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THE RELATIONSHIP BETWEEN E-CIG USE, ALCOHOL CONSUMPTION, AND SMOKING PROHIBITION WHERE ALCOHOL IS CONSUMED

For the degree of Master of Science

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THE RELATIONSHIP BETWEEN E-CIG USE, ALCOHOL CONSUMPTION, AND SMOKING PROHIBITION WHERE ALCOHOL IS CONSUMED

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ABSTRACT

Hershberger, Alexandra Raemin. M.S., Purdue University, December, 2015. The Relationship Between E-cig Use, Alcohol Consumption, and Smoking Prohibition Where Alcohol is Consumed. Major Professor: Melissa A. Cyders.

Smoke-Free legislation in the United States has unintentionally resulted in a decline in alcohol consumption. However, more recently electronic-cigarettes (e-cigs), which are associated with alcohol use, are reportedly being used to circumvent smoking bans. The present study surveyed community dwelling individuals in the United States reporting e-cigs may be used where they drink (N=365, mean age=33.63, SD=9.91, 53.2% female, 78.9% Caucasian) to examine how e-cig use and alcohol consumption varies by the presence of smoking prohibition where one consumes alcohol. Results indicated that smoking prohibition was associated with a greater likelihood of being an e-cig user than a cigarette user (OR=3.40, $p<.001$) and a higher likelihood of being an e-cig user than a dual user (OR=3.37, $p<.001$). Smoking prohibition was not associated with AUDIT scores (B=-0.06, p=.21), total drinks (B=-.07, p=.19), or average drinks (B=-0.02, p=.76). E-cig users reported significantly fewer average drinks when smoking is prohibited as compared to allowed, $t(55)=3.26$, p=.002. Overall, current results suggest smoking prohibition is associated with a greater likelihood of being an e-cig user; however, smoking prohibitions are not associated with alcohol consumption and related

problems in the current participants, who all reported being able to use e-cigs where they consume alcohol. Future research should address potential conceptual, methodological, and sample limitations in order to better discern this relationship, as this line of research could have important implications for e-cig policy and alcohol use treatment

INTRODUCTION

Since 1998, 39 states and 1,203 municipalities have enacted smoking ban legislation, prohibiting smoking in all work places, including bars and restaurants (Callinan, et al., 2010; American Non-Smokers' Rights Foundation, 2015). Following such legislation, there has been a decline in cigarettes smoked per day, smoking prevalence (Hahn, et al., 2008), acute myocardial infarction (Bartecchi, et al., 2006; Juster, et al., 2007; Sargent, et al., 2004; Seo, et al., 2007), coronary heart disease (Khuder, et al., 2007), and respiratory symptoms (e.g. cough, wheezing, sore throat; Hahn, et al. 2006; Palmersheim, et al., 2006). In addition, implementation of such legislation, somewhat unintentionally, has resulted in a decline in alcohol consumption in public among hazardous drinkers (Kaska, et al., 2012; Picone, et al., 2004) and increased remission among individuals with Alcohol Use Disorders (AUD), particularly for young, male smokers (Wolff-Young, et al., 2012). Such a decline in hazardous alcohol consumption is likely a result of decreased pairings of cigarettes and alcohol, which are mutually reinforcing through various mechanisms. Such reductions in alcohol consumption are promising as hazardous alcohol consumption causes an estimated 88,000 deaths each year in the United States and an additional 10,300 deaths occur as a result of drunken driving (Centers for Disease Control and Prevention, 2015).

Additionally, in 2006, it was estimated that alcohol-related problems have an economic cost of 223 billion dollars in the United States (Bouchery, et al., 2011).

Smoking and Alcohol Consumption

It is possible that the reduction in alcohol use following smoking ban legislation is due to the strong relationship between smoking and alcohol consumption: Individuals who smoke are more likely to drink alcohol and individuals who drink alcohol are more likely to smoke (Grant, et al., 2004). Alcohol dependence is associated with the number of nicotine self-endorsed dependence symptoms (ω^2 =0.18; Ulrich, et al., 2003) and there is a moderate correlation between scores on alcohol and nicotine screening tests (r=0.47; Batel, et al., 1995). Additionally, being a current smoker is significantly associated with having a DSM-IV alcohol related diagnosis (OR=3.52, 95% CI [3.19-3.90]) and displaying hazardous alcohol consumption behaviors (OR=2.75, 95% CI [2.54-2.95]; McKee, et al., 2007). Moreover, longitudinal data has shown that, among smokers and non-smokers with similar base-line alcohol consumption rates, smokers are at higher risk for developing an AUD (OR=4.50, 95% CI [3.10-6.60]; Grucza & Bierut, 2006).

