Examining the Association between Tobacco Use and Binge Drinking and the Effects of Tobacco Interventions on Binge Drinking Behaviors

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Abstract

Background: Binge drinking is a significant public health problem. Although effective alcohol control policies exist, many have eroded over time or face strong political opposition to their implementation. Other mechanisms to reduce binge drinking need to be found. Tobacco and alcohol use share similar biological, personal, and environmental characteristics and research has shown that among alcohol dependent population reducing smoking can lead to decreases in alcohol use.

Objectives: The purpose of this dissertation was to assess: (1) the extent that binge drinking and smoking are associated in a non-alcohol dependent population, (2) how this observed association may be modified by individual- and environmental-level factors, and (3) the effect of tobacco interventions on binge drinking.

Methods: The first study examined the association between binge drinking and smoking behaviors using a representative sample of active duty military personnel. Additionally, multivariate logistic regression tested whether frequency of deployment and the perception of an alcohol promoting environment moderated the association between binge drinking and smoking. The second study assessed the effect of an individual-level tobacco intervention (health education versus motivational interviewing counseling) on binge drinking and average daily alcohol use in a group of African American light smokers over a six-month period. Generalized linear models assessed the mediation effect of smoking cessation on the relationship between counseling intervention and drinking. The third study used pooled-time-series analyses to assess the effects of two state-level tobacco control policies (tobacco taxes and smoking bans in bars) on state-level binge drinking behaviors from 1998 to 2010.

Results: In the first study, binge drinking was found to be significantly higher among current smokers than former and nonsmokers. The frequency of deployment (but not the perception of an alcohol-promoting environment) moderated this relationship although effects varied by branch of service. In the second study, individuals randomly assigned to receive health education counseling decreased their binge drinking at week 8 of the study, but these results diminished within six months. Smoking cessation did not appear to mediate the relationship between counseling type and binge drinking; however, individuals who quit smoking (regardless of counseling type) also decreased their binge drinking at week 8 of the study; these results were not significant at the end of the study. For the third study, neither tobacco taxes nor smoking bans in bars was associated with a decrease in binge drinking outcomes at the state level.

Conclusions: Smoking and binge drinking are strongly associated in non-alcohol dependent populations and some evidence suggests that decreasing smoking leads to initial reductions in binge drinking; however, the evidence presented is not strong enough to advocate for a reliance on smoking interventions as a way to reduce and prevent binge drinking. Alcohol advocates need to continue to support and educate lawmakers about the effectiveness of alcohol control policies in order to reduce binge drinking.

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Specific Aims

Excessive alcohol use is the third leading preventable cause of death in the United States each year. Binge drinking, the most common form of excessive alcohol use, is defined as consuming five or more drinks on one occasion for men or four or more drinks for women. Approximately 15% of the U.S. population reported binge drinking in the past 30 days with a higher prevalence in certain demographic groups. Binge drinking is associated with many health and social consequences. Current alcohol-control policies effective in combating binge drinking have been repeatedly weakened over time by pressure from lobbying groups for the alcohol industry or have faced strong political opposition to their implementation; therefore, it is imperative to identify other possible mechanisms to reduce binge drinking.

Research has shown that tobacco and alcohol use have similar biological basis for the use of these two substances, similar environments that encourage their use, and similar demographics and personality characteristics of people who engage in both behaviors. One potential mechanism to reduce binge drinking may be through a reduction in smoking. Prior research in alcohol dependent populations has shown that quitting smoking can decrease alcohol use. Since the majority of binge drinkers are not alcohol dependent, a better understanding of the association between alcohol and tobacco use and how factors can affect this relationship outside of alcohol dependent populations is needed.

In addition, there are many effective individual- and policy-level interventions aimed at reducing smoking that are widely supported and used today. It may be possible that these same interventions could also lead to reductions in binge drinking; however,

current research is again limited to dependent populations or results are mixed as to the extent that tobacco policies affect binge drinking. This dissertation filled several research gaps by addressing the following three specific aims:

Specific Aim 1: To assess (1) the association between smoking status and intensity of smoking with binge drinking in the active duty military and (2) evaluate the potential moderating effects of the perception of an alcohol-promoting environment and frequency of military deployment on the observed association

Specific Aim 2: To examine potential spillover effects of an individual-level smoking intervention on binge drinking prevalence, frequency, and average daily alcohol consumption in a sample of African American light smokers

Specific Aim 3: To assess the association between two state-level tobacco control policies (comprehensive smoking bans in bars and tobacco taxes) and state prevalence and average per capita frequency of binge drinking in the U.S. from 1998 to 2010

These three specific aims used secondary data analysis to address an overarching research question of whether tobacco interventions could affect binge drinking. Aim 1 focused on a population with a high prevalence of binge drinking and smoking. Aim 2 used data from a clinical trial focused on reducing smoking within a population at high risk of alcohol consequences. Aim 3 used multiple publicly available datasets to examine the effects of tobacco policies on alcohol use at the population level.

Chapter 1

Introduction and Background

Introduction

Excessive alcohol use is the third leading preventable cause of death in the United States,[1] resulting in approximately 80,000 deaths annually[2] and costing over $223 billion (in 2006 dollars) each year.[3] This type of drinking pattern consists of both heavy daily use, defined as consuming on average more than two drinks per day for men or more than one drink per day for women, and heavy episodic use, commonly called binge drinking. Binge drinking is consuming alcohol to the point of intoxication and is defined empirically as consuming five or more drinks on an occasion for men or four or more drinks for women.[4] In the past 30 days, approximately 15% of the general population reported binge drinking at least once.[5] Binge drinking, which results in significant impairment, is responsible for more than half of the 80,000 alcohol-attributable deaths annually.[2, 6] Binge drinking is also associated with many adverse health and social consequences, including, but not limited to, interpersonal violence, motor-vehicle traffic crashes, sexually transmitted diseases, unintended pregnancy, fetal alcohol syndrome, lost work productivity and suicidal behavior.[7-11]

An effective way to reduce binge and other heavy drinking is by discouraging access to alcohol through policy changes. Although there exists numerous effective alcohol control policies, many of the current policies in place have eroded over time (such as alcohol excise taxes) or face considerable opposition to enactment from the alcohol industry.[12-15]

A possible alternative to reduce binge drinking may be interventions aimed at reducing behaviors commonly associated with alcohol use. Research has shown that many binge drinkers report smoking and vice versa.[16] Tobacco use accounts for approximately 400,000 deaths annually, making it the leading preventable cause of death among U.S. adults for over 20 years.[1, 17] Combined, alcohol and tobacco use account for a total economic burden of approximately $300 billion (in 1998 dollars) per year.[18]

To understand how tobacco interventions might affect binge drinking and other forms of alcohol use, a clear understanding of the reasons behind the association of these behaviors is needed. Research suggests that alcohol and tobacco use have similar biological features in addition to common environmental factors and personality characteristics of users. Information about how smoking cessation may influence alcohol use is rare outside of laboratory studies or studies focusing on populations suffering from alcohol dependence.[19-22] Even though individuals who are alcohol dependent may also binge drink, the majority of people who binge drink are not alcohol dependent.[23, 24] Since less than 5% of the total U.S. population can be classified as alcohol dependent,[25] research needs to be extended to non-alcohol dependent populations. This dissertation is timely given the increased efforts in recent years to prevent tobacco use through publicly funded programs to help individuals quit smoking as well as expansion of policies to limit smoking in public areas and increase price.[26] The purposes of this dissertation were as follows: (1) to assess the association between smoking behaviors and binge drinking in a non-alcohol dependent population as well as explore the potential moderating role that factors at the personal and environmental level may have on this association, (2) to examine potential spillover effects of an individual-level smoking intervention on alcohol

use behaviors, and (3) to assess effects of two state-level tobacco control policies on state-level binge drinking outcomes.

Background

I. Excessive Alcohol Use

I.a. Definition

Over half (55%) of individuals in the U.S. adult population are current drinkers (defined as consuming any amount of alcohol in the past 30 days).[27] According to the U.S. Dietary Guidelines, moderate alcohol consumption is defined as consuming one drink[1] per day for women or two drinks per day for men.[28-30] For certain groups, however, the use of any alcohol is not recommended, including pregnant and lactating women, individuals who cannot restrict their alcohol intake, children and adolescents, individuals with specific medical conditions or who take medications that can interact with alcohol, and individuals who engage in activities that require attention, skill, or coordination, such as driving or operating machinery.[28, 30] Alcohol consumption above moderate levels (referred to as excessive use) increases the risk of many health consequences both for the individuals engaging in this behavior and those around them.[9]

Excessive alcohol use can take several forms. In clinical settings, excessive alcohol use is usually called alcoholism or alcohol dependence and is a long-term maladaptive pattern of consumption.[20-22] It is characterized by and manifested through three or more of the following symptoms occurring during the past 12 months: (1)

[1] A standard drink in the U.S. is defined as 14 grams of pure ethanol which translates to: a half an ounce of alcohol or one 12-ounce beer, one 5-ounce glass of wine, or one 1.5-ounce of 80-proof distilled spirits.

tolerance (increasing dosages to experience the same effect), (2) withdrawal (abnormal physical or psychological features following the abrupt discontinuation of alcohol), (3) impaired control over alcohol consumption, (4) preoccupation with alcohol and obtaining alcohol, (5) use of alcohol despite adverse consequences, (6) distortions in thinking, (7) persistent desire to cut down or control alcohol use, or (8) giving up important social, occupational or recreational activities because of alcohol use.[31, 32] About four percent of the general population is defined as alcohol dependent in any given year.[25]

Alcohol abuse is another form of excessive alcohol use. This behavior results in significant impairment. The symptoms of alcohol abuse are similar to those of alcohol dependence but do not include the key symptoms of alcohol withdrawal and alcohol tolerance.[31] About five percent of the U.S. population abuses alcohol at any given time.[33] These forms of excessive alcohol use are usually diagnosed in clinical settings. Diagnosis relies on symptoms which are usually the result of chronic, long-term alcohol consumption.

In public health settings, excessive alcohol use is usually identified through the use of surveys that capture self-reported patterns of drinking. Although it is possible to capture medical symptoms on surveys through the use of standardized instruments such as the Alcohol Use Disorders Identification Test (AUDIT)[34] or the CAGE assessment,[35] our discussion will focus on how to identify maladaptive patterns of drinking. The advantages of using surveys to identify excessive drinking are that a large number of individuals can be assessed at once and a broader definition of what constitutes excessive use can be used. In this setting, excessive alcohol use is generally defined by two general patterns of drinking, both of which result in alcohol consumption above dietary

guidelines. The first pattern of excessive alcohol use, called heavy daily drinking, results when a man drinks *on average* more than two drinks per day or a woman drinks *on average* more than one drink per day. This definition is in contrast to the U.S. Dietary Guidelines, which define the moderate drinking threshold in absolute number of drinks per day and do not take into account intermittent episodes of heavier drinking. About 5% of the U.S. general population reports heavy drinking in the past 30 days.[5, 27] Heavy drinkers may not meet clinical definitions of alcohol abuse (or dependence), although in the long-term, this type of drinking could develop into clinical problems. The second and more common pattern of excessive alcohol use results when a man drinks five or more drinks on occasion or a woman drinks four or more drinks on occasion (usually defined by a specific time period over a few hours).[4] This behavior is commonly referred to as binge drinking and usually results in acute intoxication and impairment. In 2010, approximately 15% of U.S. adults aged 18 or older reported binge drinking in the past 30 days.[23, 27]

It is important to note that in classifying excessive alcohol use, there is overlap between clinical definitions of alcohol abuse and dependence, and public health discussions of heavy and binge drinking. Individuals who are alcohol dependent or abusing alcohol are always drinking heavily either on a daily basis or by frequently binge drinking.[31, 32] One important distinction is that not all individuals who binge drink (or drink heavily) are alcohol dependent.[24, 36] In fact, a very small proportion of individuals who report binge drinking in the past 30 days meet clinical definitions of alcohol dependence.[36] This dissertation focuses on binge drinking since the prevalence of this behavior is much higher than alcohol dependence making it a more substantial public

health problem. In addition, this dissertation makes the assumption that most binge drinkers are not alcohol dependent.

It is important to briefly discuss the history and evolution of the term "binge drinking," since it has not always been applied to the pattern of drinking described here. For many years the term "binge drinking" or "binger" was used to describe two or more days of sustained heavy drinking; however, survey researchers during the 1980s and 1990s began to apply the term "binge drinking" to shorter drinking episodes, usually describing periods of drinking five or more drinks in a row. This application of the term was debated in the field of alcohol research until 2003 when the National Institute on Alcohol Abuse and Alcoholism (NIAAA) convened a task force to develop a formal definition for the term "binge drinking."[37] The task force determined that the term binge drinking should describe "a pattern of drinking alcohol that brings blood alcohol concentration (BAC) to 0.08 gram percent or above. For the typical adult, this pattern corresponds to consuming five or more drinks (males), or four or more drinks (female), in about two hours." [4] It is worth noting that most surveys will substitute the time frame of "about two hours" with more general language such as on an occasion,[38] in a row,[39] or no specific time frame.[40] One major caveat with this definition is that it is specific to adults. Research has shown that adolescents who consume alcohol can reach the 0.08 threshold with fewer than five drinks,[41, 42] but, the five drink threshold is commonly used on many surveys of adolescents.[43, 44] In addition, using a BAC threshold of 0.08 poses additional problems, since research has shown the mean number of drinks needed to feel drunk averages a little over four and a half drinks for women and over six and a half drinks for

men;[45] however, BAC is very dependent on other factors, such body mass index or metabolism, that can affect how quickly someone reaches the 0.08 threshold.[46]

It is also important to note the current definition for binge drinking has not been uniformly accepted among journal editors. Marc Schukit, editor of the Journal of Studies on Alcohol and Drugs, has established a policy for the usage of the term "binge" in papers submitted to that journal. The policy states that "binge" should only be used to describe an extended period of time (usually two or more days) during which a person repeatedly administers alcohol or another substance to the point of intoxication and gives up his/her usual activities and obligations in order to use the substance.[47] In addition, many researchers and surveys use other terms for describing 5+/4+ drinking patterns, such as hazardous use or heavy use.[48] This makes it difficult to determine from the literature the true extent of the problem of binge drinking. This dissertation focuses on binge drinking using the NIAAA definition.

I.b. Prevalence of Binge Drinking

Binge drinking is a common public health problem with studies showing, on average, that 15% to 34% of U.S. adults aged 18 and older reported binge drinking in the past 30 days: a rate of about seven episodes per person per year or a total of 1.5 billion binge drinking episodes annually.[23, 27, 49, 50] Binge drinking rates vary geographically with the Midwest and the Northeastern states having some of the highest rates of binge drinking and the Southeastern states the lowest.[23, 49] Specifically, Wisconsin's rate of binge drinking is the highest in the U.S., averaging about 12.3 episodes per capita while Tennessee has the lowest rate with 3.1 episodes per capita.[23] Several reasons have been

postulated for the geographic variation in binge drinking, including differences in average income, religious affiliation, and the number and type of state-level alcohol control policies.[23, 51, 52] Binge drinking also varies by sex, race/ethnicity, age, education, and occupation,[23, 50, 53] and these demographic factors can differ by state or region.

Men, in general, report more binge drinking episodes than do women, accounting for approximately 81% of all episodes reported on an annual basis.[23] About 22% of all men engaged in past month binge drinking, averaging about 12.5 episodes per person per year, versus 7% of all women who average about three episodes per capita.[23, 50] When limiting estimates to current drinkers (versus the entire population), per capita episodes increase to over 20 for men and about six for women. In addition, when men binge drink, on average, they consume about eight drinks per episode, and women average about seven drinks per episode.[50] Among women of childbearing age, about 12% reported binge drinking in the past 30 days.[23]

Research suggests there are also differences in binge drinking by race/ethnicity, although results are mixed. Some studies have shown whites to have the highest prevalence of binge drinking, ranging from 15% to 25% overall.[23, 49] When limiting results to current drinkers, binge drinking prevalence among whites averages about 26% with a per capita rate of 13 episodes.[23] Individuals of Hispanic ethnicity also report a high prevalence of binge drinking, averaging between 16% to 35% with about 17 episodes per person per year.[23] Studies with more detailed racial/ethnic breakdowns report that American Indians and Alaskan Natives exhibit some of the highest prevalence of past month binge drinking (close to 30%).[49] The lowest prevalence of binge drinking is usually reported by Asians (13%)[26,54] or African Americans (10%).[23, 49] Prevalence

estimates for African Americans vary, however, with some studies showing the prevalence of binge drinking in this group closer to the prevalence among whites (i.e., approximately 19%).[49]

Age is also strongly associated with binge drinking. The prevalence of binge drinking peaks between 21 and 25 years of age.[23, 49] Underage (i.e., under age 21) binge drinking is also prevalent with 36% to 51% of this age group binge drinking in the past 30 days with a per capita rate of 30 episodes.[23, 49] The prevalence of binge drinking for individuals aged 55 and older is about four percent and represents the lowest prevalence of binge drinking by age group.[23, 49]

One of the most studied groups that engage in binge drinking is college students. Approximately four out of five college students drink alcohol, and about half report binge drinking in the past two weeks.[48] College students aged 18 to 22 are more likely than their peers who do not attend college to use alcohol and binge drink.[48, 49, 55, 56] Approximately 44% of college students, versus 38% of their noncollege peers, reported binge drinking in the previous two weeks, and college students are more likely to report binge drinking frequently (i.e., five or more times in the past month).[49, 55, 57] College students who binge drink consume 91% of all the alcohol consumed by students.[58] Researchers have found that the demographic composition of a college student body appears to be a factor in campus binge drinking. Campuses with greater racial and ethnic diversity have lower rates of binge drinking than college campuses made up of a majority of white students.[59] In addition, campus binge drinking is strongly associated with the number and type of state-level alcohol control policies and state-level binge drinking prevalence.[51]

Binge drinking and other forms of excessive alcohol use are more common in certain high stress occupations; the most thoroughly studied being active duty military personnel.[60-62] Approximately 43% of all active duty military reported binge drinking in the previous 30 days.[62] This prevalence is higher than that seen in the civilian population even after controlling for age, sex, education, and race/ethnicity.[63] Binge drinking is most prevalent among military personnel who are less than 25 years old, male, have a high school education or less, and are of white or Hispanic ethnicity.[62, 64] Additionally, being single, serving in the Army or Marine Corps, being junior enlisted, living in single housing (e.g., military barracks, dormitories or bachelor quarters), and being stationed overseas or onboard ships are also associated with a higher prevalence of binge drinking.[62, 64] In the general population, most people who binge drink are those, who on a daily basis, consume alcohol within moderate drinking guidelines (i.e., consume up to one drink per day for women or up to two drinks per day for men);[23] however, among active duty military personnel, binge drinking is more common among service members whose daily drinking patterns exceed moderate drinking guidelines (i.e., are classified as heavy drinkers).[62] As a result, a substantial portion of the military population is consuming alcohol at levels that result in numerous adverse consequences and are at increased risk of later problems with dependence and abuse.

In summary, the prevalence of binge drinking is about 15% for the general population but varies widely by geographic region, sociodemographic characteristics, and occupation. The next section discusses some of the consequences of engaging in binge drinking behaviors.

I.c. Consequences of Binge Drinking

Excessive alcohol use, including binge drinking, costs the U.S. approximately $223 billion (in 2006 dollars) per year in lost productivity, healthcare, criminal justice actions, and other effects, including hospitalizations and deaths.[3] Binge drinking results in acute intoxication and impairment and an increase in risk-taking behaviors that can result in illness, injury, or death.[6] More than half of the 80,000 alcohol-attributable deaths annually are the result of binge drinking.[2, 6] Over one-third of these deaths (about 13,000) are due to alcohol-impaired driving.[2, 65] In fact, binge drinking has been found to be more predictive of impaired driving than heavy average daily alcohol consumption.[66] Binge drinking is also associated with an increased risk of death due to suicide, homicide, and child maltreatment,[67] which account for about 35% of all alcohol-related injury deaths.[2, 6] In addition, binge drinking is also associated with deaths due to falls, drowning, and poisonings resulting from mixing alcohol and prescription drugs.[6, 68, 69] Some nonfatal health consequences associated with binge drinking include injuries requiring treatment in emergency departments,[70] sexually transmitted diseases,[71] risky sexual behavior[71] (e.g., multiple partners, not using protection during intercourse), sexual[72] and domestic assault,[73] and poor job performance due to hangover.[74] Women who binge drink increase their risk of unintended pregnancy,[75] and if already pregnant, can decrease pregnancy recognition[75, 76] and increase risk of fetal alcohol syndrome.[77]

Because of the differences in binge drinking prevalence by sociodemographic factors (i.e., sex, race/ethnicity, age, and occupation), resulting consequences also differ among these groups. Research shows that men presenting to emergency rooms are more likely than women to report drinking six hours before being admitted, and this risk

increases among individuals who report binge drinking in the past 30 days.[78, 79] Overall, men are more likely than women to die from an alcohol-attributable illness or injury.[6] For example, men are three times more likely than women to die from alcohol-attributable motor-vehicle traffic crashes, homicide, and suicide.[6]

Although research has examined alcohol-attributable consequences by racial/ethnic groups, few studies have specifically identified the contribution of binge drinking. In addition, for many chronic causes of death, the precise role of binge drinking is unclear. Taken together, chronic liver disease and cirrhosis deaths, 40% of which are alcohol-attributable, constitute the fifth leading cause of death among American Indians/Alaskan Natives and the sixth leading cause of death among Hispanics.[80] Rates of alcohol-attributable cancers of the esophagus and larynx are usually found to be higher among African American men than among white men.[81, 82] Researchers in California using the Alcohol-Related Disease Impact (ARDI) software found alcohol-attributable motor-vehicle traffic crashes (which are more likely to be the result of binge drinking) to be the leading cause of death for all racial/ethnic groups except African Americans.[81, 83] Alcohol-attributable homicide has consistently been the leading cause of alcohol-attributable deaths among African Americans in California for over 20 years.[81, 83] Whites consistently have the highest alcohol-attributable death rate for suicide compared to all other racial groups.[81]

For nonfatal consequences, research has shown that white and Hispanic men are more likely to report driving after drinking too much and being arrested for alcohol-impaired driving than are African American men.[84] A study by Caetano and associates[85] found more African American men (40%) and women (24%) reported drinking during

episodes of intimate partner violence than did white or Hispanic men (both about 30%) and women (11% and 5%, respectively). It is difficult, however, to determine the specific contribution of binge drinking in this study since it was combined with measures of frequent drinking.

Since the prevalence of binge drinking is highest in younger age groups, some of the consequences associated with binge drinking are also highest in this group. The top three leading causes of death for individuals under age 21 are motor-vehicle traffic crashes, homicide, and suicide for which binge drinking contributes significantly.[6] Alcohol is involved in 36% of homicides, 12% of male suicides, and 8% of female suicides in people under age 21.[86] In 2007, 26% of young drivers (i.e., under age 21) who were killed in a motor-vehicle traffic crash had a BAC level of 0.08 g/dL or higher.[87] About 18% of all drivers in fatal alcohol-attributable motor-vehicle traffic crashes with a BAC level of 0.08 g/dL were between the ages of 16 to 20 years.[88] In addition, research has shown that the younger an individual is when they engage in binge drinking, the more likely they are to develop alcohol dependence later in life.[48] About 5% of 19 to 20 years olds already meet the criteria for alcohol dependence and about 10% meet the criteria for alcohol abuse.[48] Among 12 to 20 year olds, the rates of abuse and dependence are highest among Native Americans compared with all other racial/ethnic groups.[48]

Among college students, binge drinking can adversely affect grades, social relationships, risk-taking behaviors, and health.[58] Binge drinking is associated with missing class, falling behind in schoolwork, and a lower grade point average.[57] Binge drinking is also associated with engaging in unplanned sexual activity and failure to use protection during sex.[89] Undergraduate females who report binge drinking are more than

six times more likely to report being a victim of an alcohol-related sexual assault.[90] Compared with college students who do not binge drink, college binge drinkers are more likely to report having a hangover, missing class, getting hurt or injured, or damaging property.[91]

College students and active duty military members report similar events associated with binge drinking, including driving after drinking, riding with someone who has had too much to drink, getting into fights or getting injured, taking part in risky sexual behaviors, becoming involved in intimate partner violence, and suffering unintentional injury or deaths.[62, 73, 92-95] Consequences unique to the military include getting a lower score on an efficiency report or performance rating, getting called up during off-duty hours and reporting to work drunk, or receiving a Uniform Code of Military Justice punishment (e.g., a lowering of rank, removal of off-base privileges, etc).[62] Costs to the military due to excessive alcohol use (including binge drinking) reach $1.2 billion annually. This includes medical costs and costs resulting from reduced readiness and misconduct charges.[96]

Even though consequences associated with binge drinking are frequent and can cause significant economic toll, this behavior is still common. This last section highlighted the many consequences associated with binge drinking for various sociodemographic groups. Reducing binge drinking among the general population was a goal of both Healthy People 2010 and 2020.[97, 98] To reach these goals, implementation of evidence-based strategies are needed. The next section highlights some effective alcohol-control policies and problems faced with implementing and enforcing them.

