adolescents. Further investigation of this association is warranted. Because obesity is now the most prevalent nutritional disease of children and adolescents in the United States, healthy mechanisms for weight control in children must be investigated (Lowrey, Galuska, Fulton, Wechsler, & Kann, 2002).

Despite the benefits of a healthy diet, national surveys indicate that adolescents are not consuming recommended amounts of fruits, vegetables, and milk (Neumark-Sztainer, Story, Hannan, & Croll, 2002). The literature demonstrates that as adolescents age, their intake of fruits and vegetables declines by an average of 0.7 serving for girls and 0.4 serving for boys during the transition from early to middle adolescence (Larson, Neumark-Sztainer, Hannan, & Story, 2007). These findings, coupled with findings from the present study, suggest the need for intervention efforts that target improvement in the consumption of fruits, vegetables, and milk by adolescents. Future interventions should target both environmental and developmental influences. Specific influences that may contribute to the associations of poor dietary behaviors should be explored in future studies to advance the development of effective interventions for early adolescents.

Although smoking status was not significantly associated with physical inactivity for most of the factors that constitute physical inactivity, reported numbers of those engaging in

physical activity were lowest for all groups of students in this sample. This low frequency of physical activity may account for failure to detect a smoking behavior/physical inactivity association within the study sample. However, the low engagement of early adolescents in adequate levels of physical activity warrants attention, given that research indicates that physical inactivity is associated with reduced risk of chronic disease in adults.

Another finding of this study is the statistical association between smoking behavior and poor dietary behavior. A statistically significant association was noted between milk and tried smoking; an inverse relationship was noted. Nationally, milk consumption is decreasing among adolescents and is being replaced by soft drink consumption and even more often today by intake of energy drinks (O'Dea, 2003). Prior evidence supports the claim that this high-risk period in adolescence is a time for experimentation as young persons address concerns related to body image, eating disturbances, affective distress, and smoking (Hankin, 1998; Stice, & Shaw, 1998). Another significant finding within the association of dietary behaviors with smoking behaviors was the association noted between vegetables and recent smoking. This could be attributed to the skyrocketing increase in consumption of fast foods (Larson, Story, Perry, Neumark-Sztainer, & Hannan, 2007). Both of the above explanations may suggest that this is a time of experimentation, and that while early adolescents are trying smoking, they also are exerting their independence to make their own selections for dietary intake. Or, these explanations may reflect a fast paced lifestyle. Therefore, further exploration is warranted not only to investigate associations but also to examine determinants and motivators.

The growing epidemic of obesity has led to an increasing focus on strategies designed to address this crisis. However, the multifactorial problem of obesity with its associations between increased consumption of calories, increased sedentary lifestyle, and increased consumption of

foods with limited nutritional value makes difficult the design and implementation of effective evidenced-based programs to combat these forces. National health agendas, such as *Healthy People 2010,* have targeted lifestyle modification as a first-line prevention strategy for overweight and its sequelae. Thus, research is needed to identify associations and to enhance our understanding of the challenges and barriers related to lifestyle behaviors that influence obesity.

The challenge to improve dietary behaviors occurs at a time when epidemic levels of overweight among Americans are observed in conjunction with increased fast food availability; increased body image dissatisfaction and weight concerns among youth are extremely influential in social and environmental ways. The present study reports significant associations between BMI and vegetables and milk. Investigators in the present study noted that 31.2% of early adolescents were overweight according to self-reported age and weight. This difference between males and females could be related to dieting behaviors among females. Dieting can translate into restricted eating, even of foods that might be included in typical dieting behavior. Previous studies have reported a decrease in both fruit and vegetable consumption during the transition from early to middle adolescence and from middle to late adolescence in both males and females (Larson, Neumark-Sztainer, Hannan, & Story, 2007). This disparity warrants further exploration, although consideration should be given to sample size in that the present study included 3,704 participants and the previous study examined a sample of 2,105 adolescents. It also should be noted that the previous study was longitudinal in design, whereas the present study was based on a cross-sectional design. In terms of compromised vegetable intake, early adolescents are reducing their intake of key vitamins and minerals and fiber that are known to minimize risk for chronic disease.

