Just one more: An examination of the prevalence, correlates, and consequences of concurrent alcohol and medication use in older adults

by

Mary Lindsey Smith

B.A., University of New Mexico, 2000

MSW, University of Pittsburgh, 2004

Submitted to the Graduate Faculty of

School of Social Work in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2009

UNIVERSITY OF PITTSBURGH

SOCIAL WORK

This dissertation was presented

by

Mary Lindsey Smith

It was defended on

[December 7, 2009]

and approved by

Sara Goodkind, Assistant Professor, School of Social Work

Rafael Engel, Associate Professor, School of Social Work

Richard Schulz, Academic Rank, Director, University Center for Social and Urban Research

Dissertation Chairperson: Daniel Rosen, Associate Professor, School of Social Work

Just one more: An examination of the prevalence, correlates, and consequences of concurrent alcohol and medication use in older adults

Mary Lindsey Smith, MSW, Ph.D.

University of Pittsburgh, 2009

Just one more: An examination of the prevalence, correlates, and consequences of concurrent alcohol and medication use in older adults

Mary Lindsey Smith, MSW, Ph.D.

University of Pittsburgh, 2009

Research suggests that the concurrent use of alcohol and medications can lead to a number of health problems. This is of importance for older adults, who take more medication than any other age group. Despite older adults' increased risk of alcohol-medication interaction there has been limited research focused on the patterns and correlates of simultaneous alcohol and medication use in older adults. The purpose of this study was to examine the prevalence and patterns of concurrent use among community-dwelling older adults by gender, race and age. The impact of group membership on health status was also examined.

Data from the Cardiovascular Health Study (CHS), a population-based longitudinal study of older adults, were analyzed for this study. The CHS cohort consists of 5,888 individuals ages 65 and older. Participants completed a series of face-to-face and telephone interviews along with clinical examinations. This analysis utilizes CHS data from waves 1 through 6. Univariate analyses were conducted at baseline to determine the prevalence rates and correlates of concomitant use among older adults. Group-based logit modeling was used to chart longitudinal patterns of use over the course of the study. Finally, multinomial logistic regression analyses were employed to assess the relationship between various patterns of concurrent use and health outcomes.

Results demonstrated that concurrent use is fairly common among community-dwelling older adults. Men, Whites, younger individuals and problem drinkers were significantly more likely to concurrently use than women, African Americans, older respondents and low to moderate alcohol users. Furthermore, group-based logic analysis revealed four distinct patterns of concurrent use: a *no to low use* group, a *decreasing use* group, an *increasing use* group, and a *high use* group. Males and Whites had the highest probability of being in the *high use* group. Group membership was found to be related to physical and mental health. Furthermore, concurrent use was found to increase the risk of mortality among study participants.

These findings indicate a significant need for social work and health care professionals to educate older adults about the dangers of concurrent alcohol-medication use. Additionally, it appears that there is a need for health campaigns that focus on the promotion of safer use of alcohol and medications by older adults.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Medication may well be the single most important health care technology to prevent illness, disability, and death in older adults (American Society of Consultant Pharmacists (ASCP), 2004; American Society on Aging (ASA), 2001). Older persons with chronic conditions and diseases benefit the most from taking medications yet risk the most from failing to take them properly and/or combining them with alcohol (Sullivan et al., 2007; Vik et al., 2006). The misuse of alcohol and medications among older adults is one of the most rapidly developing public health issues in the United States (Sullivan et al., 2007; Christensen et al., 2006; Patterson & Jeste, 1999). Over half of individuals aged 65 and older consume alcohol, with approximately 34% of older adults reporting regular weekly consumption of alcoholic beverages (Onder et al., 2002). In addition, seniors take an average of 5.3 prescription drugs and 5.7 over-the-counter medications a day (Substance Abuse and Mental Health Service Administration (SAMHSA), 2004; ASA, 2001). Although the interaction of alcohol and prescription drugs is an important health concern for individuals of all ages, it is a particularly salient issue for older adults who take more medication than any other age cohort and are more susceptible to the effects of alcohol and/or medications.

Older adults are at an increased risk for medication misuse for a number of reasons including but not limited to polypharmacy, socioeconomic changes, and physiological as well as psychological changes associated with aging (Sullivan et al., 2007; Swift et al., 2007; SAMHSA,

2004). Social workers, who come in frequent contact with older Americans, are employed in a variety of settings and have a wide range of duties, making them uniquely situated to deal with issues associated with concurrent alcohol and medication use among older adults. Social workers can play an instrumental role in identifying and reducing rates of concomitant use as well as the subsequent negative social and economic costs associated with the behavior by assisting in the development of screening and diagnostic measures of concurrent use; implementing education programs for older adults, caregivers and health care professionals; helping to form linkages among professionals in the aging care network; and assisting in the implementation of harm reduction models.

Despite an emerging body of empirical evidence that suggests that concurrent use is rather common among older adults, little research has focused on examining patterns of concomitant alcohol and medication use among older adults. The primary goal of this study was to examine the prevalence, correlates, and consequences associated with the concurrent use of alcohol and medication in a sample of community-dwelling older adults. Although past empirical research has examined concurrent use among community-dwelling older adults, this study is unique in that it explores the issue of concurrent use outside of the primary and acute care settings using longitudinal data from a large sample of individuals aged 65 and older. This allowed for the exploration of the prevalence and patterns of concurrent use in a general population of older adults without a precipitating adverse drug event.

1.1 STUDY PURPOSE

The overall aim of this research study was to examine patterns of concurrent alcohol and prescription and/or over-the-counter medications use among community-dwelling older adults. This study explored how usage patterns evolve over time and the factors, including age, gender, and race, affecting various trajectories of concurrent use. Group-based modeling was used to identify distinct clusters of individuals with homogenous longitudinal patterns of concurrent use within the sample. Moreover, individual-level differences in concomitant usage patterns at the group level were also explored. Being able to identify distinctive trajectories of concurrent use is particularly helpful for both research and practice. In addition, understanding individual developmental trajectories and what factors impact patterns of concurrent use can be instrumental in the formulation of both policy and intervention strategies that target subgroups of older adults at increased risk for concurrent use.

In addition to examining longitudinal patterns of concurrent use, this study sought to explore the impact of individual trajectories of concomitant use on health status. Despite the fact that older adults are at an increased risk of alcohol-medication interaction, limited research has focused on the effects of concomitant alcohol and medication use on their health status. In an effort to expand upon the existing knowledge base regarding concurrent use and health, this study also sought to examine how specific trajectories of concomitant use affected the health status of older adults. While existing research indicates that moderate levels of alcohol use may be beneficial to the overall health of older adults (Hendriks & van Tol, 2005), there is reason to believe that the concomitant use of alcohol and medication can lead to a number of significant health problems for older adults (Blow & Barry, 2002; Kennedy et al., 1999; Weathermon & Crabb, 1999). Physiological changes associated with aging, coupled with the high rates of

medication use, make older adults extremely vulnerable to the adverse effects of concurrent alcohol and medication use. Past research indicates that a broad range of measures are necessary to accurately assess physical and mental health functioning (Newsom & Schulz, 1996). Therefore, a combination of measures was used to obtain a comprehensive measure of health status including, self-reported health status and physical functioning (IADLs and ADLs) to measure physical health status and depression to assess mental health.

Concurrent use has been defined in a variety of ways; however, a common definition and the one employed in the present study refers to the use of one or more substances in the same time period but not necessarily at the same time (Schensul, Convey & Burkholder, 2005; McCabe, Cranford, Morales & Young 2006).[1] The focus of this study is the concurrent use of alcohol and alcohol-interactive drugs. Medications are considered alcohol-interactive if the use of alcohol with the medication influences the metabolism of the drug, impacts the enzymes involved in drug pharmacokinetics, or magnifies the effects of the medication (Jalbert et al., 2007; Alberta Alcohol and Drug Abuse Commission (AADAC), 2003).

The current study used longitudinal data from the Cardiovascular Health Study (CHS), a population-based longitudinal study of nearly 6,000 adults 65 years or older, to explore patterns of concurrent use and examine the effects of concurrent alcohol and medication on the health of older adults. This study had three specific goals:

(1) To describe the prevalence rates of concurrent alcohol and medication use among community-dwelling older adults. In addition, analyses were conducted to examine whether rates of concomitant alcohol and medication use vary by demographic factors including age, gender, and race.

[1] Note: An in-depth explanation of key study terms, including definitions of concurrent use and alcohol-interactive medications, is presented in the literature review and methodology sections.

(2) To examine how the concomitant use of alcohol and medications in older adults evolves over time. Analyses explored various trajectories of concurrent use and whether individual patterns of use differ by age, gender, and race.

(3) To assess how various trajectories of concomitant alcohol and medication use affect the physical and mental health status of older adults.

1.2 RESEARCH QUESTIONS AND HYPOTHESES

This study focused on three primary areas of interest: 1) prevalence of concurrent alcohol and medication use among community-dwelling older adults; 2) differences in longitudinal patterns of concurrent use among older adults and; 3) the relationship between patterns of concurrent use and physical as well as mental health status among community-dwelling older adults. Given these three areas of focus the current investigation addresses the following questions and hypotheses.

Given the fact that approximately half of individuals aged 65 and older consume alcohol, and seniors take an average of 5.3 prescription drugs and 5.7 over-the-counter medications a day it was predicted that concurrent use would be fairly common among older adults (Substance Abuse and Mental Health Service Administration (SAMHSA), 2004; ASA, 2001). The literature also shows that Women and African Americans report higher rates of abstinence than Men and Whites. Therefore, it was hypothesized that rates of concurrent use would be greatest among males and Whites (Breslow et al., 2003)

1. Prevalence of concurrent use among community-dwelling older adults

Q-1: What is the prevalence rate of concurrent alcohol and medication use among community-dwelling older adults?

H.1: Concurrent use is common among community-dwelling older adults.

Q-2: Do rates of concurrent alcohol and medication use differ by gender, race, and age?

H.2.a: Males are more likely than female community-dwelling older adults to concurrently use alcohol and medications.

H.2.b: White community-dwelling older adults have higher rates of concurrent use than their African American counterparts.

H.2.c: Younger community-dwelling older adults are more likely to concurrently use when compared to older individuals.

Approximately half of all seniors consume alcohol on a regular basis and epidemiological research on alcohol use among older adults estimates that anywhere from 2% to 15% of older adults are at-risk or problem drinkers (Grant et al., 2004; NIAAA, 2004; Olsin & Holden, 2002; ASA, 2001). Furthermore, 2% to 5% of these seniors meet the criteria for alcohol abuse or dependence (NIAAA, 2004; ASA, 2001). Prevalence and amount of consumption also varies by gender and race; men and Whites tend to consume higher rates of alcohol and drink more frequently than women and African Americans (Satre & Arean, 2005; Breslow et al., 2003). Based on these facts it was hypothesized that there would be several unique trajectories of

concurrent use. In addition, it was postulated that men and Whites would be more likely to be members of group trajectories with higher rates of concurrent use.

2. Longitudinal patterns of concurrent use among community-dwelling older adults

Q-1: Are there varying longitudinal patterns of concurrent use among community-dwelling older adults?

H.1: There are a minimum of two distinct trajectories of concurrent use among community- dwelling older adults.

Q-2: Do patterns of concurrent alcohol and medication use differ by gender and race?

H.2.a: Males are less likely than female community-dwelling older adults to have patterns of concurrent alcohol and medications characterized by a trajectory of no use over time.

H.2.b: White older adults are more likely than their African American counterparts to have longitudinal patterns of concurrent alcohol and medication use characterized by a trajectory of sustained concomitant use over time.

There are a number of serious consequences associated with concurrent alcohol and medication use among older adults. For example, concomitant use of medications like benzodiazepines, muscle relaxants, and opioids can cause ADEs such as increased sedation and decreased motor skills; these problems can lead to falls or other accidents (Tanaka, 2003; Weathermon & Crabb, 1999). Concurrent alcohol and medication use can also adversely affects the illness for which the medications are prescribed. Many of the chronic conditions common among older adults such as hypertension, diabetes, gastrointestinal conditions, insomnia and depression are exacerbated by alcohol use (Moore et al., 2007). Thus, it was hypothesized that individuals with higher levels of concurrent use would report lower overall physical and mental health.

3. The association between patterns of concurrent use and physical and mental health status

Q-1: Do patterns of concurrent alcohol and medication use affect the physical health status of community-dwelling older adults?

H.1.a: Older adults who have sustained longitudinal patterns of concurrent use are more likely to report poor physical health when compared to individuals with no concurrent use.

H.1.b: Older adults who have sustained longitudinal patterns of concurrent use are more likely to report difficulties with physical functioning when compared to older adults who report no longitudinal pattern of concurrent use.

Q-2: Do patterns of concurrent alcohol and medication use affect the mental health status of community-dwelling older adults?

H.2.a: Rates of depression are more common among community-dwelling older adults who have longitudinal patterns of concurrent alcohol and medication use when compared to older adults who report no longitudinal pattern of concurrent use.

1.3 STUDY SIGNIFICANCE

In recent years, significant advances have been made in the understanding of both the aging process with its attendant health problems and in the understanding and consequences of alcohol misuse. However, our understanding of concomitant alcohol and medication use in older adults remains limited. The majority of research regarding concurrent alcohol and medication use has been conducted with young or middle-aged populations and has focused primarily on chronic heavy drinkers; few studies have examined the alcohol-medication interactions among low to moderate users in the general population of older adults (Onder et al., 2002). Some studies have investigated the prevalence of concomitant use in retirement communities (Adams, 1995), emergency room departments (Adams, 1992), primary care settings (Blow et al., 2000; Adams et al., 1996) and hospitals (Bristow & Clare, 1992). Yet, community level studies are scarce, and those focusing on the effects of moderate alcohol use and medication use among older adults are even more uncommon.

This study makes a number of significant contributions to social work, gerontology, and public health policy—all of which can help improve the lives of older adults and their families. Furthermore, the results of this study can aid in developing programs and policies that reduce the economic and health burdens associated with medication misuse among older adults. First, the current study expands upon the existing knowledge base by examining concurrent use among the full spectrum of drinkers. Examining concurrent use in community-dwelling older adults will aid in developing a more thorough understanding of concomitant usage rates and patterns among seniors. Studies indicate that suboptimal drug use and medication errors such as concomitant use have an important impact on health and the national economy; adverse drug events have been found to be associated with increased costs of care in both the inpatient and outpatient settings

(Burton et al., 2007). In a recent study Ernst and Grizzle (2001) found that since 1995, the costs associated with adverse drug events has more than doubled. In 2000, the costs of drug-related morbidity and mortality exceeded $177.4 billion with hospital admissions accounting for nearly 70% of total costs (Ernst & Grizzle, 2001). Older adults are disproportionately affected by adverse drug events and reactions, yet, research has found that identifying problem alcohol and/or medication misuse is particularly difficult in elderly individuals (Sullivan, 2007). Identifying at risk individuals is the key to aiding social workers, health care professionals, and other members of the Aging care network with designing effective education, prevention, and intervention strategies that can assist in mitigating the high economic as well as medical burdens associated with adverse drug events and improve the quality of life for older adults; this study will assist in identifying specific subpopulations that may be at an increased risk for concomitant use.

Traditionally, studies examining the concurrent use of alcohol and medication have focused on heavy or chronic drinkers; thus, we know very little about the prevalence rates, patterns of usage and the adverse effects of concurrent use among low or moderate drinkers. Research paradigms that focus on persons who are abusing or who are dependent on alcohol are not as useful when applied to older drinkers whose alcohol use, despite a lower alcohol consumption level, can be problematic due to age-related physiological changes, medication use, and functional mobility (Moore et al., 1999). Given these factors, it is critical that we explore concurrent use in all older adults who consume alcohol, not just those who are considered problem drinkers. The current study explored longitudinal patterns of concomitant use in older adults with a range of alcohol consumption patterns. The identification of various patterns of concurrent use, as well as the sociodemographic factors associated with unique trajectories of

concomitant use, is crucial knowledge that can assist social workers, health professionals, and other members of the aging care network with designing prevention as well as intervention strategies that target at-risk population such as older adults who consume the majority of medications taken in the United States.

In addition to issues associated with the conceptualization of concurrent use, the small body of research that has examined the concomitant use of alcohol and medication in older adults has largely drawn from acute or primary care settings and tends to focus on prevalence rates rather than examining health outcomes (Aira, 2005). This study is unique in that it examines concurrent use in a sample of community-dwelling older adults. The growing population of older adults coupled with increased life expectancies will likely lead to more seniors living within the community, making the understanding of the correlates and usage patterns of concurrent use among older adults increasingly important for social workers, health care professionals, and other individuals in the aging care network who work with older adults on a daily basis. Data from this study can be used to educate geriatric social workers, case managers and other health care professionals about the dangers of concomitant alcohol and medication use. It can also help to inform relevant professionals of specific subpopulations that are at an increased risk for concurrent use. Further, this study advances our knowledge of concurrent use among older adults and can be used to assist geriatric social workers, as well as other health care practitioners, in the development of policies and programs that educate older adults about the dangers of concurrent alcohol-medication use. Additionally, it appears that there is a need for health campaigns to focus on the promotion of safer use of alcohol and medications by older adults. Public awareness campaigns and educational efforts are two key

tactics that can play a large role in reducing the burden associated with medication misuse (Sullivan et al., 2007).

Finally, despite the fact that research has shown that the use of alcohol with alcohol-interactive medications can lead to a number of physical and mental health issues, most of the empirical research on concurrent use among community-dwelling older adults has explored the prevalence of adverse drug events associated with concomitant use (Aira, 2005; Blow, 2002). In the majority of these studies, adverse drug reactions have been the primary outcome measure; therefore, we have very limited knowledge about the broader adverse health consequences associated with concurrent alcohol and medication use. This study is unique in that it explores a variety of health outcomes. Concomitant use is a dangerous practice that can be harmful to older adults, reducing their quality of life, impacting upon their health, and possibly leading to lethal consequences (Moore et al., 2007). For example, concomitant use of medications like benzodiazepines, muscle relaxants, and opioids can cause adverse drug events such as increased sedation and decreased motor skills, which can lead to falls or other accidents in older adults (Tanaka, 2003; Weathermon & Crabb, 1999). In order to develop effective policies and programs aimed at reducing medication misuse among older adults we must have an understanding of the patterns and correlates of medication use among this population. Understanding what subpopulations of older adults are at an increased risk for concurrent use and identifying concomitant use patterns is crucial to developing effective prevention and intervention strategies.

Over the coming decades, the increasing number of aging baby boomers will have a considerable impact on the need and demand for health care among older adults (Blow et al., 2002). With the demographic projections and alcohol use trends indicating that newer cohorts of

older adults are more likely to drink and to have heavier drinking habits than previous generations, alcohol use among older adults presents one of the most salient health problems facing this country. Moreover, as the number of older individuals using prescription medications increases, so too does the absolute number of older adults using alcohol-interactive medications. Despite these trends, little is known about the prevalence of concurrent alcohol and medication use in community-dwelling older adults.

The increased service needs of aging alcohol users will also place additional financial strain on existing resources. In a recent study Ernst and Grizzle (2001) found that the costs associated with adverse drug events have more than doubled since 1995. In 2000, the costs of drug-related morbidity and mortality exceeded $177.4 billion, with hospital admissions accounting for nearly 70% of total costs, followed by long-term-care admissions, which accounted for 18% (Ernst & Grizzle, 2001). Prevention and intervention strategies are needed in order help mitigate the high economic as well as medical burdens associated with adverse drug events.

In spite of these facts, little is known about patterns of concurrent alcohol and medication use among older Americans, a common form of medication misuse among older adults which can lead to adverse drug events. The growing population of older adults has led to service providers making primary disease prevention and the promotion of healthy lifestyles top priorities in the provision of services to older adults. Gaining a better understanding of the prevalence, correlates, and consequences of concomitant alcohol and medication use is critical to developing prevention and intervention strategies that effectively meet the needs of older adults.

2.0 REVIEW OF LITERATURE

2.1 OVERVIEW OF LITERATURE REVIEW

The literature review is divided into three major sections: alcohol use, medication use, and concurrent alcohol and medication use among older adults. In the first section there is an overview of the basic mechanisms for processing alcohol by older adults. The description of alcohol pharmacokinetics is followed by a discussion of definitions, guidelines and screening, and diagnostic issues associated with alcohol use among older adults. The next section includes a summary of past research on the prevalence rates of alcohol use among older adults. The final alcohol section is a review of the literature on the relationship between alcohol use and health status among older adults.

The review of the literature on medication use among older adults follows a similar format to that of the section on alcohol use, beginning with a summary of the pharmacokinetics of prescription medications. This is followed by a discussion of the literature regarding the prevalence of medication use and the risks associated with using prescription medications drugs. The portion of the review on concurrent use ties together the research reviewed regarding alcohol and medication use among older adults. This section includes a discussion of the prevalence and potential consequences of concurrent use.

2.2 ALCOHOL USE AMONG OLDER ADULTS

2.2.1 Alcohol pharmacokinetics

Alcohol pharmacokinetics in humans is a complex process and is dependent upon a number of factors, including the amount and type of alcohol ingested, the presence of food in the stomach, body water, age, and gender (Norberg et al., 2003). There are three basic processes associated with the delivery and removal of alcohol (ethanol) from the body: absorption, distribution and metabolism.

After entering the body, most alcohol (80%) is absorbed by the duodenum, a portion of the small intestine; the remaining alcohol is absorbed through the stomach (Swift, 2003). There are a number of factors that determine the rate at which alcohol is distributed throughout the body. The most important is the presence of food in the stomach (Paton, 2005; Swift, 2003). Food slows the rate of alcohol delivery to the intestine by delaying gastric emptying. Reducing the speed at which alcohol is transported to the intestine serves to lower the resulting blood alcohol level (Swift, 2003). In addition, food in the stomach lowers the concentration of alcohol by dilution (Swift, 2003). Other factors that impact the absorption process are time of day, the concentration of the alcohol ingested, and the pattern of drinking (Norberg et al., 2003).

After the stomach and intestine have absorbed the alcohol, it is distributed in the body via the bloodstream (Swift, 2003). Most tissues—such as the heart, brain, and muscle—are exposed to alcohol because it is dispersed throughout the water in the body (Paton, 2005). The majority of alcohol ingested (95–98%) is metabolized in the liver, while the remainder is excreted through the breath, urine, and sweat (Norberg et al., 2003).

The metabolism of alcohol is a two-step process. First, the enzyme gastric alcohol dehydrogenase (ADH) converts the alcohol to acetaldehyde (Swift, 2003). The acetaldehyde, a highly reactive and toxic substance, is then converted to harmless acetic acid by the enzyme aldehyde dehydrogenase (ALDH), metabolizing ethanol in the body (Paton, 2005). In healthy individuals this oxidation process happens rapidly (Paton, 2005). As stated earlier, there are a number of physiological and behavioral factors that influence the body's ability to process alcohol; of particular importance to this study are age, gender, and medication use.

2.2.1.1 Factors Influencing the Metabolism of Alcohol

Age

Older adults are especially susceptible to the adverse consequences of alcohol use because of physiological changes associated with aging (Sullivan et al., 2007; Lands, 1998; Atkinson et al., 1992; Vestal, 1977). Between the ages of 25 and 65, the proportion of total body weight represented by fat dramatically increases: it doubles in men and grows by almost 50% in women (Dufour, 1992). The result is a vast decrease in lean body mass and a reduction in total body water (Friedlander & Norman, 2006). Alcohol is a water-soluble substance; therefore, when alcohol is distributed in a lower volume of body water it leads to a high blood alcohol concentration (Friedlander & Norman, 2006). As a result older adults, because of their low levels of body water, develop higher blood alcohol levels than younger individuals who consume the same amount of alcohol.

In addition to changes in the body's composition, other physical conditions associated with aging also affect the distribution and metabolism of alcohol in older adults. Aging leads to an impaired ability to metabolize and clear alcohol from one's system due to compromised

hepatic and renal functioning, a decreased effectiveness of the blood brain barrier, and an increased use of medications (Sanjuan & Langenbucher, 1999). Older adults also have lower levels of the enzyme ADH, which inhibits their ability to metabolize alcohol as rapidly as younger people. The result is an increased blood alcohol concentration (Beechem, 2002). A slower metabolic rate also increases the amount of time that alcohol is in the stomach, intensifying its toxic effects (Beechem, 2002).

Gender

Due to physiological differences between the sexes, women of all ages prove more susceptible to the effects of alcohol than men. Women reach higher blood alcohol concentrations than their male counterparts in the same weight-adjusted levels of alcohol consumption (Epstein et al., 2007). This is due to several factors: women have less body water than men of a similar weight; less lean muscle mass; and lower levels of the enzyme ADH, which is responsible for breaking down alcohol in the stomach (Epstein et al., 2007). The unique physiology of women leads to what has been termed the "telescoping effect": females develop issues earlier in their drinking careers; they suffer more severe adverse health consequences from their alcohol consumption; and the health effects of their alcohol use emerge more rapidly than the rates seen in men (Redgrave et al., 2003).

An example of the telescoping effect is the development of cirrhosis of the liver: compared to men, women develop cirrhosis with less alcohol consumption and after a shorter duration of alcohol use (Nolen-Hoeksema, 2004). Age-related changes in physiology, coupled with the decrease of lean tissue experienced by older women, serve to intensify the telescoping effect in females. Thus, even low to moderate levels of alcohol consumption can be particularly hazardous for older women (Epstein et al., 2007).

2.2.2 Alcohol Guidelines for Older Adults

The physiological changes associated with aging, high levels of physical and mental health problems, and increased levels of medication use have led to the creation of alcohol guidelines for older adults that are lower than those recommended for other age cohorts. The National Institute of Alcohol Abuse and Alcoholism (NIAAA) recommends that individuals ages 65 and older consume no more than one standard drink a day or seven standard drinks a week (NIAAA, 1995). A standard drink contains approximatly14 grams or 0.6 fluid ounces (NIAAA, 1995). Although different brands and types of beverages vary in their actual alcohol content, a standard drink is roughly the equivalent of one 12-ounce beer, a 5-ounce glass of wine, or 1.5-ounces of 80 proof distilled liquor (Blow et al., 2002). NIAAA guidelines also recommend that older adults should not consume more than two drinks on any one occasion; more than this is considered binge drinking (Blow et al., 2002). The NIAAA-recommended guidelines for levels of alcohol use among older adults are consistent with research regarding alcohol-related problems, as well as current data on the beneficial health effects of moderate alcohol consumption (Blow et al., 2002).

2.2.3 Definitions of Alcohol Use among Older Adults

Older adults who consume alcohol can be placed into one of five categories: abstinence, low-risk, at-risk, problem, and alcohol abuse or dependence (Barry et al., 2001; Blow, 1998). These categories of alcohol use are designed to form a framework for understanding the spectrum of alcohol consumption among older adults (Barry et al., 2001; Blow, 1998).

Older adults who presently consume no alcohol are classified as abstainers (Barry et al., 2001; Blow, 1998). Individuals are categorized as low-risk drinkers if their alcohol consumption is below or within the recommended guidelines for older adults—one or less drinks a day or no more than seven drinks a week (Barry et al., 2001; Blow, 1998). Older adults who drink above the recommended guideline but who do not meet specific criteria for alcohol abuse or dependence are classified as at-risk drinkers (Oslin & Holden, 2002; Barry et al., 2001; Blow, 1998).

At-risk drinkers are individuals who may develop alcohol-related problems because they consume more than one drink a day or seven drinks a week. This is a particularly relevant classification category for older adults who may be consuming what they believe are safe amounts of alcohol, but who are putting themselves at risk for alcohol-related problems due to the physiology of aging and increased levels of medication use.

Problem use is defined as the consumption of alcohol at a level that has already led to a least one adverse medical, psychological or social consequence (Olsin & Holden, 2002; Barry et al., 2001; Blow, 1998). For example, an individual's alcohol use may negatively impact his/her depression or diabetes. It is not assumed that alcohol is the cause of the problem; however, there is an inference that the usage has led to or has exasperated the issue (Olsin & Holden, 2002).

The final classification category is alcohol abuse or dependence. According to the most recent version of the Diagnostic and Statistical Manual Fourth Edition (DSM-IV), alcohol abuse is characterized by an inability to fulfill responsibilities and continued drinking despite experiencing negative consequences (American Psychiatric Association (APA), 2000). Alcohol dependence or alcoholism is distinguished by the following: a loss of control, a preoccupation with alcohol, and physiological symptoms such as tolerance and withdrawal (APA, 2000). It is

worth noting that the DSM-IV criteria for diagnosing alcohol abuse and dependence have undergone minimal validation with older adults; criteria are based on knowledge gathered from young to middle-aged adults (Olsin & Holden, 2002). Therefore, the DSM-IV criteria may not be the best way to assess hazardous drinking in older adults (Olsin & Holden, 2002). Recently, the accuracy of current problem rates among older adults has been called into question (Barrick & Connors, 2002; Klein & Jess, 2002; Johnson, 2000). It is suggested that the prevalence of alcohol use among older adults significantly underestimates the problem (Barrick & Connors, 2002).

2.2.4 Screening and Diagnostic Issues

Diagnostic criteria and screening instruments for addictive disorders have tended to ignore age, lending to a dearth of information on specific diagnostic criteria for older adults (O'Connell et al., 2004). Thus, traditional screening instruments are not as useful when applied to older drinkers where substance use, regardless of consumption level, can be problematic because of age-related physiological changes, medication use, and functional mobility (Moore et al., 1999). A lack of adequate detection and diagnostic techniques for older adults means that substance abuse often goes undetected in this population, and those needing treatment do not receive services. One of the primary issues associated with determining accurate prevalence rates of alcohol use among older adults is the lack of adequate geriatric screening and diagnostic tools. This problem is confounded by age-related social and physiological issues. The number and interrelationship of physical and mental health disorders in older adults can complicate the diagnosis and treatment of substance abuse disorders. Typically, substance-related problems in this population are only identified when these individuals are hospitalized for physical illnesses.

Although screening instruments and diagnostic criteria for alcohol use disorders are clearly defined for younger populations, there is a lack of information on age-specific criteria for older adults (O'Connell et al., 2004). In a study of patients entering a general hospital in the United States, 60% of people under the age of 60 who screened positive for alcoholism were identified, as compared to only 37% of those persons 60 and older (Lynskey et al., 2003). Many of the social and legal problems that have served as traditional markers of alcohol-related problems may not be applicable to older individuals (Lynskey et al., 2003).

Additionally, existing measures of alcohol use, even those developed specifically for geriatric populations, are based on paradigms of alcohol use that have conceptualized alcohol-related problems in terms of abuse and dependence. These paradigms are not as useful when applied to older drinkers whose alcohol use, regardless of consumption level, can be problematic because of age-related physiological changes, medication use, and issues related to functional mobility (Moore et al., 1999). Adequately determining alcohol usage among older adults is further complicated by the natural processes of aging. Self-reports of alcohol consumption by older adults may be difficult to assess due to poor recall, especially if there are medical or psychiatric conditions that impair cognitive functioning (Crum et al., 2002). Moreover, service providers may have problems distinguishing symptoms of excessive alcohol consumption from health problems that are natural consequences of aging, such as forgetfulness, depression and unsteady gait (Klein & Jess, 2002).

Thus, screening tools that detect hazardous drinking (consumption above the recommended guidelines for older adults) as well as alcohol abuse among older adults need to be designed. Furthermore, diagnostic criteria should be able to classify drinking behaviors among older adults along a spectrum of use that takes into account the unique risks associated with

drinking in late life. Finally, screening and diagnostic tools need to be designed in a manner that takes into account the unique challenges associated with aging such as cognitive decline and comorbid health conditions.

2.2.5 Prevalence Rates of Alcohol Use among Older Adults

In recent years, there has been an increase in research on the use, misuse and abuse of alcohol by older adults (Klein & Jess, 2002; Johnson, 2002). Scholars have identified five primary reasons for the expanded interest in problem drinking among older adults: (1) the growing population of individuals aged 65 and older; (2) the lower prevalence of abstinence and more problem drinking among younger age cohorts; (3) the continued under-identification, diagnosis and treatment of older adults with alcohol use disorders; (4) the likelihood of the increased utilization of mental health services among older adults; and (5) the high costs associated with treating alcohol and its related health conditions (Gurnack, 2002; Klein & Jess, 2002; Gurnack & Hoffman, 1992).

Even though there has been an expansion of the literature about alcohol use disorders in older adults, the findings have often been inconsistent, and there are still large gaps in the knowledge base, especially in regards to alcohol use among older women and minority populations. Despite inconsistent findings, it is almost universally accepted that substance misuse and abuse, particularly of alcohol, among older adults is becoming one of the fastest growing health problems in the United States (ASA, 2001; Rigler, 2000).

Research indicates that 50% of older adults consume some alcohol, with approximately 34% of respondents reporting regular alcohol consumption (Onder et al., 2002; SAMHSA, 2002; ASA, 2001). A recent study of Medicare beneficiaries found that one-quarter of respondents drank within the NIAAA guidelines for older adults (Merrick et al., 2008). These findings are

similar to those found in a large sample of primary care patients: 21.5% drank within the guidelines of seven or less drinks a week (Kirchner et al., 2007). Although half of all older adults abstain from alcohol use and an additional quarter are low-risk drinkers, many older adults drink above the recommended guidelines, placing themselves at risk for the negative consequences associated with alcohol use (NIAAA, 2004).

It is estimated that anywhere from 1% to 15% of older adults are at-risk or problem drinkers; rates vary based on how rates of alcohol use were conceptualized (NIAAA, 2004). In their cross-sectional study of nearly 50,000 older adults, Kirchner and colleagues (2007) found that 4.1% of respondents were at-risk drinkers, consuming between 8 to 14 drinks a week, which is in excess of the recommended alcohol guidelines for older adults. Another recent study of alcohol usage among seniors found that 9% of the study participants utilized alcohol at levels that exceeded the guidelines of no more than 30 drinks a month or the single day limit of three drinks (Merrick et al., 2008). Analysis of the 2005 National Survey on Drug Use and Health revealed that 8.3% of older adults reported binge use, defined as 5 or more drinks on one occasion which is the standard for adults but greater than the recommended definition of binge drinking for older adults which is 2 or more drinks on one occasion (Merrick et al., 2008; Blow et al., 2002). Other recent research also points to harmful alcohol use among older adults. In a large study of older primary care patients, 4.5% were heavy drinkers, consuming 14 or more drinks a week (Kirchner et al., 2007). These findings are consistent with epidemiological research on alcohol use among older adults which estimate that anywhere from 2% to 15% of older adults are at-risk or problem drinkers and between 2% to 5% of these seniors meet the criteria for alcohol abuse or dependence (Grant et al., 2004; NIAAA, 2004; Olsin & Holden, 2002; ASA, 2001).