II. Interventions Focused on Reducing Excessive Alcohol Use Including Binge Drinking

There have been many efforts over the past 100 years to reduce alcohol use and binge drinking.[99-103] The most famous in the U.S. was Prohibition, which followed the ratification of the Eighteenth Amendment to the Constitution in 1919 and the enforcement legislation known as the Volstead Act.[104] Fought for by the temperance movement for over a hundred years and the Anti-Saloon League during the early part of the twentieth century, Prohibition was seen as a way to combat the rampant drinking taking place in saloons and the resulting consequences, including domestic violence, alcoholism, and liver cirrhosis.[104] The Eighteenth Amendment made it a crime to manufacture, sell, or transport intoxicating liquors (defined as an alcohol content of 0.5% or greater) within the U.S.[105] During Prohibition, drinking among Americans decreased substantially. Death rates from cirrhosis and alcoholism and hospital admissions for alcoholic psychosis also decreased during this time period;[104] however, Prohibition eliminated an entire industry and thousands of jobs overnight as well as government revenues from alcohol taxes. One of the many unforeseen consequences resulting from the ban of alcohol sales was a rise in organized crime in the U.S., including smuggling and bootlegging. In addition, alcohol consumption increased in groups that drank very little before Prohibition: women and college students.[104] The soaring crime rate and economic forces of the Great Depression in 1933 helped support the passage of the Twenty-first Amendment to the Constitution, which gave states the power to regulate the purchase and possession of alcohol within their borders and overturn the Eighteenth

Amendment. The experience of Prohibition has helped to shape many current alcohol control policies and the arguments and attitudes toward them.

Most alcohol control policies today are enacted at the state level (with some influence at the federal level) and predominantly focus on the following: (1) regulating underage drinking; (2) restricting where, when, and how alcohol is sold and distributed; and (3) increasing the price of alcohol. There currently exists an extensive list of alcohol control policies and programs that may affect binge drinking and other forms of alcohol use;[103, 106] however, this dissertation focuses on alcohol control policies that have been evaluated in non-alcohol dependent populations and shown in studies published in peer-reviewed journals to have a direct effect on consumption (and where noted, binge drinking).

II.a. Alcohol Control Policies Focusing on Underage Drinking

After Prohibition ended, most states established age 21 as the age of majority. This continued until the Vietnam War when states began lowering their drinking age to 18, 19, and 20, in part due to successful efforts in 1971 to lower the voting age to 18. Unfortunately, since states were not uniform in the minimum legal drinking age (MLDA), it was not uncommon for young people who bordered a state with a lower drinking age to cross state lines to drink and purchase alcohol. Studies have shown that during the time of lower state MLDAs, motor-vehicle traffic crashes increased among youth.[102, 107] This research along with efforts by Mothers Against Drunk Driving (MADD) helped to halt the trend to lower the drinking age across the remaining states and slowly increase states' MLDA back to 21. The National Minimum Drinking Age

Act (NMDAA) of 1984 (23 U.S.C. § 158) helped to ensure that all states ultimately passed some form of the age-21 MLDA.[108] This act required all states to raise the minimum age for purchase and public possession of alcohol to 21 or face a reduction in federal highway funds under the Federal Highway Act section 23.[109] By 1988 all 50 states had adopted the age-21 legal minimum drinking age. In addition to regulating who can possess or consume alcohol, the drinking age laws also prohibit individuals from selling or giving alcohol to minors. Since the inception of the age-21 MLDA law, the National Highway Traffic Safety Administration estimates that drunken driving fatalities have decreased by 13% among 18 to 20 year olds.[110, 111] Studies have shown the age-21 drinking law has also reduced youth drinking[112] and decreased suicide rates among 18-to-20 year olds.[113] In fact, an extensive review of existing programs and policies showed that increasing the legal age for purchase and consumption of alcohol to age 21 appears to have been the most successful campaign to reduce drinking among teenagers and young adults.[102]

Even with the successes in reducing drinking among youth under age 21, college students and especially underage college students, still report higher rates of alcohol use and binge drinking than their noncollege attending peers.[114, 115] Consequently, in 2008, because of the apparent lack of progress in reducing binge drinking among college students, Dr John McCardell, former President of Middlebury College and founder of Choose Responsibility, began the Amethyst Initiative.[116] This initiative, made up of (as of February 2012) 136 chancellors and presidents of universities and colleges across the U.S., calls for public debate about lowering the MLDA and suggests uncoupling state's federal highway appropriation from the age 21 MLDA.[116] As a result of this movement,

legislators in several states have proposed or suggested lowering the drinking age to 18 or lowering it specifically for active duty military;[117-119] however, none of these legislative proposals have advanced beyond the proposal stage. The NMDAA is still in effect, making it unlikely the state legislators will lower their MLDA and risk lowing losing federal highway funds.

II.b. Restricting Where, When, and How Alcohol is Sold and Distributed

After the repeal of Prohibition, several states continued a ban on the sale and possession of alcohol that lasted until 1966 when Mississippi became the last state to vote to overturn the ban. In place of prohibition, a majority of states established a license system, requiring private stores to purchase a license to sell alcohol for off-premise consumption. Several states established controls on the sale and distribution of alcoholic beverages through retail or wholesale monopolies of the sale of distilled spirits, wine, and beer above a certain concentration. These states are called "control states" because part of their alcohol distribution system is controlled by the state government. Over the years many states have discontinued the monopoly over wine sales and distilled spirits and switched to a license system through a process called privatization.[106] The most recent example is Washington state where residents, after twice voting against the repeal of the control system, voted on November 8, 2011 to approve the Washington Liquor State Licensing Initiative 1183, which will close the state liquor stores by June 1, 2012 and allow for state licensing of privately owned stores.[120] The campaign, largely paid for and endorsed by Costco Wholesale Corp, benefits private retailers in that they will now be allowed to sell hard liquor through a license system and eliminate the state's 52% mark

up on liquor. Besides removing state controls and decreasing revenue to states, privatization may also be associated with increases in the following: (1) the number of outlets licensed to sell alcohol, increasing competition and lowering price, (2) the number of days and hours that individuals can purchase alcohol, and (3) the promotion of alcohol.[121] As a result, studies have shown an increase in the purchase and subsequent consumption of alcohol in states that switch from a state-monopoly to a privatized licensure system.[122-124]

Other types of restrictions on alcohol sales include limiting the days and hours that alcohol can be sold. Most of the research examining the impact of these types of restrictions on consumption focuses on the effects of loosening the hours and days of sale. For example, in a study conducted in Canada, Carpenter and Eisenberg compared provinces with and without restrictions on Sunday sales.[125] They found that provinces such as Ontario, which recently repealed a Sunday sales ban, saw an increase in reported consumption on Sundays following the repeal of the sales ban.[125] Two studies in the U.S. examined the effect of repealing Sunday sales bans in New Mexico.[126, 127] The authors found significant increases in motor-vehicle traffic crashes and fatalities following repeal of the ban, but they did not examine any direct effect of the repeal on consumption levels.[126, 127] Recently, the Task Force on Community Preventive Services conducted a review of studies assessing the effectiveness of restricting days of alcohol sales on excessive alcohol use.[128] They examined the effects of both adding days of sale and reducing days of sale. Overall, increasing days of sales was found to be associated with an increase in excessive alcohol use and alcohol-related harms. Reducing the number of days of sales was associated with decreases in alcohol-related harms, but evidence was

lacking to draw a direct conclusion between reducing days of sales and overall consumption.[128]

Currently, 13 U.S. states restrict off-premise alcohol sales on Sundays and an additional 20 states and the District of Columbia allow Sunday sales but with restriction on the hours, locations, or type of alcohol that can be sold;[129, 130] however, these numbers reflect a recent trend of loosening restrictions on Sunday sales.[131] In the past 10 years, seven states have repealed their Sunday sales bans, the most recent being Georgia where residents voted on November 8, 2011 to allow for the sale of alcohol on Sunday.[132, 133] Because of problems associated with the current economic downturn, several state legislatures have proposed repealing Sunday alcohol restrictions in order to gather additional revenue from sales.[134, 135]

Another type of restriction on alcohol sales is a limit on the total hours alcohol can be sold. Again, examination of the effect of loosening the hours of sales has shown negative results. Researchers in Australia examined the effect of allowing certain hotels to stay open one hour later. They found a significant increase in the number of alcohol impaired driving crashes and assaults occurring at those hotels and an increase in the amount of wholesale alcohol purchased. [136, 137] The studies, however, were unable to determine if the increases in alcohol purchases and impaired traffic crashes were the result of increased patronage due to later trading hours or to an increase in the amount of alcohol consumed by individuals.[136, 137] Another review conducted by the Task Force on Community Preventive Services found that increasing the hours of sale by two or more hours was significantly associated with increases in alcohol-related harms, but changes in consumption levels could not be determined.[138]

II.c. Policies Focused on Increasing the Price of Alcohol

Research has shown that increasing the price of alcohol is an effective strategy to reduce alcohol consumption and initiation of use.[100, 139-141] The price elasticity (i.e., the amount that demand for a particular good will decrease when faced with an increase in the price of that good) ranges from 0 to -1.4 for beer (which means that a 10% increase in the price of beer results in up to a 14% reduction in consumption), -0.4 to -1.8 for wine, and -0.1 to -2.0 for distilled spirits.[142] Higher alcohol prices are associated with less youth drinking, less heavy and binge drinking, fewer motor-vehicle traffic crashes and fatalities, less alcohol-impaired driving, less all-cause mortality and mortality from liver cirrhosis, decreased violence, decreased sexually transmitted diseases, and less alcohol dependence.[142, 143]

The most common way to increase the price of alcohol is through alcohol taxes. There are three types of alcohol taxes: (1) excise tax, (2) ad valorem excise tax, and (3) sales tax. Excise taxes can be assessed at the state and federal level, are based upon a specific volume of alcohol purchased, and differ by type of alcohol sold (i.e., beer, wine or distilled spirits). Excise taxes are not indexed to inflation and, therefore, must be adjusted over time to prevent erosion of the effect in reducing alcohol-related harms.[144] A few states assess an ad valorem excise tax on alcohol that is based on the sales price and is, therefore, indexed to inflation. Finally, sales taxes on alcohol can be assessed at the state and local level (i.e., county or city) and is based upon a percent of the sales price. This dissertation focused on excise taxes since this is a tool used by almost all states.

The federal excise tax on alcohol was last raised in 1991 to $18.00 per 31-gallon

barrel of beer, $1.07 per gallon of wine (14% alcohol or less), and $13.50 per 100-proof gallon of distilled spirits, which in 1991 dollars translated to a tax of ten cents, seven cents, and 21 cents per ounce of pure alcohol for beer, wine, and distilled spirits, respectively.[13, 145] Since the federal excise tax was not indexed to inflation, the current tax rate per ounce of pure alcohol as of 2007 has dropped to five cents, four cents, and 13 cents for beer, wine, and distilled spirits.[13, 14]

State alcohol excise taxes have also not kept up with inflation. As of June 2011, only 16 states had raised their beer excise taxes since 1990, and only nine states had raised it within the last 10 years.[144, 146] Wyoming has not increased the tax on beer since 1935.[146] The state tax rate *per gallon* of beer as of January 1, 2011 ranged from $0.02 in Wyoming to $1.07 in Alaska.[147] In addition, taxes on wine (as January 1, 2011) ranged from $0.11 per gallon in Louisiana to $2.50 in Alaska.[146] The taxes on distilled spirits (as of September 1, 2010) ranged from $0.67 per gallon in Vermont up to $26.03 in Washington (an ad valorem mark-up was included in the excise tax calculation for Washington).[148, 149] From 2003 to 2007, a total of three states increased taxes on wine and five states increased taxes on distilled spirits (among states that do not have a monopoly on these types of alcohol sales);[133] however, during this same time period, two states decreased taxes on wine and four states decreased taxes on distilled spirits by repealing sales taxes, lowering tax rates, or repealing surcharges on these products.[133] Most recently, with the vote in Washington state to privatize alcohol sales, the 52% mark up on liquor will end, lowering the tax on liquor.

One of the main opponents of increasing alcohol taxes is the alcohol industry. Representatives from the alcohol industry argue that the alcohol beverage industry

contributes nearly $448 billion to the U.S. economy (in 2006 dollars) and generates over 3.8 million jobs for U.S. workers.[150] Lobbying groups including the Brewers Association, American Beverage Institute, and the Distilled Spirits Council of the United States (DISCUS), which spent nearly $3.7 million in lobbying Congress in 2011 (down from about $4.9 million in 2010) press legislators on issues including increasing taxes.[151] These groups lobby against any tax increase at the federal and state levels. According to DISCUS, the 1991 federal tax increase on all alcoholic beverages eliminated 98,000 jobs, resulted in $1.3 billion in lost wages, and reduced federal alcohol excise tax revenues for the succeeding five years;[150] however, data from the Bureau of Labor Statistics showed that between 1990 and 2000, the beer-industry wholesale trade employment rose by more than 8,000 jobs, including increases between 1990 and 1992.[12, 152]

Additionally, the alcohol industry claims that raising alcohol prices through taxation harms responsible consumers of alcohol (i.e., "Joe Sixpack") and lower income drinkers.[153] The argument is that most consumers of alcohol are moderate drinkers, blue collar workers, married, who make less than $50,000 per year, and because of the regressive nature of alcohol excise taxes, are forced to spend a greater percentage of their income on beer than individuals with higher incomes;[154] however, research from two national surveys, the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) 2001-2002 and the 2004 and 2008 Behavioral Risk Factor Surveillance System, showed individuals making over $50,000 annually have a higher prevalence of alcohol use and binge drinking than individuals making less than $50,000 per year.[40, 50, 155] In addition, changes in excise taxes usually decrease the odds of whether a person drinks alcohol or binge drinks (versus abstains) but has little effect on the overall quantity

of drinks consumed by drinkers.[15] Since alcohol taxes are only paid by drinkers, those people most likely to be affected by price increases would be those purchasing (and consuming) a greater share of alcohol. Research has shown that the top 10% of heaviest drinkers in the U.S. (i.e., those reporting drinking more than 2.5 drinks per day) consume over 60% of the total alcohol consumed.[156] These individuals are at increased risk of alcohol-related consequences and are a group for which public health interventions are needed. In a recent simulation study of a hypothetical $0.25 cent per drink tax increase, results showed that higher risk drinkers would pay over four times more than moderate drinkers after an excise tax increase.[155]

In summary, several effective policies to combat problems of excessive alcohol use and binge drinking do exist; however, many of these policies have been weakened over time or their enactment is strongly opposed by the alcohol industry. Given the current situation facing public health advocates, it may be worth exploring whether strategies aimed at reducing risk behaviors commonly associated with binge drinking and other forms of alcohol use have the potential to also reduce alcohol consumption.

III. Tobacco Use

Binge drinking and other types of alcohol use are highly correlated with other substance use behaviors, the most common being tobacco use. Tobacco use has been studied extensively and provides an excellent opportunity to test whether interventions aimed at smoking also reduce binge drinking. A brief overview of tobacco prevalence and consequences is provided in the next sections to better understand the populations most likely to smoke and the resulting health problems.

III.a. Prevalence

Tobacco use is the single most preventable cause of death in the U.S. each year, accounting for approximately 443,000 premature deaths and about 5.1 million years of potential life lost.[157, 158] Between 2000 to 2004, cigarette smoking (the most common form of tobacco use) in the U.S. was responsible for $193 billion annually in health-related economic losses.[158]

As with alcohol use, tobacco use can be described in both clinical settings (usually in association with dependence) and in the general population through surveillance methods. Nicotine dependence is defined by the following DSM-IV criteria: (1) tolerance; (2) withdrawal; (3) smoking in larger amounts or longer than intended; (4) persistent desire or unsuccessful efforts to cut down; (5) spending a great deal of time obtaining cigarettes or tobacco products, and using or recovering from smoking; (6) giving up activities in place of smoking; and (7) continued use despite physical or psychological problems caused or exacerbated by smoking.[31] Approximately 36 million people aged 12 or older in the U.S. are classified as nicotine dependent.[159] Among past month cigarette smokers, 58% meet the criteria for dependence.[159] Nicotine dependence develops much more rapidly than alcohol dependence.[160]

III.a.i. Current Smokers

Smoking behaviors are usually described by both lifetime prevalence of smoking and current (i.e., past 30 day) use to classify individuals as current, former, or never smokers.[27, 161] Current smokers are defined as having smoked at least 100 cigarettes or more during their lifetime and currently smoking every day or some days.[44, 162] In

addition, current smoking is also defined by the intensity or the number of cigarettes a person smokes on average and the frequency of smoking (daily or nondaily). Though consistent definitions exist for defining someone as a daily or nondaily smoker (i.e., smoked less than 25 days in the past 30 days), cut points are not consistent in classifying someone as a light, moderate, or heavy smoker. These distinctions are useful when determining if someone is nicotine dependent.[163, 164] Approximately 21% of adults aged 18 years and older are current smokers, a significant decrease from a peak of over 50% of the U.S. adult population during the 1960s.[157, 165, 166] The majority (over 60%) of current tobacco users report smoking every day while 22% smoke some days; those who smoke every day are more likely to show nicotine dependence.[49, 157, 167] Less than half (45.2%) of daily smokers aged 12 and older report smoking one pack or more per day.[49, 168, 169] Current smokers are more likely to be male, and smoking is more prevalent in the Midwest and the South.[49, 157, 165] Smoking prevalence peaks among persons aged 21 to 29 years with approximately 36% of individuals in this age range reporting smoking. The prevalence among individuals aged 65 and older is approximately 9%.[168]

Estimates of current smoking among different racial/ethnic groups vary. Some studies show African Americans have the highest prevalence of smoking[38] while others show whites have the highest prevalence,[49, 168, 170] and still others show no difference between the two groups.[171] Among young adults (18 to 25 years), whites are more likely to report smoking (41%) than African Americans (26%).[49] Among adults aged 26 and older, a similar prevalence between whites and African Americans is usually reported (25% and 26%, respectively).[49] One distinction between white and African American smokers is that African Americans are significantly more likely than whites to report

smoking menthol cigarettes.[172] Both whites and African Americans show a significantly higher prevalence of current smoking than individuals of Hispanic ethnicity.[49, 157, 168]

Unlike binge drinking, college students are less likely to report current smoking than their noncollege attending peers (13% versus 30%, respectively).[49, 168] Approximately 44% of college students smoke less than one cigarette per day and only 12% smoke more than one pack a day.[173] As a result, most college students are generally considered "social smokers" and tend to report smoking only in social settings with other people rather than when alone.[174] Among college students who smoke, there does not appear to be a difference in prevalence between males and females, but white students report a higher prevalence than African American students.[173]

As with binge drinking, smoking and other tobacco use vary by occupational status. Among active duty military, approximately 30% of personnel reported current smoking in 2008.[175-177] The military has taken to reduce the problems of smoking among military personnel.[178] Similar to estimates from the civilian population, smoking prevalence tends to be higher in active duty military members who are male, white, and have no college education.[176] Smoking prevalence is highest among personnel aged 20 or younger (45%) and lowest among those aged 35 and older (21%).[177] Additionally, the highest prevalence of smoking occurs among the lower enlisted ranks, generally made up of some of the youngest service members.[175, 176] Overall, about 16% of males and 12% of females began smoking after enlisting.[175, 176] Smoking prevalence is generally higher among Army and Marine Corps personnel than those enlisted in other branches.[175-177] The prevalence of heavy smoking (smoking one or more packs of cigarettes per day) among Army and Marine Corps personnel (about 13%) is about double the prevalence

among Air Force (6%) personnel,[175] and nicotine dependence follows a similar pattern (11% and 5%, respectively).[176] Similar to results found for binge drinking, overall smoking and heavy smoking is higher among active duty military personnel than civilians even after controlling for age, race/ethnicity, sex, and educational attainment.[63]

III.a.ii. Former Smokers

Former smokers are individuals who have smoked at least 100 cigarettes in their lifetime but do not currently smoke.[160] Among current smokers, 52% stopped smoking for more than one day in 2010 because they were trying to quit (about 23 million people).[165, 179] Quit attempts were highest (62%) in the younger ages (18-24 years) and decreased with age to 43% of current smokers aged 65 and older reporting a past year quit attempt in 2010. [179]

The population quit ratio (i.e., the proportion of former smokers to ever smokers) varies by race/ethnicity.[179, 180] Whites are more likely to report being former smokers than African Americans (27% versus 16%). Some of the variation in race/ethnicity population quit ratios is due to the type of cigarettes smoked. Research has shown that menthol smokers, who are more likely to be African Americans, are more likely to report a quit attempt but are less likely to successfully quit than nonmenthol smokers.[172, 181]

The military has shown a substantial decrease in smoking prevalence from 51% in 1980 to 30% in 2008.[175] Among all the branches of service, about 16% of smokers quit in the past year and 48% attempted to quit.[175] Members of the Air Force were more likely to report successfully quitting in the past year compared with the other branches.[175]

In addition, the majority of military retirees (68%) report being former smokers suggesting an adoption of a healthier lifestyle over time.[182]

III.b. Consequences of Smoking

Tobacco smoke contains over 7,000 chemicals, many of them known to be toxic to humans, including arsenic, formaldehyde, and hydrogen cyanide.[183] In 1964, a landmark Surgeon General's report released by the U.S. Public Health Service concluded that cigarette smoking was a major cause of lung and laryngeal cancer in men, a probable cause of lung cancer in women, and the most important cause of chronic bronchitis.[184] In the years since the first Surgeon General's Report, over two dozen reports have been produced outlining additional health consequences associated with smoking, including additional cancers, emphysema, chronic lung diseases, pneumonia, and cardiovascular disease.[185] Women of reproductive age who smoke are at increased risk of adverse pregnancy-related health outcomes, including problems conceiving, infertility, stillbirth, low birth weight of the baby, and sudden infant death syndrome (SIDS).[186] Exposure to second-hand smoke, as outlined in a Surgeon General's Report, can result in health consequences, including cancer, cardiovascular disease, a decrease in bone density, and an increase of asthma in children exposed to environmental tobacco smoke.[162] In addition, nicotine is highly addictive and the more someone smokes (both in quantity and duration), the more likely they are to develop dependency.[183]

Smoking and exposure to secondhand smoke resulted in over 400,000 deaths annually in the U.S. from 2000 to 2004, creating an economic burden of $193 billion per year.[158] The total economic costs (direct medical and lost productivity) associated with

cigarette smoking from 2000 to 2004 were estimated at $10.47 per pack of cigarettes sold in the U.S.[187, 188] Among adults aged 35 years and older, 41% of smoking-attributable deaths are caused by cancer.[158] The incidence of tobacco-related cancers is higher among men than women, higher among African Americans and non-Hispanics than other racial/ethnic groups, and higher among older individuals (aged 70 years or more) than those in younger age groups.[189, 190] The median smoking attributable mortality rate for the U.S. from 2000 to 2004 was about 260 deaths per 100,000 persons with a range about 140 deaths per 100,000 person in Utah to about 370 deaths per 100,000 persons in Kentucky.[191, 192]

IV. The Association between Tobacco and Alcohol Use

The next section will review the prevalence of smoking and binge drinking to highlight some of the similarities between these two behaviors. Following that section is a presentation of some of the possible reasons for the association between tobacco and alcohol use in helping to build a case of why tobacco use may be a viable option to reduce binge drinking.

IV.a. Prevalence of both Tobacco and Alcohol Use

The prevalence of both past year alcohol and tobacco use is about 20%.[193, 194] Approximately 7% of individuals in the general population are classified as both alcohol and nicotine dependent (as defined by the DSM-IV criteria).[194] Previous research has shown about 23% of individuals with nicotine dependence report a concurrent alcohol use disorder (i.e., abuse or dependence) while 35% of individuals with alcohol dependence report concurrent nicotine dependence.[195] Women with a history of regular

smoking are five to six times more likely to report a history of alcohol dependence than nonsmoking women.[196] Men who smoke are twice as likely to report alcohol dependence compared with nonsmoking men.[196] In addition, smokers are at increased risk of developing alcohol use disorders (abuse and dependence) than nonsmokers who drink in equal amounts.[197]

In the general population, about 44% of current smokers reported binge drinking at least once in the past month compared with 17% of nonsmokers.[168] In addition, current smokers are four times more likely to report frequent binge drinking (i.e., binge drinking at least five or more times in the past 30 days) than nonsmokers (about 16% versus about 4%).[168] Among drinkers, over half (55%) of frequent binge drinkers reported smoking in the past month compared with 17% of nonbinge drinkers and 16% of alcohol abstainers.[168] Individuals who report moderate or social smoking are more likely to report binge drinking in the past 30 days than regular heavy smokers.[198, 199] Even former smokers are more likely than never smokers to report binge drinking or heavy daily alcohol use.[199,197] Former drinkers report a prevalence of past-year smoking similar to that of light drinkers (i.e., those consuming alcohol below moderate drinking limits).[169] Prior research has suggested a dose-response relationship between rates of tobacco use and levels of alcohol consumption with a higher prevalence of smoking reported for frequent binge drinkers than for moderate drinkers. The lowest prevalence of smoking was reported among alcohol abstainers.[169, 193, 200]

The prevalence of both smoking and drinking is higher among men (28%) than women (16%).[193] Few studies have examined the association of these two behaviors by race and/or ethnicity in adults. One study by Falk and associates[193] found that American

Indian and Alaskan Natives were more likely to report concurrent use and concurrent dependence than whites or African Americans.[193] In a study of college students, white students were more likely to consume both alcohol and tobacco than African American students.[201] Among individuals over aged 60, African Americans who smoked had two times the odds of binge drinking than non-Hispanic whites.[202]

Both alcohol and tobacco use are more prevalent in younger age groups.[194, 203] Among 18 to 25 year olds, nondaily smoking is associated with higher levels of alcohol consumption.[204] Research has also shown that the majority of smoking episodes among college students occurs while under the influence of alcohol.[205] In addition, individuals who initiate smoking in college and who currently smoke consume more alcohol per occasion and are more likely to binge drink than students who never smoke.[206-208] Although both behaviors are common among active duty military personnel, there is a relative lack of information about the association of these two behaviors in this population.