Despite positive findings, a note of caution is warranted for interpretation of these results. It should be noted that data from this secondary analysis originally were taken from self-reported responses of adolescents on the YRBS. Because there is value in obtaining information from adolescents regarding their health behaviors, self-report is considered a viable option. Although literature supports the validity of studies that focus on individual health-risk behaviors, self-reported tobacco use (Akers, et al., 1983; Wills, & Cleary, 1997), dietary behaviors (Rockett, et al., 1997; Rosen, & Poplawski, 1987), and physical activity (Weston, Petosa, & Pate, 1997), no research has been discovered that sought to investigate the validity of self-reporting of this unique set of health-risk behaviors by adolescents: smoking behavior, overweight, physical activity, and dietary behavior. Familiarity with threats to validity for each of these specific health-risk factors may not equate to the cumulative effects of all potential threats. Future research based on methods that target these specific variables will help to eliminate this unknown as much as possible.

5.4 SPECIFIC AIM 4

5.4.1 Gender

Subgroup analysis by gender demonstrated that there were no differences between smoking behavior, physical inactivity, poor dietary behavior and overweight as contributes towards cardiovascular disease in the early adolescent.

Previous research has noted that among males, those who reported a strong desire to be thin were significantly more likely than other males to be smokers (Halek, Kerry, Humphrey, Crisp, & Hughes, 1993). In light of evidence that demonstrated an association between the tried smoker and overweight, it is reasonable to suggest that this study captured a wider window for encompassing statistical significance than did prior studies. This finding may have reflected a narrower range of male smokers. In an effort to capture all relevant associations, the *p* value was set high so that most of the statistical significance could be captured. Although statistical significance was noted, this should not be confused with practical significance. This study reported a statistically significant association; however, additional research is needed to investigate the practical significance of this finding.

5.4.2 Ethnicity/Race

In terms of specific aim 4, it is the consensus of health promotion scientists that culturally specific interventions are important for addressing health-related disparities. Most research has been conducted on the adult subpopulations of Blacks, Hispanics, and Asians, but few studies have focused on early adolescents, and a clear pattern has not been revealed (Webb, Francis, Hines, & Quarles, 2007). However, Race/Ethnicity was revealed as a contributor in varying manners for the designated classifications of Blacks, Hispanics and Whites. While previous research has demonstrated an association, especially for females it may be suggested that the time frame of early adolescence as reflected in ninth graders is truly still considered youth by many. Such that family and society still think of them primarily as youngsters in spite of the select few early adolescents who experiment with these modifiable behaviors. More differences were noted due to classification of race/ethnicity than gender. This influence may be more

pronounced due to the immediate family impact than the societal impact. Further research is warranted that investigates when and how this transitional period of early adolescents is influenced by these risk factors for cardiovascular disease. Racial/ethnic minorities are influenced by modifiable CVD risk factors in a different way than Whites. Although several studies have developed culturally specific interventions related to smoking cessation, little has been done in terms of other phases within the smoking life cycle among minority racial/ethnic groups (Webb, Francis, Hines, & Quarles, 2007). How these disparities are portrayed shows no clear pattern to date; thus, determinants that influence racial/ethnic subpopulations are not fully understood. In an effort to explore these influences, associations were examined for the categories of Whites, Blacks (or African Americans), Hispanics, and Others. Because of the small number of cases in the 'Other' category, coupled with the numerous subpopulations that make up this category, associations between modifiable CVD risk factors and BMI should be viewed tentatively. The association between genders within subpopulations was examined.

Correlations between the modifiable CVD factors of smoking behavior, physical inactivity, and poor dietary behavior, as well as BMI, across subpopulations were examined. Several studies have noted that Black adolescents were older at age of initiation, smoked fewer cigarettes, and metabolized nicotine more slowly than Whites (Moolchan, Ernst, & Henningfield, 2000; Moolchan et al., 2006). Little research has explored the characteristics associated with experimentation or tried smoking in early adolescents.