It should be noted that recent work has called into question the accuracy of current statistics regarding the prevalence of alcohol use disorders in elderly populations. Rates vary based on methodological differences between studies including: the study's location, the population studied, how alcohol-related problems are defined, and the age limits used. One of the primary reasons for variations in prevalence rates results from the various definitions of problem alcohol use employed by the researchers and how studies define levels of drinking behavior (Blow & Barry, 2002). Some studies use NIAAA guidelines to classify individuals into categories based on the quantity of alcoholic beverages they consume while others look at the quantity and frequency of consumption but use general drinking guidelines instead of those specifically designed for older adults. Moreover, researchers and clinicians have suggested that problem drinking is underestimated due to a variety of factors, including low rates of alcohol screening, insufficient diagnostic criteria, and misinterpretation of abuse symptoms.

2.2.5.1 Gender Differences in Prevalence Rates of Alcohol Use by Older Adults

Although limited research has focused on alcohol consumption and older women, the research that does exist suggests that there are gender differences in prevalence rates and utilization patterns between men and women. Studies have shown that older women are more likely to abstain from alcohol use than men, and that women that do drink have lower rates of heavy drinking than their male counterparts (Breslow & Smothers, 2004; Breslow & Smothers, 2003).

Between 2000 and 2001, approximately 11 million older adults consumed alcohol however, the prevalence and level of alcohol use differs between men and women (Breslow et al., 2003). In a recent study, a higher percentage of older women (62.8%) than older men (48.9%) reported abstaining from alcohol use in the past year; women also had higher levels of lifetime abstinence compared to men (42% versus 19.3%) (Breslow et al., 2003). Data from the

National Health Interview Survey also indicate lower levels of alcohol use by older women, with 41% of women compared to 56% of men between the ages of 65 to 74 consuming alcohol in the past year (Schoenborn & Adams, 2002). Of individuals ages 75 and older, 30% of women versus 45% of men reported drinking in the last year (Schoenborn & Adams, 2002).

In addition, to variations in the prevalence of alcohol use between the genders, evidence also points to differences in usage patterns between men and women. Research on the prevalence of alcohol use in individuals over the age of 65 has found that 37.6% of men and 32.3% of women consumed moderate amounts of alcohol; both men and women consume less quantities of alcohol at one time as they age (Breslow & Smothers, 2004; Breslow et al., 2003). Finally, studies indicate that older men have a higher prevalence of hazardous drinking than women—10% to 16% versus 1% to 8%, respectively (Merrick et al., 2008; Breslow & Smothers, 2004; Breslow et al., 2003; Fleming, 2004).

Despite the fact that men consume more alcohol than women, alcohol use by females is a growing problem. Decreased disparity in drinking between younger men and women, coupled with other emerging cohort-related factors impacting women's consumption patterns, creates an expectation that the prevalence of older female drinkers will increase in the upcoming decades (Epstein et al., 2007). For example, in their study of cohort effects on gender differences in alcohol use, Holdcraft and Iacono (2002) found higher rates of alcohol dependence in individuals born in later cohorts compared to participants from earlier birth groups. This difference was particularly high among women: the prevalence of alcohol dependence in later cohorts was 117% greater for women versus only 21% for men (Holdcraft and Iacono, 2002).

In addition to gender differences in consumption rates, a growing body of literature has provided evidence to support assertions that there are variations in alcohol usage patterns

between men and women. Research indicates that roughly one-third of older alcoholics are late-onset drinkers who typically experience their first alcohol-related problems after age 40 (Menninger, 2002). Late-onset drinking appears to be more prevalent in females than males and is often associated with difficulties coping with a wide variety of age-related changes and stressors (Barrick & Connors, 2002). Variations in drinking patterns between the sexes have also been found in longitudinal studies of alcohol use among older adults. One examination of alcohol consumption by the elderly found that moderate drinking in women decreased with age; however, heavy drinking remained stable (Breslow et al., 2003).

2.2.5.2 Racial Differences in Prevalence Rates of Alcohol Use among Older Adults

Little research has specifically focused on alcohol use among older adult racial and ethnic minority populations. The majority of the research on alcohol-related issues in the United States has been conducted with samples of Whites, largely ignoring the potential influence of cultural factors such as race or ethnicity (Caetano, 1998). Over the past decade, while considerable advances have been made in alcohol studies among ethnic minorities these groups remain underrepresented in alcohol research, particularly in studies regarding older adults. The limited research that does exist on alcohol use in racial and ethnic minority populations has primarily focused on comparing drinking patterns and problems between African Americans and Whites (Jones-Webb, 1998). Therefore, this discussion will focus on the prevalence of alcohol consumption in African Americans and Whites.

Studies have consistently found that older African Americans tend to drink less than Whites (Satre & Arean, 2005; Breslow et al., 2003). For example, a report using data from National Survey on Drug Use and Health (NSDUH) found that in 2000, rates of alcohol consumption among individuals aged 55 and older during a one-month period were twice as high

among Whites (40%) as compared to African Americans (20%) (SAMHSA, 2001). NSDUH data from 2002 and 2003 also showed higher rates of alcohol consumption among Whites aged 50 and older (SAMHSA, 2005). Alcohol use in the past month for adults aged 50 and above was 48.3% among Whites versus only 30.2% among African Americans (SAMHSA, 2005).

Older Whites drink higher quantities of alcohol than older African Americans. In their analysis of data from three nationally representative surveys, Breslow and colleagues (2003) found that in older White men and women had the highest prevalence of moderate and heavy alcohol use compared to other racial and ethnic groups. These findings are supported by a recent study of nearly 50,000 Medicare beneficiaries ages 65 and older, in which African (81%) had higher rates of abstinence than Whites (63%) (Merrick et al., 2008). In the same study, nearly 10% of Whites versus only 5.6% of African Americans, reported drinking above the recommended guidelines of one drink a day or seven drinks a week (Merrick et al., 2008).

2.2.6 Alcohol Use and Health Status among Older Adults

Research has shown that many of the acute and chronic medical and psychiatric conditions experienced by the elderly are influenced by the consumption of alcohol (Blow & Barry, 2002). Although rates of heavy drinking among older individuals are fairly low, many older Americans engage in alcohol consumption that exceeds the recommended guidelines for older adults. It is estimated that nearly 10% of older adults drink alcohol above the NIAAA recommended limits (Blow & Barry, 2002). Age-related changes in physiology cause levels of alcohol tolerance to decline while sensitivity increases, potentially putting older persons who consume alcohol, especially those that exceed recommended guidelines, at risk for adverse health consequences (Kennedy et al., 1999). Alcohol use among older adults can lead to the development of new

physical and mental health conditions, can interfere with the management and treatment of existing conditions, and can decrease overall quality of life in old age (Zanjani et al., 2008; Onder et al., 2002; Weintraub et al., 2002).

Alcohol-related health problems account for a significant proportion of hospital admissions among older adults, with considerable economic and social costs as well as high morbidity and mortality rates (Onder et al., 2002). Furthermore, serious medical conditions are more common among older adults who misuse alcohol than among the overall population of a similar age (O'Connell, 2003). Individuals who have had a history of heavy drinking have also been shown to be affected by more major illnesses, self perceived health status, more visits to the doctor, and more depressive symptoms than non-heavy drinkers and alcohol abstainers (O'Connell, 2003). For example, in a recent study of male veterans aged 65 and above, individuals classified as problem drinkers were significantly more likely than non-problematic alcohol users to report having a chronic disease, a diagnosis of depression or a functional impairment (Zanjani et al., 2008).

In addition to impacting the overall health burden experienced by older adults, alcohol use is a primary correlate of disease. Alcohol has been linked to over 60 diseases: including, cancer, gastrointestinal disturbances, depression and cognitive impairment (Taylor et al., 2005; Corrao et al., 2004; Moore et al., 2003). The relationship between alcohol and disease etiology is based on a variety of factors including the average amount of alcohol consumed as well as the pattern of consumption (Taylor et al., 2005).

Epidemiological evidence has made a strong link between the use of alcohol and an increased risk for certain cancers. For example, in a recent meta-analysis of studies on alcohol consumption and disease, the use of alcohol was strongly associated with an increased risk for

cancers of the oral cavity, esophagus, and larynx (Corrao et al., 2004). There is also an association between alcohol consumption and cancers of the liver, bowel and breast (Zhang et al., 2007; Corrao et al., 2004). Furthermore, heavy use of alcohol has been linked to a number of gastrointestinal disorders, including gastritis, stomach ulcers, cirrhosis and pancreatitis (Falck-Ytter et al., 2000). For example, prolonged alcohol use over the lifespan can lead to cirrhosis and pancreatitis in approximately 20% of people (Perreira & Sloan, 2002). In their meta-analysis, Taylor and Rehm (2005) found that even a moderate intake of alcohol was related to a number of gastrointestinal conditions. Finally, chronic alcohol use is associated with a decrease in the effectiveness of the immune system, which results in a heightened susceptibility to infections such as pneumonia and tuberculosis (Chang et al., 2002).

Alcohol not only impacts the physical health of older adults, it can also contribute to the development of mental health disorders such as depression and anxiety. Serotonin and other neurotransmitters in the brain that play an integral role in preventing depression are affected by alcohol use (Devanand, 2002; Thomas et al., 2002; Swift, 1999). Comorbid alcohol use disorders and depression are common among older adults; it is estimated that anywhere from 15% to 30% of individuals with late-life depression also have alcohol-related problems (Devanand, 2002). Problem alcohol use has also been associated with cognitive decline (Thomas et al., 2001). Neurotoxic effects associated with problem alcohol use can lead to the development of alcohol-related dementia or other illnesses, such as Alzheimer's or Wernicke-Korsakoff syndrome (Thomas et al., 2002; SAMHSA, 1998). These illnesses are associated with memory loss, cognitive problems and motor impairment (Friedlander & Norman, 2006).

Despite the solid body of research correlating alcohol use with health and disease, the relationship between health and drinking in late-life has become complicated in light of a

growing body of literature touting the benefits associated with moderate levels of drinking (Hendriks & van Tol, 2005). This emerging research increasingly points to the benefits of low-risk alcohol use among older adults. In general, findings suggest that the consumption of moderate amounts of alcohol are not necessarily harmful and may have some beneficial impacts upon health (Hendriks & van Tol, 2005). For instance, the relationship between cardiovascular health and alcohol use among older adults has been widely explored, and has often been used as an example of the protective effects of alcohol use among older adults (Turvey et al., 2006; Thun et al., 1997; Scherr et al., 1992). One illustration of this protective relationship between alcohol and disease can be seen in a study of individuals ages 70 and older: persons who consume approximately one drink per day had a lower relative risk of coronary disease compared to abstainers or heavy drinkers (Turvey et al., 2006). It should be noted that moderate alcohol consumption has only been shown to reduce the risk of specific conditions, including some forms of dementia, cardiovascular disease, and certain cancers (Blow, 2002).

The benefits of moderate drinking need to be weighed in light of the risks they pose to other key geriatric syndromes, such as cognitive impairment, depression and falls. Furthermore, good health among older adults who use moderate amounts of alcohol may be a function of positive health behaviors, such as proper diet and exercise, rather than a direct benefit from alcohol use (Tivis & Tivis, 2008). Finally, variations in the conceptualization and measurement of moderate drinking between studies inhibit the ability draw any concrete conclusions about the benefits of alcohol use among older adults (Tivis & Tivis, 2008). Further research is needed to fully explore the effects of various levels of alcohol consumption on a broad range of health outcomes with diverse populations, including women and people of color.

2.2.6.1 Gender Effects of Alcohol Consumption on Health among Older Adults

The effect of alcohol consumption on health continues to be debated. Increasingly, studies have focused on investigating both the harmful, as well as beneficial, effects of alcohol use among older adults. Recently, a number of studies examining the health consequences of moderate drinking in individuals aged 65 and older have found sex-dependent effects (Beulens et al., 2007; Flannery et al., 2007; Mann et al., 2005; Burger et al., 2004). These studies have primarily focused on cardiovascular disease, cancer, neuro-cognitive functioning, bone disease and liver problems (Epstein et al., 2007).

For example, a recent review of the literature regarding how gender affects the onset of liver disease reported that studies have consistently found that it takes less time and lower doses of alcohol exposure to cause liver damage in females than in males (Kovacs & Messingham, 2002). The consumption of moderate amounts of alcohol by women is associated with an increase risk of breast cancer (Zhang et al., 2007). Studies on cognitive functioning have been mixed: some research indicates that female alcoholics perform as poorly as men, even with fewer years of drinking and smaller quantities of alcohol consumed at each drinking occasion (Flannery et al., 2007; Mann et al., 2005). Sohrobji (2002) found increased risk of dementia and memory deficiencies among women. In contrast, while there may be a positive relationship between moderate alcohol consumption and cognition in both men and women, the association is strongest in women (McGuire et al., 2007; Britton et al., 2004).

Although some studies have documented significant gender differences in health outcomes related to alcohol consumption, many have found comparable effects for both men and women. Moderate drinking has been found to have similar effects on cardiovascular functioning, cognition, diabetes risk, and bone density in both men and women (Djousse et al.,

2007; Lang et al., 2007; Mukamal et al., 2007; Sierksma et al., 2007). Contradictory findings regarding gender differences in the effects of alcohol on health status point to a continued need for research that investigates the relationship between alcohol use and health in older adults. Understanding the relationship between health and alcohol use is especially salient for older women who, even in the absence of alcohol use, face a number of unique health challenges associated with aging (Blow et al., 2000). Additionally, although findings indicate some benefits associated with alcohol consumption by older women, studies have continued to document that on average, despite drinking for the same length of time and consuming about the same amount of alcohol, women exhibited more severe health consequences from their alcohol use than their male counterparts (Redgrave et al., 2003; Hill, 1995).

In summary, women are particularly vulnerable to the adverse consequences associated with alcohol consumption, including physical injury, cognitive impairment, cirrhosis, heart disease and negative drug interaction (Blow, 2000). Despite this fact, alcohol use in older women often goes undetected and treated (Sedlak et al., 2000). Further investigation of the epidemiology of alcohol use in subpopulations of older adults, especially with women, is key to identifying at-risk populations and developing effective intervention strategies.

2.2.6.2 The Impacts of Minority Status on the Effects of Alcohol Use on Health Status of Older Adults

Since African Americans are often underrepresented in longitudinal studies of alcohol use, the literature regarding the role that race plays in the relationship between alcohol and health among older adults is scarce. However, research on the general population indicates that the negative consequences of alcohol use have disproportionally impacted racial and ethnic minorities (McDonald et al., 2004; Boyd et al., 2003; Jones-Webb, 1998). For example, alcohol mortality

rates are highest for African-American men in all age cohorts, even though alcohol use tends to be more moderate for African Americans than for Whites or Hispanics (Caetano, 1998). African Americans are also more likely than Whites to die from cirrhosis of the liver or from an alcohol related injury (Jones-Webb, 1998). It has been postulated that older African Americans are more severely impacted by alcohol consumption because their health is typically worse than the health status of older Whites (Satre and Arean, 2005). Further research is needed to examine the relationship between race, alcohol use and health status.

2.3 MEDICATION USE AMONG OLDER ADULTS

2.3.1 Medication Pharmacokinetics

The pharmacokinetics of medications or how drugs are handled by the body is related to absorption, distribution and elimination, which consists of metabolism and excretion (Wright & Warpula, 2007). In order to produce their pharmacological effects, medications must be absorbed into the body and distributed to the site of action (Sharif, 2003). Absorption is the process by which a drug passes from the site of administration into circulation via the bloodstream. The rate, ease and degree of absorption are related to the route of administration (Sharif, 2003). Once the medication has been administered and absorbed into the bloodstream, it is then distributed to various organs in the body (Sharif, 2003). The distribution of medications is influenced by a number of factors, including: how well each organ is supplied with blood, organ size, binding of the drug to various components of blood and tissue, and the permeability of tissue membranes (Lococo & Staplin, 2006).

The majority of medications are metabolized in the liver. The cytochrome P-450 (CYP450) enzyme system is the most important known system for drug metabolism (Wright & Warpula, 2004; Sharif, 2003). As they pass through the liver, drugs undergo either phase I (oxidation, reduction, and hydrolysis) or phase II (glucuronidation, sulfation, and acetylation) metabolism (Wright & Warpula, 2004). Phase I reactions use the CYP450 system; the reaction can produce biologically active metabolites. More than half of all drugs are metabolized via the CP450 enzyme pathway (Wright & Warpula, 2004; Williams, 2002). Phase II metabolism produces inactive metabolites, which are more readily excreted by the kidneys (through urine) and the liver (through bile) than those formed in phase I non-synthetic reactions (Wright & Warpula, 2004). Some drugs undergo only phase I or phase II reactions; thus, phase numbers reflect functional rather than sequential classification (Williams, 2002). After drugs are metabolized they are removed from the body, with the kidney primarily responsible for drug elimination (Wright & Warpula, 2004).

2.3.1.1 The Influence of Age and Alcohol on the Metabolism of Medications

Two of the key factors that impact upon the body's ability to metabolize medications are age and alcohol consumption. Advancing age is accompanied by pharmacokinetic and pharmodynamic changes that, in conjunction with comorbid health conditions and the use of multiple medications, influence the metabolism of drugs in older adults (Herrlinger & Kolz, 2001). Some of the primary physiological changes that influence medication pharmacokinetics include:

1. As individuals age, there is a decrease in lean body mass and an increase in fat. Therefore, fat soluble drugs, such as valium, will remain in the body longer (Wright & Warpula, 2007; Williams, 2002).

2. The liver enzymes responsible for metabolizing and detoxifying medications decrease in efficiency in older individuals (Wright & Warpula, 2007; Williams, 2002).
3. Kidney extraction may not function as well, so drugs may remain in the body longer than anticipated (Wright & Warpula, 2007; Williams, 2002).
4. Absorption of drugs in the gastrointestinal tract is slowed (Wright & Warpula, 2007; Williams, 2002).

In addition to age, alcohol consumption also has a marked effect on the body's ability to process medications. There are four primary alcohol-drug interactions. First, alcohol may inhibit the metabolism of a drug by competing with the medication for the same set of metabolizing enzymes in the liver (Blow, 2002). This type of interaction prolongs and enhances the medication's availability, which can result in an increased risk for experiencing harmful side effects from the drugs (AADAC, 2003). Second, long term alcohol use may activate drug-metabolizing enzymes, thus decreasing the drug's availability and diminish its effects (Blow, 2002). In a third type of reaction, enzymes activated by chronic alcohol consumption transform some medications into toxic chemicals that can damage the liver and other organs (Palmer, 2004). Finally, alcohol can interact with sedative and narcotic medications, magnifying the inhibitory effects of these drugs (Lococo & Staplin, 2006). To add to the complexity of alcohol-drug interactions, some drugs affect the metabolism of alcohol, which alters its potential for intoxication and the adverse affects associated with alcohol consumption (AADAC, 2003).

2.3.2 Definitions Related to Medication Use

There are a variety of terms used to describe patterns of medication use and their associated consequences among older adults. Of particular importance to this study are the terms *potentially inappropriate medications*, *alcohol-interactive medications*, and *concurrent use*. All refer to various patterns of medication use.

A potentially inappropriate medication (PIM) is defined as any drug that poses more risks than benefits when used by older adults; many PIM interact with alcohol (Fick et al., 2003). In other words, if the potential risks outweigh the possible clinical benefits, the therapeutic use of the medication is considered to be inappropriate (Egger at al., 2006). The Beers criterion is the most widely used approach to assess the appropriateness of the use of specific medications with the elderly (Fu et al., 2007). The Beers criterion, first compiled in 1991 by an expert consensus panel, consists of a list of medications that may be unsuitable for use among older adults (Budnitz et al., 2007). Table 1 provides some examples of medications or therapeutic classes considered potentially inappropriate for use among older adults. Many of the medications identified as inappropriate under the Beers criteria could potentially interact with other drugs and/or alcohol.

Table 1 Inappropriate Medications and Therapeutic Classes to Avoid in Older Adults

Classification	Medication
Never appropriate	Barbiturates Dicyclomine, propantheline, phenobarbital Flurazepam Meperidine Meprobamate Pentazocine Trimethobenzamide
Rarely appropriate	Chlordiazepoxide, diazepam Muscle relaxants (chlorzoxazone, metaxalone, methocarbamol) Propoxyphene
Sometimes appropriate	Amitriptyline Diphenhydramine, cyproheptadine, hydroxyzine, promethazine Indomethacin Alprazolam Lorazepam Zolpidem

Source: Wright & Warpula, 2004; Frick et al., 2003; Zhan et al., 2001

A prescription medication or over-the-counter drug is considered to be alcohol-interactive if the concurrent use of alcohol and the medication influences the metabolism of the drug, impacts the enzymes involved in drug pharmacokinetics or magnifies the effects of the medication (Jalbert et al., 2007; AADAC, 2003). Some examples of classes of alcohol-interactive medications commonly used by older adults and the effects of these interactions are:

1. Nonsteroidal anti-inflammatories/Aspirin: interactions between alcohol and anti-inflammatory drugs can lead to gastritis and gastrointestinal hemorrhage;

2. Antidepressants/Antipsychotics: interaction between alcohol and these psychotropic medications and cause leads to decreased drug metabolism, causing toxicity and central nervous system depression; and
3. Narcotic analgesics: narcotic analgesics such as Codeine or Vicodin interact with alcohol and can cause CNS depression (Lynskey et al., 2003; SAMHSA, 1999).[2]

Often medications are used in concert with a variety of other substances, such as alcohol, illicit drugs, over-the-counter medications and/or prescription drugs. Studies typically refer to this behavior as simultaneous or concurrent polydrug use (McCabe et al., 2006). Simultaneous drug use is defined as the co-ingestion of different drugs at the same time; for instance, the simultaneous use of alcohol and marijuana (Schensul et al., 2005). Concurrent polydrug use also refers to the use of more than one substance within the same time period (e.g., 1 day, 30 days, or 12 months), but not necessarily at the same time (Schensul et al., 2005). For example, an individual may take an antidepressant each morning to treat anxiety; however, it is also this individual's pattern to have a glass of wine with dinner. Although the two substances are not ingested together, they are taken within the same time period—in this case the same day. Therefore, this usage pattern would be considered concurrent use. The specific focus of this discussion is the concurrent use of medications with alcohol.[3]

---

[2] A more extensive list of specific alcohol-interactive medications and the associated reactions is presented later in this review (see Table 2.)

[3] The terms *concurrent* and *concomitant* will be used interchangeably throughout this document.

2.3.3 Prevalence Rates of Medication Use among Older Adults

2.3.3.1 Rates of Medication Use Among Older Adults

Older adults consume more prescription and over-the-counter medications than any other age group (Perhats et al., 2008). Though older adults comprise only 14% of the total U.S. population, they use more than 30% of all prescription drugs and approximately 40% of all over-the-counter medications [Department of Health and Human Services (DHHS), 2004]. Seniors use prescription drugs approximately three times as frequently as the general population, and their use of over-the-counter medications is even more extensive (Patterson & Jeste, 1999).

On average, seniors take 5.3 prescription drugs and 5.7 over-the-counter drugs per day (ASA, 2001). A survey of the noninstitutionalized U.S. population found that more than 90% of individuals aged 65 and older used at least one medication per week (Gurwitz et al., 2004; Kaufman et al., 2002). Moreover, 40% reported using 5 or more different medications a week, and 12% utilized 10 or more different drugs (Gurwitz et al., 2004). These findings are consistent with other research on patterns of medication use among community-dwelling older adults. For example, in a recent national study of Medicare beneficiaries, only 11% of seniors reported not taking any prescription medications; however, 22.8% of participants reported taking 1–2 medications, just over 25% were taking 3–4 medications, and 41% reported using 5 or more prescription medications (Wilson et al., 2007).

Not only do older adults consume high numbers of medications, they also use medications from different therapeutic categories, this substantially increases their risk of experiencing an adverse drug event or reaction. For instance, a recent study of nearly 28,000 Medicare+Choice enrollees found that 49% of participants were prescribed drugs from four or

more classes (Gurwitz et al., 2003). Similarly, in a study of homebound elders, Sharkey and colleagues (2005) found that, typically seniors used drugs from 3 to 4 different medication classes. Research indicates that the most common medications taken by seniors are cardiovascular drugs, antibiotics/anti-infectives, diuretics, opiods, antihyperlipidemics, NSAIDs, and medications for the gastrointestinal tract (Gurwitz et al., 2003). Older adults are also substantial users of psychotropic medications. A retrospective analysis of the 1996 Medical Expenditures Survey (MEPS) found that nearly 1 in 5 community dwelling older adults (19%) used a psychotropic medication (Aparasu et al., 2003). The most commonly used psychotropic medications were antidepressants and antianxiety drugs. Gurwitz and colleagues (2003) found similar rates of use among community-dwelling older adults: just over 13% of participants reported using an antidepressant and 12.9% were taking a sedative or hypnotic drug (Gurwitz et al., 2003).

2.3.3.2 The Relationship of Demographic Characteristics to Medication Use Patterns

Although the majority of seniors report taking one or more medications, demographic characteristics also predict rates of medication use. Variations in both rates of use as well as the types of drugs taken have been found by age group, gender and race. Studies have continually reported that among older persons, women and Whites are more likely to use medications.

Gender

Most studies indicate that gender predicts medication use; older women have higher rates of medication use and consume a larger number of medications than older men (Ballantyne et al., 2005; Xu et al., 2003; Linjakumpu et al, 2002). For instance, a study of adults in the ambulatory

care setting aged 18 and above, found that women aged 65 and older had higher rates of prescription medication use than all other adults (Kaufman et al., 2002). In the same study, 81% of the women surveyed reported taking at least one medication and 23% used five or more different drugs per week (Kaufman et al., 2002). Not only do females use medications at higher rates than men, but women take larger quantities of medications that are potentially inappropriate. In an analysis of rates of potentially inappropriate medication use among older adults enrolled in managed care plans, women, when compared to men, had greater rates of use of medications that were classified as "should always be avoided," 6.1% versus 3.8% (Simon et al., 2004). The same study found that women also used medications classified as "rarely appropriate" at higher rates than their male counterparts, 15.7% versus 10.5% (Simon et al., 2004). Older women also use more psychotropic medications than older men; females are more likely to use higher rates of antidepressants and antianxiety agent (Aparasu et al, 2003). Many psychotropic medications are alcohol-interactive or considered inappropriate for use among older adults. This places women at an increased risk for adverse drug events (ADE) and adverse drug reactions (ADR).

Race

Continued disparities in health outcomes among African Americans and Whites have fueled recent research efforts to document disparities in health service utilization and to identify their causes (Wang et al., 2007). Unfortunately, studies have not addressed the use of prescription drugs in a comprehensive manner, especially among older adults. The existing body of literature suggests that, in general, African Americans have lower rates of mediation use and take fewer medications than Whites (Sirey et al., 1999; Brown et al., 1995; Fillenbaum et al., 1993; Hanlon et al., 1992). In a more recent study of new prescription drug utilization by individuals age 18

and older, racial disparities were found: Whites were more likely than African Americans to obtain and use a new prescription (Wang et al., 2007).

Racial differences in medication use have also been found in several studies specifically focused on use among older adults. For instance, in a study of Medicare beneficiaries, Gaskin and colleagues (2006) reported that Whites used 2.3 more prescriptions on average than African Americans. The same study also found that much of the disparity in prescription drug spending was attributed to race: total spending for Whites was nearly 9% more than for African Americans (Gaskin et al., 2006). In addition, racial differences in medication use among older adults are greatest for psychotropic medications. For example, Blazer and colleagues (2000) found that among community-dwelling older adults, only 5% of African Americans were taking an antidepressant compared to 14% of Whites. In another study of the use of psychotropic medications by the elderly, African Americans were less likely than Whites to report sedative and hypnotic usage (Aparasu et al., 2003).

Summary

The large volume of medications taken by older adults coupled with the higher likelihood that they will be prescribed an alcohol-interactive medication puts them at increased risk for adverse drug interactions. Also, drug-drug or alcohol-medication interactions in older adults can be especially problematic because of slowed metabolic and clearance mechanisms, which can result in the delayed resolution of adverse reactions (SAMHSA, 2004). Finally, differences in rates and types of medications used by gender as well as race place certain groups—women and Whites—at an increased risk for experiencing an ADE or ADR.

2.3.3.3 Prevalence of Adverse Drug Events and Adverse Drug Reactions Among Older Adults

The unintentional or intended misuse of prescription drugs can have a number of negative consequences; two widely investigated outcomes are ADEs and ADRs. Both ADEs and ADRs are caused by one of three primary types of interactions: drug-drug, drug-disease, or drug-nutritional interactions. Drug-drug interactions are defined as the effects that one drug has on another; these interactions are pharmacokinetic or pharmacodynamic in nature (Lococo & Staplin, 2006). If a medication exacerbates an underlying disease or medical condition, it is referred to as a drug-disease interaction (Mallet et al., 2007). Of particular relevance to this study are drug-nutritional interactions; this includes interactions between medications and alcohol, food or herbal products (Mallet et al., 2007). All of these interactions have the potential to cause medication-related problems, ADEs, or ADRs in older adults.

Typically, an ADE is defined as any injury resulting from the use of a prescription or over-the-counter medication (Gurwitz et al., 2003). ADEs included both expected drug side effects as well as events due to error (Lococo & Staplin, 2006). Problems that occur when treatment goes beyond the desired effect or when the medication causes additional problems are termed side effects. Some fairly common medication side effects include symptoms such as dizziness, fatigue, nausea and vomiting (Agency for Healthcare Research and Quality, US Department of Health & Human Services (AHRQ), 2001).

Although some ADEs are the unintended consequence of side effects resulting from the use of a particular drug, other ADEs the product of errors made by the patient or by medical professionals, which by definition are considered preventable (Lococo & Staplin, 2006). Examples of common errors that can lead to ADEs include: poor medication adherence,

inappropriate prescribing, and incorrect drug dosing (Perhats et al., 2008; Lococo & Staplin, 2006). It should be noted that identifying something as an adverse event does not imply negligence or poor quality of care; it simply denotes an undesirable clinical outcome which is not the result of an underlying disease process, has resulted from some aspect of the chosen pharmacological therapy (AHRQ, 2001.).

In contrast to ADEs, ADRs are harmful unintended reactions resulting from the use of a certain medication. These reactions are produced by the use of a drug in the recommended manner (Lococo & Staplin, 2006; AHRQ, 2001). The World Health Organization (1975) defines ADRs as any response to a drug which is noxious and unintended, and which occurs at doses normally used in humans for diagnosis, therapy of disease, or for the modification of physiological function. These effects can range from minor irritants to severe reactions. Some examples of common ADRs include a rash or diarrhea caused by an antibiotic or a major hemorrhage from taking a blood-thinning agent (Lococo & Staplin, 2006).

Advances in drug therapy have provided older adults with effective treatments that have made it possible to improve outcomes for conditions that were previously untreatable (Simonson & Feinberg, 2005). However, if used inappropriately, pharmacological therapies can cause more harm than good. If adverse drug effects were classified as a disease, they would rank as the fifth leading cause of death for among adults in the United States (ASA, 2001; Lazarou et al, 1998). In 2004 and 2005, over 700,000 individuals were treated for ADEs in U.S. emergency departments; one out of every six of these patients required hospital admission (Budnitz et al., 2006). Furthermore, older adults have a markedly greater risk for medication-related problems as a result of physiological changes associated with aging, the presence of multiple health problems, and the type and number of medications they consume (Chrischilles et al., 2007;

Simonson & Feinberg, 2005). Therefore, medication safety among seniors is a major safety concern.

The latest research indicated that rates of ADEs and ADRs among older adults are relatively high: among Medicare enrollees more than 1.9 million ADEs occur each year and approximately 200,000 of these events are life-threatening or fatal (Simonson & Feinberg, 2005; Gurwitz et al., 2003). A recent study of injury-related visits to the emergency room among individuals aged 65 and older found that ADEs were the second most frequent mechanism of injury and were associated with a three-fold increase in hospitalization risk (Carter & Gupta, 2007). Factors related to the type and amounts of medications used, as well as individual characteristics, have been linked with an increased risk for experiencing an ADE (Evans et al., 2005). For example, a study of community-dwelling residents aged 72 and older found that total number of medications was associated with an increased risk of adverse drug outcomes (Agostini et al., 2004). Other studies have shown that increased age, being female, and a greater number of comorbidities increase an individual's great risk of suffering an ADE (Evans et al., 2005). Despite the high rates and severe costs associated with ADEs and ADRs, it is estimated that approximately half of the illnesses, disabilities and deaths caused by these events may have been preventable (Gurwitz et al., 2003).

Many ADEs and ADRs result from medication adherence errors and are therefore preventable. Common patient errors include: administering medications incorrectly; modifying the medication regime; and not following clinical advice regarding medication use, such as ignoring directives to avoid using certain foods, over-the-counter-medications, or alcohol with a particular drug (Field et al., 2007). In a large sample of Medicare enrollees, Field and colleagues (2007) found that nearly 42% of ADEs resulted from a modification to the medication regimen;

31.8% occurred due to incorrect medication administration; and 21.7% happened because the patient did not follow clinical advice (Field et al., 2007).

These findings are consistent with other studies on ADEs (Gurwitz et al., 2003). Investigations of adverse drug effects indicate that the most frequent types of preventable ADEs are related to electrolyte/renal, gastrointestinal, hemorrhagic and central nervous system issues (Chrischilles et al., 2007; Gurwitz et al., 2003). Some of the most common medications associated with avoidable ADEs included: cardiovascular medications, diuretics, nonopioid analgesics, hypoglycemic and anticoagulants (Gurwitz et al., 2003). Many of the medications associated with preventable adverse drug effects are alcohol-interactive. Consequently, one of the major causes of preventable ADEs and ADRs is the concurrent use of alcohol and medications (Field et al., 2007; Onder et al., 2002).