As previously discussed, smoking and drinking are common among those who meet definitions of dependence and the two behaviors appear to be associated among certain sociodemographic groups. In order to understand how tobacco interventions may help reduce binge drinking, a clear understanding of some of the mechanisms – biological, environmental, and personal - that may influence the relationship between alcohol and tobacco use is needed.

IV.b. Biological Reasons for the Association of Tobacco and Alcohol Use

Several theories exist about the pharmacological effects on the brain of both nicotine and alcohol. Animal studies have shown the combined effects of nicotine and alcohol can reduce anxiety, thus, promoting the joint behaviors.[209, 210] In addition, alcohol and tobacco can both potentiate each other's rewarding effects. In human studies, however, results are mixed as to whether nicotine enhances the pleasurable effects of alcohol or vice versa.[211] Nicotine use decreases some of the sedative properties of alcohol, which may, in turn, promote the use of both.[212] Animal studies show that nicotine intake enhances the motivation to obtain alcohol and increases alcohol consumption.[213-215]

Over the past 10 years research has moved from discussing specific neurological reasons for the association between tobacco and alcohol to focusing on genetic influences of these two behaviors. A specific area of the midbrain called the ventral tegmental area (VTA) contains dopamine-releasing neurons that possess nicotine receptors.[211] Studies have found that blocking these receptors results in suppressed alcohol intake,[216] and less dopamine (a neurotransmitter involved in pleasure and learning) released when alcohol is consumed.[217, 218] Studies of the process by which a drug increases the tolerance to the toxic/aversive side effects of another drug may also explain why people combine smoking and drinking. Nicotine may increase alcohol metabolism through increased distribution and clearance, and the same may be found for alcohol's effects on nicotine.[219, 220] Research has shown that prolonged use of nicotine may decrease the pharmacological effects of alcohol, and chronic forms of alcohol use may decrease the effect of nicotine by acting on different receptors.[219, 220] Research into genetic reasons for the association of tobacco and alcohol use have focused on variations in specific genes

that may play a role in development of dependence.[221] Studies have shown a strong linkage to chromosome 15 in families of both alcoholics and heavy smokers and CYP2E1 which may play a role in ethanol metabolism in the brain where it is expressed and induced by both ethanol and nicotine.[221, 222]

Most of the research into neurobiological mechanisms of both alcohol and tobacco use have focused on either animal models, laboratory settings with human subjects, or individuals in treatment for dependence (either alcohol or tobacco);[211, 220] thus, these studies do explain some of the relationship between nicotine and alcohol use, but do not fully explain all the reasons why these two substances are commonly used together. Additionally, it is acknowledged that both smoking and alcohol use are strongly influenced by the environment. Since this dissertation is focused on determining from a public health standpoint ways to reduce binge drinking through smoking interventions, this next section will focus on nonbiological reasons for the association of tobacco and alcohol use.

IV.c. Social Cognitive Theory of the Association of Tobacco and Alcohol Use

Many of the personal and environmental influences affecting tobacco and alcohol use are the same.[223] For example, tobacco and alcohol consumption are more common among certain sociodemographic groups or people experiencing certain mental health states. In addition, smoking and drinking behaviors are both influenced by social norms, industry marketing, and environmental policies.[203]

Smoking and drinking are common among males, youth, and young adults, and initiation of these behaviors commonly occurs during adolescence and young

adulthood.[23, 49, 55, 157, 224] In addition, long-term use of either substance can result in addiction.[62, 177, 225] Both smoking and drinking are commonly used as coping factors to reduce general anxiety, attenuate withdrawal symptoms, or relax.[209, 226] In addition, individuals meeting guidelines for major depression are more likely to report heavy alcohol and tobacco use. [227-229]

Among college students, membership in a Greek society, a belief that most of your friends binge drink, and the use of drinking as a way to fit in are social norms that are all independently associated with smoking and binge drinking.[206, 230, 231] Certain locations are more likely than others to be acceptable places to engage in both smoking and drinking. For example, the most common locations at which individuals report both smoking and drinking is a bar (43%), another person's home (21%), and their own home (11%).[232] Recent implementation and enforcement of smoking bans in restaurants and bars are limiting public places where people can engage in both behaviors.

Both the tobacco and alcohol industries heavily promote smoking and drinking as fun and social activities. Both industries heavily market toward youth through the use of animals to sell their products (e.g., Joe Camel, Budweiser frogs) or marketing campaigns associated with movies or video games aimed at teens and youth.[233] Sponsorship of sporting events and use of advertisements during events that have large youth and teen audiences are common strategies used by both companies to market their products to the next generation.[234, 235] As a result, studies have shown an earlier age of smoking initiation among youth who report a favorite tobacco advertisement or receive tobacco promotional items compared with youth who do not show familiarity with the tobacco

industry.[236] In addition, awareness of beer commercials among fifth and sixth graders is significantly related to intentions to drink as adults.[237]

Lastly, tobacco and alcohol use are influenced by environmental policies aimed at regulating these two behaviors.[108] For example, enforcement of minimum purchasing ages for tobacco and alcohol has been shown to reduce binge drinking among college students and smoking among adolescents.[238, 239] In addition, taxes such as excise taxes are levied on both tobacco and alcohol to increase price and reduce or prevent consumption; however, tobacco and alcohol industries try to manipulate public policy to prevent increased regulation and control.[240, 241]

The prior examples describe two general influences – personal and environmental – to describe similarities between tobacco and alcohol use. The overall relationship between a behavior, a person, and the environment is best described by the social cognitive theory (SCT) originally proposed by Albert Bandura.[242] The SCT emphasizes the concept of triadic reciprocity through which the person, environment, and behavior all influence each other (Figure 1).[242] For example, if a person is in an environment that promotes alcohol or tobacco use, that person may be more likely to engage in those behaviors. Likewise, if a person is experiencing high levels of stress or anxiety, the risk of drinking and smoking also increases.

Within this model, both tobacco and alcohol consumption are influenced by similar personal and environmental constructs, and an additional aspect is that tobacco and alcohol consumption could also be influencing each other (Figure 2). Biological research in animals and alcohol dependent populations, suggests that one behavior can influence engaging in the other. This information combined with the knowledge

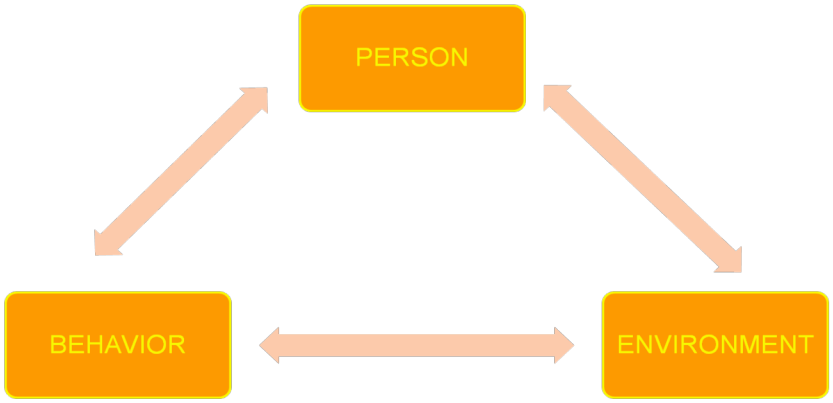


Figure 1. Bandura's social cognitive theory applied to triadic reciprocal causation

of the shared prevalence of both behaviors due to similar personal and environmental characteristics suggests that intervening on alcohol or tobacco use could influence engaging in the other behavior.

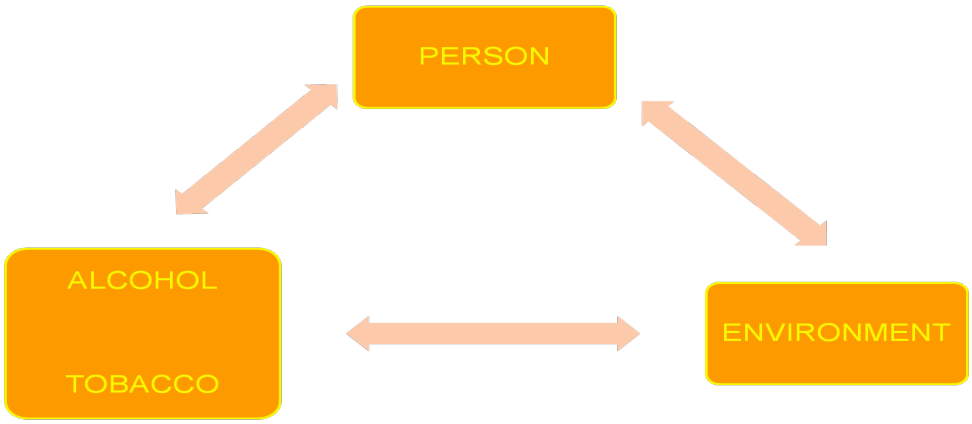


Figure 2. Interaction of alcohol and tobacco use in the social cognitive theory model

This dissertation is focused on exploring whether smoking interventions focused on a person (or individual-level) (i.e., getting people to quit smoking) or the environment (i.e., smoking bans or limiting days) that should result in a decrease in smoking can also

result in reductions in binge drinking. Before exploring these questions further, a discussion of specific tobacco interventions at both the individual- and environmental-level is needed.

V. Interventions Focused on Reducing Smoking and Other Tobacco Use

The implementation of tobacco control policies at the state and federal levels to reduce smoking and exposure to secondhand smoke have increased substantially over the past 15 years.[26] Individual-level interventions include (alone or in combination) nicotine replacement therapy, behavioral therapy, prescription drugs, support groups, etc. Environmental-level interventions are typically policies including those aimed at restricting where smoking can occur or raising the price of cigarettes.

V.a. Individual-level Tobacco Interventions

In 2010, about 69% of current smokers indicated they wanted to stop smoking.[179] Nicotine replacement therapy (NRT) is one of the most common methods to help individuals quit.[179] This method reduces withdrawal symptoms by substituting the nicotine obtained from smoking with that derived from alternative products, such as a gum, inhaler, patch, or lozenge, and based on a reduction schedule, slowly reducing the amount of nicotine intake over time.[243, 244] Studies have shown that NRT increases smoking cessation by 50 to 70%.[243]

In addition to NRT, behavioral interventions such as counseling or therapy can also increase smoking cessation. Effective behavioral therapies include physician advice, individual counseling, and telephone quit lines.[245-247] These behavioral therapies alone have been shown to increase smoking cessation and reduce the odds of smoking

relapse.[248] Physician advice (whether brief or more intensive) can increase the rate of quitting by over 60%.[249] Individual counseling including motivational interviewing techniques, can increase smoking cessation by over 30%,[245] and telephone quit lines can increase the odds of long-term smoking cessation by 40%.[246, 250]

V.b. Environmental-level Tobacco Interventions

Environmental or policy interventions to reduce smoking have been some of the most effective public health interventions over the past half century, and as a result, Americans have gained an average of 15 to 20 years of life expectancy from quitting smoking.[185] Most environmental-level tobacco control policies can be divided into three categories: (1) direct restraints on the use, manufacture or sale through laws or regulations; (2) economic incentives; and (3) education to inform or persuade.[26] A brief highlight of examples from each group follows.

V.b.i. Direct Restraints on the Use, Manufacture and Sale of Tobacco Products

One of the most popular strategies being used to restrain the use of tobacco is smoking bans. Smoking bans have increased recently among states and local municipalities and have spread from mass transit systems to workplaces, including bars and restaurants.[251] The most researched type of smoking bans are those related to the workplace.[252] Originally designed to protect nonsmokers from exposure to second-hand smoke, these laws also have the effect of decreasing smoking and increasing cessation among current smokers.[253, 254] One of the first industries to go completely smoke-free was the airline industry, which banned smoking on all domestic flights of less than two hours in 1988. In subsequent years the ban was extended to all U.S. flights and then, to

all international flights originating or ending in the U.S.[255] Workplace bans have consistently documented decreases in exposure to secondhand smoke among employees.[26] In addition, a significant reduction in smoking has been found following the introduction of smoking bans even after controlling for decreases of smoking in the community and high anti-smoking sentiment.[26, 254, 256] The most recent workplaces to begin adopting smoking bans are bars and restaurants. Beginning in 2002 with the state of Delaware,[257] states began adopting complete bans (i.e., no smoking allowed even in special ventilated areas) that included bars. As of January 2, 2012, 25 states had smoking bans that included restaurants and bars.[258] Research has shown that bans on smoking in restaurants and bars does not harm business revenue or bar and restaurant employment.[259-263] Most importantly, these bans have shown to improve the health of workers in these establishments.[264-266]

V.b.ii. Economic Incentives

Subsidizing smoking cessation treatment for individuals for either behavioral interventions and NRT or NRT alone reduces health care costs by reducing the disease burden of smoking and increasing demand for these interventions.[26,267] A study in Maryland assessed the effect of offering free nicotine patches to smokers participating in a program offered by a county health department.[268] Enrollment in the program increased by 37% after the introduction of free NRT and quit rates upon completion of the program increased from 38% to 65%.[268]

In addition to treatment, the use of telephone quitlines has been shown to be cost-effective in helping individuals to quit smoking.[269, 270, 246] Quitlines vary by states and

programs so evidence of the effectiveness of quitlines varies.[246] Most are usually free for participants and use certain types of motivational interviewing or cognitive-behavioral counseling techniques to help participants learn problem solving and coping skills in relation to quitting smoking and maintaining cessation. In 2004, the Department of Health and Human Services announced a National Smoking Cessation Quitline Network. The program has three components: (1) increase funding to states with existing quitlines to enhance services by expanding hours of operation, hiring bilingual counselors, building referral linkages with local health care systems, or promoting quitlines to more individuals; (2) give grants to states without quitlines to establish them; and (3) provide National Cancer Institute Cancer Information Service telephone counselors to individuals in states without quitlines.[271]

An additional economic incentive is to increase the price of cigarettes. Studies have found that cigarette prices and consumption are consistent with the universal law of demand; the relationship between the price of a certain good is directly related to the amount of that good that consumers are willing and able to purchase at a given price. The public health effect of increasing the price of cigarettes is substantial. Research has shown that the smoking elasticity of demand for adults is -0.3 to -0.5 (i.e., for every 10% increase in the price of cigarettes there is a 3% to 5% decrease in demand).[26] Youth price elasticity of demand is about two to three times that of adults.[26, 272, 273] Since the Master Settle Agreement (MSA), the price of cigarettes has increased substantially in the U.S., including a 45 cent per pack increase by the tobacco companies the day the MSA took effect in order to finance the settlement costs.[274]

The most direct way to increase the price of cigarettes is to raise the excise tax or sales tax on tobacco. Cigarettes and tobacco products are taxed by federal, state, and local governments. In 2009, the federal excise tax on tobacco was increased from $0.39 to $1.01 per pack.[275] State-level tobacco taxes have been a central feature in some states' health policy and planning. As of December 31, 2011 the average state cigarette excise tax rate was approximately $1.44 per pack and ranged from $0.17 in Missouri to $4.35 in New York.[276] From December 31, 1995 to April 1, 2009 a total of 107 separate cigarette excise tax increases and one decrease occurred in 45 states and Washington, DC.[277] At least 12 states use cigarette excise tax revenue to fund their tobacco control programs.[278]

V.b.iii. Education and Information

Another type of environmental strategy to reduce tobacco use is educating the public about the dangers of smoking. The first Surgeon General's Report to Congress on smoking and health was published in 1964.[184] Several studies have found that after the release of this report and subsequent media attention given to the results, adult per capita cigarette consumption decreased by 5%.[279] After the success of the first report, Congress mandated that the reports be published in ensuing years to continue investigating the harms associated with tobacco use.

One of the first tobacco control policies enacted after the original Surgeon General's report was the Federal Cigarette Labeling and Advertising Act of 1965.[280] This act required a warning label on cigarette packs, while the Federal Trade Commission pushed for warnings on advertising as well. Congress later passed the Public Health Cigarette Smoking Act of 1969 that required health warnings on cigarette packages (and

strengthened current labels to include specific diseases that smoking causes) and banned cigarette advertising in broadcast media.[281] Evidence of the effectiveness of cigarette warning labels in the U.S. is limited;[282, 283] however, evidence from other countries suggest it is not the warning about the health effects of smoking that is effective in reducing consumption, but how it is presented. In the U.S., the warning about health effects is in small print with uninteresting lettering located on the side of packs[284] while other countries have warning labels with larger print and graphic pictures.[283] Evidence from studies examining the effect of other countries' labels show that smokers take notice of these labels and are disturbed by them, and many claim an intention to quit smoking as a result of the labels.[283] As a result of passage of the Family Smoking Prevention and Tobacco Control Act of June 2009, the Federal Drug Administration has comprehensive control on tobacco products for sale in the U.S.[285] This act requires cigarette health warnings to cover the top 50% of the front and rear panels of the package, include graphic warning labels, and require tobacco companies to make public the nicotine content of their products.

VI. The Effect of Tobacco Interventions on Alcohol Use

Research into the effect of decreasing smoking on alcohol use shows promising results. A study by McKee and colleagues,[286] gave daily smokers who were also heavy drinkers (drinking at least three days per week and at least four drinks per episode for men and three drinks per episode for women) either a nicotine patch or placebo. Those given the patch delayed the onset of drinking and drank fewer drinks than those given the placebo.[286] In patients with alcohol dependence, some studies have shown that quitting

smoking may also prevent alcohol relapse.[287,288] A study by Hughes and colleagues showed no alcohol relapse in patients with past alcohol dependence who enrolled in a nicotine replacement therapy trial;[287] however, another study using buproprion to help alcohol dependent smokers quit smoking found those who had successfully quit smoking at six months reported higher abstinence from alcohol, drank less per day, or reported more alcohol abstinent days in the past 30 days, but these outcomes were not statistically different from those who did not quit smoking.[289] In other studies individuals in treatment for alcohol or drug use were more likely to be abstinent from both substances five years after treatment if they had quit smoking compared with those who had not.[290] A study by Gelsi and colleagues of patients in an alcohol detoxification program found higher abstinence levels among those who were not smoking versus current smokers.[288] Consequently, some studies have found that concurrent treatment of both alcohol and tobacco use among alcohol dependent patients may actually result in worse outcomes and failure to quit smoking and drinking.[19, 291, 292]

These studies do suggest that interventions reducing tobacco use may also affect drinking behaviors; however, most of these studies focus on alcohol dependent populations.[287, 289, 290, 293] Dependent populations are unique in that they show withdrawal symptoms from stopping a behavior, may have been using alcohol and tobacco in larger quantities than the general population, and may also have co-occurrence of mental health problems or other substance abuse problems that may result in outcomes that are unique to this group. [195, 294, 295]

The effect of smoking cessation on binge drinking and other types of drinking in non-alcohol dependent populations is unclear. A few studies have examined the effect of

smoking bans on subsequent alcohol use. Authors of a study conducted in the U.S. examining retirees found a positive association between smoking bans on reducing alcohol consumption but only for females.[296] In addition, they found that high relative prices of cigarettes (as a result of excise taxes) were associated with more consumption of alcohol (while tobacco consumption decreased). The authors suggested that cigarettes and alcohol could be economic substitutes (i.e., decreases in smoking result in increases in drinking), but the conclusions of this study must be taken in context since the population was limited to individuals aged 50 and older.[296] Another study in the U.S. found that smoking bans in bars decreased demand for beer and spirits but increased demand for wine;[297] however, a study in Scotland found no overall changes in alcohol consumption after a smoking ban in pubs was initiated.[298] The authors did find a decrease in alcohol consumption among moderate and heavy smoking pub attendees and a decrease in pub attendance in general among smokers. Interestingly, the authors also found an increase in pub attendance among nonsmokers after the smoking ban was implemented suggesting a shift in the population drinking in pubs.[298]

Studies examining the effect of price increases on cigarettes and subsequent alcohol consumption have also produced mixed results. A study in Australia found a significant and negative effect of the price of cigarettes on alcohol use.[299] These authors found that cigarettes and alcohol were economic complements and that decreases in cigarette consumption (due to increase in price) resulted in decreases in alcohol use, a result supported by other studies;[300-302] however, researchers of a study focusing on older adults (i.e., aged 50 years and older) in the U.S. found that higher cigarette prices lead to an increase in alcohol use,[296] supporting smoking and drinking as economic

substitutes.[303] Additionally, a study by Decker and Schwartz[304] using Behavioral Risk Factor Surveillance System (BRFSS) data from 1985 to 1993 found that as the price of cigarettes increased, alcohol consumption increased; however, a recent study using BRFSS data from 2001 to 2006 by McLellan[305] did not find a significant relationship between state cigarette taxes and alcohol use behaviors (i.e., current drinking, binge drinking and heavy drinking).

Given these results, the potential that reducing cigarette consumption could have on binge drinking in the general population is still unclear. Given the current and potential future erosion of many alcohol control policies, it is necessary to further explore whether tobacco interventions may provide an alternative strategy to reduce binge drinking.

VII. Conclusion

Binge drinking is related to many health and social consequences and is a common behavior in the general population. Although effective alcohol control policies exist, many of these have eroded over time or face strong political and industry opposition to implementation. Alcohol and tobacco use share similar environmental and personal influences and are highly prevalent. More research is needed to fully understand the relationship of these two behaviors in the context of personal and environmental influences and whether smoking cessation and tobacco interventions may lead to reductions in binge drinking. This dissertation focused on filling some of these gaps through the completion of three papers. The first paper examined the association between smoking behaviors and binge drinking in the active duty military (who have a

high prevalence of both binge drinking and smoking) and assessed how the perception of an alcohol-promoting environment or exposure to individual combat deployments may moderate this relationship. The second paper examined the effect of an individual-level smoking intervention (counseling) on binge drinking and average daily alcohol consumption in a population of African American light smokers. Finally, the third paper assessed the association between two environmental-level tobacco control policies (comprehensive smoking bans in bars and restaurants and tobacco taxes) and the prevalence and frequency of binge drinking among U.S. states.

Chapter 2 - Paper 1

The Association between Tobacco Use and Binge Drinking among Active Duty Military Personnel

2.1 Background

Binge drinking (i.e., consuming five or more drinks on an occasion for men or four or more drinks on occasion for women) is a common behavior among military personnel.[62] About 40% of active duty military report past month binge drinking compared with 15% of the overall population. [5, 62] Among military personnel, binge drinking is responsible for over half of non-combat-related hospitalizations and deaths.[92, 93, 306-310] In addition, binge drinking can adversely affect military readiness, workplace productivity, and safety and result in early separation from the military.[10, 164, 311] These types of consequences cost the Department of Defense in excess of $744 million per year (based on 2006 dollars).[164] Ideally, effective alcohol control policies would be implemented and enforced on both military installations and in the surrounding communities to reduce binge drinking and related consequences. Lack of enforcement of the age-21 minimum legal drinking age (especially for active duty military) and the lessening of effective alcohol control policies (i.e., limiting the hours and days of sale) some of which are attributable to aggressive tactics by the alcohol industry, undermine any effort to decrease binge drinking.[103, 128, 138]

An alternative strategy to reducing binge drinking may be through smoking interventions. Research has shown that in alcohol dependent populations quitting smoking can prevent alcohol relapse; [287, 289, 290, 293] however, dependent populations are

unique in that they show withdrawal symptoms from stopping a behavior, may be drinking alcohol in larger quantities than the general population, and may also have co-occurrence of mental health problems.[195, 294, 295] In the general population both alcohol and tobacco use are reported by 20% of the population,[193, 194] while the odds of binge drinking among smokers is four times that of nonsmokers.[49] The prevalence of both smoking and binge drinking among current active duty military is not known, but evidence suggests it may be high, since 81% of current smokers in the military report they are more likely to smoke while drinking.[312] In addition, military personnel report similar reasons why they smoke or drink (e.g., to relieve stress, peer pressure, culture of the military, easy access to cigarettes or alcohol).[312]

Before exploring whether smoking interventions may be able to decrease binge drinking, a better understanding of the relationship between smoking and binge drinking is needed. Binge drinking and smoking are two behaviors that share similar influences at the personal (e.g., used when stressed or to relieve anxiety) as well as the environmental level (e.g., both occur in context of bars or social settings). The social cognitive theory proposes that behavior, person, and environment all interact.[242] What is not known is the extent to which personal and environmental factors may affect the relationship between binge drinking and smoking. Understanding these influences may help in the identification of factors that could increase or decrease the association between binge drinking and smoking. This information could be used to determine the likelihood that tobacco interventions focused at either the individual or environmental level could have an effect on binge drinking.

There are many personal and environmental factors associated with binge drinking. This paper focused on one personal and one environmental factor unique to the military that have been much discussed in the research literature: the number of times a person has been deployed and the perception of the military environment as being alcohol-promoting.