In a recent study by Cropsey, Linker, and Waite (2007) that investigated racial and sex differences for smoking among adolescents in a juvenile correctional center, several differences were noted between Whites and Blacks. This study comprised juvenile justice adolescents (N = 4,381), a sect that was not representative of the group from the present study. The Cropsey et al.

study (2007) reported average age of initiation with cigarettes to be 12.7 years (*SD* = 2.8)—a difference of about 1.3 years from the average initiator in the present study. Another major difference was that most adolescents reported that they smoked at least some of the time, and this contrasted with present findings, which showed that 80.2% reported no engagement with cigarette smoking. The study by Cropsey et al. also revealed that almost half of the adolescents studied reported daily smoking, which contrasts with only 11.5% who reported daily smoking in the present study. These drastic prevalence rate differences suggest that other important factors may have to be considered when the behaviors of early adolescents are investigated, and that generalizations to other early adolescents must be made with caution.

Recent smoking versus exercise, vegetables, and milk showed a statistically significant relationship in a Pearson *r* correlational matrix. Tried smoking was statistically significantly related to physical education class and milk, especially for Hispanics.

Similar to the findings of another study by Forrest and Leeds (2007), an association between physical inactivity and poor dietary behavior emerged for males, but not for females. This disparity may suggest different amounts of physical engagement between genders, different food consumption patterns between genders, or a combination thereof. Another possible explanation relates to the inaccurate reporting of variables, possibly caused by method limitations.

In a previous study by Kelder et al. (2003), findings from a secondary analysis of middle school (grades 6 to 8) students (N = 9,364) taken from a 3-year middle school violence prevention project confirmed that disparities existed in racial/ethnic groups. Although some information is known about Black early adolescent behavior as it relates to smoking, few scientifically based studies have reported on early adolescent students, especially those of

minority racial/ethnic classes such as Hispanic or Latino groups. Some studies have reported a higher prevalence of overweight and obesity in Mexican American adolescents than in their White counterparts (Larcar, Soto, & Riley, 2000). Moreover, this obesity trend is occurring more rapidly than in younger children (Flegal, Ogden, & Carroll, 2004). However, which factors are the major contributors and how they are associated remain unclear. Hispanic and Latino groups represent some of the largest growing subpopulations in the United States (U.S. Census Bureau, 2006). One of the most telling findings was that White and Hispanic students by the time they reached 8th grade had smoked at two to four times the rate of Black students. This finding is consistent with those of previous cross-sectional studies, the findings of which have shown repeatedly that Black students are less likely to smoke than their White or Hispanic counterparts (Gritz et al., 1998).

For this study, a conceptual model was proposed that presented the four modifiable cardiovascular risk factors, as well as specific demographics that may have an effect on the cardiovascular risk. While CVD may have its origins in early life, its associations throughout the early years remain unexplored. This study in early adolescents investigated the association of risk factors in early adolescents that are steeped in modifiable behaviors, namely smoking behavior, physical inactivity and poor dietary behavior. Based on the analysis in this study, the conceptual model was revised. Smoking behavior was dropped from the model as there were few, if any correlations that demonstrated a significant association for smoking. In addition, gender was demonstrated to have no statistical significance and was dropped from important demographics while race was retained. Race may have its roots in cultural lifestyles and learned behaviors, thus it would be prudent to design future research that addresses these underpinnings. Therefore, the revised conceptual framework as noted in figure 33 reflects that from this study

overweight, physical inactivity and poor dietary behaviors show an association in early adolescence.