One of the major risk factors for experiencing an adverse drug event or reaction is medication nonadherence. The concurrent use of alcohol and medication is a common and dangerous form of nonadherence that can have serious consequences for older adults. Most people who consume alcohol also take medications; this is particularly true for older adults who consume more medications than any other age cohort (Perhats et al., 2008; Weathermon et al., 1999). As a result, many older adults ingest alcohol while a medication is in their body or vice versa. A large number of prescription and over-the-counter medications can interact with alcohol, resulting in potentially serious medical consequences (Lococo & Staplin, 2006). In fact, it is estimated that alcohol-drug interactions play a role in 25% of all emergency room admissions for all age groups (Holder, 1992). Significant problems can result from the concurrent use of medications and alcohol, making alcohol-related adverse drug interactions an important health concern for older adults.

2.4 CONCURRENT ALCOHOL AND MEDICATION USE

2.4.1 Prevalence of Concurrent Use among Older Adults

While there is a large body of knowledge on the prevalence, usage patterns and epidemiology of alcohol use among older adults, few studies have focused on the concurrent use of alcohol and medications. Consequently, estimates on the prevalence of concurrent use are limited. However, the research that does exist suggests that concomitant use is a common problem among older adults (Swift et al., 2007; Aira et al., 2005; Pringle et al., 2005; Fink et al., 2002; Onder et al., 2002; Adams, 1995). Yet, most of these studies are cross-sectional in nature and were conducted in acute or primary care settings.

A recent population-based study in Australia found that 35.4% of the individuals surveyed aged 65 years and older had recent (last 24 hours) concomitant use; 21.8% reported using both prescription and over-the-counter medications with alcohol in the last 24 hours (Swift et al., 2007). Higher prevalence rates were also found in a study of community-dwelling elders 75 years and older living in Finland: nearly 87% of respondents who used alcohol also reported using medications on a regular basis (Aira et al., 2005). In the same study, widespread rates of concurrent use of alcohol with alcohol-interactive drugs such as sedatives, pain killers and Warfarin were reported (Aira et al., 2005). Although these studies are important and add to the knowledge base regarding the prevalence rates of concurrent use among older adults, cultural differences in alcohol and medication use as well as variations in prescribing practices between these countries make the results less generalizable to the United States.

In the United States, estimates of concurrent use among community-dwelling older adults range from 19% to 38% (Pringle et al., 2005; Memmott, 2003; Fink et al., 2002; Adams, 1995).

Some of the first studies of concurrent use among older adults in the United States found fairly high rates of concomitant use. One study reported that 25% of community-dwelling older adults were at risk for alcohol-drug interactions due to concurrent use (Forster et al., 1993). In a study of older adults residing in retirement communities, Adams (1995) found that nearly 38% of the residents concurrently used alcohol with alcohol-interactive medications. Adams' work in retirement communities represents an important contribution to the literature regarding concurrent use among older adults yet, the sample is comprised of a unique subset of older adults who reside in retirement communities. Therefore, it is possible that the concomitant use behaviors of individuals in this particular study may not be reflective of all community-dwelling older adults.

More recent analyses of concomitant use among older adults have found lower prevalence rates than that in Adams' (1995) study. For example, an analysis of concurrent alcohol and prescription drug use among older adults living in the US and enrolled in the Pennsylvania Pharmaceutical Assistance Contract for the Elderly (PA-PACE) found that 77% of all prescription drug users were exposed to one or more alcohol-interactive medications. Moreover, nearly one-fifth (19%) of older adults who used alcohol-interactive drugs reported concurrent alcohol and medication use (Pringle et al., 2005). However, this study utilized a cross-sectional design; therefore, we do not know if these prevalence rates hold true overtime and we are unable to ascertain various patterns of concurrent use. Additionally, in the PA-PACE study, data on alcohol use was based on self-report data obtained from a mail survey; self-report data can be problematic with older adults for a number of reasons such as cognitive impairment or decline and underreported behavior. Finally, the sample was comprised of PA-PACE

members who tend to be older, female, White and have more chronic conditions than the general population of older adults in the United States.

Emerging research also suggests that concurrent use is associated with the number of drugs taken and the therapeutic class of those medications, as well as individual level characteristics. For instance, in a study of current drinkers aged 65 and older, Fink and colleagues (2002) report that 88% of participants used alcohol-interactive medications; 46% used 1 to 3 medications; 32% used 4 to 6 medications; and 9% used 7 or more medications. The most common concurrent use pattern was one or more drinks per day with the following classes of medications: arthritis and pain medications, H2-receptor antagonist, antidepressants, anticoagulant (Warfarin), nitrates, antihistamines, or antiseizure drugs (Fink et al., 2002). Similar results were found in a large sample of older adults enrolled in the PA-PACE program; the most common medications concomitantly used with alcohol were NSAID pain relievers (20.2%), antihistamines (20.1%), antihypertensive (19.9%), and angiotensin-receptor blockers (19.6%) (Pringle et al., 2005). Limited information exists on the influence of individual level characteristics on concurrent use; however, recent work suggests that such individuals are younger, White, better educated and in better health tend to have higher rates of concurrent use (Jalbert et al., 2008; Pringle et al., 2005).

Although few studies have explored the concurrent use of alcohol and medications among older adults, the research that does exist suggests that concomitant use is common amongst this group. Although rates of alcohol consumption typically decline with age, many older adults engage in patterns of use that exceed recommended guidelines. This coupled with the high rate of alcohol-interactive medications taken by seniors places them at an increased risk

of experiencing ADRs or ADEs related to concurrent use. The significant problems associated with concomitant use make it a salient public health concern for older adults.

2.4.2 Consequences of Concurrent Use

The use of alcohol not only has the potential to impact many of the health conditions for which medications are used, but it can also interact with the medicines themselves (Swift et al., 2007). Age-related physiological and metabolic changes can increase the likelihood of adverse interactions at lower alcohol and medication doses (Swift et al., 2007). As a result, there are a number of serious consequences associated with concurrent alcohol and medication use among older adults. For example, concomitant use of medications like benzodiazepines, muscle relaxants, and opioids can cause ADEs such as increased sedation and decreased motor skills; these problems can lead to falls or other accidents (Tanaka, 2003; Weathermon & Crabb, 1999). Another common type of interaction that can result from concurrent alcohol and medication use occurs when alcohol adversely affects the illness for which the medication was prescribed. Many of the chronic conditions common among older adults such as hypertension, diabetes, gastrointestinal conditions, insomnia and depression are exacerbated by alcohol use (Moore et al., 2007).

An extensive discussion of all the negative health outcomes resulting from concurrent alcohol and medication use is beyond the scope of this review; however, information on the two types of alcohol-drug interactions and some of the common reactions associated with concomitant use in older adults will be presented.

Alcohol-medication interactions fall into two primary categories: pharmacokinetic and pharmacodynamic. When the presence of alcohol directly interferes with the normal metabolism

of a medication, the interaction is pharmacokinetic in nature (Weathermon & Crabb, 1999). Pharmacokinetic interactions either decrease the breakdown and excretion of the medication because the drug must compete with alcohol for metabolism or alcohol enhances the activity of medication-metabolizing enzymes, thereby accelerating the metabolism of the affected drug (Adams, 2002; ASA, 2001). When alcohol alters the effects of a medication without changing the medication's concentration in the blood, it is referred to as a pharmacodynamic reaction. For example, the use of alcohol and antidepressants enhances the sedative effects of the medication (Adams, 2002; Weathermon & Crabb, 1999). The type of ADE or ADR experienced is based on a number of factors, including the type of alcohol-drug interaction (pharmacokinetic or pharmacodynamic), the amount and type of alcohol consumed, physiological difference, and individual characteristics (Lococo & Staplin, 2006)

There are a number of alcohol-interactive medications widely used by seniors that, when concurrently used with alcohol, can cause negative reactions. Table 2 presents an overview of some of the alcohol-interactive medications commonly used by older adults and the potential reactions associated with concomitant use (A more extensive table is presented in Appendix A.).

Table 2 Examples of Common Alcohol-Interactive Medications Used by Older Adults

Drug Class (Symptoms / Conditions)	**Medication** (Brand Name)	**Potential Reactions with Alcohol**
Antibiotics (infections)	Acrodantin Flagyl Grisactin Nizoral	Rapid heartbeat Sudden changes in blood pressure Stomach pain & upset; vomiting Headache Liver damage
Anticoagulants (prevention of blood clots)	Warfarin Coumadin	Internal bleeding Blood clots, strokes, or heart attack
Antihypertension (high blood pressure)	Accupril Capozide Hytrin	Drowsiness & Dizziness Fainting Heart problems such as arrhythmia
Benzodiazepines (sedative agent)	Ativan Valium Xanax	Drowsiness Increased sedation Decreased motor skills
Histamine antagonists (ulcers, heartburn)	Axid Zantac	Increased alcohol effects Sudden changes in blood pressure
NSAIDs (pain relief, inflammation)	Naprosyn Orudis Voltaren	Gastrointestinal bleeding
Opioids (pain relief)	Oxycodone Percocet Vicodin	Drowsiness Increased sedation Decreased motor skills
Statins (high cholesterol)	Advicor Crestor Lipitor Vytorin Zocor	Liver damage Nausea & vomiting Rapid heartbeat Sudden change in blood pressure Risk stomach bleeding
Tricyclic antidepressants (depression)	Celexa Prozac Zoloft	Dizziness Increased risk of sedation Increased risk overdose

Sources: NIAAA, 2007; Lococo & Staplin, 2006; Weathermon & Crabb, 1999

Although reactions to concurrent use are specific to the medication involved, some of the most frequent consequences of interactions experienced by older adults fall into three broad categories: central nervous system depression, gastrointestinal issues, and liver toxicity (Adams, 2002).

2.4.2.1 Central Nervous System (CNS) Depression

Older adults have substantial rates of CNS medication use, which places them at an increased risk for the negative reactions associated with concurrent use of alcohol and CNS depressants. In addition, physiological changes make older adults more susceptible to the effects of medications that suppress central nervous system activity. Table 3 gives an overview of therapeutic classes of drugs that are CNS depressants (Adams, 2002).

Table 3 Classes of CNS Medications

• Antihistamines	• Benzodiazepines
• Antidepressants	• Narcotic analgesic
• Barbiturates	• Opioids

These medications often cause sedation and decrease motor skills in older adults (NIAAA, 2007; Lococo & Staplin, 2006). Alcohol, which is also a CNS depressant, has an added sedative effect when combined with these drugs (Weathermon & Crabb, 1999). The concomitant use of alcohol and medications suppress central nervous system functioning, causing impaired balance and predisposing seniors to falls; slowing reaction times, which may lead to negative outcomes such

as automobile accidents; and excessive drowsiness (Lococo & Staplin, 2006; Adams, 2002). The concomitant use of psychotropic drugs and alcohol is most likely to produce these impairments. Benzodiazepines, commonly used by older adults, have a strong potential for this type of alcohol-drug reaction (Lococo & Staplin, 2006; Adams, 2002). Research has also shown that some tricyclic antidepressants also interact with alcohol, impairing alertness and motor functioning (Adams, 2002; Weathermon & Crabb, 1999).

2.4.2.2 Gastrointestinal Issues

Arthritis and other musculoskeletal problems are among the most common health problems faced by older adults (Adams, 2002). Nonsteroidal anti-inflammatory drugs (NSAIDs) and over-the-counter pain relievers (e.g., aspirin or ibuprofen) are often used to treat these disorders in seniors (Adams, 2002). The use of NSAIDs has been associated with an increased risk for developing ulcers and gastrointestinal bleeding in older adults (Weathermon & Crabb, 1999). The concurrent use of alcohol and NSAIDs or other anti-inflammatory drugs can have several detrimental effects. Concomitant use may:

1. increase risk for gastrointestinal bleeding;
2. increase gastric inflammation; and
3. cause longer bleeding times (Kaufman, 1999).

In addition to pain relievers, some statins used to treat high cholesterol have been associated with gastrointestinal bleeding (NIAAA, 2007). Further, the concurrent use of alcohol and aspirin has been shown to increase blood alcohol levels after small alcohol doses, possibly by inhibiting first-pass metabolism (Weathermon & Crabb, 1999). All of these potential reactions are serious, especially in light of research that indicates that older adults are more likely to die from gastrointestinal bleeding than younger adults (Adams, 2002).

Concurrent use of alcohol and the anticoagulant Warfarin can also cause internal bleeding. Warfarin is used to prevent blood clots in patients with irregular heartbeats or artificial hearts; it is also used to treat clots that form in the body's extremities (Weathermon & Crabb, 1999). The anticoagulant effects of Warfarin are appreciably altered by even small amounts of alcohol (Weathermon & Crabb, 1999). The interaction of alcohol and Warfarin results in the decreased metabolism of the drug; this increases the anticlotting effects of the medication, leading to an increased risk for bleeding (Adams, 2002). On the other hand, the chronic use of alcohol results in increased enzyme activity in the liver, resulting in higher rates of drug metabolism (Weathermon & Crabb, 1999). As a result, Warfarin breaks down faster than normal; therefore, higher doses of the drug are needed to achieve the desired effect (Adams, 2002). Anticoagulant medications are commonly used by older adults and Warfarin is one of the most common medications implicated in ADEs and ADRs. The concurrent use of alcohol and Warfarin is, therefore, highly discouraged among older adults.

2.4.2.3 Liver Toxicity

Drugs can sometimes cause serious injury to the liver. These injuries can cause loss of hepatic function leading to illness, disability, hospitalization, and even life threatening liver failure and death (Food & Drug Administration, 2009). Medications can cause liver damage for a number of reasons, and many drugs are intrinsically toxic to the liver (Palmer, 2004). Some drugs have the potential to cause liver injury when the medication is taken in a dosage that exceeds the recommended amount; drugs in this category are usually broken down by the cytochrome P450 enzyme system (Palmer, 2004).

In situations of chemical-driven liver damage (hepatotoxicity), medications are broken down into toxic byproducts instead of benign ones; the byproducts cause liver damage as they

begin to accumulate (Palmer, 2004). The drugs in this category may cause liver injury if taken in combined excess with another hepatotoxic substance, such as alcohol (Palmer, 2004; Adams, 2002). Some of the most notable examples of this effect are the hepatotoxicity of antibiotics such as isoniazid, acetaminophen, and the pain reliever phenylbutazone (Palmer, 2004; Adams, 2002).

It is worth noting that certain opioids commonly used by older adults to treat pain also contain acetaminophen (Weathermon & Crabb, 1999). Using these pain medications with alcohol can be especially harmful because of these "hidden" doses of acetaminophen, a known hepatotoxic drug (Weathermon & Crabb, 1999). Liver toxicity is a particularly salient issue for older adults since they commonly use many of the medications that, if taken incorrectly and combined with alcohol, can lead to liver damage.

2.4.3 Summary

As stated earlier, research indicates that approximately 50% of older adults consume some alcohol and the vast majority of older adults take one or more medications a day (Onder et al., 2002; ASA, 2001). However, little is known about the sociodemographic and health factors associated with concurrent use of alcohol and medications in older Americans. The majority of research regarding alcohol-medication interactions has been conducted with young or middle-aged populations and has focused primarily on chronic heavy drinkers; few studies have examined the adverse drug effects among low to moderate users in the general population of older adults (Onder et al., 2002). Some studies have investigated the prevalence of concomitant use of alcohol and medication in retirement communities (Adams, 1995), emergency room departments (Adams, 1992), primary care settings (Blow et al., 2000; Adams et al., 1996), and

hospitals (Bristow & Clare, 1992). Yet, community-level studies are scarce, and those focusing on the effects of moderate alcohol and medication use among older adults are even more uncommon.

The limited research that does exist suggests that older adults are at risk for adverse health effects due to concomitant use of alcohol and medications. As reported earlier, studies indicate that approximately 1 out of every 5 older adults concurrently use alcohol with alcohol-interactive medications, placing themselves at risk for alcohol-related ADEs or ADRs (Pringle et al., 2005; Fink et al., 2002). Even more alarming is the recent finding that 5.5% of all medication users were exposed to five or more alcohol-interactive drugs in combination with some amount of alcohol (Pringle et al., 2005).

An additional concern is the fact that many concurrent users drink above the recommended guidelines. The risk for interactions is greater at higher levels of use. Research indicates that anywhere between 1% to 15% are considered problem drinkers and in one recent analysis 6% of concomitant users meet the criteria for heaving drinking (Pringle et al., 2005; NIAAA, 2004). Despite the fairly common concurrent use of alcohol and medications and the severe negative consequences associated with the interaction of the two, most studies of adverse drug effects in older adults have focused on concomitant use of interactive prescription drugs (i.e., drug-drug interactions); little attention has been give to alcohol-drug interactions.

2.5 CURRENT STUDY

With the demographic projections and alcohol use trends indicating that newer cohorts of older adults are more likely to drink and have heavier drinking habits than previous generations,

alcohol use among older adults presents one of the most salient health problems facing this country. Moreover, as the number of older individuals using prescription medications increases, so will the absolute number of older individuals using alcohol-interactive medications. Despite these trends, little is known about the prevalence of concurrent alcohol and medication use among community-dwelling among older adults

In recent years, significant advances have been made in the understanding of both the aging process (with its attendant health problems) and in the understanding and consequences of alcohol misuse. However, our understanding of concomitant alcohol and medication use in older adults remains limited. Traditionally, studies examining the concurrent use of alcohol and medication have focused on heavy or chronic drinkers. Thus, we know very little about the prevalence rates and adverse effects of concurrent use among low or moderate drinkers.

Research paradigms that focus on persons who abuse or are dependent on alcohol are not as useful when applied to older drinkers whose alcohol use, regardless of consumption level, can be problematic due to age-related physiological changes, medication use, and functional mobility (Moore et al., 1999). In addition to issues associated with the conceptualization of concurrent use in past studies, the small body of research that does examine concomitant alcohol and medication use in older adults has largely drawn from acute or primary care settings and tends to focus on prevalence rates rather than examining health outcomes (Aira et al., 2005). In the majority of these studies, adverse drug reactions have been the primary outcome measure. Therefore, we have very limited knowledge about the broader adverse health consequences associated with concurrent alcohol and drug use in older adults.

Gaining a better understanding of the prevalence, correlates and consequences of concomitant alcohol and medication use is critical to developing prevention and intervention

strategies that effectively meet the needs of older adults. The current study expands upon the existing knowledge base by examining concurrent alcohol and medication use outside of the acute and primary care settings. Rates and correlates of concomitant use are reported for a large sample of community-dwelling older adults. Examining concurrent use in community-dwelling older adults will aid in the development of a more thorough understanding of concomitant usage rates and patterns among seniors. Past research has found that identifying problem alcohol and/or medication misuse is particularly difficult in elderly individuals; this analysis will assist in identifying specific subpopulations that may be at an increase risk for concomitant use. Finally, given their heightened susceptibility to the effects of alcohol and medications due to various physiological factors, it is critical that we explore concurrent use in all older adults who consume alcohol, not just those who are considered problem drinkers. Subsequently, the current study explores longitudinal patterns of concomitant use in older adults with various alcohol consumption patterns.

3.0 METHODOLOGY

3.1 METHODS AND PROCEDURES

3.1.1 Design, Sampling and Selection Criteria

Funded by the National Heart, Lung, and Blood Institute (NHLBI), the Cardiovascular Health Study (CHS) is a population-based, longitudinal study of risk factors for the development and progression of coronary heart disease and stroke in adults 65 years or older. Starting in 1989 and continuing through 1999, participants underwent annual clinical examinations and were contacted by phone at six-month intervals. Since 1999, participants have been contacted every six months by phone, primarily to ascertain health status. The CHS is one of the richest available data sets characterizing the health status of the elderly. Only a few other longitudinal studies have followed cohorts of older individuals for as long as the CHS. The CHS data set is extensive and includes information from interviews as well as from physical and laboratory examinations. It has excellent measures of alcohol use, physical and mental health status, and—one particularly unique aspect—a vast amount of longitudinal data available on medication use. Finally, unlike many other existing data sets, the CHS sample is comprised of a sufficient number of both women and African Americans.

The CHS cohort consists of men and women ages 65 and older drawn from four U.S. communities: Forsyth County, North Carolina; Sacramento County, California; Washington County, Maryland; and Allegheny County, Pennsylvania (Fried et al., 1991; Tell et al., 1993). Potential participants were identified using Medicare eligibility lists of the Health Care Finance Administration (HCFA) from these four counties. To be eligible to participate in the study individuals needed to meet the following criteria: (a) they were 65 years or older at the time of examination, (b) were non-institutionalized, (c) were expected to remain in the area for the next three years, and (d) were able to give informed consent and did not require a proxy respondent at baseline (Fried et al., 1991; Tell et al., 1993). Individuals were ineligible to participate in the study if they were wheelchair-bound in the home at baseline or were receiving hospice treatment, radiation therapy or chemotherapy for cancer (Fried et al., 1991 & Tell et al., 1993).

Recruitment began in June of 1989 and ended one year later. Stratified random samples were selected from the four site and were designed to produce a cohort with a 60:40 female to male ratio in each of four age groups with the following age strata: 65 – 69 (35%), 70 -74 (20%), 75 – 79 (20%), and 80+ (20%) (Fried et al., 1991; Tell et al., 1993). The population from the Allegheny County site was entirely urban; the remaining three sites recruited a mixture of urban and rural populations. A total of 3,695 individuals were recruited from the HCFA sample; an additional 1,547 eligible persons who lived in households with sampled individuals were enrolled into the study (Tell et al., 1993). The initial study sample was primarily Caucasian (95%); therefore, in an effort to achieve better representation of the African American community, three of the study sites were asked to recruit an additional 200 African American participants between 1992 and 1993 (Tell et al., 1993).

All of the recruitment procedures initially employed were also followed in the second recruitment period. An additional 687 African Americans were recruited to participate in the study during this second recruitment phase (Tell et al., 1993). Data collected during the baseline exam on the original 244 African American participants were compared to data collected during 1992-93 on the additional 687 African American participants to look for differences related to protocol changes or technician drift (Tell et al., 1993). All of the continuous variables were comparable for the two groups; therefore, baseline data for the new cohort of African Americans was combined with baseline data collected on the original sample. The final sample consisted of 5,888 individuals. These individuals were examined yearly from 1989 through 1999 (Tell et al., 1993).

3.1.2 Procedures

The baseline examinations consisted of two stages: a home interview and a clinic examination. First, interviewers went to the participants' homes to collect a variety of personal and medical information. If the person was eligible and agreed to participate in CHS, an appointment was made for a clinical evaluation. The second phase of the baseline consisted of a clinical visit where a variety of procedures, including a physical exam, were completed. In addition, participants completed several interviews assessing their cognitive functioning, nutrition habits, and neurological history.

Prior to 1999, semi-annual contacts alternated between clinic examinations and telephone contacts, during which information about hospitalizations and health status was collected. Major exam components were repeated during annual follow-up examinations through 1999. Participants have been contacted by telephone twice a year since 1999. During these telephone

interviews, participants were asked to provide information about their general health, major illnesses, hospitalizations, and medication use. Although primary data collection ended in 1999, follow-up information on key health outcomes has been continually collected through telephone interviews.

3.1.3 Sample

The basic demographic characteristics of study participants at baseline are presented in Table 4. The respondents mean age at baseline was 72.8 (5.61), with a range 65 to 100 years of age. Of the 5,888 study participants, 57.6% were female and 42.4% were male. The majority of study participants are White (83.6%), the remaining 16.7% of the sample are African American or classified as "other."

At baseline, most of the respondents reported being married (66.1%) and nearly 25% reported being widowed. The remaining respondents were divorced (4.1%), separated (1.1%), or never married (4.0%). The mean educational attainment was 13.7 years (SD=4.76). The range of years of education spanned from no schooling to 21 years. Nearly 30% of participants reported having 11 years of education or less. Just over 27% of respondents reported having a high school degree or GED, and 20.4% graduated from college or held a graduate or professional degree. The majority of the sample reported an income of less than $25,000 a year (61.8%), with nearly 27% of respondents reporting an income of $12,000 or less.

Table 4. Overview of Study Participants at baseline

Variable	Sample (*n*= 5,888)
Gender	
Female	57.6%
Male	42.4%
Race	
White	83.6%
African American	16.4%
Education	
Less than high school	
High school diploma	29.5%
Some college	27.5%
1-3 Years Vocational Training	14.0%
College Degree	8.6%
Graduate or Professional Degree	10.4%
	10.0%
Marital Status	
Married	66.2%
Widowed	24.6%
Divorced	4.1%
Separated	1.1%
Never Married	4.0%
Income	
Under $12,000	25.0%
$12,000 to $15,999	14.5%
$16,000 to $24,999	18.3%
$25,000 to $34,999	14.4%
$35,000 to $49,999	9.3%
Greater than $50,000	12.1%

3.2 HUMAN SUBJECTS

The Institutional Review Board at each participating study site approved the Cardiovascular Health Study and all participants gave informed consent. Allegheny County was one of the four communities that participated in the CHS study, and the University Center for Social and Urban

Research (UCSUR) at the University of Pittsburgh has access to the CHS data. The CHS data used in this study were provided by UCSUR; they have permission as one of the primary data collections sites to utilize these data and are in compliance with NHLBI requirements. In addition, the Institutional Review Board at the University of Pittsburgh, which adheres to all federal regulations involving studies with human subjects, approved this study. This secondary data analysis was conducted using a de-identified version of the CHS dataset; no additional human subject involvement was needed with respect to the present investigation.

3.3 STUDY VARIABLES AND MEASUREMENT

Below is an overview of the key variables used in the present study. Many of the variables utilized in the analysis were transformed from their original state in the CHS datasets.

3.3.1 Alcohol Use

During the baseline and follow-up interviews, participants were asked to report their usual consumption of alcoholic beverages (daily, weekly, monthly, yearly, or rarely/never). Respondents were then asked to report the usual number of 12-ounce cans or bottles of beer, 6-ounce glasses of wine, and liquor drinks or shots (approximately 1.5 oz) that they drank on each occasion (Mukamal et al., 2001). This information was used to calculate a continuous variable representing each individual's weekly alcohol consumption (Mukamal et al., 2001; CHS, 1999)

Calculated weekly alcohol use was then used to create a categorical variable representing various levels of alcohol consumption. Participants were placed into one of five categories

according to weekly ethanol consumption: abstainers, below recommended guidelines (< 1 drink weekly), within recommended guidelines (1 to 7 drinks weekly), above recommended guidelines (8 to 14 drinks weekly), and problem users (15 or more drinks a week). These categories were based on the recommended guidelines for alcohol consumption by older adults (NIAAA, 2004; Oslin & Holden, 2002; Barry et al., 2002; Blow, 1999). Additionally, a dichotomous alcohol variable was computed for hazardous alcohol consumption (0= no problem use, 1= problem use) with individuals who drank 14 or more drinks a week (two times the amount of drinks recommended for weekly consumption by older adults) classified as hazardous users.

3.3.2 Medication Use

To assess the prevalence of prescription medication use, the medication inventory method of assessment was used. Study participants were asked to bring the medications they had used in the past 14 days to their annual clinical visits. Interviewers then transcribed information directly from the medication containers, including the name of the drug, the dose in milligrams, and the total number of doses prescribed daily, weekly, or monthly. In addition, study participants were asked how often they had actually used each medication in the past 14 days (self-reported dosing). Questions were also asked about the use of certain non-prescription medications including aspirin, sleeping pills and antihistamines. This method of collecting prescription drug information from older adults has been shown to be more reliable than recall methods of medication ascertainment (Psaty et al., 1992). A computer program developed by CHS was used to match the medication names collected by interviewers with the corresponding National Drug Code Directory numbers and then used to group medications into analytical categories (i.e., antidepressants or beta blockers).

In order to assess each medication's risk for interaction with alcohol, a pharmaceutical consultant was employed to code the CHS medication data on a three point scale based on the severity of the drugs interaction with alcohol. Thomson Micromedex, a comprehensive drug database, was used to look up the class and clinical teaching for each medication. Medications were recoded into a three-point scale based on the severity of the drug's interaction with alcohol, where 0= no interaction, 1= minor to moderate interaction and 2= severe interaction. Interaction ratings were determined by the following criteria:

a) Medication with an ethanol interaction rated contraindicated or major by Micromedex Interactions received a rating of two, severe interaction.

b) Drugs classified as having a moderate or minor interaction in Thomson Micromedex were given a rating of one, minor to moderate interaction.

c) If the drug summary document in Thomson Micromedex did not discuss any potential interactions with alcohol, the medication received a rating of zero, no interaction.

d) In certain cases Thomson Micromedex did not specify an alcohol interaction or the drug received an unknown rating for ethanol interaction. In these situations ratings were based on a combination of the pharmacist's clinical knowledge and the information listed in the drug monograph of Thomson Micromedex.

After each medication was coded for its level of interaction with alcohol, the information was used to create several new scale variables: the total number of alcohol-interactive medications, the total number of medications with a mild to moderate interaction, and the total number of medications with a severe interaction taken in the past 14 days. Also, a dichotomous

variable was created with zero being no alcohol-interactive medication use and one representing any alcohol-interactive medication use in the past 14 days.

3.3.3 Concurrent Use

Information from the alcohol use and medication use measures was used to derive the variable "concurrent use." For the purposes of this analysis, concomitant use was defined as those individuals who consumed alcohol on a weekly basis and were taking one or more alcohol-interactive medications. A dichotomous variable was created where 0= no concomitant use and 1= concomitant use. A variable representing the level of concurrent use was derived by multiplying the total number of alcohol-interactive medications by weekly alcohol consumption; this scale was then recoded into a categorical variable representing low to high levels of concurrent use. Individuals were placed into one of four categories: no concurrent use, low level of use (.02 – 10), moderate level of use (11 – 29.99), and high level of use (30 or more). Finally, a continuous variable was created indicating the total number of years an individual concurrently used alcohol with alcohol-interactive medications over the course of the study (range 1 – 6).

3.3.4 Health Status

Past research indicates that a broad range of measures are necessary to accurately assess physical and mental health functioning (Newsom & Schulz, 1996). The CHS questionnaire on physical health was designed to assess the spectrum of physical functioning in study participants. The questionnaire was modified from the National Center for Health Statistic Supplement on Aging

and the NIA EPESE Study. A combination of the array of measures collected by the CHS will be used to obtain the most comprehensive measure of health status possible.

3.3.4.1 Physical Health

The National Health Interview Survey Supplement on Aging questionnaire, which assesses activities of daily living (ADL) and instrumental ADL (IADL), was used to measure physical functioning (Fulton et al., 1989). The ADL is designed to assess respondents' difficulty with basic self-care activities. It includes questions on essential activities, such as walking around the home, getting out of bed, bathing, dressing, and eating. The IADL scale measures participants' difficulty with activities considered essential for living in the community. Respondents are asked about six tasks: heavy housework, light housework, shopping, preparing meals, managing money, and using the telephone. For both the ADL and IADL scales, response alternatives are dichotomous: 0 = no difficulty and 1= difficulty. The number of "yes" responses are summed to yield a total score; scores can range from 0 – 6 for each scale. Higher scores reflect greater difficulties with ADL and IADL. The scale ADL and IADL variables were also converted into categorical variables; the categories were based on the frequency distributions of the raw number of ADL and IADLs. The vast majority of respondents reported zero (91.8% and 75.1%) or one (4.8% and 18.1%) for total number of ADLs and IADLs, respectively. The percentiles were so low in the other categories (less than 5%), that the scale variables were collapsed into categorical variables. The total number of ADL and IADL scale contained the following categories: 0=Zero, 1=One, 2=Two and 3= Three or more.

Perceived health was assessed using single-item measures of perception of one's health. Participants were asked to rate their general health on a 5-point Likert scale from "excellent" to "poor." The second self-report health questionnaire asked respondents to compare their health to

that of others with three options: worse than, the same as, or better than others. On these two measures, higher scores indicate better perceived health.

3.3.4.2 Mental Health Status

Depression status was measured using the 10-item Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977). Participants were asked to describe how they had felt during the previous week. Responses to statements such as "I am depressed" or "I felt lonely" – were rated on a 4-point scale ranging from 0 to 3 ("rarely to none of the time" to "most of the time") and focuses on five areas: mood (5 items), level of irritability (1 item), energy level (2 items), concentration (1 item), and sleep (1 item). The 10-items were summed to create a depression score with a range from 0 to 30; higher scores indicated greater experience of depressive symptoms in the past week.

The 10-item CES-D was derived from the 20-item CES-D, which is one of the most widely used self-report instruments for assessing depression status (Schroevers et al., 2009). The psychometric properties of the CES-D scale have been tested in several populations of varying sociodemographic factors and health status. In general these studies have supported the reliability and validity of the CES-D (Lee & Chokkanathan, 2008; Turvey et al., 1999; Pasacreta, 1997; Andersen et al., 1994; Callahan & Wolinsky, 1994; Radloff, 1977). Reliability statistics have found the 10-item CES-D to be comparable to those reported for the original CES-D (Irwin et al., 1999).

The 10-item CES-D has been found to be a valid measure for use as a screening instrument for identification of depression in older adults (Irwin et al., 1999; Turvey et al., 1999). For example, Andersen and colleagues tested the reliability and validity of the CES-D 10 in a sample of healthy older adults (1994). The CES-D showed good predictive accuracy when

compared to the full-length 20-item version of the CES-D (kappa = .97, P < .001) (Andersen et al., 1994). In addition, the CESD-10 showed a negative correlation with positive affect (r = -.63) and was also positively correlated with showed with poorer health status (r = .37) (Andersen et al., 1994). Validation of the CESD-10 against the 20-item CES-D using a cut-offs points of eight, nine and ten 10 have been conducted. A cut-off score of ten or more, which is used in the current study, has been shown to minimize false positives with little loss of sensitivity (Andersen et al., 1994).

3.3.5 Demographic Information

A number of demographic characteristics were measured during the baseline interviews and at each follow-up assessment. The measures included gender, age, race, marital status, educational attainment, income, and employment status.

3.4 DATA ANALYSIS PLAN

3.4.1 Descriptive and Univariate Analyses

The first part of the analysis consisted of cross-sectional analyses of baseline data using the statistical software SPSS 15.0. As mentioned earlier, there were no statistically significant differences in baseline data between participants in the first wave of data collection and those in the additional recruitment period between 1992 and 1993. Therefore, baseline data from the second wave of recruitment was combined and analyzed with that of the original cohort.

This preliminary analysis was employed to determine baseline rates of concurrent alcohol and medication use, as well as physical and mental health status among community-dwelling older adults. The two goals of this descriptive data analysis were to derive a general description of the data and to establish baseline prevalence rates for crucial study variables. These preliminary analyses were conducted on all key study variables at wave 1, time point 1 (face-to-face interview), and serve as the primary source of comparison throughout the analysis.