Military deployment is associated separately with an increase in binge drinking and smoking. Recent research has focused on the effects of military combat deployments on binge drinking and other forms of alcohol use once the service member returns home.[313, 314] Among United Kingdom soldiers, deployment was found to be associated with high levels of stress and post-traumatic stress disorder[61, 313, 315, 316] and subsequent increases in alcohol use and binge drinking.[314] Heavy alcohol use rates (which include binge drinking) have also been found in U.S. active duty military personnel who were recently deployed (i.e., deployed in the past year) compared with those who were deployed more than three years ago.[176] Combat exposure is associated with military personnel reporting being intoxicated two or more times in the past month.[312] Additionally, deployment is also associated with increases in smoking initiation and relapse of smoking among military members who had quit.[317] Individuals serving in combat units have been found to be more likely to smoke than those serving in noncombat units.[312, 318]

Part of the struggle with curbing alcohol problems in the military is the perception that drinking is tolerated and is part of being in the military environment.[319] A study of Naval personnel showed that drinking to the point of intoxication was not necessarily viewed as inappropriate, especially if done in conjunction with liberty or shore leave.[269]

Alcohol is also part of many military traditions and rituals.[311, 320] The Marine Corps issued a directive in 2007 that allowed for base commanders to lower the drinking age to 18 for events on base so that underage youth can partake in alcohol consumption.[321] In fact, 36% of all service members (with 41% of Marine Corps participants) feel that drinking alcohol is part of military culture.[312] About 20% of all service members have felt encouraged to drink alcohol.[312] Enforcement of alcohol control policies varies based on duty station (service members overseas report less enforcement in general) and branch of service (Marine Corps personnel report greater limits on the amount of alcohol allowed in barracks than Air Force personnel).[312] In addition, the beer and tobacco industries commonly target active duty military through promotions, free products, and direct marketing.[317, 322-325]

To better understand the relationship between smoking and binge drinking and how personal and environmental influences affect this association, this paper examined two primary research questions: (1) Are current smoking status and intensity of smoking associated with past-30 day binge drinking among non-alcohol dependent active duty military personnel? and (2) Are the observed associations between smoking behaviors and binge drinking moderated by personal (the number of times the service member has been deployed) or environmental (perception of an alcohol-promoting environment in the military) influences? It was hypothesized there would be a significant and positive association between smoking status and intensity of smoking and binge drinking among military personnel, and this relationship would be stronger in persons who believe the military environment is favorable to drinking or have been deployed frequently.

2.2 Methods

Data used in this study were obtained from the Department of Defense Survey of Health Related Behaviors among Military Personnel 2008, an anonymous, self-administered survey of health outcomes and health risk behaviors among current active duty military personnel conducted every two to three years by Research Triangle Institute (RTI).[175]

2.2.a. Sample

For each round of data collection, military personnel were randomly selected using a two-stage sampling frame to ensure a representative sample. The first stage involved randomly selecting 64 military bases after stratifying by service and region of the world. The second stage consisted of randomly selecting (without replacement) active-duty military personnel on these bases stratified by rank and sex. Officers and women were oversampled because of their smaller numbers. Individuals excluded from participating were recruits, service academy cadets, personnel transferring to another base during data collection, those who left the military during data collection, those who were absent without leave (AWOL), or those who had an unknown status. Because of nonresponse, post-stratification adjustments were made by branch of service, age, and race/ethnicity to maintain the representativeness of the sample. Details of the nested sampling, purpose, method, and analysis are published elsewhere.[175]

The overall response rate for the 2008 survey was 70.6%, a rate based on the number of completed, usable interviews of personnel who were eligible to participate in the survey. Nonrespondents were people who either did not show up for the survey session during their scheduled time or did not return a completed survey. The final sample size was 28,546. The 2008 survey included individuals serving in the Coast

Guard; however, we removed these individuals from the analyses to restrict our sample to only those serving in the Department of Defense.

In addition, to limit the analyses to non-alcohol dependent military personnel, individuals were removed from the sample who appeared to show signs of alcohol dependence based on a summary cutoff score of 16 on the Alcohol Use Disorders Identification Test (AUDIT),[34] which is included in the survey. This is a slightly lower threshold for a diagnosis of alcohol dependence than specified in the AUDIT (score of 20). Lower thresholds have been used in other studies to assess alcohol dependence and found to be reliable.[326] The rational for using a lower threshold with this study was the inclusion of both women and younger individuals in the study sample for which lower cutoff points for the AUDIT are suggested.[327] The final analytical sample was 23,210 (Table 1).

2.2.b. Survey

The Department of Defense Survey of Health Related Behaviors among Military Personnel is cross-sectional and has been conducted every two to three years since 1982. All questionnaires were accompanied by text explaining the purpose of the study and assuring participants that their responses will be kept confidential and anonymous. Data for the proposed paper were taken from the most recent survey data that are publicly available; this 2008 survey was administered between May and July 2008. Ninety percent of the surveys were completed during group sessions held on selected bases. These survey sessions were administered by RTI staff. The remaining surveys were administered by mail for individuals stationed overseas. These participants were mailed a copy of the survey and asked to return it by mail to RTI when completed.

2.2.c. Measures

Outcome variable

Binge drinking was assessed using the following question: "*During the past 30 days, on how many days did you have 5 or more drinks of beer, wine, or liquor on the same occasion (4 or more if you are a woman)?"* Binge drinkers were coded as a "1" if they reported any days of binge drinking in the last 30 days and "0" if they did not binge drink or did not drink any alcohol in the past 30 days. Over 40% of the total sample reported binge drinking in the past 30 days.

Explanatory variables

Smoking behaviors

Smoking behaviors were included in the model as two separate indicators: current smoking status and the average number of cigarettes smoked per day, which is a measure of smoking intensity. To categorize participants by smoking status, (either current regular smoker, former regular smoker, or never regular smoker), two survey questions were used. The first question was "Have you ever smoked at least 100 cigarettes in your entire life?" If participants reported that they had never smoked at least 100 cigarettes, they were coded as never regular smokers (58% of the total sample). The second question was "What is the best estimate of the number of days you smoked part or all of a cigarette during the past 30 days"? If participants responded that they did not smoke any cigarettes in the past 30 days, they were categorized as former regular smokers (about 13% of the total sample). If participants responded that they had smoked at a minimum of one or two days in the past 30 days, they were categorized as current regular smokers (about 30% of the total sample).

To determine the intensity of smoking, the frequency of smoking and the quantity of cigarettes smoked in the past 30 days were averaged together to obtain a measure of average cigarettes smoked per day. First, responses for the number of days in the past 30 days someone reported smoking were given a numeric value. Responses options were originally grouped into categories (all 30 days, 20 to 29 days, 10 to 19 days, 6 to 9 days, 3 to 5 days, 1 or 2 days), and the midpoint of each category was chosen to represent the mean number of days in the past 30 days that a person had smoked. Second, participants were asked to think about how many cigarettes they had smoked on a typical day in the past 30 days. Response options were originally grouped into the following categories: more than 35 cigarettes (about 2 packs a day or more), 26 to 35 cigarettes (about 1 ½ packs a day), 16 to 25 cigarettes (about 1 pack a day), 6 to 15 (about ½ a pack a day), 2 to 5 cigarettes a day, 1 cigarette a day, less than 1 cigarette a day, on average. The numerical midpoint of each category was used except for the last two categories for which "1" was used for 1 cigarette a day and "0.5" was used for less than 1 cigarette a day. The mean number of cigarettes was multiplied by the mean number of days that participants reported smoking and divided by 30 to obtain the mean number of cigarettes smoked per day in the past 30 days. The mean number of cigarettes calculated was then categorized into the following groups: Nonsmokers (69%), Half a pack or less (10 cigarettes or less) (23%), More than half up to 1 pack (11 to 20 cigarettes) (7%), More than 1 pack up a day (2%).

Moderators

Alcohol-promoting Environment and Deployment

To determine whether personnel perceived the military environment to be alcohol-promoting, ten survey questions were used. Nine of the survey questions asked the respondents on a 5-point Likert scale to indicate how much they agreed or disagreed with a group of statements about alcohol. These statements included themes about drinking as a way of fitting in, leadership and peers being tolerant of alcohol intoxication, and drinking at social functions. An additional question was included that asked respondents if they were aware if their supervisors drank alcohol. Any response option that was listed as "Don't Know" or "No Opinion" was coded as missing. A factor analysis was run with the ten questions using SAS Proc Factor. Responses loaded on one factor with an eigenvalue of greater than one that explained about 80% of the variance. Two questions were dropped from the analysis due to poor loadings onto the factor (loadings less than 0.3). These questions were related to whether there were non-alcoholic drinks available at social functions and whether base supervisors drank alcohol. The factor scores were output and log-transformed to correct for skewness. The resulting factor scores were modeled three ways to determine the best fit of this variable to the data. One model used the log-transformed factor scores as a continuous variable in the model. The second model divided the log-transformed factor scores into two groups using the mean as the split. The third model divided the log-transformed factor scores into four groups with about equal distribution.

To capture deployment status, we used the following question from the survey: "How many combat deployments (including peacekeeping missions) have you been on since September 11, 2001?" Response options were 0, 1, 2, 3 or 4, 5 or 6, and 7 or more. Reponses were combined into the following categories "0 times," "1 or 2 times," and "3

or more times." Approximately 44% of the sample reported they had not been deployed since 2001, 41% reported once or twice, and about 15% of the sample reported being deployed at least three or more times since 2001. Additionally, we categorized individuals by whether they had deployed in the previous 12 months by creating a dichotomous variable, labeling those who had deployed in the past year "1" and those who had not deployed in the previous 12 months (including those who have never been deployed) as "2". Approximately 29% of the total sample reported being deployed in the past 12 months while the remaining had either not been deployed or were deployed more than a year ago.

Since deployment differs by branch of service both in length and in type of deployment,[328] we were concerned that any moderation between deployment and smoking and binge drinking would vary by branch. Overall, deployment frequency varied with approximately 21% of the Navy and 16% of the Air Force being deployed three or more times since 2001 compared with only 10% of the Army and 11% of the Marine Corps. Additional models were run stratifying by branch of service to test for effect modification of deployment by smoking behaviors and binge drinking within each service.

Additionally, research has shown that individuals with a history of deployment may report higher levels of stress.[312] To help control for the effects of stress, responses to four general stress-related questions were tested for inclusion in the models. The questions asked how much stress the service member experienced at work or with his or her family in the past 12 months and how much that interfered with the ability to perform his or her military job. Response options were "A lot" coded as 3, "Some" coded as 2,

"A little" coded as 1, and "Not at all" and "Had no stress related to… in the past 12 months" coded as 0. The responses were summed across the four variables resulting in a range of 0 to 12 and this score was modeled as a continuous variable.

Covariates

Certain sociodemographic characteristics are known to be associated with binge drinking and were controlled for in the analyses.[23] Sociodemographic variables included in this study are as follows: sex; age group (17-20, 21-25 26-34, 35 or older); branch of service (Army, Navy, Marine Corps, Air Force); race/ethnicity (Non-Hispanic white, Non-Hispanic black, Hispanic, and Non-Hispanic other); pay grade or rank grouped categorically by Junior enlisted (E1-E3), Non-Commissioned Officer (E4-E6), Senior Non-Commissioned Officer (E7-E9), Warrant Officer (W1-W5), Junior Officer (O1-O3), Senior Officer (O4-O10); highest educational attainment (high school, some college, or college graduate); marital status (married and spouse is at present at current duty location, married and spouse is not present at current duty location, or not married); single parent (yes/no); and duty location (U.S. base, overseas location or onboard ships). In addition, information about whether a person had started smoking since joining the military was included as a dichotomous (Yes/No) variable in the model. Correlations were run to determine if the demographic variables were highly correlated with each other. A variable was dropped if the correlation between two variables exceeded 0.7. Based on these parameters, education was dropped from the model since it was highly correlated with rank and age.

2.2.d. Analysis

Bivariate analyses were run for all predictors and covariates with binge drinking status (Table 2). Potential moderators (alcohol promoting environment and deployment) were first checked for confounding by using the 10% rule; in other words, if the parameter estimates of the main effect of smoking behaviors and binge drinking changed by more than 10% after adding the potential moderator to the model, this variable was reclassified as a confounder and no further tests were conducted.

Research Question 1: *Is current smoking status or intensity of smoking associated with binge drinking among non-alcohol dependent active duty military personnel?*

To test the main effects model of smoking behaviors (smoking status and average number of cigarettes smoked per day) and binge drinking, a logit model was used:

$$\textbf{Logit (Binge}_i\textbf{)} = \beta_0 + \beta_1(\textbf{Smoke})\mathbf{x}_i + \beta_k\mathbf{z}_k$$

where β_0 is the intercept (i.e., the probability of binge drinking among never regular smokers for smoking status or nonsmokers for intensity of smoking); β_1 is the probability of binge drinking of former or current regular smokers compared with never regular smokers, or the probability of smoking up to a half a pack, a pack, or more than a pack of cigarettes per day compared with nonsmokers; and z represents k covariates included in the models. Statistical significance was measured with an alpha value of 0.05 with a Bonferroni adjustment for multiple comparisons. Separate models were run for current smoking status and intensity of smoking. Covariates were included in both models to control for sociodemographic differences.

Research Question 2: *"Are the observed associations between smoking behaviors and binge drinking moderated by the perception of an alcohol-promoting environment in the military or the number of times the service member has been deployed?"*

Analyses for Research Question 2:

For this research question, each of the main effects models from the first research question were modeled again with the inclusion of a main effect for the potential effect moderator and an interaction term of the potential effect moderator and each smoking predictor.

$$\textbf{Logit (Binge}_i\textbf{)} = \beta_0 + \beta_1\textbf{(Smoke)}x_1 + \beta_2\textbf{(Moderator)}x_2 + \beta_3\textbf{(Smoke X Moderator)}x_3 + \beta_k z_k$$

All three measures of alcohol-promoting environment (continuous log factor scores, dichotomous log factor variable, or a 4-level log factor variable) were modeled to determine if there was significant effect modification, and the model with the best fit was reported. To test for effect modification of deployment, models were first run testing the moderator with the entire sample (with the addition of stress in the model if significant). Then, the models were rerun stratifying the sample by past year deployment status. The models were run a third time with the sample stratified by branch of service (regardless of whether or not participants had deployed in the past year). Type 3 analyses of effects using a Wald chi-square test were used to determine if the interaction term (i.e., the effect modifier) was significant at the alpha = 0.05 level. All analyses were conducted using SAS version 9.2. Models were run using PROC SURVEYLOGISTIC, which can account for the complex sampling design and post-stratification weights of the data.

2.3 Results

Binge drinking varied significantly by branch of service with over half of active duty Marine Corps participants binge drinking in the past-30 days while the Air Force participants reported the lowest prevalence (37%) (Table 2). Males were more likely than females to binge drink (46% versus 29%). Non-Hispanic whites and Hispanics

reported a higher prevalence of binge drinking compared with other races (47% and 45%, respectively). Individuals with a high school education (or less), who were between the ages of 21 to 25 years, who were single (i.e., not married), or who were stationed on board a ship reported the highest prevalence of binge drinking compared with others in those categories. Nonsmokers reported a lower prevalence of binge drinking (34%) than current (63%) or former smokers (40%). Individuals who started smoking after joining the military were more likely to report binge drinking than those who had not (56% versus 41%, respectively).

The odds of binge drinking differed by smoking status with current regular smokers three times more likely to binge drink than never smokers even after controlling for demographic characteristics (Table 3). Former smokers also had an increased odds of binge drinking than never smokers. We conducted additional analyses to compare differences in binge drinking between former and current smokers. Current smokers had an increased odds of binge drinking compared with former smokers (AOR 2.23, 95% CI {1.98, 2.51}).

For intensity of smoking, those who smoked up to a half a pack per day had the highest odds of binge drinking compared with nonsmokers ($p<0.001$). Overall, smokers (no matter what their intensity of smoking) had almost three times the odds of binge drinking in the previous 30 days than nonsmokers. Additional analyses showed that the odds of binge drinking did not differ significantly between those smoking the least amount compared with those smoking more than one pack per day (AOR 0.99, 95% CI {0.72, 1.38}).

The next step in the analyses for this study was to test for potential moderating effects. After comparing model fit, the four-level measurement of the perception of an alcohol-promoting environment was used to test whether this perception moderated the association between smoking and binge drinking. Since the factor scores for measuring an alcohol-promoting environment had to be reverse coded before being log-transformed (due to negative skewness), the first quartile, which served as the reference group, represented the highest level of perception of an alcohol-promoting environment. Based on the main effects model (Table 4, first column), as the perception of an alcohol-promoting environment decreased, the odds of binge drinking increased with the fourth quartile (representing the lowest perception of an alcohol-promoting environment) having about a 60% increased odds of binge drinking compared with the reference group. The perception of an alcohol-promoting environment was not a statistically significant moderator for either current smoking status or intensity of smoking and binge drinking (Table 4, second column).

Among those who deployed once or twice since September 11, 2001, there was a significantly increased odds of binge drinking compared with those who had never deployed (Table 4, first column). Those who had deployed the most (3 or more times) reported a 22% increased odds of binge drinking compared with those who had not deployed; however, deployment was not a statistically significant moderator of the association between either current smoking status or intensity of smoking and binge drinking (Table 4, second column). Similarly, when stratifying results by whether the deployment occurred in the past year, no effect modification was found. Stress was not

included as a covariate in the final models since initial tests found it was not a confounder.

When stratifying by branch of service, there appeared to be effect modification of deployment on smoking status and binge drinking for both the Navy (p=0.004) and Marine Corps (p=0.036) (Table 5). Unadjusted results for the Navy showed that among those who have never deployed or deployed once or twice, never smokers have the lowest binge drinking prevalence followed by former smokers and finally current smokers (Figure 3). This relationship was different for those who had deployed three or more times with former smokers showing the lowest prevalence followed by never smokers and finally current smokers. After adjusting for covariates, current smokers who had either never deployed or had deployed three or more times were almost three times more likely to binge drink than never smokers who had never deployed (the reference group) (current smokers with no deployments = AOR 2.88 95% CI {2.21, 3.76}; current smokers with three or more deployments = AOR 2.90, 95% CI {2.11, 3.98}). Unadjusted results for the Marine Corps showed a similar pattern as the Navy with never smokers showing the lowest prevalence of binge drinking followed by former smokers and finally current smokers and this pattern was consistent across frequency of deployments (Figure 4). After adjusting for covariates, current smokers who had never deployed reported almost four times the odds of binge drinking compared with never smokers who had never deployed (3.82 AOR 95% CI {2.85, 5.12}). Since the parameter estimates for the interaction terms were positive for both the Navy and Marine Corps, deployment resulted in a synergistic multiplicative effect of the association between smoking status and binge drinking.

When examining intensity of smoking, the effect modification of deployment on average number of cigarettes smoked per day and binge drinking was only significant for the Marine Corps ($p<0.001$) (Table 5). Among the Marine Corps, there did not appear to be a dose pattern between smoking intensity and binge drinking and the patterns differed by deployment status (Figure 5). After adjusting for covariates, smokers who smoked up to a pack a day and had not deployed had over five times the odds of binge drinking compared with those who had never deployed and were nonsmokers (reference group) (AOR 5.56 95% CI {3.12, 9.94}). Due to small cell sizes, only results for those who smoked up to one pack a day (i.e., 20 cigarettes) are reported. The parameter estimates for the interaction terms were positive resulting in a synergistic multiplicative effect of the association between intensity of smoking and binge drinking.

2.4 Discussion

Overall, our results support earlier findings of a high prevalence of binge drinking and current smoking in the active duty military.[62, 175] Over 60% of current smokers reported binge drinking in the past 30 days, and the prevalence of binge drinking was similar across levels of smoking intensity. We found an increased odds of past month binge drinking among former smokers compared with never smokers; however, current smokers still had a higher odds of binge drinking than former smokers, suggesting a possible decrease in binge drinking when someone quits smoking.

We found an inverse relationship between someone's perception of the military environment as alcohol-promoting and binge drinking (i.e., an increase in the perception resulted in a lower odds of binge drinking); however, the perception of an alcohol-promoting environment was not a statistically significant moderator of the association

between smoking behaviors and binge drinking. One explanation may be that perception of an alcohol-promoting environment is just one factor that may influence drinking and could be associated with age and time in service. Drinking motives, personality characteristics, and the physical environment (such as price of alcohol or density of alcohol outlets around the base), may be greater influences on binge drinking than a perception of how pro-alcohol the environment is.[329-331] In addition, the perception of an alcohol-promoting environment may differ by branch of service and could be associated with the visibility of efforts to reduce alcohol use.[332-335] Most importantly, in a previous study using focus groups consisting of military members, participants who reported easy access to alcohol, especially in the barracks, were more likely to report higher levels of alcohol use; however, this finding varied by branch of service.[312] These factors may also play a role in the association between binge drinking and smoking, but more research is needed.

When examining whether deployment moderated the association between smoking and binge drinking, significant effects were found, but only in certain branches of service. The Navy and Marine Corps showed the highest odds of binge drinking among current smokers who had not deployed and for the Navy only, among current smokers who had deployed three or more times. Based on intensity of smoking, smokers in the Marine Corps who smoked up to a pack of cigarettes a day had the highest odds of binge drinking if they had never deployed. Consistent across these results is that members of the Marine Corps who have never deployed have a significantly increased odds of binge drinking associated with smoking. It may be that for the Navy, increased frequency of deployment is at least a partial contributor to increased binge drinking and smoking and

prevention efforts may want to focus on those returning from deployment. For the Marine Corps, however, members were least likely to report deployment and had the lowest prevalence of those who were deployed three or more times compared with other service branches. The lack of a substantial portion of the Marine Corps being exposed to deployment could be a reason for these results. Additionally, certain demographics groups (both in the general population and in the military) report a higher prevalence of binge drinking (males, younger ages, lower ranks, and single marital status).[23, 62] Among all the branches of the military, the Marine Corps has the highest proportion of individuals who are male, age 20 or younger, age 21 to 25 years, not married, and in the Junior Enlisted ranks.[312] These results highlight the need for prevention efforts in the Marine Corps to focus on the entire population.

Additionally, this study only focused on the effect of frequency of deployments. By only assessing frequency there may be important components of deployment missing that not only differ significantly between the branches of service but may also be a stronger influence on the association between binge drinking and smoking.[175, 314, 317, 336] One example is combat exposures during deployment. Members of the Army and Marine Corps are more likely to report being shot at, witnessing members of their unit being wounded or killed, or being fired upon than members of other branches.[175, 336] In addition, the length of time a service member is deployed greatly differs by service with the Army deployed for an average of 12-15 months, the Marine Corps seven months, the Navy (typically on board ship) for about six months, and the Air Force about three months. These factors increase stress of deployments and increase risk of developing symptoms of PTSD, which are associated drinking and smoking.[175, 337] Future research

should examine both combat exposures and length of deployment to better understand the possible association with binge drinking and smoking.

This study had several limitations. The study is based on self-reported behaviors about binge drinking and smoking. We know from previous research that self-reported alcohol use tends to be underestimated on population surveys;[338] however, even with this limitation, our study found binge drinking to be very common in this population. This study consisted of secondary data analysis, and therefore, limits the variables that can be used for the research questions. For example, the perception of an alcohol-promoting environment was assessed but information about the actual alcohol environment including price of alcohol or density of alcohol establishments around the base might have been a more robust measure, but was not included in the survey. The response rate for the survey was fairly high, but there is always a concern that respondents to health surveys may be differ in some ways from nonrespondents, especially in relation to adverse health behaviors. Several strengths of the current study include the large sample size, the use of standard measures for both binge drinking and smoking behaviors, and use of a non-alcohol dependent population to examine our research questions.

This is the first study to examine the association between binge drinking and smoking and how an alcohol promoting environment or deployment affected this association. There was a strong association found between binge drinking and smoking, raising the potential to examine possible spillover effects for smoking interventions on binge drinking. In addition, deployment and perceptions about an alcohol-promoting environment were assessed for potential moderating effects on the association between these two behaviors. Identifying potential modifiers helps us to better target

interventions. Future research should explore the potential moderating effects of the actual alcohol environment (rather than perceptions) including policies on or around bases. Finally, future research should also examine more specific exposures related to deployment (e.g., combat exposures, length of deployment) to better understand how these may influence smoking and drinking across the branches of service.

In conclusion, this study showed a strong association between smoking and binge drinking and that a personal factor (deployment) moderated this relationship, although the environmental factor (alcohol-promoting environment) did not.