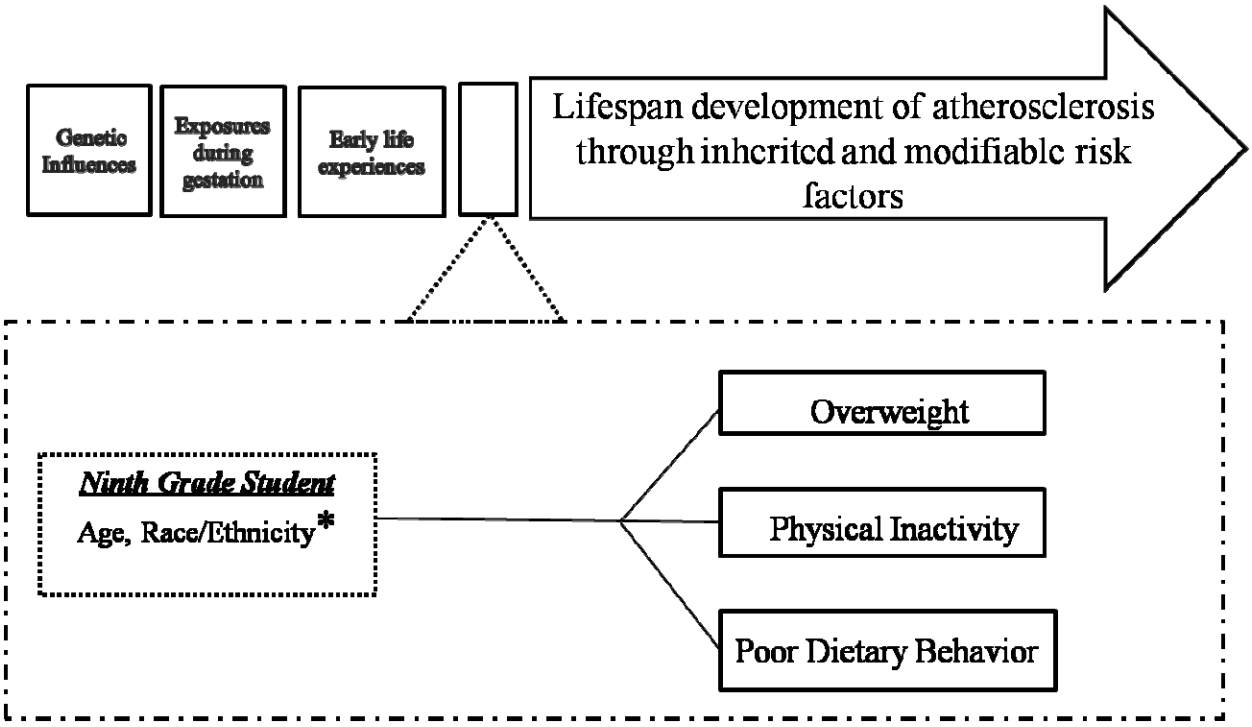

Figure 33: Revised conceptual framework for the significant modifiable risk factors towards cardiovascular disease in early adolescence.

This study suggests that the modifiable risk behaviors of physical inactivity and poor dietary behavior in early adolescents may target a source for intervention to combat overweight, a major risk factor in CVD disease. Recent research suggests that the effects of overweight contribute significantly to the development of cardiovascular disease (ADA, 2007). This study supports current findings and suggests that both physical inactivity and poor dietary habits contribute to the obesity epidemic. This study reports a 31.3% prevalence rate of obesity for ninth graders, which is consistent with national standards which report 31.9% (95% CI, 29.4%-34.4%) of adolescents aged 2 through 19 for the years 2003-2006 were identified as at or above the 85th percentile (Ogden, Carroll, & Flegal, 2008). Although the lack of temporal relationships between

risk factors of physical inactivity, poor dietary behavior and overweight in the study population cannot show causality, findings suggest that further inquiry into these related risk factors may yield insights that could contribute to negating the deleterious health impact of CVD development in early adolescents by encouraging physical activity and healthy dietary habits.

5.5 LIMITATIONS

Several limitations of the current study must be noted. First, the sample was not randomly selected. Although, the sample size was large because data were extracted from a parent study, participants represented only a portion of all adolescents. Adolescents who attended private and public schools were represented (Brener & Kahn, 2004). Adolescents who were home schooled, attended secular schools, attended Department of Defense schools, or were schooled in another manner were not represented. The variables selected for this study were chosen from a predetermined set of variables. Thus, the generalizability of findings from this study must be viewed cautiously. This study would have been strengthened had the variables been predetermined and operationalized according to preestablished standards set by the principal investigator.