Analysis of sociodemographic variables (e.g., gender, race, age) related to alcohol, medication, and concurrent use was conducted. Frequency counts and percentages were utilized to summarize the various categorical variables. Additionally, descriptive statistics—including measures of central tendency (means, medians, modes) and dispersion (standard deviations and ranges)—were obtained for key study variables such as alcohol consumption, medication use, and health status. Cross tabulations were run to examine bivariate relationships between sociodemographic variables and alcohol consumption, medication use, and concurrent use at baseline. Finally, bivariate relationships between concurrent use and health status at baseline were also explored using cross tabulations.

3.4.2 Multivariate Analysis

The multivariate portion of the analysis focused on examining various patterns and consequences of concurrent alcohol and medication use over time. The two primary goals of the multivariate analyses were to identify trajectories of concurrent use among older adults and to examine how various trajectories impacted health status over time. The follow-up point, not the interview year, was essential to conducting the group-based trajectory modeling analyses, appropriately using both the original and the new cohort of study participants. Because of the introduction of a

second cohort of individuals into the CHS study in year 5, the data needed to be reorganized so that each wave was representative of the equivalent follow-up time point for each of the two groups. For example, year 3 is the second follow-up for the original cohort; however, the second follow-up time point for the new cohort actually took place in year 7. These two datasets were combined to create wave 2 (follow-up 2). Table 5 summarizes how the datasets used in this analysis were formulated.

Table 5. Overview of CHS Data sets

	Baseline	Second Follow-up	Third Follow-up	Fourth Follow-up	Fifth Follow-up	Sixth Follow-up
Original	Year 1 & 2	Year 4	Year 5	Year 6	Year 7	Year 8
New	Year 5	Year 7	Year 8	Year 9	Year 10	Year 11

Note: Data from the first follow-up was not included in this analysis because several key study variables were not collected for the original cohort at this measurement point (Year 3).

3.4.2.1 Group-Based Trajectory Analysis

Group-based trajectory modeling is a specialized application of finite mixture modeling that can be used to simplify longitudinal data by identifying clusters of individual developmental trajectories on a likelihood basis. The technique creates groups by clustering individuals whose trajectories most closely resemble one another using a probability function. The methodology assumes the existence of latent subpopulations. Although these groups do not necessarily exist, their identification has applications in both the interpretation and further analysis of longitudinal

data (Broadbent et al., 2008). Handling a small number of groups of trajectories is less complicated than analyzing hundreds of individual trajectories (Nagin, 2005). Group-based trajectory analysis was used to: 1) identify the number of unique trajectories of concurrent use among older adults over the six-year study period; 2) examine the trends of concurrent use among this population, and; 3) assess whether group membership varied based on sociodemographic factors, including gender, race, and age. To meet these objectives, trajectories based on concurrent use were generated using the SAS-based procedure known as Proc Traj.

Group-based trajectory models are designed to identify clusters of individuals following similar progressions of behavior or outcomes over age or time. Mixture models are useful for modeling unobserved heterogeneity in a population. They also allow for the inclusion of time-stable and time-dependent covariates (Jones & Nagin, 2007). Time-stable covariates are incorporated into group-based trajectory models by assuming the influence the probability of belonging to a particular group. On the other hand, time-dependent covariates can directly affect the observed behavior (Jones et al., 2001). Proc Traj is a specialized application of finite mixture modeling intended to identify distinctive groups of individual trajectories within the study population and for profiling the characteristics of between-group differences (Nagin, 2005, 1999). The group-based logit modeling yields two results: the optimal number of groups and the proportion of the sample belonging in each of the trajectory groups.

The group-based modeling is an elaboration of the conventional maximum likelihood model that forms the basis for many statistical methods, such as logit and Tobit regression (Xie et al., 2006). The statistical method provides the basis for determining the number of groups that best fits the data. Determining the optimal number of groups and the shape of the trajectory for each group is a dynamic modeling fitting process. To determine the optimal number of

trajectory groups that best fit the data, models with various numbers of groups are estimated (Nagin, 2005). After defining the models, the optimal number of groups and the appropriate degree of the polynomial (constant, linear, quadratic, or cubic), which is used to define the shape of the trajectory for each group, is determined (Xie, et al., 2006).

Group-based trajectory modeling is a fairly new technique that is continuing to evolve. As a result, no true consensus on determining the best fitting model currently exists (Xie et al., 2006). However, the Bayesian Information Criterion (BIC) is widely recommended as the preferred goodness-of-fit statistic; the larger the BIC the better the fit of the model (Nagin, 2005). *P*-values for the specified order of each trajectory were also considered as a model-fit indicator. Thus, the model with the highest BIC value and significant trajectories was considered the best fit for the data.

Proc Traj not only allows for the determination of the optimal number of trajectories, it also determines the probability of belonging to each of the group trajectories. The probability scores generated by Proc Traj show the percentage of individuals assigned to each group as well as the likelihood of correct group assignment. It produces an explicit metric for every study participant (i.e., the probability of group membership to each trajectory) for evaluating the accuracy of group assignment (Nagin, 2005, 1999). The term *probability score* refers to the probability of membership in each of the trajectory groups. Proc Traj also assigns a categorical score based on each individual's highest probability score, referred to as the *categorical score*. For example, if four groups were identified for a specified model, each participant would receive four probability scores based on that individual's probability of being in each of the four groups. In addition to the probability score, each participant would be assigned a categorical score based on the respondent's highest probability score (e.g., group 2). Continuing on with the four group

solution, “Participant A” might have probability scores of .10, .05, .60 and .25 for groups 1, 2, 3 and 4, respectively. Because the probability score was highest for the third group, “Participant A” would be assigned to group 3. Cote and colleagues (2002) assert that mean trajectory group assignment probabilities around or greater than .70 – .80 implies a good fit. Group assignment probabilities were also considered when determining model fit.

Group-based trajectory modeling assumes data is missing completely at random (MCR) or missing at random (MR). Conceptually it was not appropriate to assume that data missing for concurrent use was MCR or MR because the majority of attrition in the CHS data is due to death. Therefore, in order to accurately classify an individual developmental trajectory and correctly assign them to a trajectory group it was necessary to be able to establish their concurrent use behavior at each of the study measurement points. In order to accurately classify an individual into the correct trajectory group it was necessary to be able to establish their concurrent use behavior at each of the study measurement points. Therefore, only individuals with data on concurrent use at all of the six data points were included in the longitudinal portion of the analysis. Of the 5,888 study participants nearly 60% (58.9%) had no missing information on alcohol and medication use for all six waves of the study. As a result, it was possible to determine whether or not these participants reported concomitant use at each measurement point making it possible to chart their longitudinal patterns of use and they were included in the trajectory analysis (N=3,470). Of the 2,478 participants that were dropped from this section of the analysis, 15.5% were missing one wave of data, 8.2% were missing two waves of data and the remaining 17.3% were missing three or more waves of data. As stated earlier, the entire sample was included in the cross-sectional analysis of baseline data. In addition, post-hoc analyses were conducted to examine differences between participants who completed the study

and those who dropped out due to attrition or death. As a result, it was possible to determine whether or not these participants reported concomitant use at each measurement point making it possible to chart their longitudinal patterns of use and they were included in the trajectory analysis (N=3,470). Of the 2,418 participants that were dropped from this section of the analysis, 15% reported only one wave of data, 26.1% were had two or three waves of data and the remaining 57.9% four or five waves of data. As stated earlier, the entire sample was included in the cross-sectional analysis of baseline data. In addition, post-hoc analyses were conducted to examine differences between participants who completed the study and those who dropped out due to attrition or death.

Post hoc analysis of sociodemographic factors and key study variables at baseline revealed that the participants who were excluded from the trajectory analysis were fairly comparable to those respondents who were included. At baseline the majority of participants in each group were women and White. The mean age at baseline for the excluded group was 74.5 which is slightly higher than the mean age for individuals included in the multivariate analysis (71.7). Just over 46% of those persons excluded from the analysis reported weekly alcohol consumption versus 52.6% of those individuals who were included. Medication use was fairly comparable between the two groups although rates were slightly higher for individuals who were not included in the trajectory analysis. The mean number of medications taken for the excluded group was 2.7 compared to 2.09 for the analysis group and the total number of alcohol-interactive medications used by persons not included was 1.48 versus 1.09 for individuals included in the trajectory analysis. Last, in both groups 28% of participants reported concurrent use at baseline.

Although the two groups have similar sociodemographic profiles, rates of medication use, and drinking behaviors, those participants who were excluded from the study reported poorer overall health. Individuals in the excluded group were nearly two times more likely to report fair or poor (35.7%) than those participants who were included in the group-based trajectory analysis (18.3%). In addition, analysis revealed that those persons excluded from the multivariate analyses had more difficulties with activities of daily living (ADL) as well as instrumental activities of daily living (IADL). Only 5.8% of individuals who were included in the trajectory analysis reported difficulties with ADLs compared to 11.7% of those who were not included. Also, 32.6% of individuals dropped from the analysis reported difficulties with IADLs where as only 21.1% of respondents who were included in the analysis reported problems with IADLs. Finally, when compared to those participants who were included in the trajectory analysis, respondents in the excluded group reported higher rates of depression, 13.7% versus 17.4%. These differences in physical as well as mental health status at baseline are not unexpected given that the majority of attrition in the CHS data is due to mortality. Therefore, it would be anticipated that individuals who did not complete the study due to death would report poorer over health status at baseline than those participants who completed the study.

In the current study, it was hypothesized that there would be a minimum of two unique trajectories of concurrent use among older adults. In addition, it was theorized that longitudinal patterns of concurrent use would vary by sociodemographic characteristics, including gender, race, and age. In order to assess these hypotheses, group based trajectory analyses were run to determine the most appropriate number of groups. For the current study the assessment points served as the independent variable and concurrent use (0=No, 1=Yes) served as the dependent variable. To determine the optimal number of trajectory groups that fit the data, 1, 2, 3, 4, and 5

group models were estimated. The model that best fit the data was determined by the use of the BIC *P*-values for the specified order of each trajectory and group assignment probabilities. After determining the best fitting model, analysis was run on the model, including the time-dependent factors of gender and race.

3.4.2.2 Multinomial Logistic Regression

Multinomial logistic regression was used to examine how various trajectories of concurrent use affect the health status of older adult. Respondent patterns of concurrent use along with demographic characteristics such as age, gender, and race were regressed on physical and mental health variables to examine which characteristics predicted health outcomes using SPSS 15.0.

Multinomial logistic regression is designed to handle dependent variables that have more than two classes, although it is sometimes used for binary dependents (Garson, 2009). Logistic regression can be used to predict the percentage of variance in the dependent variable explained by the independent variable, to rank the relative importance of independent, to assess the interaction effects, and to understand the impact of covariate control variables (Pampel, 2000). Logistic regression applies maximum likelihood estimates after transforming the dependent variable into a logit variable—the natural odds of the dependent variable occurring or not occurring (Pampel, 2000). Thus, logistic regression estimates the odds of a certain event occurring.

Logistic regression is popular because it lacks many of the restrictive assumptions of OLS regression. Specifically, logistic regression does not assume a linear relationship between the dependent and the independent variable, does not require normally distributed variables, does not assume homoscedasticity, and has overall less stringent requirements (Garson, 2009). Multinomial logistic regression is the best regression procedure for this particular study because

it can handle dependent variables with multiple classes and allows for between-group comparisons. Therefore, I am able to assess the results in relation to how members of a particular group compared to those classified in all the other trajectories. For example, members of the *no to low use* trajectory may be significantly more likely than individuals in the *increasing use* group to report excellent health rather than good health. Multinomial regression allows these types of comparisons to be made.

In the current study, it was hypothesized that individuals with higher levels of concurrent use would report poorer overall health than those individuals who had no-to-low levels of concurrent use. Main-effects multinomial logistic regression was used to test this hypothesis; models were run using data from the final follow-up point (Wave 6)[4]. Several logistic regression models were run. In all of the models, group membership (that is, belonging to the *no to low use*, *decreasing use*, *increasing use* or *high use* trajectory) served as the independent variable. SPSS automatically generated three dummy variables for the group membership variable; *no to low use* served as the comparison group. In order to assess the impact of concurrent use on physical health status, group membership was regressed on self-reported health status, the number of IADLs and the number of ADLs at wave six. Assessing the impact of concurrent use on mental health status was determined by running a multinomial logistic regression with group membership predicting depression status at wave six. The covariates of gender, race and age were included in all of the models. Models were evaluated using the Person and Deviance goodness-of-fit statistics, the likelihood ratio tests and the parameter estimates.

[4] Multinomial logistic regressions were only run on the follow-up time point because the independent variable, group membership, was formulated based on the group-based logit modeling and includes the time component.

3.4.2.3 Logistic Regression

Four additional logistic regression models were run to investigate the extent to which participants physical and mental health status at baseline helped explain reported health status at Wave 6. In each of the models, health status (self-reported health status, number of IADLs and ADLs and depression status) at baseline and group membership (belonging to either the *low to no use*, *decreasing use*, *increasing use*, or *high use* cohort) were included as independent variables. The dependent variables from Wave 6 serving as proxies for physical health status included self-reported physical health status (1=Excellent, 2=Very Good, 3=Good, 4=Fair,5=Poor), total number of IADLs (0=none,1= one to three, 2= four to six) and total number of ADLs (0= none, 1=one to two, 2= three to six). The demographic covariates of gender (0=Female, 1=Male), race (0=African American, 1=White) and age (continuous) were included in all four of the logistic regression models. Since no *a priori* hypotheses had been made to determine the order of entry of the predictor variables, a direct method was used for these multiple linear regression analyses.

3.4.2.4 Cox Regression

Cox regression analysis was employed to examine the relationship between concurrent use and mortality status; the entire sample was included in this regression analyses (N=5,888). The time variable in this model, or duration to the event, was study wave and the binary variable of mortality was used as the status or outcome variable. Two measures of concurrent use were used to predict the event (time until death): having ever concurrently used during the study (0=No and 1=Yes) and the interaction of weekly alcohol consumption and total number of alcohol-interactive medications (concurrent use) at baseline. The additional covariates of gender

(0=Female, 1=Male), race (0=African American, 1= White) and age (continuous) were included in the model.

4.0 RESULTS

4.1 OVERVIEW OF RESULTS

The results are presented in three sections. The first section includes baseline information on key study variables as well as information from cross-sectional analyses on concurrent use. This preliminary analysis provides descriptive statistics about the prevalence of concurrent alcohol and medication use among community-dwelling older adults. The second section focuses on longitudinal patterns and correlates of concurrent alcohol and medication use among older adults. I tested the hypothesis that there would be several different trajectories of concurrent use among older adults. Furthermore, I evaluate the relationship of various socio-demographic characteristics with different patterns of concurrent use. To tests these hypotheses I use group-based trajectory modeling. The final section discusses the impact of concurrent use on physical and mental health status. I hypothesized that individuals with higher levels of concurrent use would have poorer physical and mental health outcomes than those individuals who reported no or low levels of concomitant use. I use Multinomial logistic regression to assess these hypotheses.

4.2 DESCRIPTIVE ANALYSIS

The following analysis provides a general description of the data and establishes the baseline status of the sample (wave 1) for key study variables. Further, I review the relationship between concurrent use and socio-demographic as well as other key factors such as health status.

4.2.1 Alcohol Use

Table 6 provides an overview of alcohol consumption at baseline. Most respondents either abstained from alcohol use (50.1%) or drank below (36.3%) or within (3.7%) NIAAA guidelines for older adults (1 drink a day). However, 6.7% of participants drank above recommended guidelines (more than 1 drink a day) and 3.3% of respondents reported drinking twenty or more drinks a week, nearly three times the recommended consumption for older adults. Moreover, 7.7% of respondents were classified as hazardous users, drinking 14 or more drinks a week which is double the recommended alcohol consumption for older adults. These statistics are consistent with past research on alcohol consumption patterns among older adults that suggests that approximately 50% of seniors consume alcohol and 10% drink above recommended guidelines (Blow & Barry, 2002).

Table 6 Overview of Alcohol Consumption at Baseline

	Overall Sample (n=5862)	Men (n=2484)	Women (n=3380)	x^2	African American / Other (n=960)	Whites (n=4904)	x^2
Any Weekly Alcohol Use	49.9%	58.2%	43.8%	.000*	34.6%	52.9%	.000*
Weekly Alcohol Consumption							
M ± *SD*	2.44±6.32	3.69±8.08	1.54±4.42		1.57±5.91	2.61±6.39	
Range	0 - 85	0 - 85	0 – 49		0 - 84	0 - 85	
Alcohol Use Scale							
Abstinence	50.1%	41.8%	56.2%	.000*	65.4%	47.1%	.000*
Below Guidelines (<7)	36.3%	38.9%	34.3%		27.5%	38.0%	
Within Guidelines (7)	3.7%	4.5%	3.0%		1.6%	4.0%	
Above Guidelines (8–19)	6.7%	9.3%	4.9%		3.0%	7.4%	
Problem Use (20+)	3.2%	5.5%	1.6%		2.5%	3.4%	
Hazardous Use (14+)	7.7%	11.2%	5.1%	.000*	4.4%	8.3%	.000*

*Significant at p<.001

Men (58.2%) were statistically more likely than women (43.8%) to report weekly alcohol consumption. Men also reported higher rates of alcohol consumption; the mean number of drinks per week for men (3.7) was nearly two and a half times as much as the reported mean for females (1.5). In addition, 11.2% of men reported hazardous alcohol use, consuming 14 or more drinks a week or twice the NIAAA recommended guidelines, compared to only 5.1% of women. There were statistically significant differences in rates of alcohol consumption between Whites and African Americans. Only 5.5% of African Americans reported drinking above NIAAA guidelines compared to 10.8% of Whites; Whites were also more likely than African Americans

to be hazardous alcohol users. Furthermore, rates of alcohol use differed by age with those individuals age 75 and older having higher rates of abstinence and lower rates of alcohol consumption than individuals under the age of 75. Additionally, individuals over the age of 75 were less likely than their younger counterparts to report hazardous use, 8.3% versus 6.5% respectively. These findings are consistent with past research that indicates that although rates and levels of alcohol consumption decrease with age, nearly half of all older adults continue to drink alcoholic beverages; consumption of alcohol among older adults is most prevalent among men, Whites, and younger individuals (Hanson & Gutheil, 2004).

In looking at rates of alcohol use among drinkers only, the average number of alcoholic beverages consumed weekly by drinkers only was 4.9; 15% of the drinkers were classified as hazardous users (consuming 14 or more drinks a week) (see Table 7.). Men and Whites had higher rates of weekly alcohol consumption than women and African Americans. Nearly 16% of male drinkers reported consuming levels of alcohol above the recommended guidelines and 9.4% drank 20 or more drinks a week whereas only 11.3% of women drinkers reported rates of consumption above the recommended guidelines and even fewer (3.6%) consumed 20 or more drinks a week.

Table 7 Overview of Alcohol Consumption at Baseline (Drinkers Only)

	Overall Sample	Men	Women	x^2	African American / Other	Whites	x^2
	(n=2925)	(n=1445)	(n=1480)		(n=330)	(n=2595)	
Weekly Alcohol Consumption							
M ± *SD*	4.91±8.26	3.69±8.08	1.54±4.42		1.57±5.91	4.95±8.10	
Range	0.02 - 85	0.2 - 85	0.2 – 49		0 - 84	0.02 - 85	
Alcohol Use Scale							
Below Guidelines (<7)	72.7%	66.9%	78.3%	.000*	80.0%	71.8%	.005**
Within Guidelines (7)	7.4%	7.8%	7.0%		4.5%	7.7%	
Above Guidelines (8–19)	13.5%	15.9%	11.1%		8.8%	14.1%	
Problem Use (20+)	6.5%	9.4%	3.6%		6.7%	6.5%	
Hazardous Use (14+)	15.4%	19.2%	11.6%	.000*	12.1%	15.8%	.084

**Significant at p<.01
*Significant at p<.001

4.2.2 Medication Use

Table 8 describes the sample baseline of medication use. Seventy-seven percent of participants took at least one medication in the past 14 days; on average participants took 2.34 medications a day. Just over 52% of participants reported daily use of 1 to 3 medications, 19.6% were using 4 to 6 medications and 5.1% took seven or more medications a day. Sixty-two percent of the sample reported taking an alcohol-interactive medication at baseline; the mean number of alcohol-interactive medications used by respondents was 1.25.

Table 8 Medication Use at Baseline

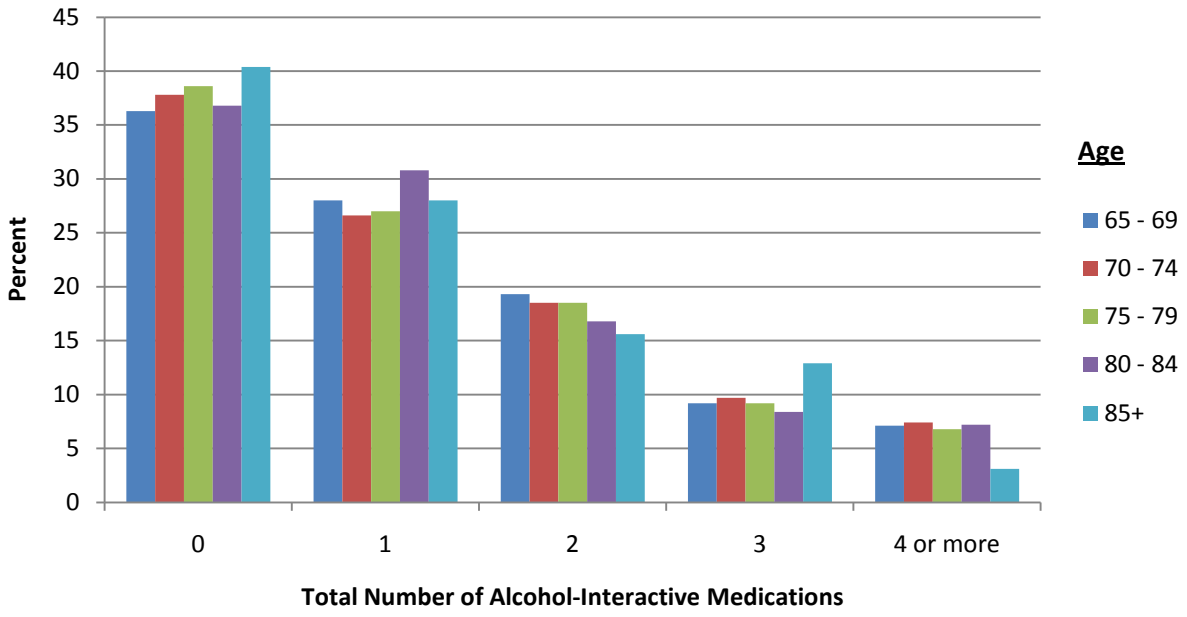
	Overall Sample (n=5888)	Men (n=2495)	Women (n=3393)	x^2	African American / Other (n=963)	Whites (n=4925)	x^2
Any Medication Use (Past 14 Days)	76.9%	73.3%	79.5%	.000*	81.5%	76.0%	.000*
Total Number Medications							
M ± *SD*	2.34 ± 2.20	2.16 ± 2.15	2.47 ± 2.23		2.75 ± 2.29	2.26 ± 2.17	
Range	0 – 20	0 – 19	0 – 20		0 – 13	0 – 20	
Any Use of Alcohol-Interactive Medications	62.6%	59.1%	65.1%	.000*	74.1%	60.3%	.000*
Total Number Alcohol Interactive Medications							
M ± *SD*	1.25 ± 1.36	1.14 ± 1.30	1.33 ± 1.39		1.59 ± 1.43	1.19 ± 1.36	
Range	0 – 9	0 – 8	0 – 9		0 – 8	0 – 9	

*Significant at p<.001

Women were statistically significantly more likely than men to be taking any medications, ($p < .001$). Analysis of the total number of alcohol-interactive medications being take by study participants revealed that usage rates for alcohol-interactive medication also varied by gender with women taking more alcohol-interactive medications than their male counterparts ($p < .001$). The percentage of participants using medications differed by race. African Americans were less likely than Whites to be taking no medications, 18.5% versus 24.0% ($p < .001$). In addition to taking fewer medications than African Americans, Whites used alcohol-interactive medications less than African Americans ($p < .001$). Finally, age was found to be a

significant predictor of medication use. At baseline individuals age 75 and older were more likely to be taking multiple medications, $\chi^2(4, N = 5888) = 30.33, p < .001$. However, there were no statistically significant differences in rates of usage of alcohol-interactive medications between age categories.

Figure 1 Alcohol-Interactive Medication Use by Age at Baseline



4.2.3 Health Status

One of the primary goals of this investigation was to examine the impact of various patterns of concurrent use on the physical as well as mental health status of older adults. Prevalence rates of key health status indicators were analyzed at baseline in order to gain a general overview of the

health of the older adults in the sample. The relationships between health status and gender, race and age were also examined.

4.2.3.1 Physical Health Status

The majority of participants, 61.1%, reported being in good or very good health at baseline (see Figure 2.). Over 57% of respondents felt their health was better than others their age. African Americans were significantly more likely than Whites to report fair or poor health, 42.4% versus 22.2% respectively ($p < .001$). However, no racial difference in how respondents viewed their health compared to others were found; the majority of both African Americans and Whites felt their health was better than others their age. There was no statistically significant difference in self-report health status by gender, the majority of both women (60.7%) and men (61.7%) reported good to very good health. However, men were significantly more likely than women to consider their health to be better than others their age, 60.1% versus 55.1% ($p < .001$). Individuals 80 and above were significantly more likely than other age groups to report fair or poor health (31.8%). However, older individuals, eighty and above, were more likely to believe there health was better than others their age; for example, 61.3% of individual eighty and over compared to 52.8% of individuals age 65 to 69 ($p < .001$).

Figure 2 Self-Reported Health Status at Baseline

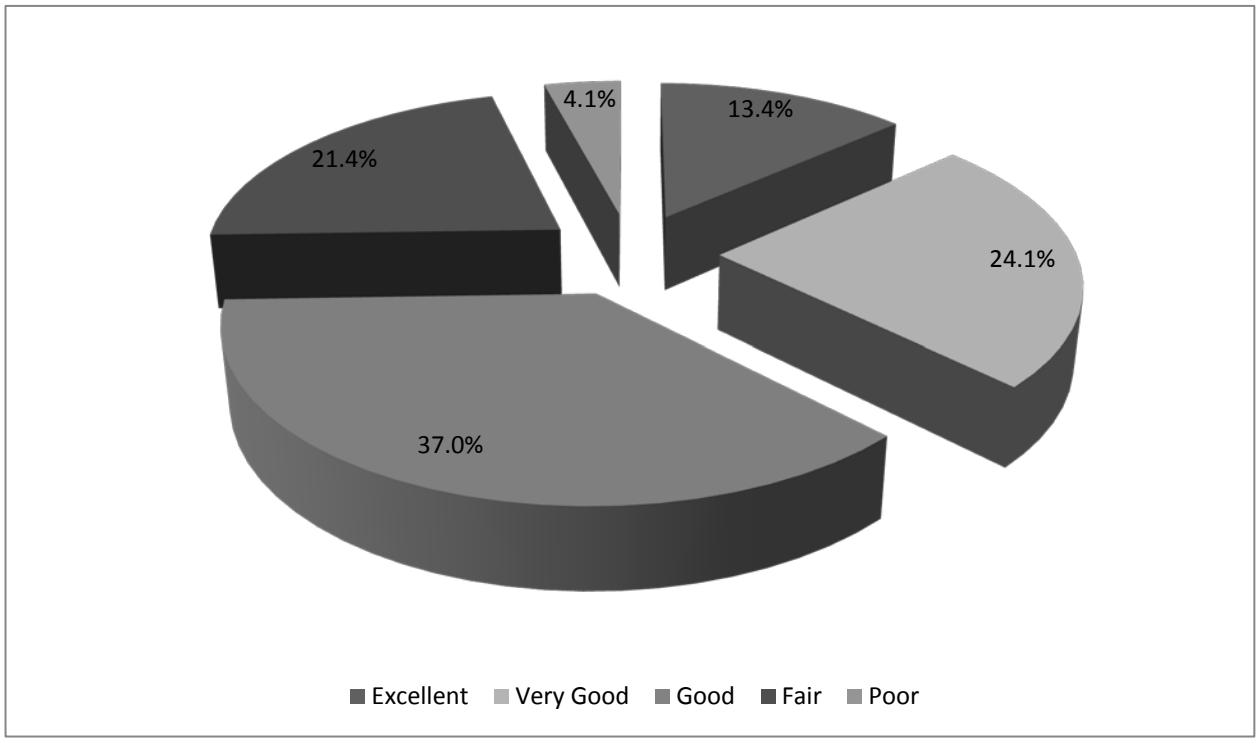


Table 9 describes overall physical functioning for the study sample at baseline; percentages of total number of ADLs and IADLs are reported for the overall sample as well as by race and gender.

Table 9 Physical Functioning at Baseline

	Men	Women	x^2	African American / Other	White	x^2	Age 65 – 69	Age 70 - 74	Age 75 – 79	Age 80 – 84	Age 85+	x^2
	(n=2489)	(n=3389)		(n=962)	(n=4916)		(n=2018)	(n=1870)	(n=1195)	(n=571)	(n=224)	
Number of ADL												
Zero	94.4%	90.1%	.000*	85.7%	93.1%	.000*	94.1%	92.8%	91.1%	87.4%	79.9%	.000*
One	3.7%	5.8%		7.8%	4.3%		4.4%	3.8%	4.7%	7.7%	12.5%	
Two	1.2%	2.8%		4.1%	1.7%		1.0%	2.2%	2.7%	2.5%	7.1%	
Three or more	0.7%	1.4%		2.5%	0.8%		0.5%	1.1%	1.5%	2.5%	0.4%	
Number of IADL												
Zero	69.3%	81%	.000*	71.9%	74.7%	.09	79.7%	76.8%	69.0%	65.7%	54.0%	.000*
One	22.5%	15.1%		20.1%	19.2%		16.7%	18.2%	22.5%	24.3%	22.8%	
Two	4.8%	2.6%		4.5%	3.7%		2.4%	3.3%	5.1%	4.9%	12.1%	
Three or more	3.5%	1.4%		3.5%	2.6%		1.2%	1.7%	3.4%	5.1%	11.2%	

**Significant at p<.01
*Significant at p<.001

Women reported significantly more difficulties with Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) than men ($p < .001$). African Americans had significantly higher levels of reported ADL deficiencies than Whites ($p < .001$); they also had more difficulty with IADLs than Whites but the difference was not statistically significant. Age was a significant predictor of both ADLs and IADLs with individuals in the older age categories reporting higher rates of ADLs and IADLs ($p < .001$).

4.2.3.2 Mental Health

Using the recommended cut-point for the CES-D of 10, 13.8% of respondents were classified as depressed at baseline. The mean CES-D score was 4.41 (SD=4.6) with a range from 0 to 29. Women and African Americans were significantly more likely to be depressed than men and Whites ($p<.001$). Nearly 17% of women compared to only 9.8% of men were classified as depressed at baseline. Twenty-one percent of African Americans had a positive screen for depression at baseline versus 12% of Whites. Depression status was not significantly related to age category yet older individuals had higher rates of depression at baseline; for example 12.9% of individuals between the ages of 65 and 79 were classified as depressed at baseline compared to 15.7% of individuals in the age range of 80 to 84.

4.2.4 Concurrent Use

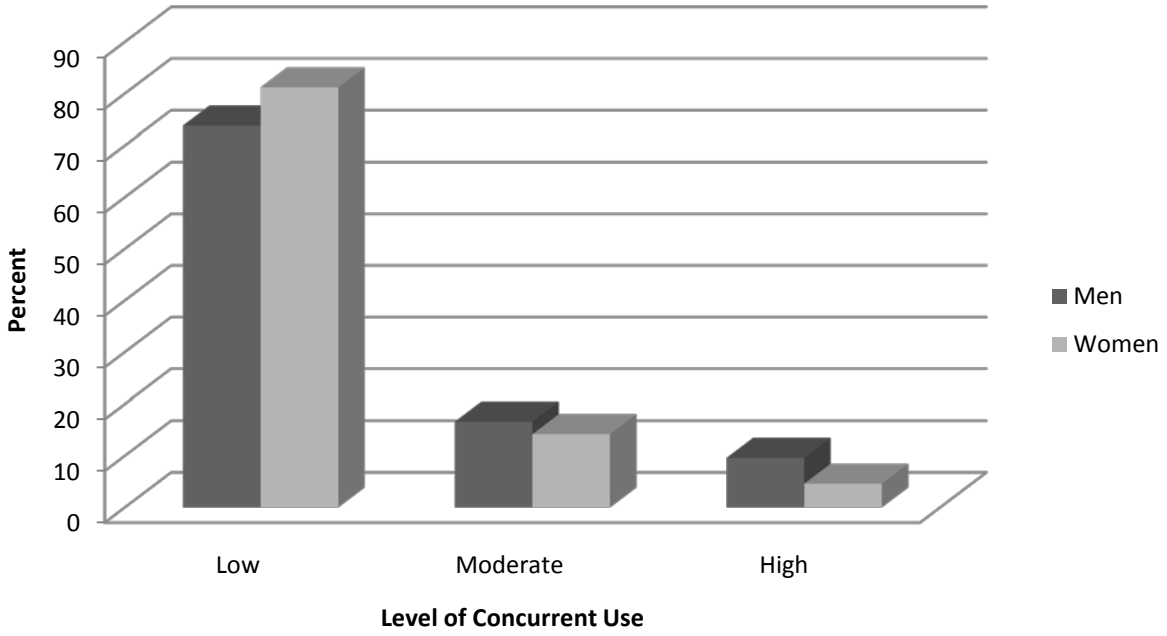
Twenty-eight percent of all study respondents reported concurrently using alcohol with one or more alcohol- interactive medications at baseline. Of those individuals who reported weekly alcohol use, 56.7% were taking one or more alcohol-interactive medications. The number of

alcohol-interactive medications used by individuals who reported concurrent use ranged from 1 to 9 with a mean of 1.06 (SD=1.24). Most participants were taking one alcohol-interactive medication (48%) however; 22.1% of respondents who reported concurrent use were taking three or more alcohol-interactive medications.