Table 1. Characteristics of sample

	Number of respondents	Weighted proportion of military population
		(n=1,004,879)
All respondents	23,210	100%
Branch of service		
Army	5512	38.5%
Navy	6269	23.8%
Marine Corps	4631	12.6%
Air Force	6798	25.1%
Sex		
Male	16,659	85.0%
Female	6551	15.0%
Age (years)		
17-20	2378	14.4%
21-25	6971	30.9%
26-34	7279	29.8%
≥ 35	6582	24.9%
Race/ethnicity		
White	13,705	64.1%
Black	3928	16.9%
Hispanic	3262	10.2%
Other	2315	8.9%
Education		
≤ High school	6403	31.3%
Some college	10,921	45.4%
College graduate	5886	23.3%
Pay grade/Rank		
Junior enlisted	4789	20.0%
NCO	10,816	51.4%
Senior NCO	2855	10.6%
Warrant Officer	563	1.4%
Junior Officer	2385	9.8%
Senior Officer	1802	6.9%
Marital Status		
Married, Spouse Not Present	1840	8.3%
Married, Spouse Present	11,300	47.3%
Not married	9841	44.3%
Single Parent		
Yes	1828	6.1%
No	21,225	93.6%
Duty Location		
U.S. location	16,234	65.6%
Overseas location	5678	27.1%
Onboard ship	1298	7.3%
Spouse on Active Duty		

Yes	2956	9.3%
No	12,597	57.3%
Not married	7352	33.5%
Initiated smoking after joining military		
Yes	3223	14.1%
No	19580	85.9%
Cigarettes smoked per day		
Nonsmoker	16,290	68.9%
Half a pack or less	4828	22.9%
Half a pack to 1 pack	1270	6.6%
More than 1 pack	299	1.7%
Smoking status		
Current regular smoker	6080	29.5%
Former regular smoker	3007	12.5%
Never regular smoker	13,722	58.0%
Deployment frequency		
0 times	9845	43.6%
1 to 2 times	18,890	41.9%
3 or more times	22,197	14.4%
Alcohol-promoting environment		
First quartile	5292	27.6%
Second quartile	8968	19.8%
Third quartile	14,325	30.6%
Fourth quartile	17,930	22.0%

Table 2. Prevalence of binge drinking by sociodemographics and smoking behaviors among active duty military personnel, 2008

	Binge drank in the past 30 days	No binge drink in the past 30 days	p-value
All respondents	43.4%	56.6%	p<0.001
Branch of service			
Army	44.1%	55.9%	
Navy	44.5%	55.5%	p<0.001
Marine Corps	52.0%	48.0%	
Air Force	37.1%	63.0%	
Sex			
Male	46.1%	53.9%	p<0.001
Female	28.6%	71.4%	
Age (years)			
17-20	33.1%	66.9%	
21-25	56.6%	43.4%	p<0.001
26-34	45.8%	54.2%	
≥ 35	30.3%	69.7%	
Race/ethnicity			
Non-Hispanic white	46.6%	53.4%	
Non-Hispanic black	32.7%	67.3%	p<0.001
Hispanic	45.2%	54.8%	
Non-Hispanic other	38.7%	61.3%	
Education			
≤ High school	48.3%	51.7%	
Some college	44.5%	55.5%	p<0.001
College graduate	34.8%	65.2%	
Pay grade/Rank			
Junior enlisted	41.2%	58.8%	
NCO	48.4%	51.6%	
Senior NCO	36.7%	63.3%	p<0.001
Warrant Officer	36.8%	63.2%	
Junior Officer	44.1%	55.9%	
Senior Officer	23.9%	76.1%	
Marital Status			
Married, Spouse Not Present	44.0%	56.0%	
Married, Spouse Present	38.3%	61.7%	p<0.001
Not married	49.0%	51.0%	
Single Parent			
Yes	43.5%	56.5%	p<0.001
No	43.4%	56.6%	
Duty Location			
U.S. location	41.9%	58.1%	
Overseas location	45.3%	54.7%	p<0.001
Onboard ship	50.2%	49.8%	
Spouse on Active Duty			
Yes	39.5%	60.5%	

No	46.9%	53.1%	p<0.001
Not married	48.3%	52.7%	
Initiated smoking after joining military			
Yes	56.1%	43.9%	p<0.001
No	41.0%	59.0%	
Cigarettes smoked per day			
Nonsmoker	33.9%	66.1%	
Half a pack or less	63.0%	37.0%	p<0.001
Half a pack to 1 pack	64.7%	35.3%	
More than 1 pack	64.6%	35.4%	
Smoking status			
Current regular smoker	63.2%	36.8%	p<0.001
Former regular smoker	40.2%	59.8%	
Never regular smoker	33.7%	66.4%	
Deployment frequency			
0 times	39.9%	60.1%	p<0.001
1 to 2 times	46.0%	54.1%	
3 or more times	44.4%	55.6%	
Alcohol-promoting environment			
First quartile	37.1%	62.9%	p<0.001
Second quartile	44.4%	55.6%	
Third quartile	51.3%	48.7%	
Fourth quartile	54.8%	45.2%	

Table 3. Results of multivariate analyses assessing the association between smoking behaviors and binge drinking among active duty military personnel, 2008.

			Type 3 Analysis of Effects		
			Categorical variables		
	AOR (95% CI)	*p-value*	*df*	*Wald* χ^2	*p-value*
Smoking status:			2	537.77	<0.001
Current regular smoker	2.90 (2.65, 3.18)	<0.001			
Former regular smoker	1.30 (1.16, 1.46)	<0.001			
Never regular smoker (ref)	1.00				
Service:			3	69.84	<0.001
Army	0.96 (0.86, 1.07)	0.201			
Marine Corps	1.28 (1.14, 1.44)	<0.001			
Air Force	0.82 (0.74, 0.91)	<0.001			
Navy (ref)	1.00				
Duty station:			2	17.93	0.000
Overseas	1.19 (1.09, 1.30)	0.000			
Onboard ships	1.20 (1.03, 1.40)	0.021			
US (ref)	1.00				
Single parent:			1	1.90	0.168
Yes	0.90 (0.76, 1.05)	0.168			
No (ref)	1.00				
Age group:			3	347.56	<0.001
17 to 20 years	0.80 (0.66, 0.97)	<0.001			
21 to 25 years	2.39 (2.08, 2.74)	<0.001			
26 to 34 years	1.69 (1.49, 1.91)	<0.001			
35 and older (ref)	1.00				
Family status:			2	136.45	<0.001
Married, spouse not present	0.78 (0.67, 0.90)	0.000			
Married, spouse present	0.59 (0.54, 0.64)	<0.001			
Not married (ref)	1.00				
Sex:			1	230.32	<0.001
Female	0.48 (0.43, 0.52)	<0.001			
Male (ref)	1.00				
Paygroup/Rank:			5	33.48	<0.001
Junior enlisted	0.94 (0.74, 1.21)	0.645			
Non-commissioned officer	1.16 (0.93, 1.44)	0.189			
Senior non-commissioned officer	1.42 (1.14, 1.77)	0.002			
Warrant officer	1.09 (0.73, 1.62)	0.675			
Junior officer	1.39 (1.10, 1.75)	0.005			
Senior officer (ref)	1.00				
Race/ethnicity:			3	74.15	<0.001
Hispanic	0.99 (0.62, 1.36)	<0.001			
Non-Hispanic black	0.65 (0.58, 0.73)	<0.001			
Non-Hispanic other	0.74 (0.65, 0.83)	0.012			
Non-Hispanic white (ref)	1.00				
Initiated smoking after joining the military (Yes)	1.19 (1.06, 1.33)	0.004	1	8.50	0.004

	Type 3 Analysis of Effects				
	Categorical variables				
	AOR (95% CI)	*p-value*	*df*	*Wald* χ^2	*p-value*
Cigarettes per day:			4	597.43	<0.001
Half a pack or less	2.93 (2.67, 3.22)	<0.001			
Half a pack to 1 pack	2.85 (2.45, 3.32)	<0.001			
More than 1 pack	2.87 (2.13, 3.87)	<0.001			
Nonsmoker (ref)	1.00				
Service:			3	66.54	<0.001
Army	0.97 (0.87, 1.08)	0.601			
Marine Corps	1.28 (1.13, 1.43)	<0.001			
Air Force	0.82 (0.74, 0.91)	0.000			
Navy (ref)	1.00				
Duty station:			2	12.74	0.002
Overseas	1.16 (1.06, 1.27)	0.002			
Onboard ships	1.17 (1.00, 1.36)	0.054			
US (ref)	1.00				
Single parent:			1	1.86	0.173
Yes	0.90 (0.77, 1.05)	0.173			
No (ref)	1.00				
Age group:			3	343.90	<0.001
17 to 20 years	0.75 (0.62, 0.91)	<0.001			
21 to 25 years	2.30 (2.01, 2.64)	<0.001			
26 to 34 years	1.66 (1.47, 1.88)	0.002			
35 and older (ref)	1.00				
Family status:			2	126.74	<0.001
Married, spouse not present	0.79 (0.68, 0.91)	<0.001			
Married, spouse present	0.60 (0.54, 0.65)	<0.001			
Not married (ref)	1.00				
Sex:			1	224.96	<0.001
Female	0.48 (0.43, 0.53)	<0.001			
Male (ref)	1.00				
Paygroup/Rank:			5	33.20	<0.001
Junior enlisted	0.96 (0.75, 1.23)	0.743			
Non-commissioned officer	1.18 (0.95, 1.46)	0.135			
Senior non-commissioned officer	1.46 (1.18, 1.82)	0.001			
Warrant officer	1.12 (0.76, 1.67)	0.565			
Junior officer	1.39 (1.10, 1.75)	0.006			
Senior officer (ref)	1.00				
Race/ethnicity:			3	83.88	<0.001
Hispanic	0.96 (0.85, 1.07)	0.440			
Non-Hispanic black	0.63 (0.56, 0.70)	<0.001			
Non-Hispanic other	0.73 (0.64, 0.82)	<0.001			
Non-Hispanic white (ref)	1.00				
Initiated smoking after joining the military (Yes)	1.15 (1.02, 1.29)	0.019	1	5.55	0.019

Table 4. Main effects and interaction results of effect modifiers with smoking behaviors controlling for demographics*

	Main effects model		**Interaction model**		
			Type 3 effects		
Alcohol-Promoting environment	AOR (95% CI)	p-value	df	Wald χ^2	p-value
Smoking status:					
Current regular smoker	2.71 (2.45, 3.00)	<0.001			
Former regular smoker	1.25 (1.10, 1.43)	0.001			
Never smoker (ref)	1.00				
Alcohol-promoting environment:					
First quartile (ref)	1.00				
Second quartile	1.24 (1.10, 1.40)	0.001			
Third quartile	1.54 (1.38, 1.71)	<0.001			
Fourth quartile	1.61 (1.43, 1.82)	<0.001			
Interaction term:			6	10.71	0.098
Smoking status X alcohol-promoting environment	----------				
Cigarettes per day:					
Half a pack or less	2.76 (2.47, 3.07)	<0.001			
Half a pack to 1 pack	2.41 (2.03, 2.86)	<0.001			
More than 1 pack	3.34 (2.34, 4.77)	<0.001			
Nonsmoker (ref)	1.00				
Alcohol-promoting environment:					
First quartile (ref)	1.00				
Second quartile	1.25 (1.11, 1.41)	<0.001			
Third quartile	1.53 (1.37, 1.71)	<0.001			
Fourth quartile	1.60 (1.42, 1.81)	<0.001			
Interaction term:			9	5.52	0.787
Cigarettes per day X alcohol-promoting environment	----------				
Deployment					
Smoking status:					
Current regular smoker	2.83 (2.58, 3.11)	<0.001			
Former regular smoker	1.30 (1.16, 1.46)	<0.001			
Never smoker (ref)	1.00				
Deployment:					
1 or 2 times	1.18 (1.08, 1.29)	0.000			
3 or more times	1.22 (1.08, 1.38)	0.001			
Never deployed (ref)	1.00				
Interaction term:			2	5.99	0.200
Smoking status X deployment	----------				
Cigarettes per day:					
Half a pack or less	2.86 (2.59, 3.15)	<0.001			
Half a pack to 1 pack	2.82 (2.41, 3.30)	<0.001			
More than 1 pack	2.91 (2.13, 3.97)	<0.001			
Nonsmoker (ref)	1.00				
Deployment:					
1 or 2 times	1.00				

3 or more times	1.18 (1.08, 1.30)	0.000			
Never deployed (ref)	1.22 (1.08, 1.38)	0.001			
Interaction term:			6	8.99	0.174
Cigarettes per day X deployment	----------				

*Demographics include duty station, branch of service, single parent status, age group, sex, rank/pay group, race/ethnicity and whether the person initiated smoking after joining the military

Table 5. Results of tests for effect modification of the association of smoking behaviors and binge drinking by deployment stratified by branch of service, controlling for demographics*

	Type 3 effects for binge drinking		
Current smoking status X deployment	df	Wald χ^2	p-value
Branch of service			
Army	4	0.39	0.983
Navy	4	15.66	0.004
Marine Corps	4	10.28	0.036
Air Force	4	2.94	0.568
Cigarettes per day X deployment	df	Wald χ^2	p-value
Branch of service			
Army	6	3.11	0.795
Navy	6	3.77	0.707
Marine Corps	6	479.39	<0.001
Air Force	6	7.84	0.250

*Demographics include duty station, branch of service, single parent status, age group, sex, rank/pay group, race/ethnicity and whether the person initiated smoking after joining the military

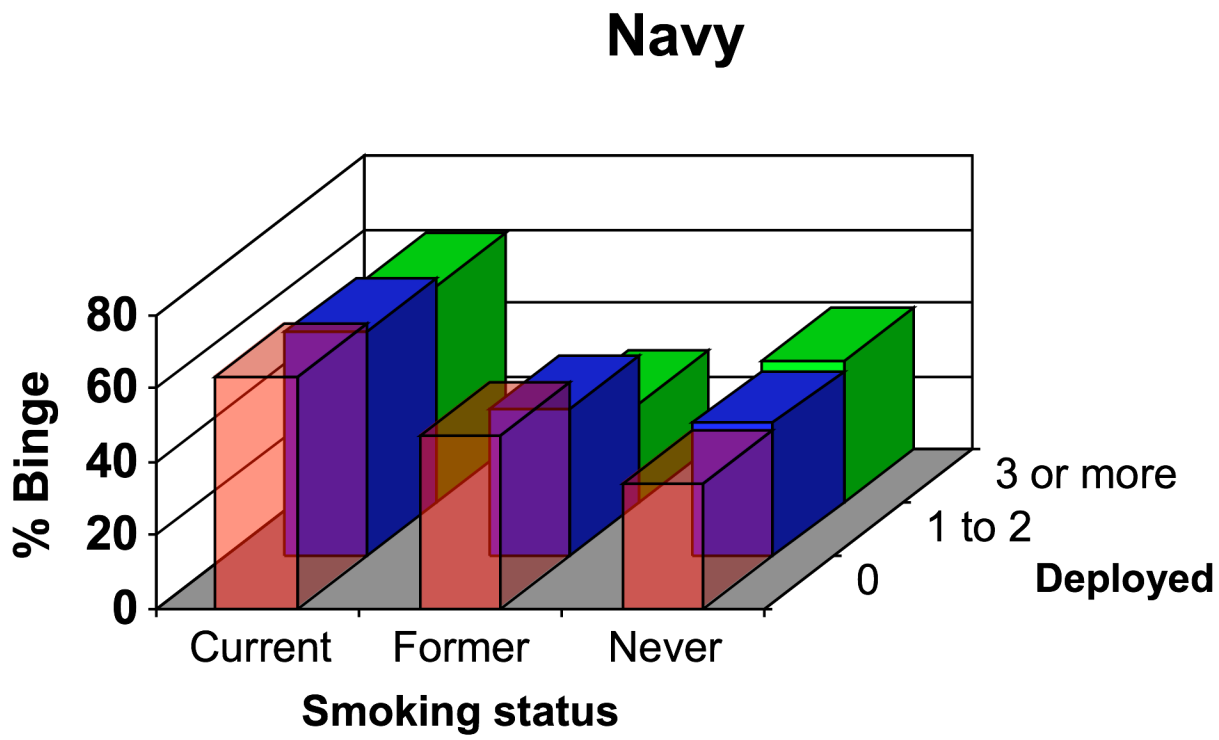


Figure 3. Unadjusted prevalence of binge drinking among Naval personnel by number of times deployed and current smoking status

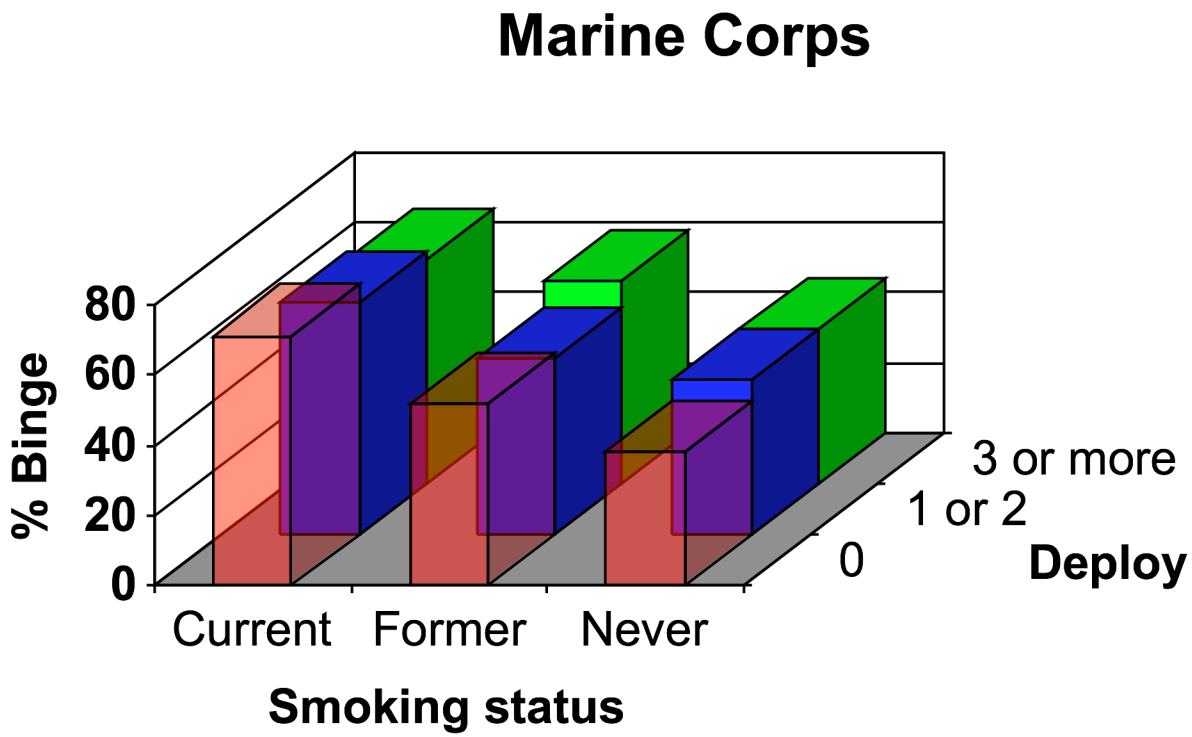


Figure 4. Unadjusted prevalence of binge drinking among Marine Corps personnel by number of times deployed and current smoking status

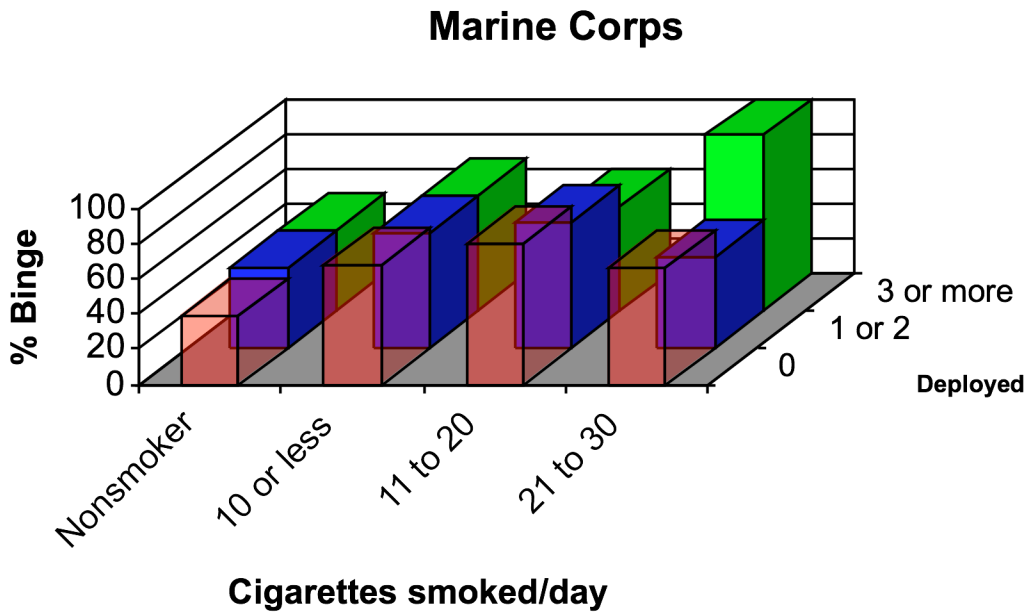


Figure 5. Unadjusted prevalence of binge drinking among Marine Corps personnel by number of times deployed and average number of cigarettes smoked per day

Chapter 3 - Paper 2

The Effect of an Individual-Level Tobacco Intervention on Binge Drinking among African American Light Smokers

3.1 Introduction

Binge drinking (i.e., consuming five or more drinks on an occasion for men or four or more for women) is a significant public health problem and contributes to more than half of the 79,000 alcohol-attributable deaths in the U.S. annually.[6, 23] Approximately 15% of the U.S. adults report at least one occasion of binge drinking during the past 30 days.[5, 23] African Americans report a slightly lower prevalence of binge drinking (10%) compared with other racial/ethnic groups;[23] however, they are more likely than other racial/ethnic groups to experience alcohol-attributable deaths from alcohol-related cancers, violence, and alcohol-related liver damage.[81, 339] In addition to mortality, compared with whites, African Americans suffer more alcohol-related diseases and injuries, including gastrointestinal ulcers,[340] liver disease,[341, 342] hypertension (especially among women),[343] and violence-related injuries resulting from intimate partner violence.[85, 344]

Binge drinking and other forms of alcohol use are commonly associated with tobacco use.[16] Approximately 10-15% of the total population reports both alcohol and tobacco use in the past year.[193, 194] Tobacco and alcohol use together account for a total economic burden of approximately $416 billion per year.[3, 189] The odds of binge drinking among smokers is four times that of nonsmokers and the odds of smoking among

frequent binge drinkers (i.e., individuals who binge drank five days or more in the past 30 days) is six times that of individuals who drink alcohol, but do not binge.[49]

Research has shown that engaging in either alcohol or tobacco use may influence the use of the other.[225, 345-347] Acheson and colleagues,[348] in a study of non-alcohol dependent individuals, found that smoking increased the amount of alcohol consumed at the same sitting. Additionally studies have shown that reductions in tobacco use can subsequently lead to decreases in alcohol use.[287, 288, 290] In alcohol dependent populations, studies show that individuals who quit smoking decreased their consumption of alcohol compared with those who did not quit smoking[288, 290] and reported fewer drinking relapses.[287] In a laboratory study of nondependent heavy drinkers (who were also smokers), administering nicotine replacement therapy (nicotine patch) delayed the participant's first drink and reduced the amount of alcohol consumed.[286] Most of these studies have limited generalizability, however, since they took place in a laboratory settings with participants who were heavy drinkers and smokers,[286, 348] involved populations seeking treatment for alcohol dependence,[287, 288] or involved individuals who had a history of alcohol abuse problems.[287] Additionally, none of these studies examined the possible differences by race or ethnicity in the effects of smoking cessation or tobacco interventions on alcohol use.

This study examined the effect of an individual-level tobacco intervention on multiple alcohol use behaviors, including binge drinking, in a sample of African American smokers using data from a randomized clinical trial called Kick It at Swope II (KIS-II).[349] The KIS-II study examined the combined effect of nicotine replacement therapy (NRT) and behavioral therapy on smoking cessation by randomizing 755

smokers to one of four treatment arms. Two arms received 2mg of nicotine gum combined with behavioral therapy (either motivational interviewing (MI) or health education (HE) counseling sessions) and two arms received 2mg of placebo gum and MI or HE behavioral therapy. Participants were followed for a total of six months. Approximately 15% of the total number of participants were not smoking at the end of six months.[350] A higher percentage of individuals in the nicotine gum and HE group quit smoking at six months compared with individuals in the nicotine gum and MI group (the full intervention group) (36% versus 19%).[350] There were no differences found in seven-day quit rates based on type of gum used, but there was a significant effect of the type of counseling received with individuals in the HE group more likely to quit than those randomized to the MI group.[350]

To further explore the effect of an individual-level tobacco intervention on alcohol use, the current study addressed three research areas. First, the tobacco interventions from the KIS-II study were assessed to determine their effect on past 30-day binge drinking prevalence, frequency, and average daily alcohol consumption. Since individuals in the HE group were more likely to quit smoking than those in the MI group, it was hypothesized that participants who received HE would decrease their alcohol use behaviors more than participants who received MI. Second, the observed effects of the intervention on alcohol use outcomes were assessed to determine if these were mediated by (or attributed to) a person quitting smoking. It was hypothesized that given the strong association between tobacco and alcohol use, any effect of the intervention on alcohol use would be fully explained by whether or not a participant quit smoking. Third, to further understand the relationship between smoking cessation and alcohol use, the effects of

quitting smoking on drinking, regardless of type of intervention received, was assessed. It was hypothesized that if observed reductions in alcohol resulted from individuals quitting smoking, then there should be reductions following smoking cessation regardless of intervention group.

3.2 Methods

3.2.a Study Design

The Kick It at Swope II (KIS-II) study was a double-blind, placebo-controlled randomized trial of African American light (10 cigarettes per day or less) smokers recruited from the Kansas City area. The study design used a 2 X 2 factorial design with four study arms. The study arms were (1) eight-week treatment of nicotine gum and six MI counseling sessions, (2) eight-week treatment of nicotine gum and six HE sessions, (3) eight-week treatment of placebo gum and six MI counseling sessions, and (4) eight-week treatment of placebo gum and six HE sessions. Participants were randomly assigned to one of the four arms of the study at the initial visit. Over the course of the study, four of the HE or MI counseling sessions were delivered in person, and two were delivered by telephone. All subjects received a culturally sensitive smoking-cessation guide addressing the health consequences of smoking 10 cigarettes or less per day, smoking menthol cigarettes, and being exposed to second-hand smoke. Participant recruitment began in March 2003 and follow-up data collection was completed by December 2004.

3.2.b. Sample

Participants were recruited through flyers, posters, physician letters, pharmacy inserts, newspaper advertisements, billboards, mass mailings, and religious organizations.