Mechanisms underlying the relationship between alcohol consumption and smoking

The strong relationship between alcohol consumption and smoking has led many researchers to investigate possible mechanisms underlying the association, including biological, classical conditioning, and social learning mechanisms. First, the mesolimbic dopamine system, which is responsible for the reinforcing effects of substances of abuse (Funk, et al., 2006), is involved in the motivation to seek both alcohol and nicotine.

Blocking nicotinic receptors, which are a part of this dopamine reward system, has shown to lessen alcohol consumption (Soderpalm, et al., 2000). Additionally, blocking nicotinic receptors during alcohol consumption reduces alcohol-induced dopamine release (Ericson et al., 2003; Tizabi et al., 2002; Funk, et al., 2006). Thus, it appears cigarettes and alcohol may be mutually rewarding via the dopamine system.

The Incentive Sensitization Theory of addiction suggests that addictive behaviors, such as alcohol use and smoking, cause neuro-adaptations in dopaminergic transmission. Repeated drug administration results in the sensitization of dopaminergic responses, making substance-related cues more salient and more sought after over time (Robinson & Beridge, 1993; Robinson et al., 2000). Subsequently, the rewarding value of a substance draws one's attention to substance-related cues in the environment (Robinson, et al. 1993; Robinson, et al., 2000) and cue exposure, in turn, leads to increased substance craving (Sayette, et al., 2005; Field, et al., 2009; Shiffman, et al., 2013) and consumption (Jones, et al., 2013). This pattern of cues, craving, and ultimately, consumption is observable for both alcohol and cigarette use (Field, et al., 2005), and suggests that effects generalize across alcohol and smoking behaviors. For instance, Rohsenow and colleagues (1997) propose a "priming hypothesis," in which associative learning occurs through a classically conditioned process, in which alcohol cues become a conditioned stimulus for smoking, and smoking cues serve as a conditioned stimulus for alcohol consumption. Evidence supports this model, as exposure to typical alcohol cues (e.g., odor) increases tobacco craving (Rohsenow, et al, 1997). These conditioned mechanisms suggest that increases in incentive sensitization generalize across smoking and alcohol use behaviors and likely contribute to the relationship between smoking and alcohol use.

Additionally, another form of learning, social learning, also likely influences the relationship between smoking and alcohol use behaviors through the formation of substance-related expectancies. Expectancies are "If…then" statements that represent one's learned expectations associated with a drug (Natvigaas, et al., 1998). These expectancies, such as "If I drink, then I will feel more relaxed," are formed through one's personal history with the drug and also through observations concerning the drug use, including direct observations and those learned through media or anecdotal sources (Abrams & Niaura, 1987). In addition to individuals having expectancies about cigarettes or alcohol, there is also evidence that individuals have associative expectancies for these substances, particularly in expectancies of the likelihood of combined use. For instance, many individuals endorse that smoking cigarettes will give them a desire for alcohol or drugs and that they expect to drink more or use drugs more after they have smoked a cigarette (Rosenshaw, et al., 2005); these expectancies are associated with drug usage (Goldman, et al., 1987; Fromme & D'Amico, et al., 2000; Fearnow-Kenny, et al., 2001; Pabst, et al., 2014).