At baseline, concurrent users had higher rates of overall medication use and were taking more alcohol-interactive medications than individuals who reported no concurrent use. Over 35% of concurrent users reported taking 4 or more medications compared to just 20.4% of non-concurrent users, $p < .001$. Study participants who reported concomitant use were also more likely than non-concurrent users to take multiple alcohol-interactive medications; 22.1% versus 14.1% respectively ($p < .001$).

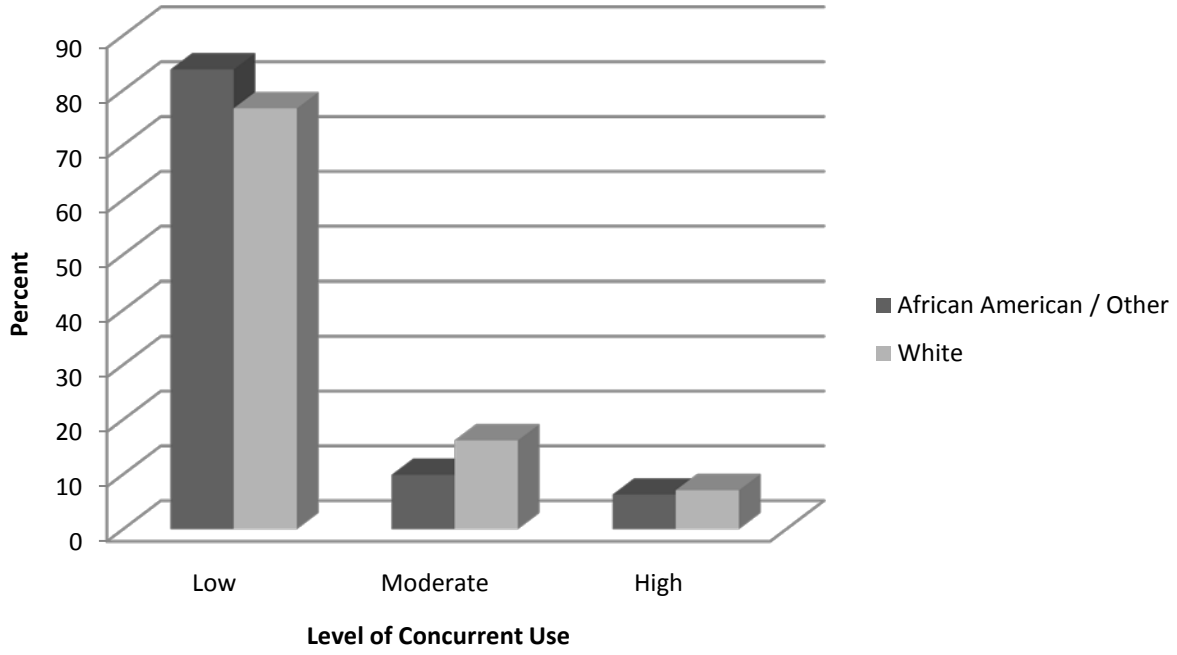
Men had greater rates and reported more hazardous levels of concurrent use than women. At baseline, rates of concurrent use for women and men were 26% and 32% respectively. Men were statistically more likely to report concurrent alcohol and medication use than women, $\chi^2 = 27.91$, $p < .001$. Men were also more likely than women to report high levels of concurrent use at baseline (see Figure 3.); level of concurrent use was determined by the amount of weekly alcohol consumption and total number of alcohol-interactive medications being taken. Men (9.6%) were twice as likely as women (4.6%) to have high levels of concurrent use at baseline ($p < .001$).

Figure 3 Level of Concurrent Use by Gender at Baseline (Drinkers Only)



Rates of concurrent use varied by race as well; 29% of Whites verses 23% of African Americans reported concurrent use at baseline. Whites were significantly more likely than African Americans to report concurrent use, $p < .001$. Additionally, Whites reported higher levels of concurrent use than their African American counterparts, $p < .04$ (see Figure 4). Nearly 16.2% of Whites reported moderate levels of concurrent use compared to only 9.9% of African Americans. No significant difference in rates of concurrent use were found for age ($p = .66$), concurrent usage rates remained fairly stable regardless of age category.

Figure 4 Level of Concurrent Use by Race at Baseline (Drinkers Only)



Although the majority of individuals taking alcohol-interactive medications drink at or below the NIAAA recommended guidelines for older adults (81.2%), nearly 19% of respondents reported drinking above the recommended guidelines (>8 drinks a week). Individuals who were classified as problem users, drinking nearly three times the weekly recommended guidelines for older adults (>20 drinks a week), were statistically more likely to concurrently use than non-problem users; 54.4% versus 26.1% respectively ($p < .001$).

Differences in health status between concurrent users and non concurrent users at baseline were also examined (these results were used as a comparison point for the later multivariate analysis that assessed whether or not longitudinal patterns of concurrent use impact health outcomes). There were no statistically significant differences between concurrent users

and non concurrent users at baseline, Table 10 shows rates of self-reported health, physical functioning and depression status for concurrent users versus non concurrent users.

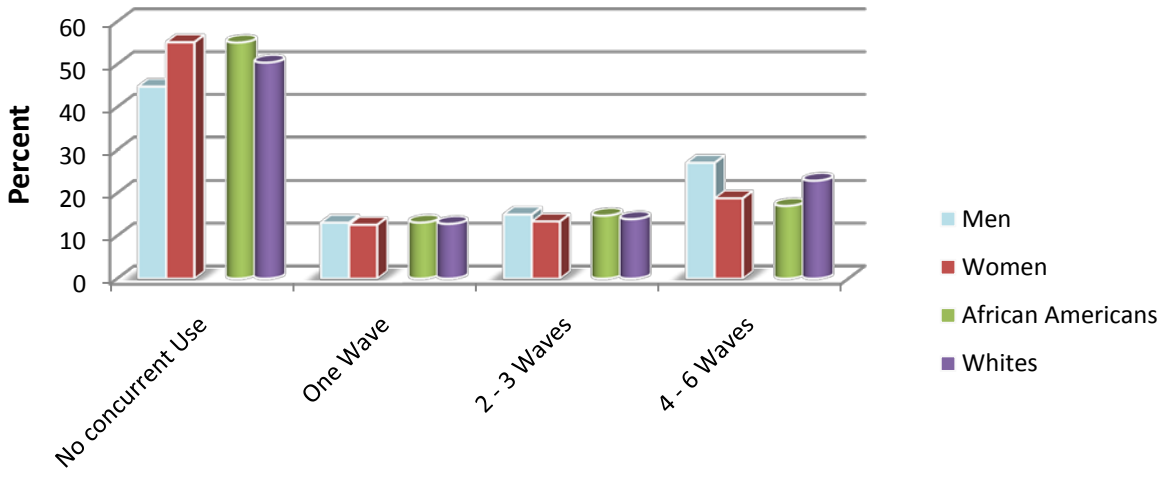
Table 10 Health Status at Baseline: Concurrent User versus Non-Concurrent Users

	No Concurrent Use	Concurrent Use
Health Status		
Poor	4.4%	3.3%
Fair	21.5%	21.1%
Good	35.1%	41.8%
Very Good – Excellent	39.0%	33.8%
Number of IADLs		
Zero	75.1%	72.1%
One	18.1%	22.3%
Two	4.0%	3.4%
Three or more	2.7%	2.1%
Number of ADLs		
Zero	91.8%	92.2%
One	4.8%	5.0%
Two	2.2%	2.0%
Three or more	1.2%	0.8%
Depression Status		
No Diagnosis	86.4%	85.9%
Depression Diagnosis	13.6%	14.1%

4.3 GROUP-BASED TRAJECTORY MODELS

As stated earlier, initial descriptive analyses were conducted as a precursor to more in-depth multivariate analysis examining concurrent alcohol and medication use among older adults. It was hypothesized that there would be more than one pattern of concurrent use. Preliminary explorations of the data revealed that, of the respondents with complete data on concurrent use for all measurement points (N=3,470) nearly half (48.9%) concurrently used alcohol with alcohol-interactive medications during at least one of the six waves of the study; 58.7% of concurrent users reported concomitant alcohol-medication use in 3 or more waves of the study (see Figure 5).

Figure 5 Total Waves of Concurrent Use by Gender and Race



The preliminary findings indicated the possible existence of different trajectories of concurrent use. Additionally, it appeared that longitudinal patterns of concomitant use varied by gender and race. Group-based logit modeling was used to test these hypotheses. The group-based logit modeling yielded two results: the optimal number of trajectory groups as well as the proportion of the sample belonging in to each of the trajectory groups. Determining the optimal number of groups and the shape of the trajectory for each group is a dynamic modeling fitting process. In this analysis two, three, four, and five-group models were fitted. The Bayesian Information Criterion (BIC) was used for model selection. BIC scores for the various models are listed in Table 11; two BIC scores are presented, one based on the total number of participants and another based on the total number of observations. Based on the BIC scores, the model with four groups has the best fit, as this model has the largest BICs (-8448.40 and -8465.43).

After determining the model with four groups was the best-fitting model, the parameter estimates were refined to create a more parsimonious model. In the initial analyses, all groups were set to calculate through the cubic order however, only the *increasing use* group was significant up to the cubic order. Therefore, the model was refined to create a more parsimonious model. In the refined four group model only the *increasing use* group was set to calculate up to the cubic order, the other three groups only calculated through the quadratic order. All of the four groups maintained similar trajectory patterns, refining the model simply served to eliminate the unnecessary parameters to create the most parsimonious model that best reflects the four unique trajectory patterns.

Table 11 BIC Scores for Concurrent Use Models

Number of Groups	BIC Score(Participants) *N*= 3470	BIC Score (Total Observations) *N*= 20820
2	-8686.89	-8694.95
3	-8488.17	-8500.71
4	-8448.40	-8465.43
4 (Refined Model)	-8436.82	-8451.15
5	-8462.36	-8482.86

Parameter estimates for the four group model are displayed under Model One in Table 12 and Figure 6. This population includes a mixture of four distinctive groups that are defined by their trajectories with respect to concurrent use over the six years study period. Group 1, which was classified as the *no to low use* trajectory constitutes the majority of the population (61.9%) and is defined by the intercept linear, and quadratic parameters. The *no to low* use trajectory is characterized by a slight U-shaped pattern with concurrent use starting off slightly elevated in wave one, declining and maintain a fairly stable level in waves two through five and increasing slightly in the final wave of the study. The trajectory for Group 2 or the *decreasing use* trajectory, accounts for 14.2% of the sample and is stable in the initial waves of the study but overtime it begins to steadily decline. Group 3, the *increasing use* trajectory, is comprised of 7.2% of the sample and is defined by all four of the parameters (intercept, linear, quadratic and cubic); this trajectory starts off low but, steadily increases overtime with a slightly decrease near

the end of the study. Group 4 is defined by the intercept, linear, and quadratic parameters. Just over 16.6% of study participants belonged to Group 4, entitled the *high use* trajectory, which is characterized by a curve shaped trajectory. In the *high use* group there is an increase in concurrent use between waves one and two of the study; rates remain high and stable between waves two and four and then begin to decrease in wave five.

Table 12 Parameter Estimates for Group Trajectories and Group Membership[5]

Group (N=3470)	Parameter	Model 1		Model 2	
		Estimates	SE	Estimates	SE
1 *No to low*	Intercept	-2.63	0.11**	-2.69	0.11**
	Linear	-0.67	0.10**	-0.67	0.09**
	Quadratic	0.09	0.02**	0.09	0.02**
2 *Decreasing*	Intercept	0.41	0.17*	0.40	0.16*
	Linear	0.08	0.10	0.07	0.09
	Cubic	-0.06	0.02**	-0.06	0.02**
3 *Increasing*	Intercept	-1.19	0.27**	-1.35	0.28**
	Linear	-1.60	0.50**	-1.57	0.51**
	Quadratic	0.87	0.22**	0.87	0.22**
	Cubic	-0.09	0.02**	-0.09	0.02**
4 *High*	Intercept	1.71	0.15**	1.70	0.15**
	Linear	0.76	0.13**	0.78	0.13**
	Quadratic	-0.12	0.02**	-0.12	0.02**
Group Membership[6]					
1 *No to low*	Constant			0.00	
2 *Decreasing*	Constant			-1.22	0.16**
	Sex (Male= 1)			0.08	0.16
	Race (White=1)			-0.28	0.14
3 *Increasing*	Constant			-3.27	0.47**
	Sex (Male= 1)			0.93	0.20 **
	Race (White=1)			0.69	0.40
4 *High*	Constant			-2.07	0.18**
	Sex (Male= 1)			0.59	0.10**
	Race (White=1)			0.56	0.17**

*Significant at p<.05
**Significant at p<.001

[5] Model 1 is an unconditional model that only identifies group membership. Model 2 is a conditional model that links demographic variables to group membership.

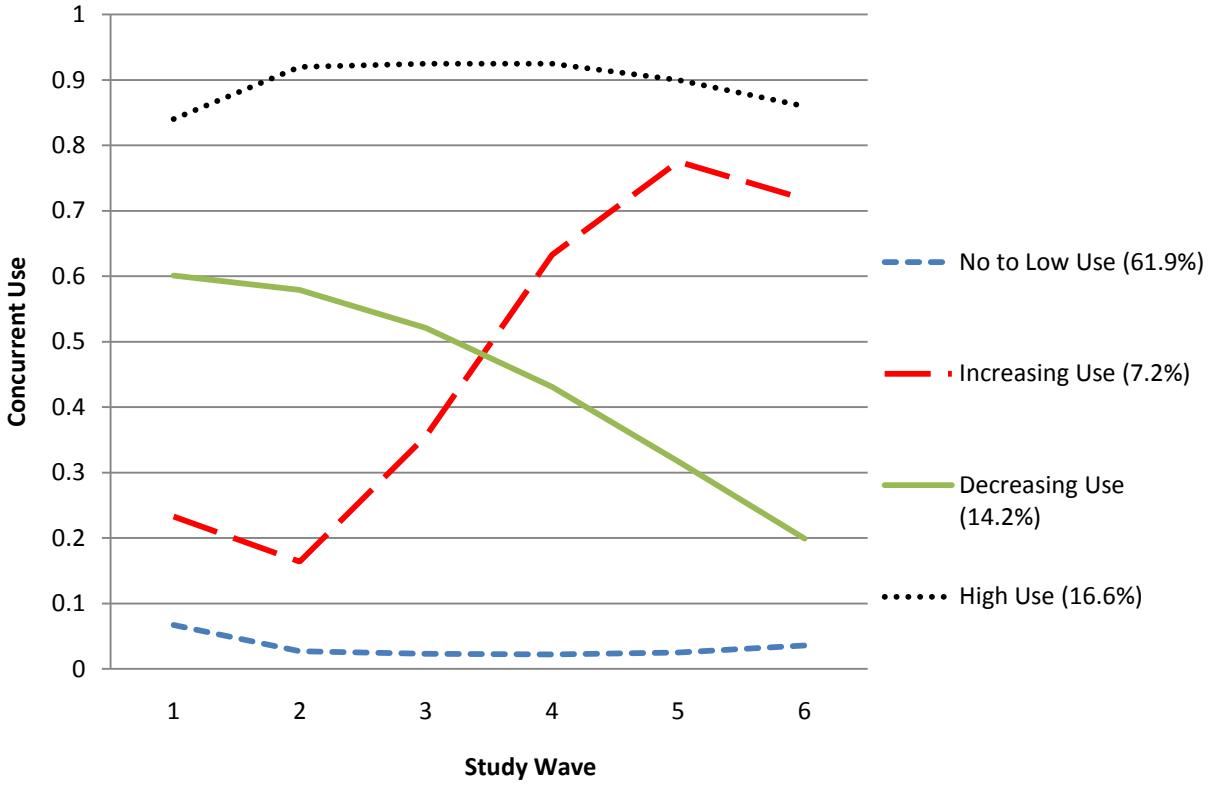
Posterior probabilities were also determined and used as an indicator of good model fit (Cote et al., 2002). Table 13 shows the number of individuals assigned to each group along with the average and range of posterior group assignment probabilities. The percentage of the sample assigned to each of the four groups (64.4%, 12.2%, 6.1% and 17.4%) based on maximum posterior probabilities corresponds closely to the estimated group probabilities (61.9%, 14.2%, 7.2% and 16.6%). Table 13 also shows the average trajectory group assignment; these probabilities are 0.95, 0.80, 0.77 and 0.90 for the four groups, respectively. Therefore, between 77 to 95 percent of individuals were correctly assigned to different trajectory groups. These probabilities are around or greater than the minimum acceptable threshold defined by Nagin (2005) as having all group posterior probabilities at or above 0.7. The BIC scores and the posterior probabilities both indicate that the four trajectory model is the best fit.

Table 13 Trajectory Group Assignment Probabilities

Assigned Group	Number Assigned	Group							
		1		2		3		4	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
No to Low	2233(64.4%)	**0.95**	**0.42-0.99**	0.04	0.01-0.41	0.01	0.00-0.17	0.00	0.00 -0.001
Decreasing	423(12.2%)	0.05	0.00-0.25	**0.80**	**0.51-0.99**	0.09	0.00-0.46	0.24	0.00-0.24
Increasing	210(6.1%)	0.03	0.00-0.17	0.14	0.03-0.41	**0.77**	**0.41-0.96**	0.05	0.00-0.27
High Use	604(17.4%)	0.00	0.00-0.001	0.07	0.01-0.40	0.40	0.00-0.29	**0.90**	**0.44-0.99**

Each of the four cohorts identified by the best fitting model are characterized by their own distinct patterns of concurrent use. The *no to low use* trajectory (Group 1), is comprised of individuals who did not concurrently use alcohol and medications or those individuals who had low levels of concomitant use. The trajectory for the *no to low use* (Group 1) group is fairly flat and essentially these individuals maintained a stable pattern of no or low levels of use over the course of the study. The *decreasing use* trajectory (Group 2) is characterized by a gradual and steady decrease in concurrent use over time. Rates of concurrent use were moderately high among members of the *decreasing use* group (Group 2) in the initial waves of the study but substantially decreased with time so that by the final study wave concurrent use was fairly low among this population. The trajectory for Group 3, *increasing use*, is best characterized as a group of individuals whose concurrent use fluctuates over time. Initially levels of concurrent use in the *increasing use* cohort (Group 3) were fairly low. However, concurrent use increases among this population over the course of the study; by wave 5 this group was characterized by moderate to high levels of concomitant use. Finally, the trajectory for the *high use* cohort (Group 4) is indicative of high-stable rates of concurrent use over time. Individuals in the *high use* cohort (Group 4) tended to concurrently use alcohol and medications throughout the course of the study.

Figure 6 Longitudinal Patterns of Concurrent Use among Older Adults



In addition to identifying the best-fitting model in terms of the optimal number of groups and their trajectory shapes, analysis was also run to determine whether or not any of the individual-level covariates predict or distinguish group membership. The model containing time constant demographic covariates is contained in Table 12; Model 1 identifies group membership only whereas Model 2 also assesses whether individual-level covariates are associated with group membership. In Model 2, using the *no to low use* group as the comparison group, both gender and race were a significant predictors of group membership. Males had a higher probability of group membership in the *high use* group and the *increasing use.* There were no

significant differences by gender for membership in the *decreasing use* trajectory. Race also predicted cohort membership; being White increased the probability of group membership in the *high use* group with significant coefficients of 0.56. However, race did not predict membership in the *decreasing use* (p=0.08) or *increasing use* (p=0.08) groups yet, African Americans had a higher percentage of membership in the *decreasing use* group and Whites had higher rates of membership in the *increasing use* trajectory. Additional cross-tabular analyses displaying rates of group membership by gender, race, and age are displayed below in Table 14.

Men were nearly twice as likely as women to be in the *increasing use* group and had higher rates of membership in the high use cohort, 21.6% of men compared to only 14.7% of women. Just over 15% of African Americans were in either the *increasing use* or the *high use* trajectories whereas 24.8% of Whites were placed in one of these cohorts. Age was significantly related to group membership (p=0.015). The majority of individuals in each age category (65 – 69, 70 – 74, 75 – 79, 80 – 84, and 85+) were in the *no to low use* group. Membership in the *decreasing use* group was highest for individuals ages 80 to 84 (17.9%) and the 85 and over category (19.6%) which is nearly double the percentage of those ages 65 to 69 in this group (11%). Membership in the high use trajectory was greatest among the younger age categories. For example, 17.9% of individuals ages 65 to 69 were members of the high use trajectory compared to only 5.4% of individuals ages 85 and older.

Table 14 Demographic Characteristics by Group Membership

	Men (n=1369)	Women (n=2101)	x^2	African American / Other (n=489)	White (n=2981)	x^2
Group						
No to low Use	58.3%	68.3%	.000**	68.5%	63.7%	.000**
Decreasing Use	11.8%	12.5%		16.2%	11.5%	
Increasing Use	8.3%	4.6%		4.5%	6.3%	
High Use	21.6%	14.7%		10.8%	18.5%	

4.4 MULTINOMIAL LOGISTIC REGRESSION

After identifying the four major patterns of concurrent use (*no to low use*, *increasing use*, *decreasing use*, and *high use*) multinomial logistic regression was used to analyze the relationship between patterns of concurrent use and the physical as well as mental health status of community-dwelling older adults. In the baseline analysis of the relationship between physical health status and concurrent use, no significant differences were found between concurrent users and non-concurrent users on measures of self-reported health and physical functioning (IADLs and ADLs) as well as depression status. To examine how various trajectories of concurrent use impact upon the physical health of older adult's four multinomial logistic models were run. In each of the models, group membership served as the independent variable (belonging to either the *low to no use*, *decreasing use*, *increasing use*, or *high use*

cohort); dependent variables from Wave 6 serving as proxies for physical health status included self-reported physical health status, total number of IADLs, and total number of ADLs. Additionally, a model to assess the effects of patterns of concurrent use on mental health status was run with group membership as the predictor variable and depression status as the outcome variable. The demographic covariates of gender (0=Female, 1=Male), race (0=African American, 1=White) and age (continuous) also included in the model were included in all four of the logistic regression models. Frequency distributions were run to determine the appropriate reference category for each of the dependent variables. For the independent variable of group membership, consisting of three dummy variable, the *no to low use* trajectory was used as the default comparison group in all analyses.

4.4.1 Physical Health

4.4.1.1 Self-Reported Health Status

In the first model, group membership was regressed upon physical health status with the covariates of gender, race, and age also included in the model. Model fitting information indicated the existence of a relationship between the independent variables and self-reported health status; the probability of the model chi-square (159.40) was significant at $p<.001$. Furthermore, the likelihood ratio test indicated a significant relationship between concurrent use and self-reported health status; ratio tests also confirmed a statistically significant relationship between health status and gender, race and age (see Table 15). Finally, both the Persons ($p=.637$) and Deviance ($p=.997$) goodness-of-fit statistics were not statistically significant indicating adequate model fit.

Table 15 Likelihood Ratio Tests for Physical Health Regression Models (N=3470)

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	Df	Sig
Self-Reported Health				
Intercept	2159.13	.000	0	
Gender	2192.67	33.54	4	.000**
Race	2230.25	71.12	4	.000**
Age	2176.39	17.23	4	.002*
Group Membership	2189.29	30.16	12	.003*
Number of ADLs				
Intercept	1417.65	.000	0	
Gender	1453.57	35.92	3	.000**
Race	1436.22	18.57	3	.000**
Age	1492.91	75.26	3	.000**
Group Membership	1435.83	18.18	9	.033*
Number of IADLs				
Intercept	1589.44	.000	0	
Gender	1659.89	70.45	3	.000**
Race	1595.28	5.83	3	.20
Age	1799.58	210.13	3	.000**
Group Membership	1602.14	12.69	9	.177

*Significant at $p<.05$
**Significant at $p<.001$

Using good health as the reference category, being male increased the odds of reporting excellent to very good health rather than good health by 1.7 and 1.2, respectively. There were no significant differences between Whites and African Americans in reporting excellent rather than good health. However, Whites were significantly more likely than African Americans to report very good health; African Americans had significantly higher rates of self-reported fair or poor ($p<.001$). Being White was associated with a 46.5% decrease in fair and a 70.8% decrease in poor rather than good self-reported health status. Additionally, compared to younger individuals, older respondents were significantly more likely to report fair or poor health than good health ($p<.001$). Looking at trajectories of concurrent use, members of the *high use* trajectory are significantly less likely than those in the *no to low use* group members to report excellent health rather than good health; no other group membership contrasts were significant (see Table 16. for parameter estimates). This finding is a departure from the initial baseline analysis which found no significant differences between non-concurrent users and concurrent users possibly indicating that it is the pattern of concurrent use, not necessarily concurrent use in itself that affects health status.

Table 16 Parameter Estimates for Self-Reported Health Status Regression Model (N=3,470)

	B	Std. Error	Wald	df	Sig	Exp(B)	CI
Excellent							
Intercept	-1.60	1.38	1.35	1	.245		
Gender	0.57	0.16	12.02	1	.001*	1.76	(1.28, 2.44)
Race	0.27	0.27	1.02	1	.313	1.31	(0.78, 2.21)
Age	-0.01	0.01	0.50	1	.484	0.99	(0.95, 1.02)
Group							
High Use	-0.74	0.25	8.35	1	.004*	0.48	(0.29, 0.79)
Increasing	-0.23	0.35	0.45	1	.506	0.79	(0.40, 1.57)
Decreasing	-0.53	0.29	3.52	1	.061	0.56	(0.34, 1.02)
No to Low	0	.	.	0	.	.	.
Very Good							
Intercept	- 0.36	0.71	0.26	1	.611		
Gender	0.22	0.09	6.66	1	.010*	1.25	(1.05, 1.48)
Race	0.38	0.14	7.41	1	.006*	1.46	(1.11, 1.91)
Age	-0.01	0.01	0.80	1	.371	0.99	(0.97, 1.00)
Group							
High Use	-0.05	0.11	0.20	1	.651	0.95	(0.76, 1.18)
Increasing	0.24	0.17	2.54	1	.162	1.27	(0.91, 1.77)
Decreasing	-0.22	0.14	2.54	1	.395	0.88	(0.62, 1.05)
No to Low	.	.	.	0	.	.	.
Fair							
Intercept	-3.29	0.71	21.24	1	.000**		
Gender	0.06	0.09	0.41	1	.525	1.06	(0.88, 1.27)
Race	-0.62	0.12	28.13	1	.000**	0.54	(0.43, 0.67)
Age	0.04	0.01	17.95	1	.000**	1.04	(1.02, 1.06)
Group							
High Use	-0.72	0.13	0.33	1	.564	0.93	(0.73, 1.19)
Increasing	-0.17	0.21	0.66	1	.418	0.84	(0.55, 1.28)
Decreasing	0.22	0.13	2.80	1	.094	1.24	(0.96, 1.60)
No to Low	.	.	.	0	.	.	.
Poor							
Intercept	-7.83	1.73	20.33	1	.000**		
Gender	0.35	0.24	2.16	1	.142	1.43	(0.88, 2.29)
Race	-1.23	0.26	23.14	1	.000**	0.29	(0.18, 048)
Age	0.07	0.02	11.11	1	.001**	1.08	(1.03, 1.12)
Group							
High Use	-0.29	0.36	0.67	1	.414	0.75	(0.37, 1.50)
Increasing	-1.48	1.02	2.12	1	.145	0.23	(0.03, 1.67)
Decreasing	0.15	0.32	0.23	1	.634	1.17	(0.62, 2.19)
No to Low	.	.	.	0	.	.	.

*Significant at p<.05
**Significant at p<.001

4.4.1.2 Physical Functioning

Two models were run to assess the relationship between patterns of concurrent use and physical functioning. In the first model, group membership was regressed upon the categorical variable number of IADLs with the covariates of gender, race and age also included in the model. In the second model, group membership was the independent variable and the categorical variable number of ADLs was the dependent variable. In both models, the reference category for the independent variable of group membership was the *low to no use* trajectory and for the dependent variables the comparison group was having no IADLs or ADLs. Model fitting information indicated the existence of a relationship between the independent variables and physical functioning; the probability of the model chi-square (295.59) was significant at $p<.001$ for the IADLs model and the model chi-square for the ADLs model was also significant, $\chi^2 = 152.21$, $p<.001$. Goodness-of-fit statistics for both models were non-significant indicating satisfactory model fit for both physical functioning models (see Table 17). The likelihood ratio tests indicated a significant relationship between concurrent use and physical functioning (see Table 13). Additionally, statistically significant relationships between total number of IADLs as well as ADLs and gender, race and age were found (see Table 15).

Table 17 Goodness-of-Fit Statistics For Physical Functioning Regression Model

Model	Chi-Square	Df	Sig
Total Number of IADLs			
Pearson	829.20	843	.626
Deviance	755.40	843	.986
Total Number of ADLs			
Pearson	878.03	840	.176
Deviance	750.24	840	.988

Parameter estimates showing significant relationships between total number of IADLs and gender, race, and age can be found in Table 18. An inverse relationship was found between total number of IADLs and gender and race. However, the likelihood ratio test did not show race to be significantly related to the independent variable, number of IADLs, therefore it is not appropriate to assess its role in distinguishing between pairs of groups. Women were significantly more likely than men to report having any IADLs rather than no IADLs. Being male was associated with a 34% decrease in reporting one IADL, a 62.2% decrease in reporting two IADLs and a 58.6% decrease in having four to nine IADLs. Age was positively correlated with total number of IADLs with older individuals reporting higher rates of IADLs compared to no IADLs. As with race, comparisons of group membership were not assessed because the likelihood ratio test found no significant relationship between cohort membership and number of IADLs.

Table 18 Parameter Estimates Physical Functioning (IADL) Regression Model (N=3,470)

	B	Std. Error	Wald	Df	Sig	Exp(B)	CI
One IADLs							
Intercept	-6.30	0.69	84.41	1	.000**		
Gender	-0.42	0.09	22.73	1	.000**	0.66	(0.56, 1.09)
Race	-0.09	0.12	0.59	1	.442	0.91	(0.72, 1.16)
Age	0.07	0.01	64.43	1	.000**	1.05	(1.05, 1.09)
Group							
High Use	0.18	0.11	2.55	1	.110	1.19	(0.96, 1.48)
Increasing	0.25	0.18	1.99	1	.158	1.28	(0.91, 1.81)
Decreasing	0.27	0.13	4.68	1	.030*	1.31	(1.03, 1.67)
No to Low	0	.	.	0	.	.	
Two IADLs							
Intercept	-13.22	1.19	122.21	1	.000**		
Gender	-0.97	0.19	27.84	1	.000**	0.38	(0.26, 0.54)
Race	-0.26	0.21	1.53	1	.216	0.77	(0.51, 1.17)
Age	0.14	0.02	93.83	1	.000**	1.15	(1.12,1.19)
Group							
High Use	-0.11	0.24	0.24	1	.631	0.89	(0.56, 1.42)
Increasing	-0.06	0.39	0.03	1	.875	0.94	(0.44, 2.00)
Decreasing	0.16	0.23	0.48	1	.487	1.18	(0.75, 1.85)
No to Low	0	.	.	0	.	.	
3 or more IADLs							
Intercept	-14.87	1.21	150.46	1	.000**		
Gender	-1.05	0.19	29.84	1	.000**	0.35	(0.24, 0.51)
Race	-0.47	0.27	5.26	1	.022*	0.62	(0.48, 1.34)
Age	0.17	0.02	122.19	1	.000**	1.18	(1.15, 1.21)
Group							
High Use	-0.22	0.26	0.70	1	.402	0.80	(0.48, 1.34)
Increasing	0.04	0.39	0.01	1	.912	1.04	(0.49, 2.25)
Decreasing	0.47	0.22	4.71	1	.030*	1.60	(1.05, 2.45)
No to Low	0	.	.	0	.	.	

*Significant at p<.05
**Significant at p<.001

Similar to the IADL model, gender, race and age were all significantly related to the total number of ADLs reported by an individual (See Table 15 for likelihood ratio tests and Table 19 for parameter estimates). Men were more likely than women to report having no ADLs versus having one or more ADLs. Being female increases the odds of reporting one, two, and three or more ADLs rather than no ADLs by 0.61, 0.58 and 0.44, respectively. Whites were more likely than African Americans to report having no ADLs versus one or more ADLs. Being African American increases the odds of reporting one (0.65), two (0.56) or three or more (0.51) ADLs rather than no ADLs. Increasing age was significantly related to the number of ADLs reported. Each one year increase in age corresponds to a 0.05 unit increase in reporting one ADL versus none, a 0.08 unit increase in reporting two ADLs rather than none and a 0.12 unit increase in reporting three or more ADLs rather than no ADLs. Finally, among this set of predictors, group membership was helpful in distinguishing among the groups defined by total number of ADLs; this is a significant relationship that was not found when using a dichotomous comparison at baseline. Respondents in the *decreasing use* group were more likely than individuals in the *no to low use* group to report having one ADL or two ADLs rather than no ADLs; there was no significant difference between reporting three or more ADLs for individuals in the *decreasing use* group compared to the *no to low use* group.

Table 19 Parameter Estimates for Physical Functioning (ADL) Regression Model (N=3,470)

	B	Std. Error	Wald	Df	Sig	Exp(B)	CI
One ADLs							
Intercept	-5.30	0.84	40.25	1	.000**		
Gender	-0.48	0.11	17.71	1	.000**	0.62	(0.50, 0.77)
Race	-0.43	0.14	9.08	1	.003*	0.65	(0.50, 0.86)
Age	0.05	0.01	22.16	1	.000**	1.05	(1.03, 1.07)
Group							
High Use	0.16	0.15	1.24	1	.265	1.18	(0.89, 1.56)
Increasing	-0.02	0.24	0.01	1	.946	0.98	(0.61, 1.59)
Decreasing	0.43	0.15	8.4	1	.004*	1.54	(1.15, 2.06)
No to Low	0	.	.	0	.	.	
Two ADLs							
Intercept	-8.91	1.27	49.48	1	.000*		
Gender	-0.54	0.18	8.54	1	.003*	0.58	(0.41, 0.84)
Race	-0.58	0.21	7.37	1	.007*	0.56	(0.37, 0.85)
Age	0.08	0.02	28.16	1	.000**	1.08	(1.05,1.12)
Group							
High Use	0.37	0.22	2.74	1	.098	1.44	(0.94, 2.23)
Increasing	-0.37	0.47	0.61	1	.437	0.69	(0.28, 1.74)
Decreasing	0.50	0.23	4.67	1	.031*	1.65	(1.05, 2.58)
No to Low	0	.	.	0	.	.	
3 or more ADLs							
Intercept	-11.56	1.43	64.78	1	.000**		
Gender	-0.82	0.23	12.36	1	.000**	0.44	(0.28, 0.70)
Race	-0.66	0.24	7.50	1	.006*	0.52	(0.32, 0.83)
Age	0.12	0.02	43.16	1	.000**	1.12	(1.02, 1.16)
Group							
High Use	-0.46	0.35	1.78	1	.183	0.63	(0.32, 1.24)
Increasing	-0.12	0.48	0.06	1	.81	0.89	(0.35, 2.27)
Decreasing	0.34	0.27	1.59	1	.21	1.40	(0.83, 2.37)
No to Low	0	.	.	0	.	.	.