Another significant consideration is that although the sample was representative of the U.S. population, this study and the parent study employed statistical procedures that accounted for less than adequate representation of certain subpopulations (i.e., weighting). Although ethnic rates are representative of subpopulations based on the weighting process, findings from this study warrant further investigation to substantiate these preliminary results. Although sampling

weighting was applied to compensate for potential bias of the dataset, one strength of this study is its large, ethnically diverse sample. Nonetheless, results show that an association exists between some of the modifiable cardiovascular risk factors in early adolescents that warrant further investigation before cardiovascular disease intervention and policy development can occur.

5.6 IMPLICATIONS AND FUTURE DIRECTIONS

Several directions for future study have emerged from this research project. First, this study was an initial attempt to investigate modifiable CVD risk factors in early adolescents. Although previous research has focused on adults, minimal research that targets modifiable CVD risk factors has been conducted on infants and youth. Investigators have yet to explore various age groups to investigate associations between modifiable and nonmodifiable CVD risk factors. Longitudinal studies will be especially important in this regard. To date, no longitudinal study has considered the associations of CVD risk factors in children and youth, except in areas of high risk. Prevention researchers may well find the current findings valuable in modifying standards of care as they relate to children and youth.

The sample used in this study was extracted from a parent study. Thus, it is prudent to validate these findings through additional studies in which the YRBS is used. If subsequent exploration validates these findings, the design of other studies that target both modifiable and nonmodifiable CVD risk factors may warrant investigation. To continue with the theoretical exploration of CVD, confirmatory factor analysis may be performed as part of these studies.

These findings have important implications for CVD prevention, which has been shown to have serious deleterious effects on the health of aging individuals and is very costly in terms of human capital/time, resources, lost wages, and suffering. This study revealed significant associations within the modifiable CVD risk factors as defined in an early adolescent population. Although current environs are relooking at CVD now in the context of cardiometabolic risk, these studies may contribute to our understanding of obesity in early adolescents. This study was

limited by the operational definitions as noted from the parent study. However, future studies may identify CVD progression in individuals by building on the results of this preliminary study.

The current study is based on findings from the YRBS, which was noted to have a narrow range that defined the targeted variables of smoking behavior, physical activity, and dietary behavior. In the future, efforts would have to be applied by which reliable and valid instruments that target modifiable CVD risk factors would be used to capture the totality of the variables. After a battery of psychometrically sound instruments has been established and applied to these studies, methods that capture CVD risk in the younger population would have to be considered. Historically, most studies to date have demonstrated associations of CVD with modifiable risk behaviors through a cross-sectional design, typically on the basis of a secondary analysis. It would be most enlightening if future studies could be designed to measure the physiological components that are involved with CVD health-risk behaviors, such as using dietary journals, measuring the height and weight of individuals, or measuring kilocalories as generated by physical activity.

Many professionals in the fields of education, health care, psychology, sociology, nursing, and medicine are gravely concerned about the exponential rate at which excess weight and lifestyles are adversely affecting the health of individuals. This trajectory of exploration is but an initial attempt to investigate associations as they relate to CVD in the younger population. Once associations have been identified, it then becomes necessary to demonstrate causal relationships. The hope is that if causal relationships can be established for modifiable CVD risk factors, then reversal of those relationships may be possible. This line of research is only an initial attempt to halt further health degradation and to promote the health of individuals.

Although a greater number of common than unique determinants of early adolescent behavior have been identified, further research is needed to determine the influence of differing social, economic, and cultural contexts on CVD development in the early adolescent period as it relates to smoking behavior, physical inactivity, and poor dietary behavior. Study findings suggest the need for enhanced efforts undertaken to target improvements in smoking behavior, physical activity, and dietary behavior in early adolescents. To ensure the development of effective interventions, future research should continue to focus on the developmental and environmental influences that may affect modifiable CVD risk factors in early adolescents.