There is also evidence that expectancies for smoking and alcohol consumption extend beyond ones perceived likelihood of combined use to include expected combined effects of the substances. For instance, individuals tend to have positive expectancies of the effects of combined alcohol and tobacco use, including both negative reinforcement related outcomes ("I become more relaxed" or "it relieves stress") and positive reinforcement related outcomes ("I will feel a buzz" or "I will become more sociable"; Mckee, et al., 2004). Such expectancies could be the result of one drug enhancing the positive effects or lessening the negative effects of the other drug. Smokers report

increased pleasure and decreased punishment from their last cigarette while consuming alcohol, and smoking is associated with increased pleasure from alcohol consumption (Piasecki, et al., 2011). Additionally, nicotine mitigates the sedative effect of alcohol, as nicotine has an alerting effect in small doses (Perkins, 1997). Interestingly, individuals who smoke while drinking, compared to those that do not, show continued excitement, even as blood alcohol level declines, which should associate with decreased excitement (Piasecki, et al., 2012). Together, these findings suggest that users may perceive benefits of combined cigarette and alcohol use.

Overall, there appear to be several mechanisms that may produce the strong link between alcohol consumption and smoking behaviors. It is further viable that the implementation of smoking bans in bars and restaurants may have eliminated or lessened opportunities for the activation of associative mechanisms (e.g. biological, conditioned cues, expectancies; Townshend & Duka, 2001), ultimately leading to decreased use. For example, decreases in hazardous alcohol consumption since the implementation of smoking bans may be explained by individuals' inability to carry out the associated behaviors of alcohol consumption and smoking together in a place where they came to be associated (e.g. a bar). Thus, smoking bans may have served to partially extinguish the association between alcohol consumption and smoking in bars and restaurants. Moreover, this effect may generalize beyond bars and restaurants and the presence of any smoke-free cigarette policy or prohibition where one consumes alcohol (e.g. at home, a sporting event, a friend's home) may also have a positive effect on decreasing alcohol consumption. However, these effects might be undone by electronic cigarettes (e-cigs), which are becoming increasingly used in lieu of cigarettes (Etter & Bullen, 2011).

E-cigs and Risks

E-cigs, a new nicotine delivery device created to approximate the experience of cigarette use, are growing in popularity in the United States. Though similar to a cigarette in nicotine delivery and experience (inhale aerosol, similar in shape and look), e-cigs do not contain tar and are smoked through the vaporizing of a nicotine liquid, rather than burning tobacco. The prevalence rate of e-cig use in the United States doubled between 2012 and 2013, up to 6.2%, and of these e-cig users, 21.2% use cigarettes as well (King, et al., 2013). It is possible that the increase in prevalence rates are related to the institution of smoking ban legislation (Cataldo, et al., 2015), targeted advertisements emphasizing the benefits of e-cig use (Kim, et al., 2013; Grana & Ling, 2014; Pepper et al., 2014), perceived general positive beliefs of e-cig use (Hershberger, et al., under review), and the belief that e-cigs can be used for smoking cessation (Etter & Bullen, 2011).

Importantly, e-cig use is increasing despite minimal knowledge about the safety of e-cigs. Additionally, there is no regulation of the production of e-cigs by a governing body in the United States (Goniewicz, et al., 2013), which further calls into question the safety of e-cigs. The nicotine liquids used in e-cigs contain nicotine and water, but also other substances, such as propylene glycol and diethylene glycol (FDA, 2009; Etter, et al., 2013; Kosmider, et al., 2014). E-cig liquid reaches high temperatures, at which propylene glycol decomposes into carcinogens, including nitrosamine, formaldehyde and acetaldehyde, and exposure to these chemicals increases as a function of e-cig battery voltage (Kosmider, et al., 2014). Recent research has shown that e-cig emissions contain an amount of acetaldehyde, comparable to those from cigarettes (Blair, et al., in press).

Acetaldehyde has been implicated in reinforcing the addictive properties of nicotine, thus likely aiding in perpetuating e-cig use (Belluzzi, et al., 2005). Diethylene glycol, an ingredient in antifreeze, is toxic to humans (FDA, 2014) and may have cytotoxic effects (Bahl, et al., 2012; Williams, et al., 2013). Recent research using animal models has demonstrated that e-cig liquid, independent of the effects of nicotine, resulted in decline in lung endothelial barrier function and inflammation (Schweitzer, et al., 2015), which can lead to hypertension, high blood pressure, and cardiovascular disease (Siasos, et al., 2012). Additionally mice exposed to e-cig vapor have shown impairment in anti-bacterial and anti-viral defenses, resulting in more frequent mortalities following exposure to pneumonia and influenza, compared to mice not exposed to e-cig vapor (Sussan, et al., 2015). Moreover, human lung fibroblasts (i.e., cells of connective tissues) exposed to e-cig liquid release Interleuken-8 (IL-8; Lerner, et al., 2015), which is a pro-inflammatory protein secreted by cells that contribute to chronic inflammation in the lungs (Jing, et al., 2012). In sum, there is a growing body of evidence that suggests e-cig liquid may be harmful to users' health, but more research is required.