Of the 1933 individuals screened for the study, 1,015 were eligible and 755 enrolled in the study and were randomly assigned to one of the four treatment arms (approximately 189 in each arm). Participants had to be the following to satisfy the inclusion criteria: African American; 18 years of age or older; a light smoker (defined as smoking one to 10 cigarettes per day for six months or longer); a smoker on at least 25 of the past 30 days; interested in quitting smoking within 14 days of screening. In addition, participants had to have a functioning telephone number and current home address. Exclusion criteria included the following: the use of pharmacotherapy for smoking cessation in the past 30 days; the use of other forms of tobacco within the past 30 days; myocardial infarction, irregular heartbeat, heart attack, or stroke in the past four weeks; current jaw problem that precluded chewing of the nicotine gum; pregnancy, breastfeeding, or plan to become pregnant within six months; and another household member enrolled in the study. In addition, participants who planned to move from the Kansas City area within six months were excluded from the study.

Overall, the study population was predominantly female (67%) with a mean age of 45 years (SD = 10.7). Less than half (38%) of the sample reported being married or living with a partner, and most had at least a high school education (84%). Fifty-eight percent of participants consumed alcohol in the past 30 days, and 30% reported binge drinking.

3.2.c. Intervention

The intervention consisted of three components: 1) an eight-week treatment with gum (either 2mg nicotine gum or placebo gum), 2) six sessions of a behavioral therapy

(either HE of MI), and 3) a culturally sensitive smoking-cessation guide developed for African American light smokers.

Participants randomly assigned to an arm that included HE saw trained counselors who followed semi-structured counseling scripts tailored to the KIS-II project. Participants received the intervention in person at the initial visit and then again at weeks one, eight, and 16 and by telephone at weeks three and six. The HE technique focused on providing information and advice, reviewing the health effects of tobacco smoking, completing exercises at each session (e.g., setting quit plan, listing smoking-related habits and replacement activities, coping with smoking urges and relapse), setting a plan for the use of the gum, setting a date to stop smoking, and outlining a plan for preparing to quit. Follow-up sessions included assessment of barriers hindering smoking cessation. All counseling sessions were taped and rated by investigators to monitor adherence to the health education script. All counselors participated in a two-day in-service training before enrollment of participants.

Participants randomly assigned to one of the MI arms followed the same counseling session schedule as those randomly assigned to receive HE. Based on the work of Miller and Rollnick, motivational interviewing uses a direct, client-centered counseling style,[351] that consists of five key techniques: (1) expressing empathy, (2) developing discrepancy between the client's real and ideal behavior, (3) rolling with resistance, (4) avoiding argumentation, and (5) supporting self-efficacy. [352] For this study, MI was conducted by trained counselors following semi-structured counseling scripts. These sessions encompassed exploring both the positive and negative aspects of quitting smoking, the pros and cons for change, the participants' motivation for and

confidence in quitting smoking, and plans for change. In addition, participants were asked to identify key values and attributes in their lives, explore connections between smoking and their ability to live out these values, and state how quitting smoking might be related to these values. All counseling sessions were taped and rated by investigators to monitor adherence to the motivational interviewing principles. Counselors also received ongoing supervision for the duration of the trial and met weekly in a group setting with counselors and supervisors to review audiotapes and discuss current issues.

The culturally sensitive smoking-cessation guide was developed and tailored to the quitting needs and barriers of African American light smokers. The guide provided health information and contained brief exercises focusing on the pros and cons of smoking, reasons for quitting, social support, replacement techniques, stress-reduction activities, and relapse prevention. The guide was given to all participants before they were randomized to groups.

3.2.d. Data Collection

At the initial (randomization) visit, participants visited a research site where trained clinic staff collected baseline data. Staff read questions aloud to participants, ascertaining demographic information, smoking history and current smoking behavior, quantity and frequency of alcohol use and binge drinking in the past 30 days, and current level of stress using the four-item Perceived Stress Scale (PSS)[353] (additional baseline measures were collected, but were not analyzed for this study). Smoking cessation information was collected at six different time points in addition to baseline: weeks 1, 3, 6, 8, 16, and 26. Data from weeks 1, 8, and 16 were collected in person, and data from weeks 3 and 6 were collected by phone. Information about alcohol consumption was

collected at baseline, and weeks 8 and 26. Of the 755 participants randomized at baseline, 653 (86%) were followed up at week 1, 612 (81%) were followed up at week 3, 591 (78%) were followed up at week 6, 603 (80%) were followed up at week 8, 580 (77%) were followed up at week 16, and 637 (84%) were followed up at week 26.

3.2.e. Measures

Dependent variables

Three separate measures of alcohol consumption are used as dependent variables in this study: prevalence and frequency of past 30-day binge drinking, and average daily alcohol consumption. To determine past 30-day binge drinking prevalence, participants were asked "Considering all types of alcoholic beverages, how many times during the past 30 days did you have five or more drinks on one occasion?" If respondents answered they had binge drank one or more times in the past 30 days, they were coded as "1." Respondents reporting no binge drinking in the past 30 days were coded as "0." Frequency of past 30-day binge drinking was estimated using the total number of times participants reported having five or more drinks. To calculate average daily alcohol consumption, participants were asked about their frequency and quantity of alcohol consumed in the past 30 days. Frequency was ascertained by the following question: "A drink of alcohol is 1 can or bottle of beer, 1 glass of wine, 1 bottle of wine cooler, 1 cocktail, or 1 shot of liquor. During the past 30 days, on how many days did you have at least one drink of any alcoholic beverage?" Quantity was measured by the following question: "On the days when you drank, about how many drinks did you drink on average?" The frequency and quantity of alcohol consumption were multiplied together to obtain the total number of drinks consumed in the past 30 days and then divided by 30

to obtain the average number of drinks consumed per day; however, since most individuals underestimate their true average number of drinks by reporting modal drinking patterns,[338, 354] a technique called indexing was applied to these estimates to take into account episodes of binge drinking in the calculation of average number of drinks consumed per day.[355, 356]

Independent variable

The independent variable for the current study was intervention group. In the original KIS-II study results, a significant effect on quitting smoking was seen by type of counseling received but no effects were found by type of gum. Similarly, initial models for this study showed no differences in alcohol use by type of gum used. Given these results, all analyses were performed by collapsing groups by counseling type.

Covariates

Most of the smoking measures taken at baseline and all demographic information were examined to determine if any significant differences between counseling groups still existed after randomization (Table 6). Participants in the HE group reported a slightly higher mean level of perceived stress than those individuals randomly assigned to the MI group ($p=0.0319$). No other statistically significant differences were observed. In all analyses, mean level of perceived stress was controlled.

Mediator

Measures collected to assess quitting smoking included self-reported number of cigarettes smoked in the past seven days, exhaled carbon monoxide, and cotinine (serum and saliva) levels. Previous research has shown accuracy problems when using serum cotinine or exhaled carbon monoxide as measures of successful quitting among African

Americans.[357, 358] Based on their review of the literature, Hughes and colleagues[287] suggested that the number of cigarettes smoked in the past seven days is an appropriate measure of quitting in cessation-induction trials. Based on this information, we coded individuals reporting zero cigarettes smoked in the past seven days were coded as quitters at each time point in the study.

3.2.f. Analyses

Attrition

The dataset includes missing data due to attrition. There were a total of 152 participants (20% of total sample) missing at week 8 and 116 (15% of total sample) missing at week 26 with improvements likely due to increased efforts to locate individuals lost to follow-up. Of greater concern, the percentage of participants missing differed by counseling group. Approximately 26% of individuals in the MI group dropped out of the study at week 8 compared with 14% in the HE group ($p<0.001$), and significant differences still existed between counseling groups at week 26 with 18% of the MI group and12% of the HE group missing ($p=0.028$). Attrition at week 8 and week 26 was not related to whether the person had reported past 30-day binge drinking at baseline ($p=0.854$ and $p=0.901$, respectively); however, differential attrition by counseling group could affect the results and further implications of this is discussed in the discussion section.

Analysis for Research Question 1: Did participants randomly assigned to HE decrease their past 30-day binge drinking prevalence and frequency, and average daily alcohol consumption more than participants randomly assigned to MI?

Multivariate models were estimated separately for each of the three alcohol outcomes. Since there was missing data on several subjects, analytical models were run that would not perform a listwise deletion of individuals with some missing data. The general linear mixed model (via SAS Proc MIXED)[359] utilized as a growth curve model was used for frequency of past 30-day binge drinking episodes and average daily alcohol use with both outcomes log-transformed to limit skewness and modeled as continuously distributed. The generalized linear mixed model (via SAS Proc GLIMMIX)[359] was used for past 30-day binge drinking prevalence, which was modeled as a binary distribution with a logit link function. In each model, perceived stress was controlled for along with baseline alcohol use (i.e., either past 30-day binge drinking prevalence or frequency, or average daily alcohol use). A TIME (baseline, week 8, week 26) by CONDITION (HE or MI counseling group) interaction was tested using a 2 degrees of freedom (df) test for each alcohol outcome with TIME as a random effect in the model. A further exploration of the overall test of counseling group with 1 df planned contrasts was conducted looking at the effects of the TIME by CONDITION interaction on each alcohol use outcome separately from baseline to week 8 and baseline to week 26. Statistical significance was assessed at alpha = 0.05.

Analyses for Research Question 2: Are observed effects of counseling group on alcohol use outcomes mediated by quitting smoking?

To determine if the observed effects of counseling group on alcohol use outcomes were mediated by quit smoking status, a two-step process was undertaken. First, a general linear model (for frequency of past 30-day binge drinking episodes and average daily alcohol consumption) or a generalized linear model[360] (for past 30-day binge

drinking prevalence) was estimated for counseling group and alcohol outcomes separately at week 8 and week 26. Second, the same models were estimated again but with the addition of quitting smoking (as measured by the 7-day prevalence of cigarettes smoked). The proportion of the association between counseling group and each alcohol outcome that was mediated by quitting smoking was estimated by dividing the standard error of the difference between the full model (with quitting smoking) and the main effects model (without quitting smoking). The results were compared to a standard normal distribution to test for statistical significance using a Sobel test.[361] Statistical significance was assessed at the alpha = 0.05 level.

Analyses for Research Question 3: Does smoking cessation affect alcohol use outcomes regardless of counseling group?

To determine if quitting smoking was associated with alcohol use outcomes regardless of counseling group, participants were first grouped together by their quit smoking status. Quitting smoking was assessed at weeks 1, 3, 6, 8, 16, and 26. Participants were divided into two groups: (1) those individuals who quit during the first eight weeks (when the majority of counseling sessions took place) and either successfully abstained for the rest of the study or did not begin smoking again until after week 8 (i.e., smoking at either week 16 or week 26) and (2) those individuals who either never quit smoking, quit after week 8, or vacillated between quitting and relapsing throughout the study. This measure was coded dichotomously with those who had quit smoking during the first weight weeks and/or continued to abstain coded as "1" and all others coded as "0." Both general linear mixed models (for frequency of past 30-day binge drinking episodes and average daily alcohol use) and a generalized linear mixed model (for past

30-day binge drinking prevalence) were estimated separately at week 8 and week 26, controlling for baseline alcohol consumption. Statistical significance was assessed at the alpha = 0.05 level.

3.3 Results

Research Question 1: Did participants randomly assigned to HE decrease their past 30-day binge drinking prevalence and frequency, and average daily alcohol consumption more than participants randomly assigned to MI?

The main effect for time from baseline to week 8 and baseline to week 26 was statistically significant for all three alcohol use outcomes with most of the reduction occurring from baseline to week 8 (Figure 6). The interaction of counseling group by time showed mixed results. None of the 2 df tests (i.e., the interaction of counseling group and time) were statistically significant, since most of the differences for alcohol use outcomes seen at week 8 were gone by week 26 (Table 7). All three alcohol use outcomes appeared to decrease from baseline to week 8 with those in the HE group showing larger decreases than participants in the MI groups (Figure 6). Of the 1 df tests (i.e., the interaction of counseling group and time from baseline to either week 8 or week 26), past 30-day binge drinking prevalence from baseline to week 8 showed a statistically significant difference by counseling group ($p=0.045$) (Table 7). Average daily alcohol use was marginally significant, and past 30-day binge drinking frequency was not statistically significant. At baseline, prevalence of past 30-day binge drinking was reported by about 20% of the HE counseling group and 16% of the MI counseling group; by week 8 the prevalence for each group decreased to 11% for the HE group and 13% for

the MI (Figure 6). There were no observed significant interactions between counseling group and time from baseline to week 26 for any of the alcohol use outcomes.

Research Question 2: Are observed effects of counseling group on alcohol use outcomes mediated by quitting smoking (Figure 7)?

The indirect or mediated effect of counseling group on alcohol use outcomes through quit smoking status was not statistically significant for any of the three alcohol use outcomes at week 8 (Table 8). The mediated effect approached statistical significance (p=0.064) for past 30-day binge drinking prevalence. On average, quitting smoking explained less than 1% of the total observed relationship between counseling group and all three alcohol use outcomes at week 8. At week 26, quitting smoking explained on average less than 2% of the relationship between counseling and all three alcohol use outcomes. For average daily alcohol consumption, the effect of counseling group on alcohol use was significantly mediated by quitting smoking (p=0.010) at this time point; however, the total effect of counseling group on average daily alcohol use (Counseling Group X Week for baseline versus week 26 for the 1df test in Table 7) was not statistically significant making the mediation results at week 26 meaningless.

Research question 3: Does smoking cessation affect alcohol use outcomes regardless of counseling group?

Participants who quit smoking before the majority of counseling sessions ended (week 8 or before) were significantly less likely to report past 30-day binge drinking prevalence at week 8 (p=0.035) than participants who did not quit smoking, quit smoking after week 8, or vacillated between quitting and smoking (Table 9); however, the effect of quitting smoking by week 8 on past 30-day binge drinking prevalence decayed by week

26, but approached statistical significance (p=0.066). Quitting smoking was not associated with binge drinking frequency or average daily alcohol use.

3.4 Discussion

The intervention (counseling group) was significantly associated with a decrease in past 30-day binge drinking prevalence at week 8 of the study. Consistent with the hypothesis, those in the HE group reported a lower prevalence of past 30-day binge drinking at week 8 than participants in the MI group. Quitting smoking did not appear to mediate the effect of counseling group on past 30-day binge drinking prevalence. Regardless of counseling group, participants who quit smoking by week 8 or before were less likely to report binge drinking in the previous 30 days at week 8, but results were not significant at week 26.

In the original study, smokers in the HE counseling group showed an increase in smoking cessation at week 8.[350] A similar reduction in past 30-day binge drinking was seen in the HE group at week 8 as well; however, unlike the original study, the differences between the counseling groups in relation to binge drinking disappeared by week 26. In fact, binge drinking prevalence appeared to increase among individuals in the HE group after week 8, approaching a prevalence similar to that of the MI group by week 26. Health Education did not appear to have much of an effect on the other alcohol use outcomes. It is not entirely clear why the HE group performed better than the MI group with regard to past 30-day binge drinking. The original study hypothesized that, possibly, this particular group of smokers found the HE counseling more relevant, since at baseline, the majority of smokers in the study were highly motivated to quit. In

addition, MI counseling has been shown to have more favorable outcomes in people who show low motivation to change their behavior.[351]

It is important to fully understand how the HE intervention affected binge drinking, since our results showed that quitting smoking played a very minor role in the observed relationship between counseling type and alcohol use. Some component of the HE counseling sessions had an effect on binge drinking even though the HE counseling sessions did not specifically address alcohol use or binge drinking. It could be that individuals who were assigned to the HE counseling group were making more attempts to quit smoking and could have been actively avoiding situations where smoking and drinking are more likely to occur.

It is also important to note, that when disregarding the counseling intervention, persons who quit smoking earlier in the study decreased their binge drinking by week 8. These results were statistically significant at week 8 and approached statistical significance at week 26. This would also support the idea that individuals who successfully quit smoking may be avoiding environments that encourage smoking, at least initially. More research needs to be done to fully understand the actions some people take to enhance their likelihood of quitting smoking and how these actions may affect binge drinking and other forms of alcohol use.

There are several limitations to the current study. First, average number of drinks per day and binge drinking are self-reported measures, which usually result in underreporting of alcohol use.[338, 354, 362, 363] In addition, the survey only contained questions regarding the alcohol consumption patterns, so it was not possible to limit the sample to non-alcohol dependent participants; however since participants were screened

in person by counselors and had biological measurements taken, this may have discouraged participants who are alcohol dependent from joining the study. Second, there could be additional factors not controlled for in the analyses that could affect alcohol consumption, although all known baseline differences between the groups were controlled. Third, considering there was differential attrition by counseling group in the study (i.e., more individuals in the MI group dropped out over the course of the study than did individuals in the MI group), and this could have affected the results. Specifically, it is unclear if those individuals who dropped out of the study from the MI group were more likely to binge drink or of have higher levels of average daily alcohol use at week 8 or week 26 than those who stayed in the study; therefore, the results could be inflated (or attenuated) due to differential attrition. Fourth, the generalizability of the results beyond that of the study population of African American light smokers is limited; however, this is one of the first studies that assessed effects of a smoking intervention on alcohol use among African Americans.

The limitations to this study are offset by several strengths. This is a secondary analysis of data from a randomized controlled trial with a relatively large sample size and generally good efforts to reduce attrition. In addition, this is one of the first studies to assess the effect of smoking cessation on alcohol use outcomes in a nondependent population. Although this study was limited to African Americans, future studies should be conducted with more diverse demographics.

Overall, this study provides evidence that tobacco interventions such as counseling could have a potential spillover effect on alcohol use, particularly past 30-day binge drinking. Additionally, it appears that when individuals quit smoking, their alcohol

use behaviors are at least initially affected as well and by our results, appear to decrease. Future tobacco cessation studies should consider collecting data on alcohol consumption throughout the study period to better understand how these two behaviors could be affecting each other.

Table 6. Baseline demographic differences by counseling group at baseline

		Counseling group		
	Overall (N=755)	*Health Education* (N=377)	*Motivational Interviewing* (N=378)	Significance test, p-value
Age in years, mean (SD)	45.1 (10.7)	44.3 (11.0)	45.8 (10.3)	t= -1.92, p=0.055
Sex				
Male	250 (33%)	120 (32%)	130 (34%)	χ^2= 0.599,
Female	505 (67%)	257 (68%)	248 (66%)	p=0.455
Education				
Less than HS grad	124 (16%)	56 (15%)	68 (18%)	χ^2= 1.315,
HS graduate or more	630 (84%)	320 (85%)	310 (82%)	p=0.252
Marital status				
Married/living with partner	284 (38%)	130 (34%)	154 (41%)	χ^2= 3.053,
Not married	470 (62%)	246 (65%)	224 (59%)	p=0.081
Employment status				
Employed	362 (48%)	182 (48%)	180 (48%)	χ^2= 0.033,
Not employed	393 (52%)	195 (52%)	198 (52%)	p=0.857
Health care coverage				
No	187 (25%)	89 (24%)	98 (26%)	χ^2= 0.545,
Yes	568 (75%)	288 (76%)	280 (74%)	p=0.461
Monthly income				
<$1800	433 (59%)	205 (54%)	228 (60%)	χ^2= 2.823,
$1800 or more	302 (41%)	162 (43%)	140 (37%)	p=0.093
Number of cigs/day, mean (SD)	7.6 (3.2)	7.4 (2.9)	7.7 (3.5)	t= -1.08, p=0.279
Age of initiation (in years), mean (SD)	17.8 (5.8)	17.7 (5.8)	18.0 (5.8)	t= -0.77, p=0.442
Age started smoking regularly, mean (SD)	21.2 (6.9)	20.8 (6.7)	21.5 (7.1)	t= -1.46, p=0.146
Duration of smoking years, mean (SD)	23.9 (12.0)	23.5 (12.2)	24.3 (11.8)	t= -0.89, p=0.372
Number of cigs/day				
1 to 5	204 (29%)	109 (29%)	95 (25%)	χ^2= 0.942,
6 to 10	496 (71%)	245 (65%)	251 (66%)	p=0.332
Currently smoke menthol cigs				
Yes	615 (82%)	304 (81%)	311 (82%)	χ^2= 0.339,
No	138 (18%)	72 (19%)	66 (17%)	p=0.560
Fagerstrom score,	2.9 (1.8)	3.0 (1.8)	2.8 (1.9)	t= 1.25,

mean (SD)				p=0.212
No. of serious quit attempts in the past year, mean (SD)	3.6 (6.6)	3.10 (5.4)	3.4 (7.7)	t= -0.66, p=0.508
Perceived stress, mean (SD)	8.7 (2.1)	8.9 (2.2)	8.5 (1.9)	t= 2.15, p=0.032
Baseline exhaled CO, mean (SD)	13.9 (8.9)	13.9 (9.1)	13.9 (8.9)	t= 0.04, p=0.972

Table 7. Overall multivariate model for intervention effects on alcohol outcomes*

Variables **Model 1 (adjusted)**	**df**	**Estimate (SE)**	**p-value**
Past 30-day binge drinking prevalence			
Week (time)			
Baseline versus Week 8 versus Week 26	2	-	<0.001
Baseline versus Week 8	1	-0.445 (0.116)	<0.001
Baseline versus Week 26	1	-0.247 (0.108)	0.022
Counseling Group (HE versus MI)	1	0.005 (0.176)	0.979
Counseling Group X Week			
Baseline versus Week 8 versus Week 26	2	-	0.084
Condition (HE versus MI) X			
Baseline versus Week 8	1	-0.465 (0.231)	0.045
Condition (HE versus MI) X			
Baseline versus Week 26	1	-0.364 (0.215)	0.091
Past 30-day binge drinking frequency			
Week (time)			
Baseline versus Week 8 versus Week 26	2	-	<0.001
Baseline versus Week 8	1	-0.129 (0.030)	<0.001
Baseline versus Week 26	1	-0.096 (0.030)	0.001
Counseling Group (HE versus MI)	1	0.010 (0.049)	0.844
Counseling Group X Week			
Baseline versus Week 8 versus Week 26	2	-	0.190
Condition (HE versus MI) X			
Baseline versus Week 8	1	-0.086 (0.060)	0.153
Condition (HE versus MI) X			
Baseline versus Week 26	1	-0.098 (0.059)	0.097
Average daily alcohol use			
Week (time)			
Baseline versus Week 8 versus Week 26	2	-	<0.001
Baseline versus Week 8	1	-0.102 (0.018)	<0.001
Baseline versus Week 26	1	-0.091 (0.017)	<0.001
Counseling Group (HE versus MI)	1	0.010 (0.038)	0.782
Counseling Group X Week			
Baseline versus Week 8 versus Week 26	2	-	0.181
Condition (HE versus MI) X			
Baseline versus Week 8	1	-0.063 (0.036)	0.078
Condition (HE versus MI) X			
Baseline versus Week 26	1	-0.011 (0.035)	0.760

*Adjusted for baseline perceived stress

Table 8. Results of mediation analysis by alcohol use outcomes at week 8 and week 26 separately*

	Total effect[a] Estimate (SE)	**Direct Effect**[b] Estimate (SE)	**Mediated effect**[c] Estimate (SE)	**Sobel test statistic**	**p-value**
Past 30-day binge drinking prevalence					
Week 8	-0.626 (0.304)	-0.545 (0.308)	0.014 (0.014)	1.506	0.132
Week 26	-0.251 (0.259)	-0.117 (0.270)	0.022 (0.022)	1.780	0.075
Past 30-day binge drinking frequency					
Week 8	-0.081 (0.049)	-0.073 (0.049)	0.008 (0.004)	1.852	0.064
Week 26	-0.070 (0.052)	-0.058 (0.053)	0.012 (0.010)	1.219	0.223
Average daily alcohol use					
Week 8	-0.067 (0.031)	-0.061 (0.031)	0.006 (0.004)	1.521	0.128
Week 26	-0.004 (0.032)	0.009 (0.032)	0.014 (0.005)	2.586	0.010

*adjusted for baseline perceived stress and baseline alcohol use outcome

[a] Total effect is the effect of counseling group on alcohol use (c)

[b] Direct effect is the effect of counseling group on alcohol use controlling for quit smoking status (c')

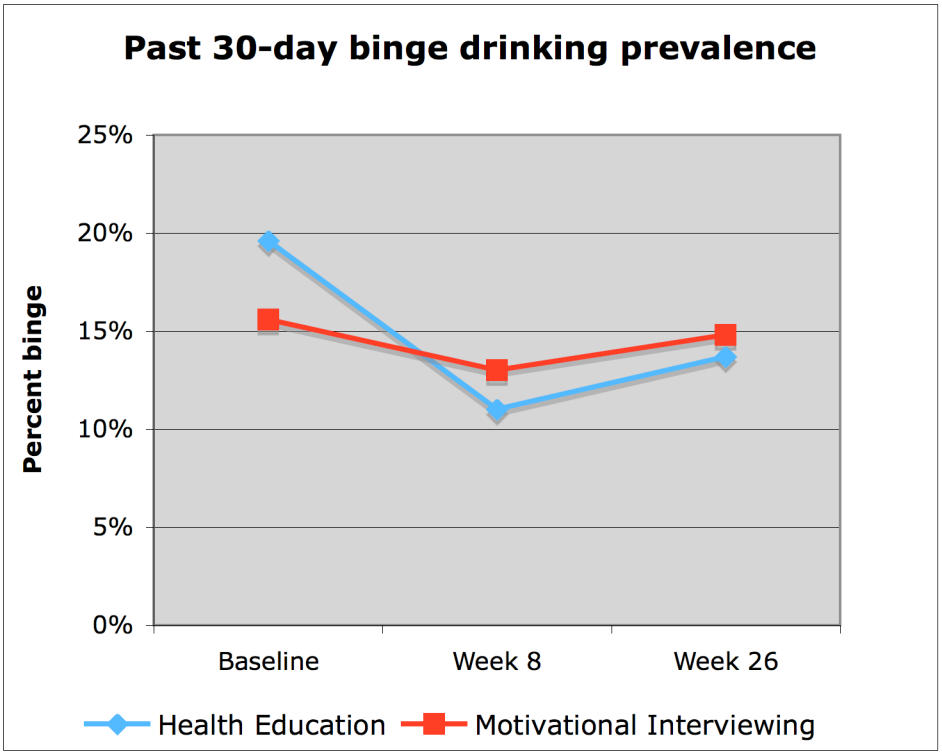
[c] Mediated effect is the indirect effect of counseling group on alcohol use through quit smoking (a)(b) or (c-c')