APPENDIX A

ITEMS EXTRACTED FROM 2003 YOUTH RISK BEHAVIORAL SURVEY CODEBOOK

Used in Completing a Factor Analysis on the Constructs of Smoking Behavior, Physical Inactivity, and Poor Dietary Behavior

APPENDIX A (Continued-Smoking Behavior)

Item	Question	Response	Weighted number of respondents and percent
28	Have you ever tried cigarette smoking, even one or two puffs?	1. Yes 2. No	1. 2222 (52.0%) 2. 2051 (48.0%) n=4,273 (96.1%)
29	How old were you when you smoked a whole cigarette for the first time?	1. I have never smoked a whole cigarette. 2. 8 years old or younger 3. 9 or 10 years old 4. 11 or 12 years old 5. 13 or 14 years old 6. 15 or 16 years old 7. 17 years old or older	1. 2638 (63.3%) 2. 186 (4.5%) 3. 242 (5.8%) 4. 377 (9.0%) 5. 616 (14.8%) 6. 107 (2.6%) 7. 2 (.01%) n=4,169 (93.7%)
30	During the past 30 days, on how many days did you smoke cigarettes?	1. 0 days 2. 1 or 2 days 3. 3 to 5 days 4. 6 to 9 days 5. 10 to 19 days 6. 20 to 29 days 7. All 30 days	1. 3470 (82.6%) 2. 181 (4.3%) 3. 102 (2.4%) 4. 91 (2.2%) 5. 94 (2.3%) 6. 56 (1.3%) 7. 208 (5.0%) n=4,200 (94.4%)
31	During the past 30 days, on the days you smoked, how many cigarettes did you smoke per day?	1. I did not smoke cigarettes during the past 30 days 2. Less than 1 cigarette per day 3. 1 cigarette per day 4. 2 to 5 cigarettes per day 5. 6 to 10 cigarettes per day 6. 11 to 20 cigarettes per day 7. More than 20 cigarettes per day	1. 3411 (82.5%) 2. 165 (4.0%) 3. 139 (3.4%) 4. 260 (6.3%) 5. 84 (2.0%) 6. 39 (.9%) 7. 39 (.9%) n=4,136 (93%)
34	Have you ever smoked cigarettes daily, that is, at least one cigarette every day for 30 days?	1. Yes 2. No	1. 476 (11.5%) 2. 3660 (88.5%) n=4,135 (93%)

APPENDIX A (Continued-Physical Inactivity)

Item	Question	Response	Weighted number of respondents and percent
80	On how many of the past 7 days did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard, such as basketball, soccer, running, swimming laps, fast bicycling, fast dancing, or similar aerobic activities?	1. 0 days 2. 1 day 3. 2 days 4. 3 days 5. 4 days 6. 5 days 7. 6 days 8. 7 days	1. 628 (14.6%) 2. 343 (8.0%) 3. 387 (9.0%) 4. 530 (12.3%) 5. 383 (8.9%) 6. 694 (16.1%) 7. 250 (5.8%) 8. 785 (18.4%) n=4,305 (96.8%)
81	On how many of the past 7 days did you participate in physical activity for at least 30 minutes that did not make you sweat or breathe hard, such as fast walking, slow bicycling, skating, pushing a lawn mower, or mopping floors.	1. 0 days 2. 1 day 3. 2 days 4. 3 days 5. 4 days 6. 5 days 7. 6 days 8. 7 days	1. 1337 (31.0%) 2. 503 (11.7%) 3. 586 (13.6%) 4. 519 (12.0%) 5. 269 (6.2%) 6. 330 (7.7%) 7. 152 (3.5%) 8. 614 (14.3%) n=4,310 (96.8%)
82	On how many of the past 7 days did you do exercises to strengthen/tone muscles, such as pushups, sit-ups or weight-lifting	1. 0 days 2. 1 day 3. 2 days 4. 3 days 5. 4 days 6. 5 days 7. 6 days 8. 7 days	1. 952 (22.3%) 2. 441 (10.3% 3. 493 (11.6%) 4. 593 (13.9%) 5. 337 (7.9%) 6. 483 (11.3%) 7. 183 (4.3%) 8. 785 (18.4% n=4,266 (95.9%