In addition to a growing body of research on the direct effects of e-cig liquid to the user, the health effects of e-cig aerosol exposure (i.e. second-hand e-cig "smoke") are also gaining research attention. Studies conducted under controlled laboratory conditions show that e-cig aerosols contain formaldehyde (Jensen, et al., 2015), ultrafine particles (airborne particles created during combustion and responsible for cardiovascular and respiratory diseases; Health Effects Institute, 2013), propylene glycol, glycerol, and carbonyls (Czogala et al., 2013; Geiss et al., 2014; Schripp, et al., 2013). E-cig aerosols have also been found to contain tin, silver, iron, nickel, aluminum, chromium and silicate,

many of which are known to cause respiratory problems and diseases (Williams, et al., 2013). Also detected in e-cig aerosols are potentially toxic levels of diacetyl (DA) and acetyl propionyl (AP; Farsalinos, et al., 2015), which are often found in food flavorings. Although approved for use in food (CDC, 2012), DA and AP are not approved for inhalation and have been shown to cause inflammation in the nose, larynx, trachea, and bronchi (Hubbs, et al., 2008). The concentration of such compounds in indoor air where e-cigs are used, such as in bars and restaurants, remains under investigated, although e-cig aerosol content and concentration likely vary by brand and type of e-cig (Williams, 2011; Goniewicz, et al., 2013; Zhang, et al., 2013). It is further likely that indoor air quality may vary as well.

Despite these major health concerns, many use e-cigs as they mimic a cigarette in look and feel (Dawkins, et al., 2013) and drug experiences—such as displaying similar increases in blood nicotine levels (Dawkins, et al., 2012) nicotine absorption (Flouris, et al., 2013), and serum cotinine levels (Grana, et al, 2014a). However, e-cigs given their similarity to cigarettes, may pose a risk in that they may have a similar relationship with alcohol use. Thus, in addition to the potentially negative direct health effects of e-cig liquid and aerosol, e-cigs could pose increased risk to individuals with or at risk for developing an AUD. Recent studies have found that e-cig use is associated with problematic alcohol consumption (Hershberger, et al., 2016), past 30 day binge drinking (Saddleson, et al., 2015), and daily alcohol consumption (Cohn, et al., 2015). In line with Incentive Sensitization Theory and the Priming Hypothesis, e-cigs could potentially replace cigarette smoking as a cue for alcohol consumption. In fact, unlike cigarettes, e-cig use is permitted in most bars and restaurants in the United States, even in those

regions with smoking ban legislation. To date, North Dakota, New Jersey and Utah are the only three states prohibiting e-cig use in venues with smoking ban legislation, with an additional 354 local laws from 18 states prohibiting e-cig use in smoke-free cigarette venues (ANSRF, 2015). In addition to widespread permitted use in bars and restaurants, it may be likely that individuals can use e-cigs in other places where cigarette use in not allowed (e.g. at home, a sporting event, someone else's home). Individuals in the United States generally have a positive view of e-cigs, particularly viewing them as safer than cigarettes (Hershberger, et al., under review), which could in turn increase the likelihood that individuals can use e-cigs where they consume alcohol.