Table 9. Results of quit smoking (quit smoking during the first eight weeks = 1; all others = 0) and alcohol use outcomes at week 8 and week 26*

	Estimate (SE)	**F test**	**p-value**
Past 30-day binge drinking prevalence			
Week 8	-0.816 (0.386)	4.47	0.035
Week 26	-0.604 (0.328)	3.38	0.066
Past 30-day frequency of binge drinking episodes			
Week 8	-0.087 (0.055)	2.49	0.115
Week 26	-0.078 (0.060)	1.71	0.191
Average daily alcohol use			
Week 8	-0.044 (0.035)	1.62	0.204
Week 26	-0.037 (0.037)	1.00	0.318

*adjusted for baseline alcohol use outcomes and perceived stress

Figure 6. Adjusted alcohol use outcomes by counseling group over time



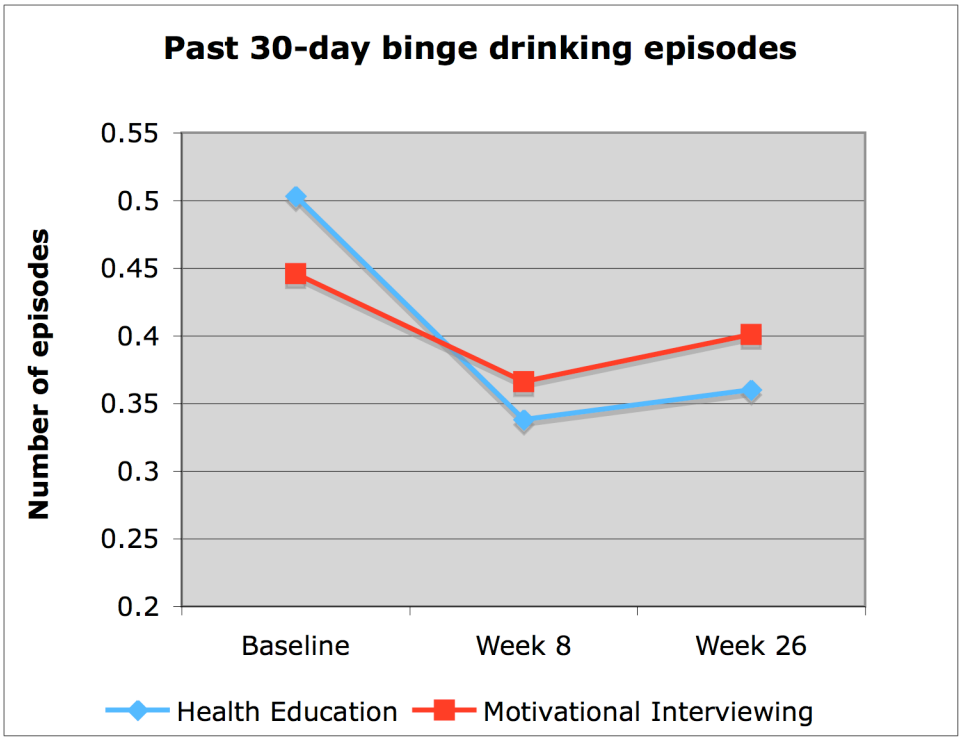


Figure 6. continued

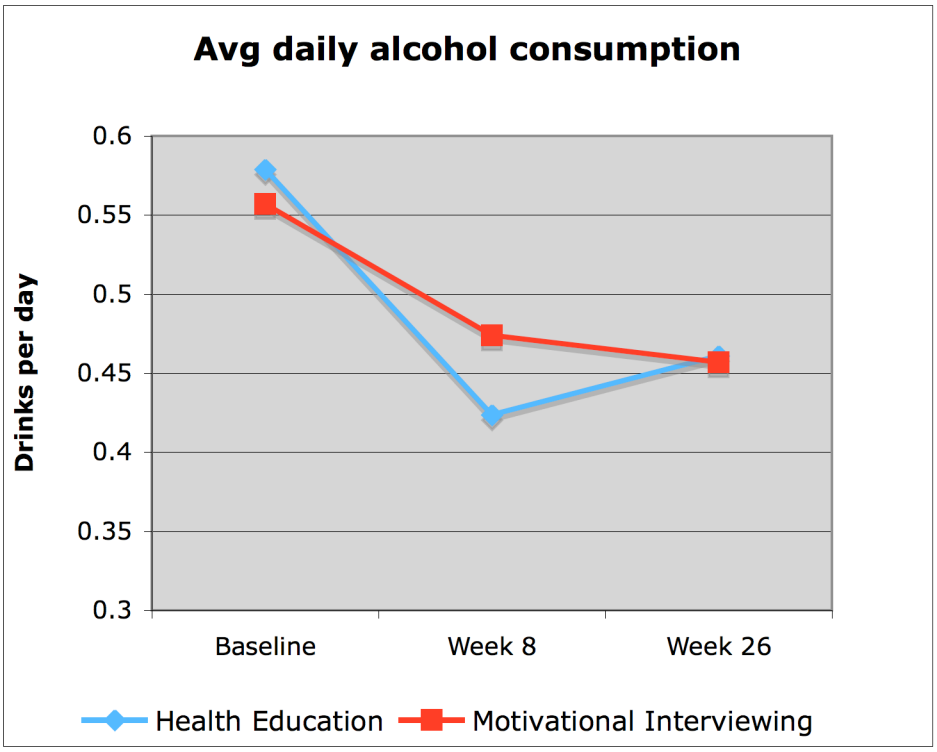
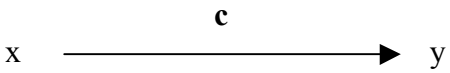
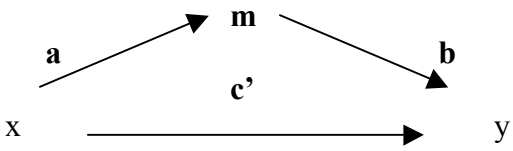


Figure 7. Mediation model

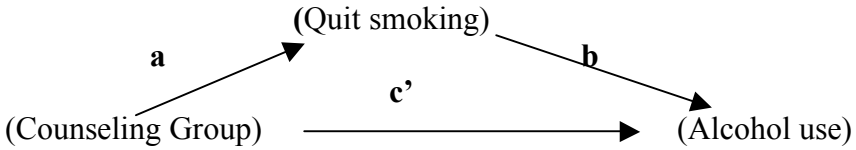
Base model



Mediation model



Mediation model



c = Total effect
c' = Direct effect
a = effect of **x** on **m**
b = effect of **m** on **y** controlling for **x**
ab or (c-c') = Indirect (Mediated) effect

Chapter 4 - Paper 3

The Effect of State Tobacco Policies on State-level Binge Drinking Behaviors

4.1 Introduction

Binge drinking, consuming five or more drinks in a setting, contributes to many public health problems, including deaths, alcohol-impaired driving, workplace productivity loss and risky sexual behaviors.[2, 6, 70, 71, 74] Binge drinking rates are higher in states in the Midwest and Northeast than in states in other regions of the U.S.[23, 49] Differences across states in per capita income, religious identification, and the type and number of alcohol control policies have been theorized as some of the reasons for the geographic variation in alcohol use and binge drinking.[23, 50-53]

Several state-level alcohol control policies, including higher alcohol excise taxes, restrictions on the hours and days of alcohol sales, and mandated responsible beverage server training, have been found to be effective in reducing binge drinking and/or alcohol-related problems;[103] however, in many states these policies have not been politically feasible to enact due to strong opposition from the alcohol industry and lobbying groups.[150] In some states, alcohol policy restrictions, such as limiting hours and days of sale, have been lessened over time or abolished altogether.[106, 133,144] In addition, state and federal excise taxes, known to reduce consumption through increasing price, have not been indexed to inflation and the effect of these taxes has eroded over time.[144,13, 14] The current political challenges to alcohol control policies suggest the need to consider alternative strategies to reduce population levels of binge drinking and excessive alcohol use.

A possible alternative approach is to focus on interventions targeting behaviors that are associated with alcohol use, such as smoking. Past-year alcohol and tobacco use is reported by 20% of the population[193, 194] with 45% of smokers reporting binge drinking and 58% of frequent binge drinkers smoking.[49] Binge drinking and smoking share similar biological, personal, and environmental influences[203, 213-215, 364, 365] In research studies on alcohol dependent populations, reducing tobacco use has also led to reductions in alcohol use.[287,288,290] It may be possible that tobacco interventions aimed at the entire population may also lead to reductions in binge drinking.

Two state-level tobacco control policies that are effective in reducing smoking rates are worksite smoking bans (i.e., smoking bans that include bars and restaurants) and increases in tobacco taxes.[254, 256, 277,366] Smoking and alcohol use are common behaviors that tend to occur in the same environment, particularly in bars.[232] It might be expected that worksite smoking bans that include bars may decrease binge drinking rates, since bars are the second most common location at which binge drinking occurs.[367] Only two studies were found in the U.S. that examined the association between smoking bans and alcohol consumption. One study found a positive association between smoking bans and decreases in alcohol consumption among females, but the population sample was limited to individuals age 50 years and older.[296] The other study found that smoking bans decreased demand for beer and spirits, but increased demand for wine.[297] The likelihood of finding a population-level effect of smoking bans on binge drinking is slightly diminished, since research has shown that revenue in bars is not affected by the enactment of smoking bans;[259, 260] however, this may reflect an increase in food purchases or other beverages not just a lack of a decrease in alcohol consumption. As of

December 31, 2011, 25 states had enacted laws that required bars to be 100% smoke free.[258, 366]

Tobacco taxes include both excise and sales taxes and are recommended as one way to raise the price of cigarettes.[129] The combined state tobacco excise and sales taxes currently averages about $1.70 per pack and has been a central feature in some states' recent health policy and planning.[278, 369] Research has shown the adult price-elasticity of demand for cigarettes is about -0.3 to -0.5, which means that for every 10% increase in the price of cigarettes, demand decreases by three to five percent.[26] Researchers assessing the cross-price elasticity of cigarette price on alcohol use have found mixed results. In a study conducted in Australia, researchers found a significant and negative effect of the price of cigarettes on alcohol use.[299] The authors of this study found cigarettes and alcohol to be economic complements and that decreases in cigarette consumption (due to increase in price) resulted in decreases in alcohol use a result supported by other studies;[300-302] however, in a study focusing on older adults (aged 50 years and older) in the U.S., researchers found that higher cigarette prices lead to an increase in alcohol use,[296] thus, supporting smoking and drinking as economic substitutes (i.e., decreases in smoking result in increases in drinking).[303] Additionally, Decker and Schwartz[304] using Behavioral Risk Factor Surveillance System (BRFSS) data from 1985 to 1993 found that as the price of cigarettes increased, alcohol consumption increased; however, in a recent study using BRFSS data from 2001 to 2006, McLellan[305] did not find a significant relationship between state cigarette price and alcohol use behaviors (current drinking, binge drinking and heavy drinking) at the population level. By way of explanation, this study was limited to 2001 to 2006, which may have been too short a

time period to observe a cross-state correlation and binge drinking analyses were limited even further to 2001 to 2005.

The proposed study will address two research questions: (1) Are state-level comprehensive smoking bans in bars associated with state-level binge drinking prevalence and state-level average (per capita) frequency of binge drinking episodes among drinkers? and (2) Are state-level tobacco taxes (combined excise and sales taxes) associated with state-level binge drinking prevalence and state-level average (per capita) frequency of binge drinking episodes among drinkers? It is hypothesized that states with a smoking ban will be associated with decreased binge drinking prevalence and average frequency of binge drinking episodes. In addition, it is also hypothesized that increases in state-level tobacco taxes will result in decreases in binge drinking behaviors (i.e., have a cross-price elasticity of demand).

4.2 Methods

To examine the association of state-level tobacco control policies and binge drinking, a pooled-time-series analysis was conducted using cross-sectional data of all U.S. states from 1998 to 2010. Two state-level tobacco control policies were used in this study: comprehensive smoking bans in bars and tobacco taxes (combined excise and sales).

4.2.a. Data Sources and Measures

Outcome variables

The main study outcomes were binge drinking behaviors, defined as overall prevalence of binge drinking at the state-level and the average per capita (i.e., per person per year) frequency of binge drinking episodes among drinkers at the state-level. Binge

drinking estimated were obtained through the Behavioral Risk Factor Surveillance System (BRFSS), which is conducted annually through the Centers for Disease Control and Prevention.[370] The BRFSS is a state-based system of health surveys that collects information on health risk behaviors through a random-digit dial telephone survey of about 150,000-400,000 individuals aged 18 and older in the U.S. each year. Response rates for states for the 1998 to 2010 surveys typically ranged from 35% to 65%.[371] The target population for the BRFSS are non-institutionalized adults with telephones (excluding group homes).[372] Data were collected on a monthly basis and then aggregated at the state level for the year.

To collect binge drinking information, participants were asked how many times in the past 30 days they consumed five or more drinks on an occasion. The specific wording of the question changed slightly over the years; in 2006, a sex-specific question was included that lowered the drinks per occasion threshold for women to four or more drinks on an occasion. To calculate state-level binge drinking prevalence, participants were coded as either "1" if they reported binge drinking in the past 30 days or "0" if they did not. Alcohol abstainers were also included in the "0" category for binge drinking prevalence. Responses were aggregated to the state level and weighted to the state population. The proportion of the state population that participated in binge drinking was modeled as a continuous variable. In addition to prevalence, state-level average per capita frequency of binge drinking episodes was calculated. For this outcome, the sample was limited to current drinkers (those who reported any alcohol use in the past 30 days). The number of times participants reported binge drinking in the past 30 days was averaged across all drinkers and then aggregated to the state level. This result was

weighted to the state population and then log-transformed to correct for skewness. The log-transformed average frequency of state-level binge drinking was modeled as a continuous variable. To control for changes in prevalence and frequency that may have resulted from the change in definition of binge drinking for women, an indicator variable was included in the model labeling the years before the change (preceding 2006) as "0" and year 2006 and forward as "1."

Exposure variables

Two types of tobacco control policies are the focus of this study: (1) comprehensive smoking bans in bars and (2) tobacco taxes (combined sales and excise) (Table 10). The CDC's State Tobacco Activities Tracking and Evaluation (STATE) system was used to determine whether a state had enacted a comprehensive smoking ban in bars.[257] The STATE system utilizes a variety of sources to track different state-level tobacco control policies and reports the policy information by year and state from 1995 through 2011 (as of January 2012). The comprehensive smoking bans were limited to bars, since studies have shown that next to a person's home, bars and clubs are the most common location at which binge drinking occurs;[373] it was assumed a smoking ban focused on bars would be most likely to produce an effect on binge drinking. The state comprehensive smoking ban was modeled as a dichotomous variable. For each year, a state without a comprehensive smoking ban in bars was assigned a "0" (no ban) and a state with a comprehensive smoking ban in bars was assigned a "1" (full ban). Starting in 2006, quarterly data became available in the STATE system (versus just 4th quarter data from 1995-2005). To be consistent across years, the status of the state's smoking ban

was assessed at the 4th quarter to represent the entire year even though a policy change may have occurred at any time during the previous year.

To determine state-level tobacco taxes, data were collected from *The Tax Burden on Tobacco* volume 45 by Orzechowski and Walker.[369] The consulting firm Orzechowski and Walker produces this annual report in cooperation with tobacco tax administrators and the U.S. Department of Treasury's Alcohol and Tobacco Tax Trade Bureau.[374] Tobacco taxes for a pack of cigarettes were calculated for each state by combining the annual state sales tax (if one existed) with the annual state excise tax based upon tax rates reported by November 1 of that year (we did not include municipal taxes in our calculations). The total amount of taxes assessed on a pack of cigarettes was modeled as a continuous variable for each state and year in the study.

Covariates

Four types of alcohol control policies were identified and controlled (Table 10). These policies were selected based on a review of the research literature, recommendations from the Guide to Community Preventive Services,[128, 138, 375, 376] and the availability of policy data through the state Alcohol Policy and Information System (APIS).[377]

Beer taxes

Research has shown the price of alcohol is inversely related to alcohol use.[375, 378, 379] A state-level policy that may affect the price of alcohol is excise taxes. Beer accounts for over 67% of all alcohol consumed during binge drinking episodes, and about 80% of all binge drinkers report consuming beer (either exclusively or in combination).[367] Beer excise tax information (based on the excise tax per gallon of beer) was collected from

APIS from 2003 to 2007 and from the Federation of Tax Administrators for the remaining years.[377, 380] The actual excise tax for beer per year was modeled as a continuous variable. In addition to excise tax, some states assess an ad valorem excise tax (i.e., an excise tax based on price). Unfortunately, this information was only available from the APIS system and only for the years 2003 to 2007, and there were no additional references found that listed this tax separately for all the years included in the study. To control for this tax, an indicator variable for all states and all years was included using a "1" if a state had assessed an ad valorem excise tax at any time during the 2003 to 2007 time frame and a "0" if they did not assess this tax. Beer excise tax and ad valorem beer taxes were both included in the model as unique variables but were treated as a pair in the multivariate analyses (i.e., both included in the model or both dropped out of model).

Alcohol Control Systems

Currently 18 states have some part of their alcohol distribution system controlled by the state government (i.e., not privatized).[377] These types of state-run systems, termed control states, generally apply to off-premise alcohol outlets such as liquor stores. Research studies assessing the effect of privatizing some part of the alcohol control system have found an increase in alcohol consumption following privatization.[376] All changes in control systems identified in APIS for the period of 1998-2010 were reviewed. Although there were many small changes, no privatization changes that were likely to significantly affect state-level binge drinking behaviors were identified; however, states with an alcohol control system may differ from non-control states in terms of the number of hours and days alcohol can be sold, density of alcohol establishments, types of alcohol

products available, and price of alcohol.[128, 138] To control for these differences, an indicator variable of "1" was assigned to states with some part of their alcohol distribution system state-run and "0" if they had a completely privatized system.

Sunday sales

Research has shown that limiting the days of the week on which alcohol is sold can be a way to reduce excessive alcohol consumption.[128] Sunday sales bans have been used most commonly in the US to control the number of days of sales; however, over the past decade, some states have repealed Sunday sales bans as a way to increase revenue from sales. The Guide to Community Preventive Services conducted a review of studies and found an overall slight increase in consumption and alcohol-related harms when the number of days of sales was increased.[128] Information about state Sunday sales bans was obtained from APIS.[377] To control for states with and without a Sunday sales ban, states were assigned a "1" if they had a Sunday sales ban for each year and a "0" if they did not have a ban for that year. If a state repealed its ban at any time during a year, the entire year was coded as a "0" for no ban.

Adult BAC limits

The legal limit for blood alcohol concentration (BAC) has been shown to have a significant relationship with motor-vehicle traffic crashes with lower limits associated with a decrease in crash deaths, especially among youth.[381, 382] No studies were identified that assessed whether lowering the legal BAC limit for operating a motor-vehicle was associated with reductions in alcohol consumption among adults; however, it was hypothesized that lowering the legal BAC limit could reduce traffic crashes through changes in drinking behaviors. State BAC limit was included in the model as a way to

control for state-level alcohol control policies that may affect binge drinking during the study period. BAC limits are generally determined by states, but in 2000, Congress passed the Department of Transportation's Appropriations Act of FY2001, which adopted 0.08 grams per dL as the national illegal BAC limit for impaired driving. States that did not adopt 0.08 BAC law by October 1, 2003 risked losing federal highway funds.[383] By 2006, all states had lowered their BAC limit to 0.08.[377] State BAC limit was modeled by coding states with a BAC of 0.08 as "1" for each year they were at that level and "0" for each year they were greater than 0.08.

Population quit ratio

Since the hypothesis assumes that alcohol and tobacco use are related, changes in secular trends in state-level smoking rates need to be controlled. To do this, a state-level population quit ratio was calculated by taking the number of former smokers divided by the total number of current and former smokers.[172] To obtain smoking status, the BRFSS computed smoking status variable that is based on two questions was used. The first question assessed whether a person has smoked at least 100 cigarettes in their life-time and the second question asks whether a person currently smokes cigarettes every day, some days, or not at all. Current smokers are individuals who report smoking at least 100 cigarettes in their lifetime and currently smoke on some days or every day, and former smokers are individuals who report smoking at least 100 cigarettes in their lifetime but currently do not smoke. The state-level population quit ratio was calculated for each year and state and modeled as a continuous variable.[172]

Additional covariates

Certain demographic characteristics are associated with a higher likelihood of binge drinking.[23] To help control for the effects of these demographics, data were collected on sex, race/ethnicity, age, education, per capita personal income, and unemployment at the state level, and proportion of the state population that identified as Catholic. Using data from the BRFSS, the proportion of individuals in each state who are male, self-identified as white, self-identified as Hispanic, were under 25 years of age at the time of data collection, and reported some college education or a college degree was estimated. These proportions were weighted to state populations and modeled as continuous variables. The average per capita personal income for each state by year was obtained from the Bureau of Economic Analysis (BEA).[384] Per capita personal income is the total of personal income (defined as the sum of wage and salary disbursements, supplement to wages and salaries, proprietors' income, dividends, interest, and rent, and personal current transfer receipts less contributions for government social insurance) of residents within a given area divided by the population of that area (i.e., states).[384] The population estimates were determined from the annual midyear population estimates from the Census Bureau.[385] Since per capita income differs by states due to regional price levels, we modeled a dichotomous variable indicating if a state-level per capita income was above or below the national average for that year. States with an average per capita income less than the national average were assigned a "0" and those states whose average was more than the national average were assigned a "1" for that year. To control for the state-level unemployment rate, estimates were calculated from the Current Population Survey (CPS), a sample survey of households conducted for the Bureau of Labor Statistics (LBS) by the U.S. Census Bureau.[386] Unemployed persons were those who

were not employed during the reference week used in the survey (i.e., the week including the 12th day of the month), had actively looked for a job sometime in the four-week period ending with the reference week, and were currently available for work. The state unemployment rate was defined as the number of unemployed persons expressed as a percent of the total labor force for that state (i.e., the sum of all employed and unemployed persons for that state). The state population estimates for unemployment were adjusted to the April 2000 decennial estimates and modeled as a continuous variable for each state and year. Finally, to control for state-level religious differences, the proportion of individuals in each state who self-identified as Catholic, a characteristic that has been associated with a higher odds of binge drinking, was determined.[52] Religious identity was collected from the *Religious Congregations and Memberships in the United States* 2000,[387] a report that contains information for 149 religious bodies that participated in the Associations of Statisticians of American Religious Bodies (ASRAB). The proportion of the state population that reported as Catholic from that report was modeled as a continuous variable and listed for all years included in the study.

In addition to state-level demographics, a geographic variable was included in the model indicating census divisions to help control for effects of clustering of drinking outcomes by geographic location. The nine census divisions included are subsets of the four census regions (west, Midwest, south, and northeast).[385]

4.2.b. Analyses

To determine if tobacco policies were associated with state-level binge drinking prevalence or average per capita frequency, a pooled-time-series analysis was applied using a mixed model regression estimated as:

$$Y_{nt} = \Sigma\beta_k X_{knt} + e_{nt}$$

where n = the cross-sectional units (states) , t = time period units (years), and k = number of predictors, Y is the outcome measure (state-level binge drinking prevalence or average per capita frequency of binge drinking), and X refers to the independent variable (smoking bans or tobacco taxes), and *e* is a random error. The pooled-time-series model was estimated via a mixed model regression using PROC PANEL in SAS version 9.2.[359] The years included in the model were 1998 through 2010 and all fifty states were included in the analyses. The pooling of the series across cross-sections of states and years increases sample size and increases the reliability and stability of the estimates.[388] The mixed model was specified with random effects for slopes and intercepts. To determine the final model, a backwards stepwise method was employed. First, a full model was run with all possible covariates. Then, each variable that was not statistically significant at the alpha = 0.05 level was removed from the model one at a time, with the least significant variable being removed first. Given the importance of each of the tax variables defining the overall level of state taxes on alcohol, both beer ad valorem excise taxes and excise tax were retained if at least one of these variables was significant in the final model. Separate models were run for state-level binge drinking prevalence and state-level average per capita frequency of binge drinking and for each tobacco policy (smoking bans and taxes).

For all results, a diagnostic assessment of the residuals was conducted. The outcome measures were deemed appropriate given that the distribution of the residuals appeared normal with little or no heteroscedasticity.

4.3 Results

Research Question 1: Are state-level comprehensive smoking bans in bars associated with state-level binge drinking prevalence and state-level average (per capita) frequency of binge drinking episodes among drinkers?