APPENDIX A (Continued-Physical Inactivity)

Item	Question	Response	Weighted number of respondents and percent
83	On an average school day, how many hours do you watch TV?	1. I do not watch TV on an average school day 2. Less than 1 hour per day 3. 1 hour per day 4. 2 hours per day 5. 3 hours per day 6. 4 hours per day 7. 5 or more hours per day	1. 365 (8.6%) 2. 505 (11.9%) 3. 584 (13.8%) 4. 921 (21.7%) 5. 810 (19.1%) 6. 380 (9.0%) 7. 673 (15.9%) n=4,238 (95.3%)
84	In an average week when you are in school, on how many days do you o to physical education (PE) classes?	1. 0 days 2. 1 day 3. 2 days 4. 3 days 5. 4 days 6. 5 days	1. 1125 (29.0%) 2. 121 (3.1%) 3. 280 (7.2%) 4. 764 (19.7%) 5. 119 (3.1%) 6. 1467 (37.9%) n=3,876 (87.1%)
85	During an average physical education (PE) class, how many minutes do you spend actually exercising or playing sports?	1. I do not take PE 2. Less than 10 minutes 3. 10 to 20 minutes 4. 21 to 30 minutes 5. 31 to 40 minutes 6. 41 to 50 minutes 7. 51 to 60 minutes 8. More than 60 minutes	1. 1130 (29.0%) 2. 182 (4.7%) 3. 363 (9.3%) 4. 458 (11.8%) 5. 526 (13.5%) 6. 387 (9.9%) 7. 283 (7.3%) 8. 570 (14.6%) n=3,900 (87.7%)
86	During the past 12 months, on how many sports teams did you play?	1. 0 teams 2. 1 team 3. 2 teams 4. 3 or more teams	1. 1601 (39.7%) 2. 939 (23.3%) 3. 693 (17.2%) 4. 796 (19.8%) n=4,029 (90.6%)

APPENDIX A (Continued-Physical Inactivity)

Item	Question	Response	Weighted number of respondents and percent
93	During the past 30 days, did you see a doctor or nurse for an injury that happened while exercising or playing sports?	1. I did not exercise or play sports in the past 30 days 2. Yes 3. No	1. 598 (16.8%) 2. 636 (17.8%) 3. 2334 (65.4%) n=3,569 (80.2%)

APPENDIX A (Continued-Dietary Behavior)

Item	Question	Response	Weighted number of respondents and percent
73	During the past 7 days, how many times did you drink 100% fruit juices such as orange juice, apple juice, or grape juice?	1. I did not drink 100% fruit juice during the past 7 days 2. 1 to 3 times during the past 7 days 3. 4 to 6 times during the past 7 days 4. 1 time per day 5. 2 times per day 6. 3 times per day 7. 4 or more times per day	1. 860 (19.7%) 2. 1500 (34.4%) 3. 720 (16.5%) 4. 332 (7.6%) 5. 410 (9.4%) 6. 222 (5.1%) 7. 320 (7.3%) n=4,364 (98.1%)
74	During the past 7 days, how many times did you eat fruit?	1. I did not eat fruit during the past 7 days 2. 1 to 3 times during the past 7 days 3. 4 to 6 times during the past 7 days 4. 1 time per day 5. 2 times per day 6. 3 times per day 7. 4 or more times per day	1. 689 (15.8%) 2. 1625 (37.3%) 3. 831 (19.0%) 4. 443 (10.1%) 5. 360 (8.2%) 6. 188 (4.3%) 7. 227 (5.2%) n=4,363 (98.1%)
75	During the past 7 days, how many times did you eat green salad?	1. I did not eat green salad during the past 7 days 2. 1 to 3 times during the past 7 days 3. 4 to 6 times during the past 7 days 4. 1 time per day 5. 2 times per day 6. 3 times per day 7. 4 or more times per day	1. 1708 (39.2%) 2. 1483 (34.0%) 3. 534 (12.3%) 4. 314 (7.2%) 5. 159 (3.7%) 6. 64 (1.5%) 7. 98 (2.2%) n=4,361 (98.1%)