*Significant at p<.05
**Significant at p<.001

4.4.2 Mental Health

In order to assess the relationship between patterns of concurrent use and mental health status group membership was regressed on depression status; the covariates of gender, race, and age were also included in the model. Goodness-of-fit statistics suggested an adequate model fit with both the Persons (p=.578) and Deviance (p=.1214) being non significant. Model fitting information also indicated the existence of a relationship between the independent variables and depression status, $\chi^2 = 49.26$, p<.001. Likelihood ratio test were significant indicating a relationship between group membership and depression status (See Table 20). Finally, ratio tests confirmed statistically significant relationship between depression status and gender, race and age.

Table 20 Likelihood Ratio Tests for Mental Health Regression Model

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig
Depression Status				
Intercept	713.63	.000	0	
Gender	735.96	22.33	1	.003
Race	717.96	4.32	1	.038
Age	722.59	8.96	1	.000
Group Membership	724.55	10.92	3	.012

Table 21 shows the parameter estimates for the mental health regression model. There was a significant inverse relationship between gender and depression status with females being more likely to have a diagnosis of depression than males. The odds of being clinically depressed decreased by 0.64 for men compared to women. There was also a significant relationship between race and depression status with African Americans having a higher rates of depression compared to Whites. The odds of having a depression diagnosis rather than no depression diagnosis were 23% less for Whites versus African Americans. Age is positively associated with depression status; older individuals have higher rates of depression than their younger counterparts. Considering patterns of concurrent use, a significant relationship between depression status and membership in the *increasing use* and the *decreasing use* trajectories was found; no other contrasts for group membership were significant. The odds of being depressed rather than not depressed increased by a factor of 1.35 for individuals in the *decreasing use* group rather than those in the *no to low use* trajectory. On the other hand, when compared to individuals in the *no to low use* group, being a member of the *increasing use* trajectory is associated with lower levels of depression; the odds of being depressed decrease by 0.64 for members of the *increasing use* group. Given that rates of depression were comparable for non-concurrent users and concurrent users, the results indicate that, as with physical functioning, it is the pattern of concurrent use that explains the relationship between concomitant use and depression status.

Table 21 Parameter Estimates for Mental Health Regression Model (N=3,470)

	B	Std. Error	Wald	df	Sig	Exp(B)	CI
Intercept	-2.99	0.70	18.19	1	.000**		
Gender	-0.44	0.10	21.63	1	.000**	0.64	(0.53, 0.77)
Race	-0.26	0.12	4.45	1	.035*	0.77	(0.61, 0.98)
Age	0.03	0.01	9.10	1	.003*	1.03	(1.01, 1.04)
Group							
High Use	0.02	0.12	0.03	1	.854	1.02	(0.81, 1.30)
Increasing	-0.45	0.23	3.85	1	.050*	0.64	(0.41, 1.00)
Decreasing	0.30	0.13	5.65	1	.017*	1.35	(1.05, 1.73)
No to Low	0	.	.	0	.	.	.

*Significant at p<.05
**Significant at p<.001

4.4.3 Medication Use and Alcohol Consumption

Follow-up analyses using multinomial logistic regression models were run to assess the relationship between medication and alcohol use and physical as well as mental health status in wave 6 of the study. Alcohol use (number of drinks a week), total number of medications, the total number of alcohol-interactive and the interaction effect of alcohol with the medication variables was regressed on self-reported health status, total number of IADLs, and total number of ADLs; the covariates of gender, race, and age were also included in the model. In the self-reported health model, good health was used as the reference category in the analysis and in the physical functioning models reporting no IADLs or ADLs served as the reference point for the

models. In the fourth model run alcohol use (number of drinks a week), total number of medications, the total number of alcohol-interactive, and the interaction of alcohol use with the medication variables was regressed on depression status. Sociodemographic characteristics were also included as covariates in the model and lack of a depression diagnosis was used as the reference category for this analyses.

Men, African Americans, and older adults were significantly more likely to report poor health than good health. Women, African Americans, and older individuals were more significantly more likely to report difficulties with IADLs and ADLs than men, Whites, and younger individuals. Medication use was significantly related to self-reported health status. Individuals taking more medications were less likely to report excellent or very good health and significantly more likely to report poor or fair health rather than good health. Additionally, medication use was significantly related to total number of ADLs and IADLs. There was a positive correlation between number of medications and difficulties with ADLs and IADLs; individuals with more ADLs and IADLs were more likely to be taking one or more medications rather than none. Alcohol use was significantly related to self-reported health status yet there was no significant relationship between alcohol use and total number of ADLs or IADLs. A 1 unit increase in weekly alcohol consumption increased the odds of reporting very good rather than good health by 1.3%. Conversely, a 1 unit increase in alcohol consumption decreased the odds of reporting poor rather than good health by 23.5%. The interaction effect of alcohol and medications was not significantly related to self-reported health status or physical functioning models.

Multinomial logistic regression models were also run to examine the effect of alcohol and medications use on depression status. Females and older individuals were more likely to report

depression when compared to men and younger respondents. Medication use was significantly related to depression status. A one unit increase in the total number of medications being used increased the chance of being depressed rather than not depressed by 11.9%. Alcohol use was not significantly related to depression status nor was the interaction between weekly alcohol use and total number of medications.

4.4.4 The Relationship between Baseline Health Status and Overall Health in Wave 6

Four additional logistic regression models were run to investigate the extent to which participants physical and mental health status at baseline helped explain reported health status at Wave 6. In each of the models, health status (self-reported health status, number of IADLs and ADLs and depression status) at baseline and group membership (belonging to either the *low to no use*, *decreasing use*, *increasing use*, or *high use* cohort) were included as independent variables. The dependent variables from Wave 6 serving as proxies for physical health status included self-reported physical health status (1=Excellent, 2=Very Good, 3=Good, 4=Fair,5=Poor), total number of IADLs (0=none,1= one to three, 2= four to six) and total number of ADLs (0= none, 1=one to two, 2= three to six). The demographic covariates of gender (0=Female, 1=Male), race (0=African American, 1=White) and age (continuous) were included in all four of the logistic regression models. Since no *a priori* hypotheses had been made to determine the order of entry of the predictor variables, a direct method was used for these multiple linear regression analyses.

4.4.4.1 Physical Health Status

In the first model, logistic regression was employed to help determine the influence of group membership and self-reported health status at baseline on reported health status in the final wave of the study. Together group membership, health status at baseline, gender, race and age explain 27.5% of the variance in self-reported health status in Wave 6 (F (5, 3453)= 262.98, p=.000). Regression coefficients are presented in Table 22. The strongest predictor was self-reported health status at baseline (β=.43). The independent variable of group membership also predicted health status (β=.26). The covariates of race and age significantly predicted self-reported health status; gender was not a statistically significant. African Americans and older respondents were more likely to report lower levels of self-reported health than Whites and younger study participants.

Table 22 Regression Coefficients for Self-Reported Physical Health Regression Model (N=3,470)

	Unstandardized Coefficients		Standardized Coefficients		
	B	**SE**	**B**	**t**	**Significance**
Constant	1.09	.206		5.28	.000**
Group Membership	.026	.010	.036	2.44	.015*
Health Status (Wave 1)	.431	.013	.502	34.16	.000**
Gender	-.040	.026	-.022	-1.54	.124
Race	-.160	.036	-.064	-4.39	.000**
Age	.010	.003	.057	3.94	.000**

*Statistically Significant at p<.05
**Statistically Significant at p<.001

4.4.4.2 Physical Functioning

Two logistic regression models were run to determine the impact of physical functioning at baseline and cohort membership on reported functional status in Wave 6. Group membership was not a significant predictor of number of reported difficulties with IADLs or ADLs in Wave 6. The covariates of gender, race and age significantly predicted physical functioning in both models. The greatest predictor of total number of IADLs in the final wave of the study was total number of IADLs at baseline (β=.47). Number of IADLs at baseline, gender, race and age explain 19.9% of the variance in rates of IADLs in Wave 6 (F (5, 3434)= 172.07, p=.000). Approximately 12% of the variance in the number of ADLs in the final wave of the study was explained by the independent variable of ADLs at Wave 1 and the covariates of gender, race and age (F (5, 3406)= 92.48, p=.000). The predictor of total number of reported ADLs (β=.51) in the final wave of the study. Regression coefficients for both models are presented in Table 23.

Table 23 Regression Coefficients for Physical Functioning Regression Models (N=3,470)

	Unstandardized Coefficients		Standardized Coefficients		
	B	**SE**	**B**	**t**	**Significance**
IADLs					
Constant	-1.37	.134		-10.27	.000**
Group Membership	.005	.007	.012	.777	.437
Total IADLs (Wave 1)	.468	.020	.367	23.55	.000**
Gender	-.068	.017	-.063	-4.02	.000**
Race	-.047	.024	-.030	-1.97	.050*
Age	.022	.002	.198	12.88	.000**
ADLs					
Constant	-.761	.129		-5.90	.000**
Group Membership	.009	.007	.023	1.43	.152
Total ADLs (Wave 1)	.514	.029	.284	17.52	.000**
Gender	-.080	.016	-0.81	-4.96	.000**
Race	-.077	.023	-.055	-3.38	.001**
Age	.013	.002	.132	8.20	.000**

*Statistically Significant at p<.05
**Statistically Significant at p<.001

4.4.4.3 Mental Health

Multiple regression analyses was used to investigate the extent to which participants depression status at baseline and group membership explained reported depression status in the final wave of the study. As was the case in the physical health models, the strongest predictor of depression status in Wave 6 was baseline depressive diagnosis (β=.26). Depression status at baseline, gender and age explain 7.7% of the variance in mental health status in Wave 6 (F (5, 2596)= 44.39, p=.000). Regression coefficients are presented in Table 24. Group membership and race

did not predict depression status. The covariates of gender and age significantly predicted mental health status; women and older individuals were more likely to report depression.

Table 24 Regression Coefficients for Mental Health Regression Model (N=3,470)

	Unstandardized Coefficients		Standardized Coefficients		
	B	**SE**	**B**	**t**	**Significance**
Constant	1.09	.206		5.28	.000**
Group Membership	.026	.010	.036	2.44	.015*
Health Status (Wave 1)	.431	.013	.502	34.16	.000**
Gender	-.040	.026	-.022	-1.54	.124
Race	-.160	.036	-.064	-4.39	.000**
Age	.010	.003	.057	3.94	.000**

*Statistically Significant at p<.05
**Statistically Significant at p<.001

4.4.5 Concurrent Use and Mortality

Cox regression analysis was employed to examine the relationship between concurrent use and mortality status; the entire sample was included in this regression analyses (N=5,888). The time, variable in this model was study wave and the binary variable of mortality was used as the status or outcome variable. Two measures of concurrent use were used to predict the event (time until death): having ever concurrently used (0=No and 1=Yes) and the interaction of weekly alcohol consumption and total number of alcohol-interactive medications (concurrent use) at baseline.

The additional covariates of gender (0=Female, 1=Male), race (0=African American, 1= White) and age (continuous) were included in the model.

The likelihood ratio test for the model was significant indicating that one or more of the covariates contributes significantly to the explanation of duration to death. The null model had a -2 Log Likelihood of 16,667.58 and the full model had a -2 Log Likelihood of 16188.07. The model chi-square difference was 540.32 ($p<.001$). The two measures of concurrent use and the covariates of gender, race and age were all significantly related to time until death (see Table 25.)

Table 25 Test Statistics for Cox Regression: Concurrent Use and Mortality

	B	SE	Wald	df	*p*	β
Ever Concurrent Use	-.338	.069	23.98	1	.000**	.713
Concurrent Use (Wave 1)	.007	.003	5.36	1	.021*	1.01
Gender	.699	.067	112.85	1	.000**	2.01
Race	-.187	.081	5.15	1	.023*	.830
Age	.090	.005	347.22	1	.000**	1.09

*Significant at $p<.05$
**Significant at $p<.001$

For every one unit increase in concurrent use (the interaction of weekly alcohol use and total number of alcohol-interactive medications) the hazard ratio for mortality increased by a factor of

1.01. The binary variable of having ever concurrently used over the course of the study was inversely related to mortality (β=.71). Gender and age were both positively correlated with mortality with men and older individuals being more likely to experience an event than women and younger individuals. Finally, being White was significantly associated with a lower risk of mortality.

4.4.6 Summary of Results

Concurrent use is fairly common among community-dwelling older adults; the majority of study participants (55.4%) concurrently used alcohol with alcohol-interactive medications during at least one of the six waves of the study; one-third of concurrent users reported concomitant alcohol-medication use in 3 or more waves of the study. The majority of individuals who reported alcohol consumption also reported concurrent use; over the course of the study rates ranged between 57% to 64%. The most common form of concurrent use was drinking below or within recommended guidelines and taking one alcohol-interactive medication. Concomitant alcohol and medication use vary between the subgroups: men, Whites and problem drinkers were significantly more likely to concurrently use than women, African Americans and low to moderate alcohol users; there were no significant differences by age.

Group-based logit analysis revealed four distinct patterns of concurrent use. Concurrent use among the first group of individuals increased over the course of the study. The second trajectory is fairly flat and is comprised of individuals who maintain a stable pattern of *no to low use* over the course of the study. The third group, the *decreasing use* group, is characterized by moderately high levels of use in the initial waves of the study however there is a gradual steady

decrease in concurrent use over time. The final group is indicative of high-stable rates of concurrent use over time. Using the *no to low use group* as the comparison group, gender was a significant predictor of group membership. Males had a higher probability of group membership in the *increasing use* and *high use* groups. Race did not significantly predict membership in the *increasing use* group however the relationship was positive indicating a greater number of Whites in this cohort. Yet, being White significantly increased the probability of group membership in the *high use* group.

Regression analysis revealed that specific patterns of concurrent use are significantly related to both physical and mental health status among community-dwelling older adults. Using good health as the reference category, being male increased the odds of reporting excellent to very good health rather than good health. There were no significant differences between Whites and African Americans in reporting excellent rather than good health. However, Whites were significantly more likely than African Americans to report very good health; African Americans had significantly higher rates of self-reported fair or poor. Additionally, compared to younger individuals, older respondents were significantly more likely to report fair or poor health than good health. Looking at trajectories of concurrent use, members of the *high use* trajectory were significantly less likely than those in the *no to low use* group members to report excellent health rather than good health; no other group membership contrasts were significant. Regression analysis also revealed a significant relationship between medication use and self-reported health status. Individuals taking more medications were less likely to report excellent or very good health and significantly more likely to report poor or fair health rather than good health. Alcohol use was significantly related to self-reported health status yet the interaction effect of alcohol use and medications was not significant.

In addition to assessing the relationship between self-reported health status and concurrent use, models were run to examine the relationship between concomitant use and physical functioning. Women were significantly more likely than men to report having any IADLs or ADLs rather than no IADLs or ADLs. Age was positively correlated with total number of IADLs and ADLs with older individuals reporting higher rates of IADLs and ADLs compared to no IADLs or ADLs. Group membership was not found to be significantly related to total number of IADLs however, it was related to total number of ADLs. Respondents in the *decreasing use* group were more likely than individuals in the *no to low use* group to report having one ADL or two ADLs rather than no ADLs; there was no significant difference between reporting three or more ADLs for individuals in the *decreasing use* group compared to the *no to low use* group. A positive correlation between number of medications and difficulties with ADLs and IADLs was found; individuals with more ADLs and IADLs were more likely to be taking one or more medications rather than none.

Depression status was found to be related to sociodemographic characteristics as well as group membership. There was a significant inverse relationship between gender and depression status with females being more likely to have a diagnosis of depression than males. The odds of being clinically depressed decreased for men compared to women. There was also a significant relationship between race and depression status with African Americans having a higher rates of depression compared to Whites. Age was found to be positively associated with depression status; older individuals have higher rates of depression than their younger. Significant relationships were also found between depression status and membership in the *increasing use* and the *decreasing use* trajectories. The odds of being depressed rather than not depressed increased for individuals in the *decreasing use* group rather than those in the *no to low use*

trajectory. Conversely being a member of the *increasing use* trajectory was found to be associated with lower levels of depression. Multinomial logistic regression models were also run to examine the effect of alcohol and medications use on depression status. Medication use was significantly related to depression status. A one unit increase in the total number of medications being used increased the chance of being depressed rather than not depressed by 11.9%. Alcohol use was not significantly related to depression status nor was the interaction between weekly alcohol use and total number of medications.

Multiple logistic regression models were run to investigate the extent to which participants physical and mental health status at baseline helped explain reported health status at Wave 6. Logistic regression revealed that physical and mental health statuses at baseline were the best predictors of health status in the final wave of the study. Group membership was a significant predictor of self-reported health status but it did not predict physical functioning or depression at Wave 6.

A significant relationship was found between concurrent use and duration to death. For every one unit increase in concurrent use (the interaction of weekly alcohol use and total number of alcohol-interactive medications) the hazard ratio for mortality increased by a factor of 1.01. Gender and age were both positively correlated with mortality with men and older individuals being more likely to experience an event than women and younger individuals. Finally, being White was significantly associated with a lower risk of mortality.

5.0 DISCUSSION AND IMPLICATION

5.1 OVERVIEW

The interaction of alcohol and prescription drugs is an important health concern for individuals of all ages, it is a particularly salient issue for older adults, who take more medication than any other age cohort and are more susceptible to the effects of alcohol and/or medications due to physiological changes associated with aging (Moore et al., 2007; Swift et al., 2007; Pringle et al., 2005; SAMHSA, 2004). Despite older adults' increased risk of alcohol-medication interaction there has been limited research focused on the prevalence, patterns and correlates of simultaneous alcohol and medication use in community-dwelling older adults. To date, the majority of research regarding concurrent alcohol and medication use has been conducted with young or middle-aged populations and has focused primarily on chronic heavy drinkers; few studies have examined the alcohol-medication interactions among low to moderate users in the general population of older adults (Onder, et al., 2002). Additionally, the body of literature that has examined concurrent use among community-dwelling older adults has largely been conducted in primary and acute care settings and has focused on adverse drug reactions.

The current study presents data on the prevalence, usage patterns and health outcomes associated with concurrent among community-dwelling older adults. Many of the hypotheses examined in this investigation were at least partially substantiated by the results; however other

hypotheses were not supported by the data. The following chapter discusses the results of this study and offers possible justifications for the study's findings. In addition, implications for social work practice and policy are presented. Suggestions regarding future research are offered followed by a discussion of the study's strengths and limitations.

5.1.1 The Prevalence of Concurrent Use among Older Adults

Alcohol Consumption

The first aim of this investigation was to examine rates and correlates of concurrent use among community-dwelling older adults. In order to assess concurrent use it was first necessary to look at baseline rates of alcohol consumption and medication use in this sample. Analysis revealed that half of the respondents reported weekly alcohol consumption; the majority of older adults who reported weekly alcohol usage drank below or within NIAAA recommended guidelines (39.8%). However, 6.7% of respondents reported drinking above the recommended guidelines (8 – 19 drinks a week) and 3.3% consumed 20 or more drinks a week, nearly three times the recommended guidelines for weekly alcohol consumption for older adults. These statistics are consistent with past research on alcohol consumption among older adults; research indicates that between 40% and 50% of seniors consume alcohol and 10% drank above recommended guidelines (Breslow, Faden & Smothers, 2003; Blow & Barry, 2002). Therefore, rates of alcohol use in the study sample are comparable to past knowledge regarding drinking behavior among older adults.

Reduced alcohol consumption in late life is associated with a number of factors including the onset of chronic condition, increased medication use, age, and gender. However, recent

studies indicate that gender, not cohort effects, may be a better predictor of both rates and level of alcohol consumption. Studies indicate that the rates of alcohol consumption among the newer cohort of aging baby bombers are decreasing slower than previous cohorts indicating that the "age effect" is not the only factor influencing level of alcohol consumption among older adults (Karlamangla et al., 2005; Moore et al., 2005) . In addition, research indicates prevalence rates and the likelihood of heavy drinking declined more slowly with increasing age in men versus women (Karlamangla et al., 2005). Given that women are more likely to abstain from alcohol use, have lower levels of consumption and tend to live longer than their male counterparts, it is likely that gender plays a large role in impacting the prevalence of alcohol use among older adults.

Men were significantly more likely than women to report weekly alcohol consumption. Men also reported higher rates of alcohol consumption; the mean number of drinks per week for men was twice that for females. In addition, males were more likely to be classified as hazardous alcohol users, consuming 14 or more drinks a week, twice the NIAAA recommended guidelines. Whites reported higher rates of alcohol consumption than African Americans and were more likely than African Americans to report drinking above NIAAA guidelines. Furthermore, rates of alcohol use differed by age, with older individuals having higher rates of abstinence and lower rates of alcohol consumption. Individuals over the age of 75 were less likely than their younger counterparts to report hazardous use. The current study supports past findings regarding drinking behavior among older adults. Although rates and levels of alcohol consumption decrease with age, nearly half of all older adults continue to drink alcoholic beverages; consumption of alcohol among older adults is most prevalent among men, Whites,

and younger individuals (Merrick et al., 2008; SAMHSA, 2005; Breslow et al., 2004; Schoenborn & Adams, 2002).

By 2040 more than 20% of the US population will be over the age of 65, while alcohol use generally declines with age the results of this study indicate that at least half of seniors report weekly alcohol use (Kensella & He, 2009). Moreover, this study further corroborates research findings that approximately 10% of people over 65 consume alcohol in excess of the NIAAA guideline for seniors of drinking no more than seven alcoholic beverages in a week (Kirchner et al., 2007; Blow & Barry, 2002). Research has shown that birth cohorts that experience high rates of alcohol use in youth or young adulthood have subsequently shown higher rates of use as they age, relative to other cohorts (SAMHSA, 2000). Significantly higher rates of alcohol and illicit drug use have been found in the birth cohorts of the "baby boom" generation (SAMHSA, 2001). The higher prevalence of alcohol and drug use among this generation coupled with the overall large population size of this cohort, suggests that the number of alcohol and illicit drug users among older adults will increase in the coming years as this group enters older adulthood. (SAMHSA, 2001). Therefore, it is expected that the increasing number of aging baby boomers will probably have an enormous impact on the need and demand for health care among older adults (Blow, et al., 2002). Of particular concern is the increasing rate of concurrent alcohol and medication use among older adults.

Medication Use

The hypothesis that concomitant use was fairly common among older adults was supported in the current study. Seventy-seven percent of participants reported took at least one medication in the past 14 days; on average participants were taking 2.34 (SD=2.2) medications a day. The rate of

medication use among the study sample was somewhat lower than national averages found in the past. For example, in 2006 more than 93% of adults ages 65 and older reported taking at least one medication in the last week, over half (58%) reported taking five or more medications, and 18% reported taking ten or more (Slone Epidemiology Center, 2006). The lower percentage of medication use in the study sample is most likely due to the fact that a number of individuals such as those in institutional settings were excluded from participating in the study.

Sixty-two percent of respondents were taking an alcohol-interactive medication at baseline; the mean number of alcohol-interactive medications used by respondents was 1.25 (SD=1.35). The majority of participants reported taking alcohol-interactive medications that had a low to moderate interaction with alcohol. Women were significantly more likely than men to be using one or more medications and were also significantly more likely to be taking more alcohol-interactive medications than their male counterparts. As one might expect, age was found to be a significant predictor of medication use; older individuals were more likely to be taking multiple medications and had higher usage rates of alcohol-interactive medication than study participants younger study participants.

The percentage of participants using medications differed by race as well. African Americans were less likely than Whites to be taking no medications, 18.5% versus 24.0%. Interestingly African Americans had significantly higher rates of overall medication use and reported greater use of alcohol-interactive medications than Whites. There are a number of possible explanations for this finding. Racial and ethnic disparities in health care have been described across a wide spectrum of health services, research indicates that being a member of ethnic or racial minority group appears to be a risk factor for receiving less comprehensive care. There are three factors that most likely are responsible for racial differences in the rate of use of

alcohol-interactive medications. First, older African Americans exhibit higher rates of many common chronic conditions, such as hypertension, diabetes, stroke, circulatory disease, arthritis and other musculoskeletal impairments, as well as mental health and nervous disorders (Fillenbaum et al., 2000; Martin & Soldo, 1997). Many of these chronic conditions are traditionally treated with medications that are alcohol-interactive such as antidiabetic agents, antihypertention drugs, and NSAIDs which contributes to differences in rates of use of alcohol-interactive drug use between Whites and African Americans.

In addition to differences in health conditions, recent research indicates disparities in prescribing practices (specifically regarding medication class) between Whites and African Americans (Hanlon et al., 2009; Blazer, et al., 2000). Using the example of antidepressants, several recent studies have found that when African Americans are prescribed antidepressants they are more likely to receive tricyclic antidepressants than SSRIs despite the fact that there is a significant reduction in side effects with SSRIs than with tricyclic antidepressants (Blazer, et al., 2000). This is just one example of a difference in prescribing practices that is partially determined by the race of the patient that may partially explain differences in the use of alcohol-interactive medications between Whites and African Americans.

Finally, as stated earlier, there are differences in the quality of care received by African Americans. White older adults are more likely than African Americans to receive regular ambulatory care from private physicians, whereas African Americans tend to use community health centers, hospital outpatient departments, or emergency rooms (Martin & Soldo, 1997). These practice settings are characterized by less satisfactory patient-physician relationships and less continuity of care than private physicians' offices (Martin & Soldo, 1997). Whites may be less likely to be prescribed alcohol-interactive medications because of the higher quality of care

they receive; there physicians may be more likely to screen for and / or know about their alcohol consumption and write prescriptions accordingly.

Concurrent Use

At baseline, just over a quarter of study participants (28%) reported concurrently using alcohol with one or more alcohol-interactive medications. Although national estimates of the combined prevalence of alcohol and medication use among individuals aged 65 and older are still unknown, the rates of concomitant use found in the current study are fairly consistent with the limited literature that does exist on concurrent use among older adults in the United States (Moore et al., 2007). One investigation of 667 community-dwelling older adults in northeast New York estimated that 25% of study participants drank alcohol with alcohol-interactive medications (Foster et al., 1993). In a more recent study using data from the Pennsylvania PACE program (a state-funded program providing prescription benefits to older person with low to moderate incomes), Pringle and colleagues (2005) found that 19% of those individuals who reported consuming alcohol (20.3% of the sample) took medications that could have negative interactions with alcohol. The increased service needs of aging alcohol users will most likely place a financial strain on existing resources, particularly given the high rates of medication use among this group. Older adults are the heaviest users of prescription medicines and over-the-counter drugs of all population sectors, and mixing these substances with alcohol can cause harmful interactions as well as exaggerate or reduce the effects of many medications. In addition, concomitant use increases the risks for falls and accidents, which can be very serious for people in this age group. Finally, concurrent use can exacerbate many medical conditions common in older people, such as high blood pressure and ulcers.

Although medications are central to managing the health of older patients, medication nonadherence such as concurrent use can lead to a number of adverse outcomes. As the U.S. population ages, new drugs are developed, and new therapeutic and preventive uses for medications are discovered, medication use by older adults will most likely continue to grow (Budnitz & Layde, 2007). Older patients, especially those who are chronically frail or acutely ill, may require special consideration when making prescribing decisions because of age-related changes in the metabolism and clearance of medications and enhanced pharmacodynamic sensitivities (Spinewine et al., 2007). The growing population of older adults has made primary disease prevention and efforts to promote healthy lifestyles a top priority of those providing services to older adults. Finding ways to prevent and reduce rates of concurrent use can play a key role in reducing the health care burden associated with alcohol use among older adults. This study confirms previous findings that approximately one-quarter of community-dwelling older adults concurrently use alcohol and medications. Given this statistic it is clear that concurrent use is a common public health issue among older adults that can lead to significant economic and social costs as the number of older adult's increases in this country.

5.1.1.1 Correlates of Concurrent Use among Older Adults

Analyses at baseline reveled concurrent users had higher rates of overall medication use and were taking more alcohol-interactive medications than individuals who reported no concurrent use. Study participants who reported concomitant use also were more likely than non-concurrent users to take multiple alcohol-interactive medications; 22.1% versus 14.1% respectively. These findings are to be expected, one would hypothesize that individuals who consume more medications would have a higher likelihood of being prescribed an alcohol-interactive

medication placing them at an increased risk for concurrent use. Thus, prevention efforts and education campaigns should target individuals who report taking multiple medications. Men had greater rates and reported more hazardous levels of concurrent use than women. At baseline, men had higher rates of concurrent use than women despite the fact the women were more likely than men to be taking one or more alcohol interactive medications. Rates of concurrent use for women and men were 26% and 32% respectively. Men (8.4%) were twice as likely as women (4.8%) to have moderate to high levels of concurrent use at baseline. Additionally, Whites reported higher levels of concurrent use than their African American counterparts. Nearly 7% of Whites reported moderate to high levels of concurrent use compared to only 3.8% of African Americans. Given that men and Whites have a higher frequency of alcohol use and consume greater quantities of alcohol when compared to women or African Americans it is not surprising that analysis revealed they were the group with the highest rates and levels of concurrent use. This finding points to the need for increased monitoring of alcohol consumption and medication adherence among White males. Interestingly, there were no significant difference in rates of concurrent use found for age; concurrent usage rates remained fairly stable regardless of age category. This pattern may be indicative of the fact that alcohol consumption is a behavior that is carried on throughout the course of life and although rates of consumption may decrease with age, individuals who have a history of alcohol use continue to drink regardless of the introduction of medications that can potentially interact with alcohol.

Although many of the interactions between alcohol and medications occur primarily among individuals who drink heavily ($\geq$ 3 drinks/occasion), interactions may also occur in individuals who consume light to moderate amounts of alcohol (1 – 2 drinks/occasion) (Moore et al., 2007). Older adults are at increased risk for a variety of adverse consequences depending on

the amount of alcohol and the type of medications consumed. In this investigation it was found that of those individuals who reported weekly alcohol use at baseline, 56.7% were concurrently using alcohol with alcohol-interactive medications. Most participants were taking one alcohol-interactive medication (48%) however; 22.1% of respondents who reported concurrent use were taking three or more alcohol-interactive medications. Individuals who were classified as problem users, drinking nearly three times the weekly recommended guidelines for older adults (>20 drinks a week), were statistically more likely to concurrent use than non-problem users. It is likely that these individuals have a history of misuse or abuse of alcohol that has continued on into late life. Therefore, they continue to consume alcohol irrespective of the fact that they are also using one or more alcohol-interactive medications.

5.1.1.2 Prevalence and Correlates of Concurrent use among Older Adults: Implications for Practice

Social workers and geriatric social workers in particular, try to improve the quality of life for older adults by alleviating some of the negative aspects of aging. As such, social workers play an integral role in improving the quality of life of older adults and their caregivers. Geriatric social workers are employed in a variety of settings and have a range of duties, making them uniquely situated to deal with issues associated with concurrent alcohol and medication use among older adults. The results of this study offer data on the prevalence rates and correlates of concurrent use among community-dwelling older adults and can be used to inform both practice and policy.

The two most important aspects of promoting medication adherence and preventing hazardous behavior such as concurrent alcohol and medication use are identifying problem

behaviors (screening and diagnosis) and providing a system of coordinated care. Although the current investigation found that a quarter of seniors concomitantly use alcohol and medication rates more seniors could be at risk due to the increased number of older adults and higher rates of medication use. Therefore, medication and alcohol use need to be part of the regular screenings received by older adults in both medical and Aging care network settings. Because social workers frequently have contact with older adults and they are familiar with the types of information collected by various agencies in the Aging care network, social work professionals are in the position to assist in creating brief screening tools to assess medication adherence. In addition, they can help in implementing screening tools for concurrent use among older adults. Social workers can also play a key role in creating linkages between primary care, other health care professionals and agencies in the Aging care network allowing for a continuum of care; linking these various providers can make it easier to ensure medication adherence. If an individual not only concurrently uses alcohol and medications but also presents with an alcohol problem, social workers can assist in helping these individuals get the substance abuse treatment they need and in some cases actually provide the treatment itself.

Educating older adults, their families, and caregivers about the dangers of concurrent use is a critical element in reducing concomitant use and improving the overall quality of life and health outcomes of older adults. Social workers who have a rapport with clients and frequently meet with seniors, their families, and caregivers can make sure that these individuals are aware of the problems associated with concurrent use. The findings from this study indicate a significant need for social work and health care professionals to educate older adults about the dangers of concurrent alcohol-medication use. Additionally, it appears that there is a need for health campaigns that focus on the promotion of safer use of alcohol and medications and

increase public awareness about concurrent use among older adults. Education initiatives should be senior-specific rather than targeting the larger adult population. Because of their frequent and ongoing contacts with older adults, social workers are ideal candidates for designing and implementing educational initiatives aimed at educating the public about concurrent alcohol and medication use. Social work professionals also have the skills necessary to assist in creating educational curriculums designed to prevent alcohol and medications by older adults as well as educational modules aimed at reducing or eliminating harmful medication practices such as concurrent use. In addition to social workers, health care professionals and pharmacists can assist in identifying individuals at risk for concurrent use.

The results of this study indicate that the use of medication in concert with alcohol is fairly common among Americans ages 65 and older it is imperative that health care professionals regularly ask seniors about their consumption of alcohol even if it is something as simple as asking "Do you drink any alcohol?" or "How do you use alcohol". Because even low to moderate alcohol consumption can lead to harmful adverse drug reaction, simply knowing that an older adult uses alcohol is useful in determining if they are at risk for or are currently concomitantly using alcohol and medications. Health care professionals or caretakers who are with individuals in their homes and therefore are able to observe behaviors regarding alcohol and medication use are in a unique position to assess harmful behavior. For example, home health care workers are ideally situated to engage in ongoing monitoring of medication adherence and to assess whether or not a particular client is at risk for or are engaging in concurrent alcohol and medication use.