Particularly concerning is that the rate of e-cig use in substance dependent populations is estimated to be 17% (Peters, et al., 2015), which is three times the rate found in the general population (King, et al., 2013). If e-cigs serve as a potential cue for alcohol use, and can be used where cigarettes cannot, these substance dependent individuals may be at risk for increased substance use while using e-cigs, and vice versa. Though it is plausible that those with an AUD are more likely to use an e-cig, it is similarly plausible that those who use e-cigs may in turn consume more alcohol. However, there are important clinical implications for examining the direction of e-cig use increasing alcohol use, particularly given the use of e-cigs in substance dependent populations and for smoking cessation; if e-cigs increase alcohol use this may call into question their efficacy for smoking cessation in those at risk for problematic

Present Study

There is much still unknown about the use and safety of e-cigs. Further research is needed to examine the relationship between e-cig use and other addictive behaviors, such as alcohol consumption. High rates of dual e-cig and cigarette use suggest that one may easily replace the effects of one with the other. Given the strong relationship between cigarette and alcohol use, it is further possible that e-cigs could have a comparable relationship with alcohol use. Since e-cigs are being investigated as a smoking cessation tool (Etter & Bullen, 2011) and are likely permitted in areas where one consumes alcohol, understanding the effects of this product on alcohol consumption is imperative. This may be especially so, given that that e-cig use could inadvertently increase alcohol consumption or even cigarette use (King, et al., 2014), and thus cause undo harm for the individual. Knowledge of such harm could be utilized by clinicians working with individuals with AUDs. It is possible that the use of e-cigs where alcohol is or was previously consumed (e.g. at home, a friend's home, a bar) could trigger alcohol use for such individuals and may need to be addressed in relapse prevention treatment.

The present study assessed smoking status (e-cig user, cigarette user, dual user, or non-user), alcohol consumption, and smoking prohibitions where one consumes alcohol most frequently. The smoking prohibition may have been a result of legislation (i.e. smoking or e-cig ban), policy of a building or restaurant, or a personal preference (e.g. choose not to smoke or use an e-cig in one's own home). Based on the reviewed literature, I tested the following hypotheses, all corrected for the effects of age, gender, and race:

1) Smoking prohibition status will significantly relate to smoking status (Etter & Bullen, 2011), such that smoking prohibition (as compared to when it is allowed) will be significantly related to a greater likelihood of being an a) e-cig user as compared to a cigarette user, b) an e-cig user as compared to a dual user, and c) a dual user as compared to a cigarette user.
2) Smoking prohibition status will significantly relate to alcohol consumption and problems (Kaska, et al., 2012; Picone, et al., 2004), such that smoking prohibition (as compared to when it is allowed) will be significantly associated with lower alcohol consumption and fewer alcohol problems.
3) There will be a significant interaction between smoking prohibition and smoking status as related to alcohol consumption and problems, such that smoking prohibition (as compared to when it is allowed) will be significantly associated with lower alcohol consumption rates among cigarette users. There will be no relationship between smoking prohibition and alcohol consumption rates among e-cig and dual users.

METHOD

Participants

Seven hundred and forty-three participants were recruited using Amazon's Mechanical Turk (MTurk; https://www.mturk.com/mturk/welcome; last accessed September 20, 2015). MTurk is an online web service that connects researchers to individuals willing to complete tasks for a wage. Participants were paid 50 cents for completing the fifteen minute study and an additional 25 cents for passing attention checks. An MTurk survey pay rate of fifty cents has been shown to promote increased participation, compared to lower pay rates of two and ten cents, for a thirty-minute long survey (Buhrmester, et al., 2011). This suggests that MTurk workers were satisfied with the 75 cents per quarter of an hour compensation rate for the present study.

Inclusion and Exclusion Criteria

Participants must have reported being 1) 21 years of age or older, 2) current alcohol drinkers, 3) United States residents, and 4) able to answer and read a questionnaire in English. A primary interest of the present study was alcohol consumption behaviors. In the United States, individuals must be 21 to legally drink, thus I excluded anyone under this age or those who did not endorse current alcohol consumption.

Amazon's MTurk

What is MTurk?

Amazon's MTurk is an online crowdsourcing tool that can be used to recruit participants for social science research. The MTurk subject pool has recently been used to research an array of psychological constructs, including addiction (Boynton & Richman, 2014), personality (Holden, et al., 2013), relationships (Adams, et al., 2014), self-injury (Andover, 2014) and grief (Papa, et al., 2014). Participants obtained via MTurk are known as *workers*. Workers are able to choose from and complete a variety of Human Intelligence Tasks (HITs) posted by organizations or individuals. Those that post HITs are known as *requesters*. Requesters can set exclusion criteria for workers that complete their HITs (e.g. age restrictions, language restrictions). After meeting HIT criteria, workers are able to take part in the tasks. After HIT completion, the workers receive compensation from the requester through an Amazon pay system. Workers main interest in completing HITS on MTurk is not money; 69.6% of workers use MTurk as a source of entertainment (Paolacci, et al., 2010).