APPENDIX A (Continued-Dietary Behavior)

Item	Question	Response	Weighted number of respondents and percent
76	During the past 7 days, how many times did you eat potatoes?	1. I did not eat potatoes during the past 7 days 2. 1 to 3 times during the past 7 days 3. 4 to 6 times during the past 7 days 4. 1 time per day 5. 2 times per day 6. 3 times per day 7. 4 or more times per day	1. 1371 (31.8%) 2. 1957 (45.4%) 3. 556 (12.9%) 4. 202 (4.7%) 5. 90 (2.1%) 6. 52 (1.2%) 7. 86 (2.0%) n=4,313 (97%)
77	During the past 7 days, how many times did you eat carrots?	1. I did not eat carrots during the past 7 days 2. 1 to 3 times during the past 7 days 3. 4to 6 times during the past 7 days 4. 1 time per day 5. 2 times per day 6. 3 times per day 7. 4 or more times per day	1. 2323 (53.6%) 2. 1414 (32.6%) 3. 262 (6.0%) 4. 143 (3.3%) 5. 63 (1.5%) 6. 54 (1.3%) 7. 77 (1.8%) n=4,336 (97.5%)
78	During the past 7 days, how many times did you eat other vegetables?	1. I did not eat other vegetables during the past 7 days 2. 1 to 3 times during the past 7 days 3. 4to 6 times during the past 7 days 4. 1 time per day 5. 2 times per day 6. 3 times per day 7. 4 or more times per day	1. 752 (17.6%) 2. 1555 (36.5%) 3. 972 (22.8%) 4. 532 (12.5%) 5. 224 (5.3%) 6. 104 (2.4%) 7. 121 (2.8%) n=4,261 (95.8%)

APPENDIX A (Continued-Dietary Behavior)

Item	Question	Response	Weighted number of respondents and percent
79	During the past 7 days, how many glasses of milk did you drink?	1. I did not drink milk during the past 7 days 2. 1 to 3 times during the past 7 days 3. 4to 6 times during the past 7 days 4. 1 time per day 5. 2 times per day 6. 3 times per day 7. 4 or more times per day	1. 709 (16.6%) 2. 910 (21.3%) 3. 731 (17.1%) 4. 457 (10.7%) 5. 628 (14.7%) 6. 365 (8.5%) 7. 466 (10.9%) n=4,266 (95.9%)

APPENDIX B

IRB APPROVAL LETTER

University of Pittsburgh
Institutional Review Board

Exempt and Expedited Reviews

University of Pittsburgh FWA: 00006790
University of Pittsburgh Medical Center: FWA 00006735
Children's Hospital of Pittsburgh: FWA 00000600

3500 Fifth Avenue
Suite 100
Pittsburgh, PA 15213
Phone: 412.383.1480
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TO: Julia Greenawalt

FROM: Christopher M. Ryan, PhD, Vice Chair

DATE: December 21, 2006

PROTOCOL: An Exploration into the Relationship of Weight Concerns, Physical Activity and Smoking as They Relate to Ninth Grade Students

IRB Number: 0612023

The above-referenced protocol has been reviewed by the University of Pittsburgh Institutional Review Board. Based on the information provided in the IRB protocol, this project meets all the necessary criteria for an exemption, and is hereby designated as "exempt" under section 45 CFR 46.101(b)(4).

- If any modifications are made to this project, please submit an 'exempt modification' form to the IRB.
- Please advise the IRB when your project has been completed so that it may be officially terminated in the IRB database.
- This research study may be audited by the University of Pittsburgh Research Conduct and Compliance Office.

Approval Date: December 21, 2006

CR:dj

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