In addition, encouraging medication adherence and appropriate prescribing practices are critical components necessary to reduce concomitant use among older adults. Health care

professionals can play a key role in reducing concurrent use by making certain older adults understand the medications they are taking and the possible side effects. Health care professionals need to encourage older adults to keep an up to date list of all the medications they are taking and the dosing to provide at medical appointments; if an individual is seeing multiple doctors such a list will ensure safe prescribing practices. The use of more than one pharmacy is a leading cause of adverse drug reactions because there is no running record of all the prescriptions an individual may be taking which makes it difficult for a pharmacist to assess any potential interactions. Therefore, nurses and doctors should encourage patients to use only one pharmacy to fill prescriptions.

Finally, nurses and doctors should encourage older adults to communicate with their pharmacist about any medications they are taking so that they understand any possible side effects or interactions. Providers of services to seniors need to make sure that instructions for taking medications are explicit and understood. Potential declines in hearing and vision may make it hard for seniors to understand how to properly use their medications; small fonts on labels and scientific terminology can often lead to the misuse of medications among older adults.

Pharmacists are in a powerful position to assist in preventing concurrent use and can also aid in identifying problems with medication and alcohol interactions, misuse, or abuse (Sullivan et al., 2007). Since they are uniquely situated to recognize and prevent concurrent use, pharmacists need to be aware of the various factors that place older adults at an increased risk for concurrent use.

Communicating with older adults about their medication use is key; patience and persistence are crucial factors to effective communication with seniors. Perceptions about medications used are a significant indicator of how well older adults will adhere to regimes;

older adults who see medications as necessary, useful, and less harmful are more likely to take as prescribed (Sullivan et al., 2007; Horne & Weinman, 1999). Pharmacists can assist in medication adherence and reduce rates of concurrent use by properly explaining the reason for and the effects of any medications prescribed and dispersed; the dangers associated with concurrent use should also be reviewed with the patient and / or caregiver. Pharmacists should get in the habit of asking older adults if they drink when they are filling a prescription for a medication that is considered alcohol-interactive. Pharmacists should recommend than an individual not drink when they have been prescribed certain types of drugs such as benzodiazepines, sedatives and narcotic analgesics; medications commonly used by older adults. Lastly, when prescriptions for alcohol-interactive medications are refilled, pharmacists should remind the individual or the caretaker that alcohol should not be consumed when taking that medication.

5.1.2 Patterns of Concurrent Use among Older Adults

Preliminary explorations of the data revealed that nearly half of all study participants (46%) concurrently used alcohol with alcohol-interactive medications during at least one of the six waves of the study; one-third of concurrent users reported concomitant alcohol-medication use in 4 or more waves of the study. Based on these preliminary findings**,** it was hypothesized that there would be a minimum of two unique longitudinal trajectories of concurrent use. Group-based trajectory modeling was used to test the hypothesis that various trajectories of concurrent use exist among community-dwelling older adults. Group-based modeling was particularly useful in helping to identify multiple trajectories of concurrent use among community-dwelling

older adults; often overall percentages obscure important trends and fail to take into account unique patterns of behavior. The hypothesis regarding multiple patterns of concomitant use was substantiated by the data; four distinct trajectories of concurrent use were identified.

Each of the four cohorts identified by the best fitting model were characterized by their own distinct patterns of concurrent use. The majority of respondents were grouped into the *no to low use* trajectory which is comprised of individuals who did not concurrently use alcohol and medications or those respondents who had low levels of concomitant use. The trajectory for the *no to low use* group is fairly flat and essentially these individuals maintained a stable pattern of no or low levels of use over the course of the study. Given that half of seniors do not consume alcohol and drinking tends to decrease in age we would expect that the majority of older adults would fall into a developmental trajectory that includes no or low rates of concurrent use. This cohort is most likely comprised of lifetime abstainers and occasional drinkers and individuals in this group are at low risk for concurrent use.

The *decreasing use* trajectory is characterized by a gradual and steady decrease in concurrent use over time. Rates of concurrent use were moderately high among members of the *decreasing use* group in the initial waves of the study but substantially decreased with time so that by the final study wave concurrent use was fairly low among this population. It is possible that this group is characterized by individuals with declining health and / or the addition of new alcohol-interactive medications which lead them to make the decision to not drink alcohol. An additional possibility is that members of this trajectory have declining rates of concurrent use because new or existing chronic conditions limit their ability to consume alcohol. Social workers and other health care providers should encourage individuals in this cohort to continue to curtail their concurrent use and offer support in assisting them in altering their behavior.

The *increasing use* trajectory is best characterized as a group of individuals whose concurrent use fluctuates over time. Initially levels of concurrent use in the *increasing use* cohort were fairly low. However, concurrent use increases among this population over the course of the study. The most logical explanation for this pattern of concurrent use is this group is comprised of individuals who developed new chronic conditions over the course of time and these conditions are treated with alcohol-interactive medications. Yet, despite the introduction of a new medication into their regime these individuals continue to consume alcohol; this may be due to the fact that patients are under informed about the potential for alcohol-drug interactions. Therefore, it is essential that geriatric social workers and health care providers monitor older adult's medication regimes and counsel them about the potential interactions of a medication with alcohol each time the regime is altered.

Finally, the trajectory for the *high use* cohort is indicative of high-stable rates of concurrent use over time. Individuals in the *high use* group, approximately 15% of the sample, maintained a consistent pattern of concurrently using alcohol and alcohol-interactive medications throughout the course of the study. As stated earlier it is most likely that this group is characterized by individuals who have a history of alcohol use and therefore, irrespective of their medication regime, they continue to drink. This group which is disproportionately comprised of White males is at an elevated risk for the adverse consequences of concurrent use. Thus, individuals in the aging care network should use consistently screen individuals who meet this profile for concurrent use behavior. In addition, education and prevention strategies should target this at risk group.

5.1.2.1 Impact of Concurrent Use on the Health Status of Older Adults

Regression analysis was used to examine the relationship between patterns of concurrent use and health status. Specifically, it was hypothesized that individuals with developmental trajectories of ongoing concurrent use would have lower rates of self-reported health, lower levels of physical functioning as well as higher rates of depression. The hypothesis that there was a relationship between longitudinal trajectories of concurrent use and health status was partially substantiated by the data. The analysis revealed that specific patterns of concurrent use are significantly related to both physical and mental health status among community-dwelling older adults however, the directionality of some of the originally hypothesized relationships did not hold up.

The hypothesis that self-reported health status would be lower among concurrent users was partially substantiated by the data. Using good health as the reference category, being male increased the odds of reporting excellent to very good health. Also, Whites were significantly more likely than African Americans to report very good health; African Americans had significantly higher rates of self-reported fair or poor. This finding is consistent with research that suggests health disparities between Whites and African Americans. Finally, compared to younger individuals, older respondents were significantly more likely to report fair or poor health rather than good health. Members of the *high use* trajectory were significantly less likely than those in the *no to low use* group members to report excellent health rather than good health; no other group membership contrasts were significant. This finding deviates from the results of the initial baseline analysis where no difference was found between concurrent users and non-concurrent users. Individuals in the *high use* may be less likely to report excellent health for a number of reasons which may be related to the side effects associated with concurrently using

alcohol with alcohol-interactive medications. An equally valid explanation for this finding is that the onset or worsening of existing chronic conditions due to concomitant use has lowered the perceived health status for members of this group. Interestingly, no differences were found between the *no to low use* group and the *increasing* or *decreasing* use cohorts. Given the research on self-medication we might expect that individuals in the *increasing use* group would report lower levels of overall health when compared to those in the *no to low use* group. An alternative explanation for this finding may be that the increasing use of alcohol and medications is due to pain management but the addition of additional medications to deal with chronic conditions.

In addition to assessing the relationship between self-reported health status and concurrent use, models were run to examine the relationship between concomitant use and physical functioning. Women and older individuals were significantly more likely than men and younger respondents to report having any IADLs or ADLs. Group membership was found to be to total number of ADLs. Respondents in the *decreasing use* group were more likely than individuals in the *no to low use* group to report having one ADL or two ADLs rather than no ADLs. This finding is of particular interest because it partially substantiates the idea that individuals in the *decreasing use* trajectory are discontinuing concurrent use practices because of declining health and / or the addition of new alcohol-interactive medications.

Depression status was also found to be related to socio-demographic characteristics as well as group membership. There was a significant relationship between gender and depression status with females being more likely to have a diagnosis of depression than males. There was also a significant relationship between race and depression status with African Americans having a higher rates of depression compared to Whites. Age was found to be positively associated with

depression status; older individuals have higher rates of depression than their younger counterparts. Finally, significant relationships were found between depression status and membership in the *increasing use* and the *decreasing use* trajectories. The odds of being depressed rather than not depressed increased for individuals in the *decreasing use* group rather than those in the *no to low use* trajectory. Increased rates of depression in the *decreasing use* group may be related to declining physical health or the introduction of a new chronic condition which has caused mental distress. It is also possible that members of the *decreasing use* group have chosen to stop drinking because they are being treated for depression. Conversely being a member of the *increasing use* trajectory was found to be associated with lower levels of depression. Individuals in this group may be in better physical condition and more social therefore, they are less likely to be isolated which decreases rates of depression but can effect rates of alcohol consumption which can lead to concurrent use.

Logistic regression revealed that, although group membership was related to specific health outcomes, physical and mental health statuses at baseline were the best predictors of health status in the final wave of the study. Although it is not surprising that health status at baseline was found to be the greatest predictor of physical and mental health outcomes, it is interesting that trajectories of concurrent use were not related to health status in Wave 6. Group membership was expected to predict health status and, although the relationships were in the predicted directions, with the exception of self-reported health, they were not significant. It is possible that group membership was not a significant predictor of physical and mental health status because the majority of the people fall into the *no to low use* group. Thus it is suggested that future research further investigate the relationship between overall health and concurrent use among older adults with a wide range of health outcomes.

Finally, survival analyses of the entire sample (No=5,888) showed a significant relationship between concurrent use and mortality. The interaction of weekly alcohol consumption and the total number of alcohol-interactive medications taken at baseline was significantly related to duration until death; a one unit increase in time increased the risk of mortality by 1. This finding points to the potentially hazardous consequences of concurrent use among older adults. More research is needed to fully understand how concomitant use impacts upon mortality overtime. Interestingly, having ever concurrently used was inversely related to mortality status. This finding is most likely due to the fact that individuals who live longer are more likely to be exposed to alcohol-interactive medications and as a result have a higher likelihood of reporting concomitant use.

5.1.2.2 The Patterns and Consequences of Concurrent Use among Older Adults: Implications for Practice

The risk posed by concurrent alcohol and medication use among older adults is not minimal, therefore, from a prevention standpoint it is essential for clinicians to screen for concomitant use and to provide warnings to older adults to prevent adverse outcomes. Although research has found that alcohol consumption declines with age, studies have shown that the average amount of alcohol consumed by older adults who continue to drink does not change overtime (Adams et al., 1990). The current study reinforces past research, data show that for the majority of study participants patterns of concurrent use remained fairly stable over the course of the investigation with fluctuation in usage patterns reported by only 18% of concurrent users. The identification of four major patterns of concurrent use has further delineated what we know about concomitant behavior among older adults. This information is particularly useful given demographic

projections and alcohol use trends indicate that newer cohorts of older adults are more likely to drink and have heavier drinking habits (Patterson, 1999).

The current investigation substantiates past work which has shown that alcohol use is a habitual behavior that tends to carry into late adulthood although consumption levels may be reduced. Given what we know about trends in alcohol consumption it stands to reason that a subset of older adults are more likely to engage in concomitant use. Individuals in the *high use* and *increasing use* cohorts are at an increased risk for poor health outcomes and lower quality of life; these individuals include males, Whites, problem users and individuals taking multiple alcohol-interactive medications. Brief interventions such as harm reduction models can be useful in preventing and reducing concurrent use among these at risk groups. Moreover, policies need to be put into place to aid in training of individuals in the Aging care network about concurrent use and to assist in establishing a more coordinated system of care.

Harm reduction strategies may be useful in preventing and lowering concurrent use among older adults. Brief interventions such as harm reduction approaches are useful in that they tolerate a continuum of behavior and do not just target individuals at the highest level of risk. Such interventions are designed to increase motivation to change a behavior and are well suited for older adults. In addition, harm reduction strategies are particularly useful for working with older adults because they can be carried out in numerous settings by a variety of professionals. Harm reduction strategies are non-confrontational and non-judgmental; they are used to encourage learning and self awareness about risky behaviors (Royer et al., 2000). Although this type of intervention may not be useful in reducing concurrent use among individuals with severe alcohol problems, the current study found that the majority of individuals exhibited low to moderate patterns of concurrent use. High risk concurrent users, typically

individuals with alcohol use disorders, will most likely need to be referred to geriatric specific substance abuse treatment programs to deal with both their medication use and problem drinking behaviors. However, harm reduction models designed to address concurrent use in low to moderate users may be an effective strategy to reducing hazardous medication behavior among the majority of older adults who concurrently used. Harm reduction strategies coupled with educational and prevention efforts implemented by social workers and other professionals in the Aging care network appears to be a cost effective strategy to addressing concurrent use among older adults.

In addition to brief intervention strategies, policies need to be established to support educational initiatives to raise awareness among older adults, families, and caretakers about the risks associated with mixing alcohol and medications. In addition, training programs need to be established for social workers, health care providers, and other individuals in the aging care network to assist them in understanding the issue of concurrent use among older adults and to provide them with the skills necessary to assess and intervene with older adults.

Collaboration and communication among professionals and agencies are critical components of delivering effective services to older adults. Community partnerships can foster relationships that can increase the coordination of services and assist in the development of a continuum of care for seniors. Policies that enhance communication between clients, caregivers, social workers and health care professionals play a vital role in reducing potentially hazardous behaviors such as concurrent use among older adults.

Older adults are most likely to come into contact with medical professionals in primary care settings, as well as professionals in the aging services network. It is crucial that these individuals receive training in identifying potentially hazardous medication usage patterns in

geriatric populations. In addition, screening tools that are specifically designed for older adults and are suited for primary care settings are needed to assist healthcare professionals in identifying individuals who are at risk for or are currently concomitantly using alcohol and medications. With education, training, and improved tools professionals in primary care settings and the aging services network can play a vital role in preventing, identifying, and treating the misuse or abuse of alcohol and medications in older adults. Unfortunately, programs and assessment tools do not exist to provide geriatric social workers and other health care professionals who work with older adults with the tools necessary to identify and address concurrent alcohol and medication use.

In order for social workers and other professionals in the aging care network to effectively implement strategies aimed at preventing concurrent use as well as programs that deal with problems associated with the issue, they must first be educated about the issue themselves. Training programs are needed for service providers to help them gain a better understanding of alcohol or other drugs in late life and when the use of alcohol and medications may lead to negative outcomes for seniors (Spencer, 2008). Policies need to be established to develop programs that provide training to these individuals on how to identify, diagnose, and treat older adult with hazardous medication use patterns or other substance abuse issues. Medicare is one of the few federal programs with the ability to implement training initiatives with medical professionals and other professionals in the aging services network.

Public programs, specifically Medicare and Medicaid, currently serve as the primary insurers for older adults. Investing in such an initiative would help save the program money in future healthcare costs associated with adverse drug reactions and health problems exacerbated or caused by concurrent use. If Medicare is committed to combating the abuse and / or misuse of

alcohol with medication among older adults, one key strategy would be to establish an outreach program designed to enhance education, prevention and screening for alcohol and medication abuse and / or misuse among the elderly. The program would link Medicare to professionals in primary care settings and those working in the Aging care network who are uniquely situated to identify and address the needs of older adults who concurrently use alcohol and medications.

Cross-training of healthcare professionals and aging service providers is critical to preventing, identifying and treating concurrent use among older Americans. Healthcare professionals along with social workers and mental health service providers need training to understand how to effectively work with older adults to promote medication adherence and lower rates of concurrent use among this population (SAMHSA, 2002). Likewise, aging service providers need to be trained to identify mental and behavioral health problems in older adults (SAMHSA, 2002). In addition to training, the creation of linkages with community partners, healthcare professionals, and aging service providers can help identify substance related problems in an aging patient population by creating a system of coordinated care.

Lastly, funding needs to be made available for research aimed at better understanding the barriers to prevention and interventions for older adults who concurrently use alcohol and medications. Future research will be invaluable in assessing the current capacity to deal with concurrent use among older adults. It will help in identifying gaps in service provision, and can provide projections regarding future needs of older adults who concomitantly use alcohol and medications. Funding is of particular importance for the implementation and assessment of demonstration projects aimed at prevention and intervention with older adult concurrent users. Pilot projects are essential to identifying best practices for supporting positive decision making

among older adults, their families, and their caregivers concerning their alcohol and medication use behavior.

As the number of older adults dramatically increases over the coming decade, service providers as well as the health care system as a whole will face a number of new challenges. Current Medicare policies around alcohol and medication use and / or abuse are not comprehensive, particularly in the areas of prevention, education, and diagnosis. The healthcare system, especially Medicare, must prepare for the influx of older adults who will need services in the next twenty years by developing policies and programs designed to meet the unique needs of older adults; in order to do this the Medicare program and other agencies in the aging care network will need to being to place more emphasis on prevention.

In summary, harm reduction models and education programs that raise awareness regarding the dangers of medication non-adherence among providers, patients, caregivers and the general public will play a key role in reducing adverse health outcomes associated with concurrent use thus assisting in lowering overall health care costs. Additionally, as budgets tighten and health care costs increase, federal and state authorities will be increasingly challenged to emphasize prevention strategies and find new ways to promote healthy lifestyles among older adults. Education and prevention strategies coupled with an infrastructure of coordinated care will go a long way in promoting positive health behaviors and preventing potentially harmful activities such as concurrent alcohol and medication use among older adults.

5.2 STRENGHTS AND LIMITATIONS OF THE STUDY

5.2.1 Strengths of Current Study

The current study attempted to address gaps in the literature regarding concurrent alcohol and medication use among community-dwelling older adults. In addition, this investigation sought to address several important methodological issues present in the existing body of knowledge regarding concomitant use among older adults; specifically, the present study focused on measurement and research design.

The Cardiovascular Health Study has the major advantage of including a large population based community sample of adults 65 years or older. The CHS data set is a large sample comprised of nearly 6,000 individuals randomly selected from four communities located throughout the country representing a mix of both urban and rural areas. The large sample size coupled with the random sampling strategy makes this sample applicable to community-dwelling older adults in the United States. Unlike many other existing data sets, the CHS sample is comprised of a sufficient amount of both women and African Americans. Therefore, this study is unique in that it allowed for the examination of differences in concurrent alcohol and medication use for various subpopulations within this population of community-dwelling older adults.

The majority of research on concurrent alcohol and medication use among older adults comes out of acute or primary care settings and is cross-sectional in nature. The CHS is one of the richest available data sets characterizing the health status of the elderly; only a few other longitudinal studies have followed cohorts of older individuals for as long as the CHS. The CHS

data set is extensive and includes information from interviews as well as from physical and laboratory examinations. Importantly, the CHS has excellent measures of alcohol use, physical and mental health status and, one particularly unique aspect, a vast amount of longitudinal data available on medication use. Therefore, this data set was well suited for examining longitudinal patterns of concurrent use.

The longitudinal nature of the data allowed for the examination of various trajectories of concurrent use over the course of the study. Additionally, the use of longitudinal data made it possible to examine how various patterns of concomitant use affect general physical and mental health outcomes overtime, something not possible with cross-sectional data. The extensive physical and mental health indicators available in the CHS data set made it feasible to assess general health via a number of proxies for physical and mental health status versus "incidents" of adverse reactions (ADRs) which is the outcome measure typically used in studies examining concurrent use. The current study was able to move beyond the traditional means of assessing the effects of concurrent use on health through acute adverse reactions and examine the effect of concurrent use on health status and quality of life. Finally, because the CHS sample is comprised only of community-dwelling older adults, information on alcohol use was obtained from a population of individuals representing the spectrum of drinking behavior among older adults. Therefore, it was possible to focus the current study on all individuals in sample not just high risk or heavy alcohol users.

5.2.2 Limitations of the Current Study

Despite the numerous strengths of the current study design, there are a number of limitations that should be addressed. First, as with all observational studies, residual confounding factors cannot be ruled out. Thus, causal inferences about relationships between concurrent use and health status among community-dwelling older adults should be made with caution.

Second there are several measurement issues that need to be acknowledged as limitation of the current study design. The reliance on self-report measures for several of the central study variables including alcohol use and self-reported health status is a cause for concern. The use of self-reported data can be problematic because of a number of issues including possible response distortions such as over or under reporting, recall error, and social desirability; this is a particularly salient measurement issue in research involving older adults. Another measurement issue concerns the use of the CES-D to assess depression status. There is the potential for misclassification of depression status, a key outcome measure, because the abbreviated version of the full CES-D questionnaire was used for this study. However, since several studies have found that reducing the screening scale to as little as the five-item CES-D scale resulted in a similar sensitivity and specificity compared with the full 20-item CES-D scale, misclassification should have been minimal (Irwin et al., 1999 & Turvey et al., 1999; Shrout & Yager, 1989). One last shortfall associated with measurement concerns the variables used to assess physical and mental health; there are other indicators of health status that were not addressed in the current investigation. The current study does not include more refined measures of health status that may be helpful in assessing the effects of concurrent use on physical and mental health. Future

studies should include additional measures of physical health status such as specific chronic health conditions and additional proxies for mental health (i.e. anxiety, quality of life indicators).

Finally, missing data due to incomplete observations, drop-out, and mortality is an issue in all longitudinal studies. Missing data can increase the potential for bias in study results. In the subset of the CHS data used for this study, attrition due to drop out was fairly low, 4.7%; an additional 17.3% of the sample was lost to mortality by the final wave of the study. In order to adequately model trajectories of concurrent use, all individuals who had incomplete data on concomitant use were dropped from the group-based trajectory analysis as well as the regression portion of the analysis. Although nearly a quarter of the sample was lost to attrition by the final wave of the study, the large sample size negates any issues of inadequate power. The decision to only include individuals with information on concurrent use for all six waves of the study ensures that information missing at various points is due to incomplete observations and is considered missing at random.

5.3 SUGGESTIONS FOR FUTURE RESEARCH

Although there is an emerging body of literature regarding concurrent use among older adults, there is still a dearth of knowledge on the subject particularly when it comes to assessing patterns of concurrent use. The current study has a number of implications for further research in the field. In order to address gaps in the literature, future research should focus on: 1) empirical research that continues to explore the prevalence, correlates, and patterns of concurrent use among older adults, 2) examination of the relationship between concurrent use and health status

and, 3) development and evaluation of educational campaigns and intervention strategies aimed at reducing concurrent use among older adults.

Future longitudinal studies are needed in order to gain a more complete picture regarding concurrent use and its associated covariates among community-dwelling older adults. Rates of combined prevalence of alcohol and medication use among older adults in the United States are still unknown however, past studies estimate rates between 40% and 50% which is consistent with this study's findings (Moore et al., 2006). Variations in prevalence rates are largely due to variations in study methodology. Future research should continue to examine rates of concurrent use among this population; efforts should be made to standardize methodological operations of concurrent use. Additionally, empirical studies should continue investigating the covariates of concurrent use. This study found that sociodemographic as well as behavioral variables, such as level of alcohol consumption, were related to concurrent use among older adults. Future research should continue to explore the complex relationship between concurrent use and a wide variety of factors including factors like total number of alcohol-interactive medications or total number of chronic conditions.

The current study is one of the first investigations looking at various developmental trajectories of concurrent use. Past research has focused on the relationship between concurrent use and ADRs. The current investigation explored the relationship between concurrent use and health status in a new way by charting developmental trajectories of use and examining their impact on general health outcomes rather than ADRs. In the current study, many of the hypotheses regarding the relationship between patterns of concurrent use and health status were not supported indicating that there is still much to be learned regarding the relationship between unique patterns of concurrent use and health outcomes. Future work should continue to examine

the impact of various patterns of concurrent use on the overall health status of older adults. Research in this area should also use various health outcomes not included in this study such as chronic conditions or quality of life. Furthermore, future research on concurrent use should look at how specific classes of medications and known alcohol-interactive drugs effect the physical and mental health status of older adults.

Finally, future research should focus on the implementation and assessment of educational programs, prevention strategies, and intervention with older adult concurrent users. Research plays a critical role in defining best practices for social work practitioners and other professionals in the aging care network. Research should begin to develop and test strategies aimed at fostering positive decision making among older adults, their families, and their caregivers concerning their alcohol and medication use behavior. Evaluation of the effectiveness of public awareness and educational efforts aimed at reducing concurrent use among older adults is an important area of future research. Moreover, future empirical work should also focus on assessing the effectiveness of various intervention strategies such as harm reduction models which can be adapted to use with older adults who concomitantly use alcohol and medications.

5.4 CONCLUSION

The current study examined the prevalence, correlates, patterns and consequences of concurrent alcohol and medication use among community-dwelling older adults. Results suggest that concurrent use is fairly common among older adults with over half of the study participants reporting concomitant use in at least one of the six waves of the study. The most common form

of concurrent use was drinking below or within recommended guidelines and taking one alcohol-interactive medication. Findings from this study provide a greater understanding of the rates of concurrent use as well as the socio-demographic characteristics associated with concurrent use among older adults. Results revealed that men, Whites and problem drinkers were significantly more likely to concurrently use than women, African Americans and low to moderate alcohol users; there were no significant differences by age. Furthermore, group-based logic analysis revealed four distinct patterns of concurrent use: a *no to low use* group, a *decreasing use* group, an *increasing use* group, and a *high use* group. Males and Whites had the highest probability of being in the *high use* group. Group membership was found to be related to physical as well as mental health. Furthermore, concurrent use was found to be related to mortality.

The growing number of older adults coupled with an increasing use of medications makes gaining a better understanding of the prevalence and consequences of concurrent use a particularly salient issue. Over 50% of older adults report regular alcohol use and the rate of take at least one medication for physical and/or mental health issues is rising among seniors. Over the coming decades, the rising number of older adults will probably have an enormous impact on the need and demand for health care among this population. The increased service needs of aging alcohol user's comorbid conditions will most likely place a financial strain on existing resources. The growing population of older adults has made primary disease prevention and efforts to promote healthy lifestyles a top priority. Gaining a better understanding of the prevalence, correlates, and consequences of concomitant alcohol and medication use is critical to developing prevention and intervention strategies that effectively meet the needs of this unique population.

In conclusion, understanding the sociodemographic characteristics associated with concomitant use will aid social work practitioners and other health care providers who work with geriatric populations in identifying individuals at risk for medication non-adherence (i.e. concurrent use). Moreover, understanding various development trajectories of concurrent use will be useful in helping to develop prevention and intervention strategies. Finally, although further research is needed to fully understand the relationship, the results of this study suggest that there is a connection between various patterns of concurrent use and health status. Practitioners can use information on development trajectories of concomitant use to assess potential risks for adverse physical and mental health outcomes associated with concurrent use that may affect the quality of life among older adults.

APPENDIX A

COMMON ALCOHOL-INTERACTIVE MEDICATIONS USED BY OLDER ADULTS

Drug Class (Symptoms / Conditions)	**Medication** (Brand Name)*	**Potential Reactions with Alcohol**
Analgesics (pain relief)	*Aspirin* Aleve Excedrin Motrin Tylenol	Stomach upset, bleeding, ulcers Liver damage Rapid heartbeat
Antibiotics (infections)	*Isoniazid* Acrodantin Flagyl Grisactin Nizoral	Rapid heartbeat Sudden changes in blood pressure Stomach pain & upset; vomiting Headache Liver damage
Anticoagulants (prevention of blood clots)	*Warfarin* Coumadin	Occasional use: internal bleeding Heavy use: bleeding or can cause opposite effect resulting in blood clots, strokes, or heart attach
Anticonvulsants (seizure disorders)	*Phenobarbital* Dilantin Klonopin	Drowsiness & Dizziness Increased seizure risk
Antidiabetic Agents (blood sugar regulation)	Glucophage Micronase Orinase	Abnormally low blood sugar levels Nausea & vomiting Rapid heartbeat Sudden change in blood pressure
Antihistamines (allergies, colds)	Benadryl Allegra Claritin Sudafed Zyrtec	Drowsiness & Dizziness Increased risk of overdose Decreased motor skills
Antihypertension (high blood pressure)	Accupril Capozide Hytrin Lotensin Minipress Vaseretic	Drowsiness & Dizziness Fainting Heart problems such as arrhythmia

Drug Class (Symptoms / Conditions)	**Medication** (Brand Name)*	**Potential Reactions with Alcohol**
Barbiturates (anesthesia, pain relief)	*Phenobarbital* Butalbital Pentobarbital Secobarbital	Increased sedative & hypnotic effects
Benzodiazepines (sedative agent)	Ativan Halcion Librium Restoril Valium Xanax	Drowsiness Increased sedation Decreased motor skills
Histamine antagonists (ulcers, heartburn)	Axid Reglan Tagamet Zantac	Increased alcohol effects Rapid heartbeat Sudden changes in blood pressure
Imidazopyridines (sleep disorders)	Ambien Lunesta Prosom Unisom	Drowsiness & dizziness Slowed or difficulty breathing Impaired motor skills Memory problems Increased risk overdose
Muscle relaxants (muscle pain)	Flexeril Soma	Drowsiness & dizziness Slowed or difficulty breathing Increased seizure risk Impaired motor skills Memory problems Increased risk overdose
Narcotic analgesic (pain relief)	Darvocet Percocet Vicodin	Drowsiness Increased sedation Decreased motor skills
NSAIDs (pain relief, inflammation)	*Ibuprofen* Nalfon Naprosyn Orudis Voltaren	Risk gastrointestinal bleeding

Drug Class (Symptoms / Conditions)	**Medication** (Brand Name)*	**Potential Reactions with Alcohol**
Opioids (pain relief)	*Codeine* *Fentanyl* *Morphine* Diaudid Darvon Demerol	Drowsiness Increased sedation Decreased motor skills
Sedatives & Hypnotics	Noctec Equanil	Sleepiness Disorientation & incoherence
Statins (high cholesterol)	Advicor Crestor Lipitor Vytorin Zocor	Liver damage Nausea & vomiting Rapid heartbeat Sudden change in blood pressure Risk stomach bleeding
Tricyclic antidepressants (depression)	Celexa Lexapro Paxil Prozac Zoloft	Dizziness Increased risk of sedation Sudden drop in blood pressure Increased risk overdose

* Generic names are italicized

Sources: NIAAA, 2007; Lococo & Staplin, 2006; Weathermon & Crabb, 1999

BIBLIOGRAPHY

Abramson, J., Williams, S., Krumholz, H. & Vaccarino V. (2001). Moderate alcohol consumption and risk of heart failure among older persons. *Journal of the American Medical Association, 285* (15), 1971 – 1977.

Adams, W., Magruder-Habib, K., Trued, S., & Broome, H., (1992). Alcohol abuse in elderly emergency department patients. *JAMA, 276*, 1964 – 1967.

Adams, W. (1995). Potential for adverse drug-alcohol interactions among retirement community residents. *Journal of the American Geriatric Society, 43*, 1021 – 1025.

Adams, W., Barry, K., & Fleming, M. (1996). Screening for problem drinking in older primary care patients. *JAMA, 276* (25), 1964 – 1967.

Adams, P. & Schoenborn, C. (2006). Health behaviors of adults: United States, 2002-04. Vital *Health Statistics, 10* (230), 1-140.

Aira, M., Hartikainen, S., & Sulkava, R. (2005). Community prevalence of alcohol use and concomitant use of medication- a source of possible risk in the elderly aged 75 and older? *International Journal of Geriatric Psychiatry, 20*, 680 – 685.

Agency for Healthcare Research and Quality, US Department of Health & Human Services (AHRQ), (2001). Retrieved September 30, 2009 from: http://www.ahrq.gov/qual/aderia/aderia.htm.

Agostini, J., Han, L. & Tinetti, M. (2004). The relationship between number of medications and weight loss or impaired balance in older adults. *Journal of the American Geriatric Society, 52*(10), 1719-1723.

Alberta Alcohol and Drug Abuse Commission (AADAC) (2003). Beyond the ABCs: alcohol and medication interactions. Retrieved March 21, 2008 from: http://www.aadac.com/documents/beyond_abcs_alcohol_medical_interaction.pdf.

American Society on Aging (ASA) (2001). The Hidden Epidemic: Prevention and intervention of alcohol and medication misuse and abuse among older adults. Meeting Summary, Hyatt Regency Hotel, New Orleans, LA.

American Psychiatric Association (APA). *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*. Washington, DC: APA, 1994.

Andersen, E., Malmgren, J. & Carter, W. (1994). Screening for depression in well older adults: Evaluation of a short form of the CES-D. *American Journal of Preventative Medicine, 10,* 77-84.

Aparasu, R., Mort, J. & Brandt, H. (2003). Psychotropic prescription use by community-dwelling elderly in the United States. *American Geriatrics Society, 51,* 671 -677.

Atkinson, R. & Misra, S. (2002). Mental Disorders and Symptoms in Older Alcoholics. In Gurnack, A., Atkinson, R. & Osgood, N. (Eds.) *Treating alcohol and drug use in the elderly* (pp. 50 – 71). NY: Springer Publishing.

Ballantyne, C., Hoogeveen, R., Bang, H., Coresh, J., Folsom, A., Chambless, L., Myerson M., Sharette, R. & Boerwikle, E. (2005). Lipoprotein-associated phospholipase A2, high-sensitivity C-reactive protein, and risk for incident ischemic stroke in middle-aged men and women in the Atherosclerosis Risk in Communities (ARIC)study. *Achieves of Internal Medicine,165*(21), 2479-2484.

Barrick, C. & Connors, G. (2002). Relapse prevention and maintaining abstinence in older adults with alcohol-use disorders. *Drugs Aging, 19*(8),583-594.

Barry, K., Oslin, D., & Blow, F. (2001). *Prevention and Management of Alcohol Problems in Older Adults*. New York: Springer Publishing.

Beechem, M. (2002). *Elderly alcoholism*. Springfield, IL: Charles C. Thomas.

Beulens, J., Bots, M. & Grobbee, D. (2007). Moderate alcohol consumption may be recommended for the prevention of heart attacks. *Ned Tijdschr voor Geneeskunde, 151*(49), 2716.

Blazer, D., Hybels, C., Simonsick, E. & Hanlon, J. (2000). Marked differences in antidepressant use by race in an elderly community sample: 1986 – 1996. *American Journal of Psychiatry, 157,* 1089 – 1094.