Overall, it appeared that states with a comprehensive smoking ban in bars had a binge drinking prevalence 10% higher than states without a comprehensive smoking ban and an average per capita frequency of about 2.5% greater episodes (Table 11); however, neither of these results was statistically significant.

Research Question 2: Are state-level tobacco taxes (combined excise and sales taxes) associated with state-level binge drinking prevalence and state-level average (per capita) frequency of binge drinking episodes among drinkers?

For every $1.00 increase in tobacco taxes, there was a 6% increase in the prevalence of binge drinking at the state-level and a 2% increase in the average per capita frequency of binge drinking episodes (Table 12); however, these results were also not statistically significant.

4.3.a. Results of Covariate Analyses

Binge drinking prevalence

For both research questions, several state-level covariates were significantly associated with binge drinking prevalence. A positive relationship was observed between the prevalence of binge drinking and the proportion of a state population with a college education or degree ($p<0.001$). A positive relationship was also observed for prevalence of binge drinking and the proportion of a state's population who identified as Catholic ($p=0.003$, $p=0.004$). If the state's per capita income was above the national average,

binge drinking prevalence was over 60% higher than states with a per capita income below the national average (p=0.037, p=0.031).

Average per capita frequency of binge drinking among drinkers

There was a statistically significant negative relationship between the average per capita frequency of binge drinking among drinkers and the percentage of a state's population that was college educated (p=0.023 and p=0.019) and the state population quit ratio (or the proportion of a state population who had successfully quit smoking) (p=0.001 and <0.001) (Tables 11 and 12). As the proportion of a state's population between the ages of 18 to 24 years increased, the average per capita frequency of binge drinking episodes also increased. Finally, there was also a positive relationship found for state beer excise taxes and binge drinking episodes.

4.4 Discussion

There was not a statistically significant association observed for either state-level tobacco taxes or smoking bans on binge drinking prevalence or average per capita frequency of binge drinking episodes among drinkers. This suggests that environmental-level factors such as tobacco control policies may not be enough to affect binge drinking behaviors. These results for the effects of state tobacco taxes on binge drinking prevalence are similar to those found in another study that also used BRFSS data;[305] however, this study is the first to examine the effects of state-level comprehensive smoking bans in bars on binge drinking prevalence and average per capita frequency of binge drinking episodes and tobacco taxes on binge drinking frequency.

The lack of significant results from this study may not come as a surprise given the overall lack of success in reducing binge drinking behaviors at the national level

(Figures 8 and 9). With little variability in binge drinking over time at the national level, it becomes difficult to detect the small contributions tobacco control policies may have in reducing binge drinking behaviors at the state level; however, previous research has shown that when individuals reduce smoking, they also reduce binge drinking (as seen in Chapter 3) and alcohol consumption.[287, 289, 290, 293, 348] It could be that the spillover effects seen at the individual level may not create sufficient change to observe at a population level. In studies using population-level data, there is some evidence to support that a reduction in smoking, brought about through an increase in price, does result in a reduction of alcohol use (i.e., cross-price elasticity of demand).[299-302] Unfortunately, these studies were conducted in a variety of countries and the results may not be generalizable to the U.S.

It was assumed that the null findings of this study are true, then alcohol researchers and advocates cannot rely on tobacco interventions alone to reduce binge drinking and must still push state legislatures to support and implement effective alcohol control policies. Recent estimates put the economic costs of excessive alcohol use at $223.5 billion per year, which is higher than estimates of the economic costs of tobacco use ($193 billion per year);[3, 389] however, current funding opportunities and state-wide resources to combat tobacco use dwarfs the infrastructure in place to combat problems with alcohol.[390] Past efforts through the Robert Wood Johnson Foundation funded the creation of coalitions in 10 states to focus on reducing underage drinking, but funding for these coalitions only lasted from 1995 to 2004.[391] At the federal level, the Surgeon General issued a Call to Action focused on preventing and reducing underage drinking in 2007 and created an Interagency Coordinating Committee on Prevention of Underage

Drinking.[392, 393] No research to date has shown these federal efforts to be effective in reducing underage drinking. To create a sustained impact on reducing binge drinking, efforts need to focus on the reduction of these behaviors in the entire population and the establishment of permanent and long-term funding programs from federal agencies and nonprofit organizations to support activities surrounding the implementation of effective alcohol control policies. Even with great push back from the alcohol industry and lobbyists, alcohol advocates need to push for the enactment and enforcement of effective alcohol policies as more and more current policies (e.g., limiting days and hours of sale, state-run control of alcohol distribution) are eroded as a result of arguments such as the loosening of controls will increase revenue for businesses and local communities.

Several considerations regarding the null results of this study are worth mentioning. When estimating the effects of tobacco control policies on alcohol use, these policies must have a strong enough reduction in tobacco use that it also results in a detectable change in alcohol use at the population level. Attributing a change in alcohol use to a specific tobacco control policy may be difficult given the "noise" of individuals quitting smoking for a wide range of reasons.[138] This study did find that the percentage of quitters in each state was significantly associated with lower binge drinking rates; however, an issue outside the scope of this study concerns how much of the reduction in smoking can be attributed to the tobacco control policies assessed in this study.

Previous studies have shown that when states have implemented smoking bans in bars revenue from alcohol sales does not diminish.[259, 260] The question is whether people who frequented the bars before the ban (possible dual smokers and drinkers) still patronize the bars after the ban or if they are replaced by people who were never smokers.

Additionally, previous research showed that the most common location for binge drinking is in the home.[373] It could be hypothesized that people who were more likely to both smoke and binge drink may have been engaging in these behaviors in their home (or the home of another) and, therefore, would not be affected by a bar smoking ban. Consequently, Adams and Cotti[394] conducted a study and found that smoking bans at the county level or in states bordering a non-ban state resulted in an increase in fatal alcohol-related motor-vehicle traffic crashes. They hypothesized that after a smoking ban, smokers still continue to engage in both binge drinking and smoking but now travel farther to go to bars that are not affected by a ban.

Strengths and Limitations:

The BRFSS is a cross-sectional survey and, therefore, does not have the strength of a longitudinal survey assessing changes over time in the same individuals; however, data were pooled across time using state as the unit of analysis to increase power and sample size. Also, the BRFSS only ascertains drinking behaviors that occurred within the past 30 days. Though the data are collected over an entire year which takes into account any seasonality of binge drinking, former drinkers or people who did not binge drink in the 30 days prior to the study period were not captured in our estimates of current binge drinking further biasing our results towards the null. Another limitation to the study is that we may not have controlled for all potential cross-state differences that may affect binge drinking. The decision to use state as a random effect in our model instead of a fixed effect meant that some unmeasured differences between states would not be controlled for; however, models using state fixed effects might underestimate the true impact of tobacco policies because they limit the variation seen in tobacco policies to

within-state variation over time. In addition, state-level alcohol prices may have been accurately controlled for in these analyses. State level beer taxes was used as a proxy for price based on several assumptions; however, in these models a significant positive relationship was seen between increases in beer taxes and increases in the average per capita frequency of binge drinking episodes. This seems counterintuitive, since the price elasticity of demand for beer states that a 10% increase in the price of beer results in a 14% decrease in consumption.[103, 379] Given the lack of information regarding the true price of beer by state, these estimates are not adequately measuring beer taxes and prices, and this could be the reason for the positive association between increases in beer taxes and increases in consumption. Finally, with regard to smoking bans, there are two specific limitations to address. First, it was assumed that smoking bans were enforced equally across states. Unequal enforcement could bias the results towards the null.[138] Second, only examined state-level smoking bans were examined. The effects of local smoking bans that may have been implemented years before statewide ban were not controlled for or measured. These local ordinances may have had an effect on binge drinking but were not captured in the data and, thus, could have also biased the results towards the null.[394]

Despite these limitations, this study still contributes to the literature as it is one of the first studies to look at multiple state-level tobacco control policies over a 13-year period to determine the potential effect on binge drinking behaviors. Although a significant effect was not found with these two specific tobacco policies, more research is needed to adequately address how quitting smoking may affect binge drinking behaviors at the population level.

Table 10. Alcohol and tobacco control policies from 1998 to 2010 by state

State	Smoking ban in bars		Tobacco taxes (sales and excise)	Beer excise tax		Control state	Sunday sales ban		.08 BAC limit
	Y/N	*Year enacted*	*Average from 1998-2010*	*# of changes*	*Year of change*	*Y/N*	*Y/N*	*Year Repealed*[1]	*Year lowered*
Alabama	N		0.45	1	2008	Y	Y		----*
Alaska	N		1.42	1	2003	N	N		2001
Arizona	Y	2007	1.55	0		N	N		2001
Arkansas	N		0.77	4	1999, 2005, 2006, 2008	N	Y		2001
California	N		1.12	0		N	N		----
Colorado	Y	2006	0.51	0		N	N	2009	2004
Connecticut	N		1.75	1	2008	N	Y		2002
Delaware	Y	2002	0.68	0		N	N	2004	2004
Florida	N		0.71	0		N	N		----
Georgia	N		0.39	2	1999, 2009	N	Y		----
Hawaii	Y	2006	1.77	0		N	N		----
Idaho	N		0.65	0		Y	N		----
Illinois	Y	2008	1.12	2	2001, 2010	N	Y		----
Indiana	N		0.79	0		N	Y		2001
Iowa	Y	2008	0.86	0		Y	N		2003
Kansas	Y	2010	0.81	0		N	Y		----
Kentucky	N		0.39	0		N	Y		2000
Louisiana	N		0.45	0		N	N		2003
Maine	Y	2004	1.63	0		Y	N		----
Maryland	Y	2008	1.33	0		N	N		2001
Massachusetts	Y	2004	1.78	0		N	N	2004	----
Michigan	Y	2010	1.78	0		Y	N		2003
Minnesota	Y	2007	0.94	1	1999	N	Y		2005
Mississippi	N		0.49	0		Y	N		2002

State	Smoking ban in bars		Tobacco taxes (sales and excise)	Beer excise tax		Control state	Sunday sales ban		.08 BAC limit
Missouri	N		0.30	0		N	N		2001
Montana	Y	2009	0.96	0		Y	N		2003
Nebraska	Y	2009	0.73	3	2004, 2006 2008	N	Y		2001
Nevada	N		0.87	1	2004	N	N		2003
New Hampshire	N		0.85	0		Y	N		----
New Jersey	Y	2006	2.22	0		N	N		2004
New Mexico	Y	2007	0.89	0		N	N		----
New York	Y	2003	1.93	3	2000, 2004, 2009	N	N		2003
North Carolina	Y	2010	0.35	5	1999, 2000, 2002, 2006, 2010	Y	N		----
North Dakota	N		0.62	0		N	N		2003
Ohio	Y	2006	0.98	0		Y	N		2003
Oklahoma	N		0.67	0		N	Y		2001
Oregon	Y	2009	1.04	0		Y	N		----
Pennsylvania	N		1.25	0		Y	N	2004	2003
Rhode Island	Y	2005	2.31	1	2007	N	N	2005	2000
South Carolina	N		0.28	0		N	Y		2003
South Dakota	Y	2010	0.91	0		N	N		2002
Tennessee	N		0.58	1	2004	N	Y		2003
Texas	N		0.95	2	2008, 2009	N	N		1999
Utah	Y	2009	0.90	1	2004	Y	Y		----
Vermont	Y	2009	1.51	0		Y	N		----
Virginia	N		0.32	0		Y	N	2005	----
Washington	Y	2005	1.92	2	2002, 2003	Y	N		1999
West Virginia	N		0.60	0		Y	N		2004

State	Smoking ban in bars		Tobacco taxes (sales and excise)	Beer excise tax		Control state	Sunday sales ban	.08 BAC limit
Wisconsin	Y	2010	1.29	1	2006	N	N	2003
Wyoming	N		0.55	0		Y	N	2002

[1]If the repeal occurred during the study period (1998-2010)

*Indicates state had lowered their adult BAC limit to 0.08 before start of study period

Sources: National Institute of Alcohol Abuse and Alcoholism - Alcohol Policy Information System; Orzechowski and Walker *The Tax Burden on Tobacco;* Centers for Disease Control and Prevention - State Tobacco Activities Tracking and Evaluation (STATE) system; Tax Foundation

Table 11. Association between smoking bans on binge drinking behaviors, 1998 to 2010

	Estimate (SE)	t-test	p-value
Binge drinking prevalence			
Smoking bans	0.104 (0.23)	0.45	0.652
Percent college*	0.149 (0.03)	4.53	<0.001
Percent Catholic	0.098 (0.04)	2.95	0.003
Per capita income	0.608 (0.29)	2.09	0.037
Binge drinking frequency			
Smoking bans	0.025 (0.02)	1.40	0.161
Percent college*	-0.006 (0.00)	-2.28	0.023
Percent youth**	0.010 (0.00)	2.65	0.008
Beer taxes	0.109 (0.05)	2.19	0.029
Ad valorem beer excise tax	-0.020 (0.04)	-0.57	0.567
Binge definition	0.099 (0.03)	3.45	0.001
Population quit ratio	-0.881 (0.25)	-3.47	0.001

*Percent college refers to the percent of the population that attended college or has a college degree

**Percent youth is the percent of the population that is age 24 years or younger

Table 12. Association between tobacco taxes on binge drinking behaviors, 1998 to 2010

	Estimate (SE)	t-test	p-value
Binge drinking prevalence			
Tobacco taxes	0.057 (0.18)	0.32	0.749
Percent college*	0.148 (0.03)	4.41	<0.001
Percent Catholic	0.097 (0.03)	2.91	0.004
Per capita income	0.621 (0.29)	3.16	0.031
Binge drinking frequency			
Tobacco taxes	0.019 (0.01)	1.38	0.168
Percent college*	-0.006 (0.00)	-2.36	0.019
Percent youth**	0.011 (0.00)	2.76	0.006
Beer taxes	0.111 (0.05)	2.22	0.027
Ad valorem beer excise tax	-0.020 (0.04)	-0.55	0.583
Binge definition	0.097 (0.03)	3.47	0.001
Population quit ratio	-0.928 (0.26)	-3.54	<0.001

*Percent college refers to the percent of the population that attended college or has a college degree

**Percent youth is the percent of the population that is age 24 years or younger

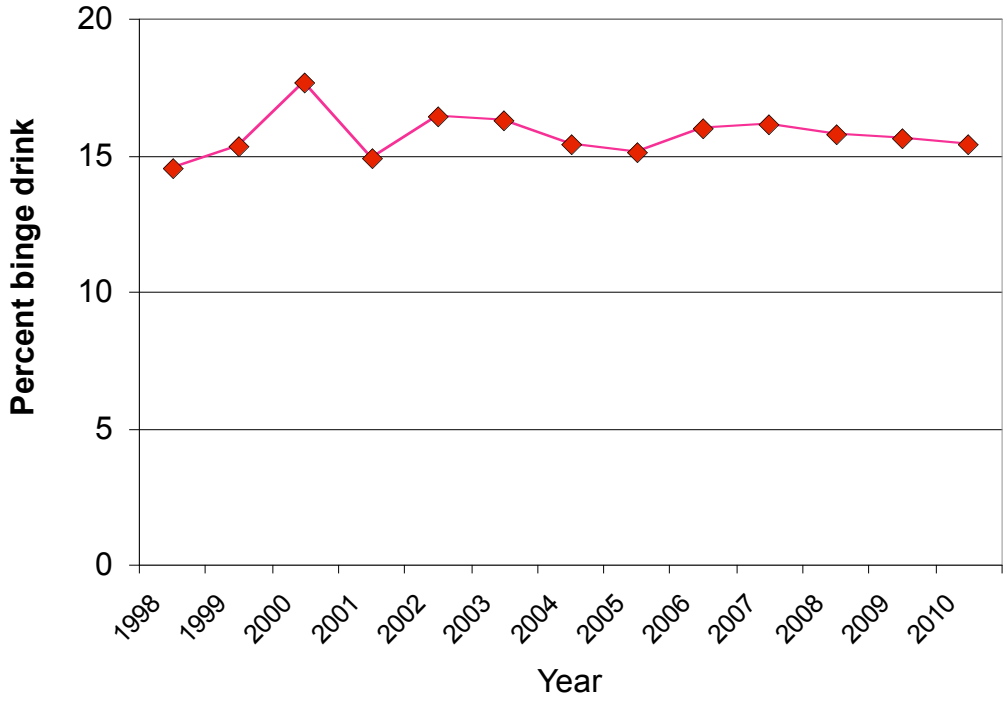


Figure 8. Past 30-day binge drinking prevalence US, 1998-2010. Source: Behavioral Risk Factor Surveillance System. www.cdc.gov/brfss

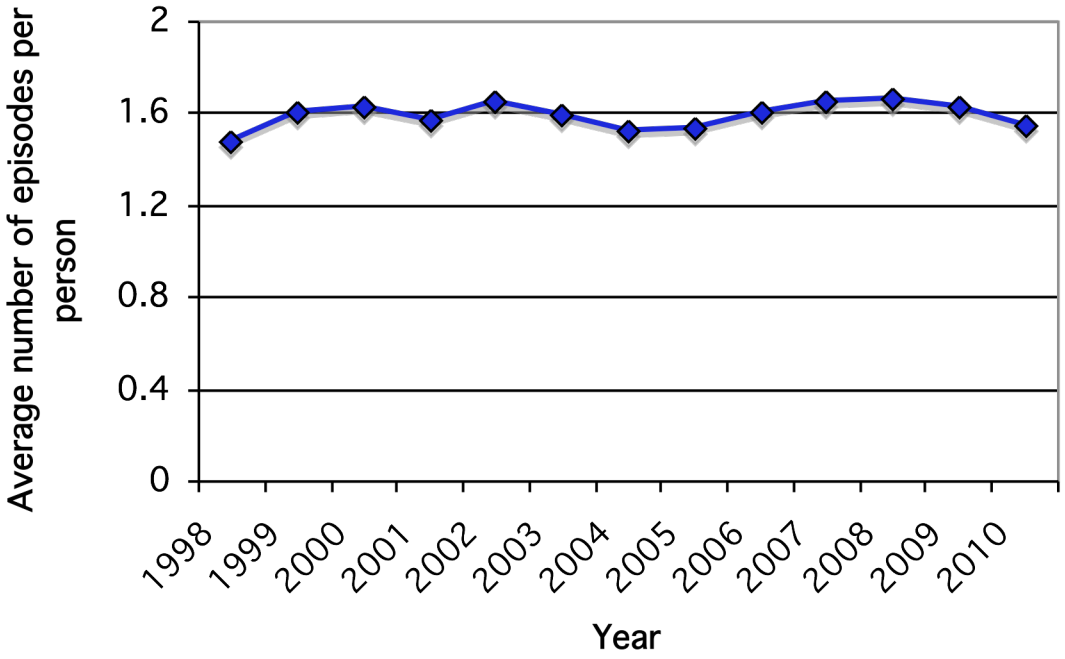


Figure 9. Past 30-day binge drinking frequency (average episodes per person) among current drinkers. Source: Behavioral Risk Factor Surveillance System www.cdc.gov/brfss

Chapter 5 – Conclusions and Recommendations

5.1 Overview

Binge drinking is a serious and common public health problem associated with many adverse health outcomes and economic consequences.[3, 5, 6] Alcohol advocates face strong opposition to implementing and enforcing effective alcohol control policies known to reduce binge drinking and other types of alcohol use.[12, 15, 154] This opposition has resulted in a loosening of alcohol controls over time and increased access to alcohol.

Other strategies to reduce binge drinking are needed. Many people who smoke also drink alcohol and smoking and binge drinking share similar biological, personal, and environmental characteristics. According to the social cognitive theory model, the person, environment, and behavior all interact.[242] An additional aspect to this model is that smoking and drinking could be affecting each other. Building on this idea, a potential alternative for reducing binge drinking may be through interventions aimed at reducing smoking. Most research of individual-level smoking interventions (e.g., NRT, counseling) and their effects on alcohol use have focused on dependent populations, which are not representative of most binge drinkers.[20, 21, 226, 227] Research assessing effects of population-level tobacco interventions (e.g., smoking bans, taxes) on alcohol use has shown mixed results.[296, 297, 299] In order to better assess whether interventions focused on reducing smoking can be a useful mechanism for reducing binge drinking, three general questions were addressed in this dissertation: (1) What is the association between smoking and binge drinking in non-alcohol dependent populations and how do environmental or personal factors affect this association?, (2) What is the effect of

individual-level tobacco interventions on binge drinking? and (3) What is the effect of population-level tobacco interventions on binge drinking? The studies reported in Chapters 2, 3, and 4 attempted to answer these questions and provide a better understanding of whether smoking interventions reduce binge drinking.

5.2 Key findings

This dissertation had three key findings, which are discussed below.

1. *Smoking and binge drinking are significantly associated in the active duty military, and deployment moderates this association.*

Binge drinking is a serious problem among active duty military personnel.[62, 164] Results of this dissertation show that among non-alcohol dependent personnel, current smokers have a higher odds of binge drinking than nonsmokers and the odds do not differ by intensity of smoking. Former smokers also have a higher odds of binge drinking than nonsmokers, although these odds are lower than for current smokers.

Based on previous research, we know that the military has a pro-alcohol environment that may contribute to the high rates of binge drinking.[311, 312] In addition, recent research assessing the effects of military deployment shows higher levels of binge drinking among personnel returning home;[313, 314, 316] however, it is not known whether either an alcohol-promoting environment or deployment moderates the observed association between smoking and binge drinking. Overall, results from this dissertation did not find a significant moderating effect of the perception of an alcohol-promoting environment on the association between smoking and binge drinking; however, deployment frequency did yield a significant moderating effect, although this effect was only seen for certain branches of service. Among the Navy, a higher odds of binge

drinking for current smokers was seen among personnel with more frequent deployments. Among the Marine Corps, the strongest association between smoking and binge drinking was seen among individuals who had never deployed showed.

The implication of these findings is that binge drinking and smoking are strongly associated, opening the door for possible research into the effects of reducing smoking on binge drinking. In addition, a person-level effect (frequency of deployment) is a significant effect modifier of the association between smoking and binge drinking for the Navy and Marine Corps. Interventions focused on reducing smoking and binge drinking within the Navy may need to be tailored for individuals returning from deployment. For the Marine Corps, however, those who had never deployed showed the highest odds of binge drinking with current smoking. This finding, and the knowledge that binge drinking is much higher in the active duty military population overall compared with the civilian population,[5, 62, 63] highlights the need for interventions that focus on the entire military, not just those who have been deployed. In addition, the finding that deployment does have an influence on the association between smoking and drinking shows that personal factors can affect this relationship.

2. *Individual-level quit smoking interventions appear to show short-term decreases in binge drinking though these results are not sustained.*

Behavioral therapies, such as individual counseling and brief motivational interviewing, have been shown to increase smoking cessation and reduce the odds of smoking relapse;[245, 246] however, it is not known how effective these types of therapies are in decreasing alcohol use in non-alcohol dependent populations. The results of this dissertation demonstrate that among African American light (less than 10 cigarettes per

day) smokers, receiving health education counseling were less likely to report past 30-day binge drinking at week 8 of a six month-study than participants receiving motivational interviewing counseling. In addition, if participants quit smoking (no matter what type of counseling they received), they were also less likely to report past 30-day binge drinking at week 8 of the study; however, these results were not sustained to the end of the study and binge drinking prevalence increased by week 26.

The implications of these findings are that individual-level tobacco interventions (specifically related to counseling) and quitting smoking may result in short-term reductions in binge drinking; however, these interventions alone cannot be relied upon as a way to create sustained reductions in binge drinking.

3. *State-level comprehensive smoking bans and tobacco taxes do not show an association with population-level binge drinking behaviors.*

Comprehensive smoking bans in worksites, including bars and restaurants, have gained popularity among state legislatures as a way to reduce exposure to secondhand smoke among employees.[251, 253] In addition, many states have increased their tobacco taxes in recent years and in some states, this money funds tobacco control initiatives;[273, 277] however, information is limited regarding the effective of these policies on alcohol consumption.

Studies assessing the effects of policies that increase the price of tobacco products and/or smoking bans on alcohol consumption have shown mixed results.[296, 297, 299, 304, 305] A pooled times series was used across 13 years and all 50 states to assess the effect of state-level tobacco taxes and comprehensive smoking bans in bars on the prevalence and frequency of binge drinking in states. No significant association was found between

either state-level tobacco taxes or smoking bans and the prevalence and/or frequency of binge drinking.

The implications of these findings are that at the state level, implementation of these tobacco control policies may not be sufficient to produce significant reductions in binge drinking. This does not mean that a combination of tobacco policies and efforts to get people to quit smoking have no effect on alcohol consumption. Results did show that the state population quit ratio (percent of smokers who successfully quit smoking) was associated with a lower frequency of binge drinking. Further information is needed to understand what combination of tobacco programs and interventions are sufficient to result in significant reductions in binge drinking.

5.3 Overall conclusion

The research presented in this dissertation examined the association between binge drinking and smoking in an attempt to better understand this relationship and determine if tobacco interventions can influence this association leading to reductions in binge drinking. The results of this dissertation show that smoking and binge drinking are strongly associated and provides some evidence to suggest that decreasing smoking leads to initial reductions in binge drinking; however, the evidence presented here is not strong enough to advocate for a reliance on smoking interventions as a way to reduce and prevent binge drinking. Even with strong opposition from the alcohol industry, alcohol advocates must educate lawmakers about the effectiveness of alcohol control policies and continue to push for alcohol control policies at all levels of government.

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