Blow, F. (1998). The spectrum of alcohol interventions for older adults. In: Gomberg, E., Hegedus, A. & Zucker, R. (Eds.) *Alcohol Problems and Aging*, 373-396. Rockville, MD: U.S. Department of Health and Human Services.

Blow, F. & Berry, K. (2002). Use and misuse of alcohol among older women. *Alcohol Research & Health, 26* (4), 308 – 315.

Boye, M., Phillips, K. & Dorsey, C. (2003). Alcohol and other drug disorders, comorbidity, and violence: Comparison of rural African American and Caucasian Women. *Archives of Psychiatric Nursing, 17*(6), 249-258.

Breslow, R., Faden, V. & Smothers, B. (2003). Alcohol consumption by elderly Americans. *Journal of Studies on Alcohol, 64*(6), 884-892.

Breslow, R. & Smothers, B. (2004). Drinking patterns of older Americans: National Health Interview Surveys, 1997-2001, *Journal of Studies on Alcohol*, *65*(2), 232-240.

Bristow, M. & Calare, A. (1992). Prevalence and characteristics of at risk drinkers among elderly acute medical in-patients. *British Journal of Addiction, 87*, 291 – 294.

Britton, A., Nolte, E., White, I., Grønbaek, M., Powles, J., Cavallo, F. & McPherson, K. (2003). A comparison of the alcohol-attributable mortality in four European countries. *European Journal of Epidemiology,18*(7), 643-651.

Broadbent, J., Thomson, W. & Poulton, R. (2008). Trajectory patterns of dental caries experience in the permanent dentition to the fourth decade of life. *Journal of Dental Research, 87*(1), 69-72.

Brown, A., Fiatarone, J., Wood, P., Bennett, M., Kelly, P., Rawlins, M., Day, C. & James, O. (1995) The effect of gastritis on human gastric alcohol dehydrogenase activity and ethanol metabolism. *Alimentary Pharmacology and Therapeutics, 9,* 57–61.

Budnitz, D., Pollock, D., Weidenback, K., Mendelsohn, A., Schroeder, T., & Annest, J. (2006). National surveillance of emergency department visits for outpatient adverse drug events. *JAMA, 296,* 1858 – 1866.

Budnitz, D., Shehab, N., Kegler, S. & Richards, C. (2007). Medication use leading to emergency department visits for adverse drug events in older adults. *Annals of Internal Medicine, 147*(11), 755 – 765.

Budniz, D. & Layde, P. (2007). Outpatient drug safety: new steps in an old direction. *Pharmacoepidemiology Drug Safety, 16* 92), 160 – 165.

Burger, M., Bronstrup, A. & Pietrzik, K. (2004). Derivation of tolerable upper alcohol intake levels in Germany: a systematic review of risks and benefits of moderate alcohol consumption. *Preventative Medicine, 39* (1), 111 – 127.

Burton, M., Hope, C., Hui, S. & Overhage, J. (2007). The cost of adverse drug events in ambulatory care. AMIA Annual Symposium Proceedings, 11, 90 – 93.

Caetano, R, Clark, C., & Tam, T (1998). Alcohol consumption among racial/ethnic minorities: theory and research. *Alcohol Health and Research World, 22* (4), 233 – 241.

Carter, M. & Gupta, S. (2007). Characteristics and outcomes o f injury-related ED visits among older adults. *American Journal of Emergency Medicine, 26,* 296 – 303.

Callahan, C. & Wolinsky, F. (1994). The effect of gender and race on the measurement properties of the CES-D in older adults. *Medical Care, 32* (94), 341 – 356.

Chang, M., Wang, Q. & Norman, D. (2002). Diminished proliferation of B blast cell in response to cytokines in ethanol-consuming mice. *Immunopharmacology and Immunotoxicology, 24*(1), 69 – 82.

Chrischilles, E., Rubenstein, L., Van Gilder, R., Voelker, M., Wright, K. & Wallace, R. (2007). Risk factors for adverse drug events in older adults with mobility limitations in community settings. *Journal of the American Geriatric Society, 55,* 29 – 34.

Christensen, H., Low, L. & Anstey, K. (2006). Prevalence, risk factors and treatment for substance abuse in older adults. *Current Opinions in Psychiatry,19*(6), 587-592.

Chou, K.L. (2005). Everyday competence and depressive symptoms: Social support and sense of control as mediators or moderators? *Aging & Mental Health*, 9 (2), 177 – 183.

Cardiovascular Health Study (1999). Data Collection Forms. Retrieved November 4, 2007 from: http://www.chs-nhlbi.org/forms/docindex.htm.

Corrao, G., Bagnardi, V., Zambon, A. & La Vecchia, C. (2004). A meta-analysis of alcohol consumption and the risk of 15 diseases. *Preventative Medicine, 38*(5), 613-619.

Cohen, S. (2004). Social relationships and health. *American Psychologist, November*, 676 – 684.

Cote, S., Tremblay, R., Nagin, D., Zoccolillo, M. & Vitaro, F. (2002). The development of impulsivity, fearfulness, and helpfulness during childhood: patterns of consistency and change in the trajectories of boys and girls. *Journal of Child Psychology & Psychiatry, 43*(5), 609-618.

Crum, R., Puddel, I., Gee, G. & Fried, L. (2002). Reproducibility of two approaches for assessing alcohol consumption among older adults. *Addictions Research & Theory, 10*(4), 373-385.

Devanand, D. (2002). Comorbid psychiatric disorders in late life depression. *Biological Psychiatry, 52*(3), 236-242.

Djoussé, L., Biggs, M., Mukamal, K. & Siscovick, D. (2007). Alcohol consumption and type 2 diabetes among older adults: the Cardiovascular Health Study. *Obesity (Silver Spring), 15*(7), 1758-1765.

Dufour, M. & Fuller, R. (1992). Alcohol in the elderly. *Annual Review of Medicine, 46,* 123 – 132.

Egger, S., Bachmann, A., Hubmann, N., Schlienger, R. & Krahenbuhl, S. (2006). Prevalence of potentially inappropriate medication use in elderly patients. Comparison between general medical and geriatric wards. *Drugs & Aging, 23,* 823 – 837.

Epstein, E., Fischer-Elber, K. & Al-Otaiba, Z. (2007). Women, aging, and alcohol use disorders. *Journal of Women & Aging, 19*(1-2), 31-48.

Ernst, F., & Grizzle, A. (2001). Drug-related morbidity and mortality: updating the cost-of-illness model. *Journal of the American Pharmacists Association, 41*(2), 192-199.

Evans, R., Lloyd, J., Stoddard, G., Nebeker, J. & Samore, M. (2005). Risk factors for adverse drug events: a 10-year analysis. *Annals of Pharmacotherapy, 39*(7-8), 1161-1168.

Falck-Ytter, Y. & McCullough, A. (2000). The effect of alcohol on body composition. *American Journal of Gastroenterology, 95*(9), 2156-2159.

Field, T., Mazor, K., Briesacher, B., Debellis, K. & Gurwitz, J. (2007). Adverse drug events resulting from patient errors in older adults. *Journal of the American Geriatric Society, 55*(2), 271-276.

Fillenbaum, G., Hanlon, J., Corder, E., Ziqubu-Page, T., Wall, W. & Brock, D. (1993). Prescription and nonprescription drug use among black and white community-residing elderly. American Journal of Public Health, 83(11), 1577-1582.

Fitzpatrick, T. (1995). Stress and well-being among the elderly: the effects of recreational services. *The Journal of Applied Social Science, 19*, 95 – 105.

Flannery, B., Fishbein, D., Krupitsky, E., Langevin, D., Verbitskaya, E., Bland, C., Bolla, K., Egorova, V., Bushara N., Tsoy, M. & Zvartau, E. (2007). Gender differences in neurocognitive functioning among alcohol-dependent Russian patients. Alcohol Clinical & Experimental Research, 31(5),745-754.

Fleming, M. (2004). Screening and brief intervention in primary care settings. *Alcohol Research & Health, 28*(2), 57-62.

Foster, L., Pollow, R. & Stoller, E. (1993). Alcohol use and potential risk for alcohol related adverse drug reactions among community based elderly. *Journal of Community Health, 18*, 225 – 239.

Fick, D., Cooper, J., Wade, W., Waller, J., Maclean, J. & Beers, M. (2003). Updating the Beers criteria for potentially IM use in older adults. Results of a US consensus panel of experts. *Achieves of Internal Medicine, 163,* 2716 – 2724.

Fink, A., Morton, S., Beck, J., Hays, R., Spritzer, K., Oishi, S. & Moore, A. (2002). The Alcohol-Related Problems Survey: identifying hazardous and harmful drinking in older primary care patients. *Journal of the American Geriatric Society, 50,* 1717 – 1722.

Food and Drug Administration (2009). Drug induced liver toxicity. Retrieved March 17, 2009 from: http://www.fda.gov/Drugs/scienceresearch/researchareas/ucm071471.htm.

Forster, L., Pollow, R. & Stoller, E. (1993). Alcohol use and potential risk for alcohol-related adverse drug reactions among community-based elderly. *Journal of Community Health, 18*(4), 225-239.

Friedlander, A. & Norman, D. (2006). Geriatric alcoholism: pathophysiology and dental implications. *Journal of the American Dental Association, 137*(3), 330-338.

Fried, L., Borhani, N., Enright, P., Furberg, C., Gardin, J., Kronmal, R., Kuller, L., Manolio, T., Mittelmark, M.., Newman, A., et al. (1993). The Cardiovascular Health Study: design and rationale. *Annuals of Epidemiology, 1*(3), 263-276.

Fu, A., Jiang, J., Reeves, J., Fincham, J., Liu, G. & Perri, M. (2007). Potentially inappropriate medication use and healthcare expenditures in the US community-dwelling elderly. *Medical Care, 45,* 472-476.

Fulton, J., Jack, S., Katz, S. & Hendershot, G. (1989). *Physical functioning of the aged: United States, 1984.* Vital and Health Statistics, Series 10, Number 167. Washington, DC: NCHS.

Garson, G. (2009). Logistic Regression. Retrieved January 2, 2010 from http://faculty.chass.ncsu.edu/garson/PA765/regress.htm.

Gaskin, D., Briesacher, B., Limcangco, R. & Brigantti, B. (2006). Exploring racial and ethnic disparities in prescription drug spending and use among Medicare beneficiaries. *American Journal of Geriatric Pharmacotherapy, 4*(2), 96-111.

Grant, B., Dawson, D., Stinson, F., Chou, S., Dufour, M. & Pickering, R. (2004). The 12-month prevalence and trends in DSM-IV alcohol abuse and dependence: United States, 1991-1992 and 2001-2002. *Drug & Alcohol Dependency,74*(3), 223-234.

Gurnack, A. & Hoffman, N. (1992). Elderly alcohol misuse. *International Journal of Addiction,* 27(7), 869-878.

Gurnack, A., Atkinson, R. & Osgood, N. (2002). *Treating Alcohol and Drug Abuse in the Elderly*. Springer Publishing Company: New York, NY.

Gurwitz, J. (2004). Polypharmacy: a new paradigm or quality drug therapy in the elderly? *Archives of Internal Medicine, 164*(18), 1957 – 1959.

Hanlon, J., Fillenbaum, G., Burchett, B., Wall, W., Service, C., Blazer, D. & George L. (1992). Drug-use patterns among black and nonblack community-dwelling elderly. *Annals Pharmacotherapy, 26*(5), 679-685.

Hanson, B. (1994). Social networks, social support, and heavy drinking in elderly men- a population study of men born in 1914, Malmo, Sweden. *Addiction*, *89*, 725 -732.

Hanson, M. & Gutheil, I. (2004). Motivational strategies with alcohol-involved older adults: implications for social work practice. *Social Work, 49*(3), 364-372.

Hendriks, H. & van Tol, A. (2005). Alcohol. *Handbook of Experimental Pharmacology, 170,* 339-361.

Hill, S. (1995). Neurobiological and clinical markers for a severe form of alcoholism in women. *Alcohol Health and Research World, 3,* 249-256.

Holdcraft, L. & Iacono, W. (2002). Cohort effects on gender differences in alcohol dependence. *Addictions, 97,* 1025 – 1036.

Holder, H. (1992). *Effects of alcohol, alone and in combination with medications.* Walnut Creek, CA: Prevention Research Center.

Horne, R. & Weinman, J. (1999). Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. *Journal of Psychosomatic Research, 47*(6), 555-567.

Irwin, M., Artin, K. & Oxman, M. (1999). Screening for depression in the older adult: criterion validity of the 10-item Center for Epidemiological Studies Depression Scale (CES-D). *Archives of Internal Medicine, 159*(15), 1701-1704.

Jalbert, J., Quilliam, B. & Lapane, K. (2008). A profile of concurrent alcohol and alcohol-interactive prescription drug use in the US population. *Journal of General Internal Medicine, 23*(9), 1318-1323.

Johnson, I. (2000). Alcohol problems in old age: a review of recent epidemiological research. *International Journal of Geriatric Psychiatry, 15*(7), 575-581.

Jones, R., Nagin, D. & Roeder, K. (2001). A SAS procedure based on mixture models for estimating developmental trajectories. Sociological Methods and Research, 29 (3), 374 – 393.

Jones, R. & Nagin, D. (2007). Advances in group-based trajectory modeling and an SAS procedure for estimating them. *Sociological Methods and Research, 35,* 542 – 571.

Jones-Webb, R. (1998). Drinking patterns and problems among African-Americans: recent findings. *Alcohol Health & Research World, 22*(4), 260-264.

Kaufman, D., Kelly, J., Rosenberg, L., Anderson, T. & Mitchell, A. (2002). Recent patterns of medication use in the ambulatory adult population of the United States: the Slone survey. *JAMA, 287*(3), 337-344.

Kennedy, G., Efremova, I., Frazier, A. & Saba, A. (1999). The emerging problems of alcohol and substance abuse in late life. *Journal of Social Distress and the Homeless, 8* (4), 227 – 239.

Kensella, K. & He, W. (2009). An aging world: 2008. Retrieved November 3, 2009 from: http://www.census.gov/prod/2009pubs/p95-09-1.pdf.

Kircher, J., Zubritsky, C., Cody, M., Coakley, E., Chen, H., Ware J., Oslin, D., Sanchez, H., Durai, U., Miles, K., Llorente, M., Costantino, G. & Levkoff S.(2007). Alcohol consumption among older adults in primary care. *Journal of General Internal Medicine, 22*(1):92-7.

Klein, W. & Jess, C. (2002). One last pleasure? Alcohol use among elderly people in nursing homes. *Health & Social Work, 27*(3), 193-203.

Kovacs, E. & Messingham, K.(2002). Influence of alcohol and gender on immune response. *Alcohol Research & Health, 26*(4), 257-263.

Lang, I., Guralnik, J., Wallace, R. & Melzer, D. (2007). What level of alcohol consumption is hazardous for older people? Functioning and mortality in U.S. and English national cohorts. *Journal of the American Geriatric Society, 55*(1), 49-57.

Lands, W. (1998). Alcohol, calories, and appetite. *Vitamins & Hormones, 54*, 31-49.

Lee, A. & Chokkanathan, S. (2008). Factor structure of the 10-item CES-D scale among community dwelling older adults in Singapore. *International Journal of Geriatric Psychiatry, 23*(6), 592-597.

Linjakumpu, T., Hartikainen, S., Klaukka, T., Veijola, J., Kivela, S. & Isoaho, R. (2002). Use of medications and polypharmacy are increasing among the elderly. *Journal of Clinical Epidemiology, 55,* 809 – 817.

Lococo, K., Staplin, L. (2006). Literature review of polypharmacy and older drivers: Identifying strategies to study drug usage and driving functioning among older drivers. National Highway Traffic Safety Administration Report, DOT HS 810 558. Retrieved March 28, 2009 from http://www.nhtsa.dot.gov.

Lynskey, M., Day, C. & Hall, W. (2003). Alcohol and other drug use disorders among older-aged people. *Drug & Alcohol Review, 22*(2), 125-133.

Mallet, L., Spinewine, A.& Huang, A. (2007). The challenge of managing drug interactions in elderly people *The Lancet, 370*(9582), 185-191

Mann, K., Schäfer, D., Längle, G., Ackermann, K. & Croissant B. (2005) The long-term course of alcoholism, 5, 10 and 16 years after treatment. *Addiction,* 100, 797–805.

McCabe, S., Cranford, J., Morales, M. & Young, A. (2006). Simultaneous and concurrent polydrug use of alcohol and prescription drugs: prevalence, correlates, and consequences. *Journal of Studies on Alcohol, 67*(4), 529-537.

McDonald, A., Nan Wang, B., Carlos, A. & Camargo, J. (2004). US emergency department visits for alcohol-related diseases and injuries between 1992 and 2000. *Achieves of Internal Medicine*, 164, 531-537.

McGuire, L., Ajani, U. & Ford, E. (2007). Cognitive functioning in late life: the impact of moderate alcohol consumption. *Annuals of Epidemiology,17*(2), 93-99.

McPhee, S. & Johnson, T. (2004). Comparing health status with healthy habits in elderly assisted living residents. *Family and Community Health, 27*, 158 -169.

Menninger, J. (2002). Assessment and treatment of alcoholism and substance-related disorders in the elderly. *Bulletin of the Menninger Clinic, 66* (2), 166 -183.

Merrick, E., Horgan, C., Hodgkin, D., Garnick, D., Houghton, S., Panas, L., Saitz, R. & Blow, F. (2008). Unhealthy drinking patterns in older adults: prevalence and associated characteristics. *Journal of the American Geriatric Society, 56*(2), 214-223.

Memmott, J. (2003). Social work practices with the elderly substance abuser. *Journal of Social Work Practice in the Addictions, 3*(2), 85 – 103.

Moore, A., Morton, S., Beck, J. Hays, R., Oishi, S., Partridge, J, Genovese, B. & Fink, A. (1999). A new paradigm for alcohol use in older persons. *Medical Care, 37* (2), 165 – 179.

Moore, A., Morton, S., Beck, J., Hays, R., Oishi, S., Partridge, J., Genovese, B. & Fink, A. (1999). A new paradigm for alcohol use in older persons. Medical Care, 37(2), 165 – 179.

Mukamal, K. & Rimm, E. (2001). Alcohol's effect on the risk of coronary heart disease. *Alcohol Research & Health* 25(4):255–261, 2001.

Mukamal, K., Jenny, N., Tracy, R. & Siscovick, D. (2007). Alcohol consumption, interleukin-6 and apolipoprotein E genotypes, and concentrations of interleukin-6 and serum amyloid P in older adults. *American Journal of Clinical Nutrition, 86*(2), 444-450.

Neugarten, B., Havighurst, R., & Tobin, S. (1961). The measurement of life satisfaction. *Journal of Gerontology, 16*, 134 – 143.

Nagin, D. (1999). Analyzing developmental trajectories: a semi-parametric, group-based approach. *Psychological Methods, 4*(2), 139 – 157.

Nagin, D. (2005). *Group-Based Modeling of Development.* Cambridge, MA: Harvard University Press.

Newman, J., & Schulz, R. (1996). Social support as a mediator in the relation between functional status and quality of life in older adults. *Psychology and aging, 11*, 34 - 44.

National Institute of Alcoholism and Alcohol Abuse (2004). Older adults and alcohol problems. Retrieved January 7th, 2008 from: http://search2.google.cit.nih.gov/search?q=cache:QGObWb_norQJ:pubs.niaaa.nih.gov/publications/Social/Module10COlderAdults/Module%252010%2520C%2520Older%2520Adults.ppt+alcohol+older+adults&site=NIAAA&client=NIAAA_frontend&proxystylesheet=NIAAA_frontend&output=xml_no_dtd&ie=UTF-8&access=p&oe=UTF-8

National Institute of Alcoholism and Alcohol Abuse (2005). Use and misuse of alcohol among older women. Retrieved February 22, 2008 from: http://pubs.niaaa.nih.gov/publications/arh26-4/308-315.htm

National Institute of Alcoholism and Alcohol Abuse (2007). Harmful interactions: mixing alcohol with medications. Retrieved September 18, 2007 from http://pubs.niaaa.nih.gov/publications/Medicine/medicine.htm

Nolen-Hoeksema, S. (2004). Gender differences in risk factors and consequences for alcohol use and problems. *Clinical Psychology Review, 24*(8), 981-1010.

Norberg, A., Jones, A., Hahn, R. & Gabrielsson, J. (2003). Role of variability in explaining ethanol pharmacokinetics: research and forensic applications. Clinical Pharmacokinetics, 42(1), 1-31.

O'Connell, H., Chin, A., Cunningham, C. & Lawlor, B. (2003). Alcohol use disorders in elderly people redefining an age old problem in old age. *British Medical Journal, 327*(7416), 664-667.

O'Connell, H., Chin, A., Hamilton, F., Cunningham, C., Walsh, J., Coakley, D. & Lawlor, B. (2004). A systematic review of the utility of self-report alcohol screening instruments in the elderly. *International Journal of Geriatric Psychiatry, 19*(11), 1074-1086.

Onder, G., Landi, F., Vedova, C., Atkinson, H. et al. (2002). Moderate alcohol consumption and adverse drug reactions among older adults. *Pharmacoepidemiology and Drug Safety, 11,* 385 – 392.

Oslin, D. & Holden, R. (2002). Recognition and assessment of alcohol and drug 11 dependence in the elderly. In: A.M. Gurnack, R. Atkinson, and N.J. Osgood, Eds., *Treating Alcohol and Drug Abuse in the Elderly,* New York, NY: Springer Publishing Company, Inc..

Palmer, M. (2004). *Dr. Melissa Palmer's Guide to Hepatitis and Liver Disease: What You Need to Know.* Penguin Putnam: USA.

Pampel, F. (2000). *Logistic Regression: A primer*. Thousand Oaks, CA: Sage.

Pasacreta, J. (1997). Depressive phenomena, physical symptom distress, and functional status among women with breast cancer. Nursing Research, 46(4), 214-221.

Paton, A. (2005). Alcohol in the body. *British Medical Journal, 8, 330*(7482), 85-87.

Patterson, T. & Jeste, D. (1999). The potential impact of the baby-boom generation on substance abuse among elderly persons. *Psychiatric Services, 50*(9),1184-1188.

Perhats, C., Valdex, A. & Gilbert, A. (2008). Promoting safer medication use among older adults. *Journal of Emergency Nursing, 34,* 156 – 158.

Perreira, K. & Sloan, F.(2002). Excess alcohol consumption and health outcomes: a 6-year follow-up of men over age 50 from the health and retirement study. *Addiction, 97*(3), 301-310.

Pringle, K., Ahern, F., Heller, D., Gold, C., & Brown, T. (2005). Potential for alcohol and prescription drug interactions in older adults. *Journal of the American Geriatric Society, 53* (11), 1930 – 1936.

Psaty, B., Savage, L., Rutan, G., German, P., & Lyles, M. (1992). Assessing the use of mediations in the elderly: Methods and initial experiences in the Cardiovascular Health Study. *Journal of Clinical Epidemiology, 45*, 683 – 692.

Radloff, L. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385 – 401.

Redgrave, G., Swartz, K. & Romanoski, A. (2003). Alcohol misuse by women. *International Review of Psychiatry*, 15(3), 256-268.

Reid, M. & Anderson, P (1997). Geriatric Substance use disorders. *Medical Clinics of North America, 81* (4), 999 – 1016.

Rigler, S. (2000). Alcoholism in the elderly. *American Academy of Family Physicians, 61*(6), 1710-6, 1883-4, 1887-8 passim.

Royer, C., Dickson-Fuhrmann, E., McDermott, C., Taylor, S., Rosansky, J. & Jarvik, L. (2000). Portraits of change: case studies from an elder-specific addiction program. *Journal of Geriatric Psychiatry & Neurology, 13*(3):130-3.

Sanjuan, P. & Langenbucher, J. (1999). Age-limited populations - Youth, adolescents, and older adults. In McCrady, B. S., & Epstein, E. E. (Eds.), *Addictions: A comprehensive guidebook for practitioners.* (pp. 477-498). New York: Oxford University Press.

Satre, D., Mertens, J. & Weisner, C. (2004). Gender differences in treatment outcomes for alcohol dependence among older adults. *Journal of Studies on Alcohol, 65* (5), 638 – 643.

Satre, D. & Areán, P. (2005). Effects of gender, ethnicity, and medical illness on drinking cessation in older primary care patients. *Journal of Aging Health, 17*(1), 70-84.

Schensul, J., Convey, M. & Burkholder, G. (2005). Challenges in measuring concurrency, agency and intentionality in polydrug research. *Addiction Behavior, 30*(3), 571-574.

Scherr, P., LaCroix, A, Wallace, R., Berkman, L., Curb, J., Cornoni-Huntley, J., Evans, D. & Hennekens, C.(1992). Light to moderate alcohol consumption and mortality in the elderly. *Journal of the American Geriatrics Society* ,40 (7), 651–657.

Schulz, R. & Williamson, G. (1990). Biases and family assessment of depression in patients with Alzheimer's disease. *American Journal of Psychology, 147*, 377 – 378.

Schroevers, M., Sanderman, R., van Sonderen, E. & Ranchor, A. (2000). The evaluation of the Center for Epidemiologic Studies Depression (CES-D) scale: Depressed and Positive Affect in cancer patients and healthy reference subjects. *Quality of Life Research, 9*(9), 1015-1029.

Sedlak, C., Doheny, M., Estok, P. & Zeller, R. (2000). Alcohol use in women 65 years of age and older. *Health Care for Women International, 21*, 567 – 581.

Sierksma, A., Sarkola, T., Eriksson, C., van der Gaag, M., Grobbee, D. & Hendriks, H. (2004). Effect of moderate alcohol consumption on plasma dehydroepiandrosterone sulfate, testosterone, and estradiol levels in middle-aged men and postmenopausal women: a diet-controlled intervention study. *Alcoholism, Clinical & Experimental Research, 28*(5), 780-785.

Simonson, W. & Feinberg, J. (2005). Medication-related problems in the elderly: defining the issues and identifying solutions. *Drugs Aging, 22*(7), 559-569.

Sirey, J., Meyers, B., Bruce, M., Alexopoulos, G., Perlick, D. & Raue, P. (1999). Predictors of antidepressant prescription and early use among depressed outpatients. *American Journal of Psychiatry, 156*(5), 690-696.

Sharif, Z. (2003). Pharmacokinetics, Metabolism, and Drug-Drug Interactions of atypical antipsyhcotics in special populations. *Journal of Clinical Psychiatry, 5*(suppl. 6), 22 – 25.

Sharkey, J., Ory, M. & Browne, B. (2005). Determinants of self-management strategies to reduce out-of-pocket prescription medication expense in homebound older people. *Journal of the American Geriatric Society, 53*(4), 666-674.

Steven, R., Simon, K., Chan, A., Soumerai, S., Wagner, A., Andrade, S., Feldstein, A., Lafata, J., Davis, R. & Gurwitz, J. (2005). Potentially Inappropriate Medication Use by Elderly Persons in U.S. Health Maintenance Organizations, 2000-2001. *Journal of the American Geriatric Society, 53*(2), 227-232

Slone Epidemiology Center (2006). Patterns of medication use in the United States. Retrieved October 3, 2009 from: http://www.bu.edu/slone/SloneSurvey/AnnualRpt/SloneSurveyWebReport2006.pdf

Sohrabji, F. (2002). Neurodegeneration in women. *Alcohol Research & Health, 26*(4), 316-318.

Spinewine, A., Schmader, K., Barber, N., Hughes, C., Lapane, K., Swine, C. & Hanlon, J. (2007). Appropriate prescribing in elderly people: how well can it be measured and optimized? *Lancet, 370,* 173 – 184.

Substance Abuse and Mental Health Services Administration (SAMHSA) (1998). *TIP 26: Substance Abuse Among Older Adults (Clinician's Version)*. U.S. Department of Health and Human Services: Rockville, MD.

Substance Abuse and Mental Health Services Administration (SAMHSA) (1999). *Substance abuse among adults.* U.S. Department of Health and Human Services: Rockville, MD.

Substance Abuse and Mental Health Services Administration (SAMHSA) (2001). *The Hidden Epidemic: Prevention and Intervention of Alcohol and Medication Misuse and Abuse Among Older Adults, Meeting Summary.* U.S. Department of Health and Human Services: Rockville, MD.

Substance Abuse and Mental Health Services Administration (SAMHSA) (2004). *Substance abuse among older adults.* U.S. Department of Health and Human Services: Rockville, MD.

Substance Abuse and Mental Health Services Administration (SAMHSA) (2005). *Substance Abuse Relapse Prevention Manual for Older Adults: A Group Treatment Approach.* U.S. Department of Health and Human Services: Rockville, MD.

Sullivan, K., Lynch, A., Artesani, A. & Seed, S. (2007). Medication and alcohol misuse among older adults. *US Pharmacist, 32*(6), HS20-HS30.

Swift, R. (1999). Drug therapy for alcohol dependence. *New England Journal of Medicine, 340*(19), 1482-1490.

Swift, R. (2003). Direct measurement of alcohol and its metabolites. *Addiction, 98* (suppl. 2), 73-80.

Swift, W., Stollznow, N. & Pirotta, M. (2007). The use of alcohol and medicines among Australian adults. *Australian and New Zealand Journal of Public Health, 31*(6), 529-532.

Tanaka, E. (2002). Clinically important pharmacokinetic drug-drug interactions: role of cytochrome P450 enzymes. Journal of Clinical Pharmacy & Therapeutics, 23(6), 403–416.

Taylor, B., & Rehm, J. (2005). Moderate alcohol consumption and diseases of the gastrointestinal system: a review of pathophysiological processes. *Digestive Diseases, 23*(3-4), 177-180.

Tell, G., Freid, L., Hermanson, B., Manolio, T., Newman, A. & Borhani, N. (1993). Recruitment of adults 65 years and older as participants in the Cardiovascular Health Study, *Annals, of Epidemiology*, 3, 358 – 366.

Thomas, V. & Rockwood, K. (2001). Alcohol abuse, cognitive impairment, and mortality among older people. *Journal of the American Geriatric Society, 49*(4), 415-420.

Thun, M., Peto, R., Lopez, A., Monaco, J., Henely, S., Heath, C. & Doll, R. (1997). Alcohol consumption and mortality among middle-aged and elderly U.S. adults. *The New England Journal of Medicine*, 337, 1705 – 1714.

Tivis, L. & Tivis, R. (2008). One-per-occasion or less: are moderate-drinking postmenopausal women really healthier than their nondrinking and heavier-drinking peers? *Alcohol Clinical & Experimental Research, 32*(9), 1670-1680

Turvey, C., Wallace, R. & Herzog, R. (1999). A revised CES-D measure of depressive symptoms and a DSM-based measure of major depressive episodes in the elderly. *International Psychogeriatrics,11*(2), 139-148.

Turvey, C., Schulz, S., & Klein, D. (2006). Alcohol use and health outcomes in the oldest old. *Substance Abuse Treatment, Prevention, & Policy, 1* (8), 1 – 8.

U.S. Department of Health and Human Services (DHHS) (2004). *National Healthcare Disparities Report.* Rockville, Md.: DHHS.

Vestal, R., McGuire, E. Tobin, J., Andres, R., Norris, A. & Mezey, E. (1977). Aging and ethanol metabolism. *Clinical Pharmacology and Therapeutics,* 21, 343–354.

Vik, H., David, B., Patten, S., Johnson, J., Romonko-Slack, L. & Maxwell, C. (2006). Medication Nonadherence and Subsequent Risk of Hospitalization and Mortality among Older Adults. *Drugs & Aging, 23*(4), 345-356.

Wang, J., Zuckerman, I., Miller, N., Shaya, F., Noel, J. & Mullins C. (2007). Utilizing new prescription drugs: disparities among non-Hispanic whites, non-Hispanic Blacks, and Hispanic whites. *Health Services Research, 42* (4), 1499-1519.

Weathermon, R., & Crabb, D. (1999). Alcohol and medication interactions. *Alcohol research and Health, 23* (1), 40 – 55.

World Health Organization (1975). Requirements for adverse reaction reporting. Geneva, Switzerland.

Williams C. (2002). Using Medications Appropriately in Older Adults. *American Family Physician*, 66(10), 1917-1924.

Weintraub, E., Weintraub, D., Dixon, L., Delahanty, J., Gandhi, D., Cohen, A. & Hirsch, M. (2002). Geriatric patients on a substance abuse consultation service. *American Journal of Geriatric Psychiatry, (3),* 337-42.

Wilson, I., Schoen, C., Neuman P., Kitchman Strollo, M., Rogers W., Chang, H. & Safran, D. (2007). Physician–Patient Communication About Prescription Medication Nonadherence: A 50-state Study of America's Seniors. *Journal of General Internal Medicine, 22*(1), 6 – 12.

Wright, R. & Warpula, R. (2007). Geriatric Pharmacology: safer prescribing for the elderly patient**.** *Journal of the American Podiatric Medical Association, 94,* 90-97.

Xie, H., Drake, R. & McHugo, G. (2006). Are there distinctive trajectory groups in substance abuse remission over 10 years? An application of the group-based modeling approach. Administration *and Policy in Mental Health, 33*(4), 423-432.

Xu, K., Smith, S. & Borders, T. (2003). Access to prescription drugs among noninstitutionalized elderly people in west Texas. *American Journal of Health-System Pharmacy*, *60*(7), 675-682.

Yen, S. & Lo, S. (2004). Living alone, social support, and feeling lonely among the elderly. *Social Behavior and Personality*, *32* (2), 129 – 138.

Zanjani, F., Mavandadi, S., TenHave, T., Katz, I., Durai, N., Krahn, D., Llorente, M., Kirchner, J., Olsen, E., Van Stone, W., Cooley, S. & Oslin, D. (2008). Longitudinal course of substance treatment benefits in older male veteran at-risk drinkers. *Journal of Gerontology, series A, Biological Sciences and Medical Sciences, 63*(1), 98-106.

Zhan, C., Sandl, J., Bierman, A., Miller, M., Friedman B., Wickizer S. & Meyer G. (2001). Potentially inappropriate medication use in the community-dwelling elderly: findings from the 1996 Medical Expenditure Panel Survey. *JAMA, 286*(22), 2823-2829.

Zhang, S., Lee, I., Manson, J., Cook, N., Willett, W. & Buring, J. (2007). Alcohol consumption and breast cancer risk in the Women's Health Study. *American Journal of Epidemiology,165*(6), 667-676.