Compensation rates for workers vary by HIT and the average HIT pays $1.40 per hour (Horton et al., 2010). Buhrmester et al. (2011) administered measures of global self-esteem, political affiliation, and Big-Five personality traits to 116 MTurk participants. Score reliability on these measures remained constant across two cents (Mean r=0.87), ten cents (Mean r=0.88), and fifty cents (Mean r=0.87) per 30 minute pay rates. Additionally, the study found 30-minute surveys paying fifty cents had an average HIT completion rate of 16.7 workers per hour. Test-retest reliabilities over three weeks on

these measures were high (mean *r*=0.87). Additionally, demographic variables assessed in MTurk samples have shown good test-retest reliability, with less than two percent showing inconsistent responses across one week (Shapiro, et al, 2013).

Demographic make-up of MTurk

MTurk workers in the United States tend to be female (female=54%), approximately 32.64 years old (SD=11.63), and Caucasian (Caucasian=83.5%; Shapiro, et al., 2013). Additionally, most MTurk workers have had some college (38.8%) or have received a four-year degree (31.8; Paolacci, et al., 2010; Goodman, et al., 2013; Shapiro, et al., 2013). MTurk samples have been found to be similar to community samples in age, gender, and education (Goodman, et al., 2010), but are younger and more educated than the general population of the United States, as measured through census (U.S. Census Bureau, 2013). Additionally, MTurk samples from the United States are similar to college samples in gender make-up, but differ from college samples by age (college sample age=19.4) and education (100% having had some college).

Personality and Psychopathology

Goodman and colleagues (2013) investigated differences in MTurk workers, compared to community and college samples, on the Big 5 Personality facets (extraversion, neuroticism, openness to experience, agreeableness and conscientiousness), measures of emotional stability, and self-esteem. MTurk workers were less extroverted and less emotionally stable than both college and community

sample participants. Additionally, MTurk workers were lower on openness to experience, compared to community samples. Workers were also lower on conscientiousness and self-esteem compared to college sample participants.

MTurk samples' lower levels of conscientiousness could have potential effects on participants' ability to fill out self-report data. However, MTurk participants were assessed for attention and random responding. Low self-esteem could have resulted in increased instances of psychopathology in the sample, such as higher anxiety, depression, and substance use disorders. However, clinical levels of anxiety, depression, and heavy alcohol consumption previously found in MTurk samples are comparable to twelve-month prevalence rates in the United States (Kessler, et al., 2005; Shapiro, 2013; CDC, 2010).

Overall, samples obtained through MTurk seem to better approximate the age of the population of the United States, compared to college samples, and more closely resemble the mean age of heavy alcohol consumption (M=31.8 years, SD= 10.1; Boynton & Richman, 2014). Additionally, MTurk allows for sampling individuals across the United States in a cost effective and efficient way that still allows for adequate reliability and validity of data.

Measures

Participants completed an online questionnaire with items assessing demographic variables, alcohol consumption, and both cigarette and e-cig usage.

Demographics

Participants provided their age, gender, and race/ethnicity (Caucasian/White, Hispanic/Latino, Asian/Pacific Islander, Black/African American, Native American/Alaskan Native, and Other (*see* Appendix A1).

Cigarette smoking and e-cig use

Cigarette smoking was assessed using a face valid measure (i.e., "Have you ever been a cigarette smoker?"). E-cig usage was assessed using a face valid measures (i.e., "Do you currently use an electronic cigarette?"; *see* Appendix A1).

Alcohol use

Alcohol consumption frequency and problematic alcohol consumption were assessed using the Alcohol Use Disorder Identification Test (AUDIT; *see* Appendix A2; Saunders, et al., 1993). The AUDIT is a ten-item scale that assesses hazardous alcohol consumption, abnormal alcohol consumption behavior, and alcohol related problems. Item 1 assesses alcohol use frequency ("How often do you have a drink containing alcohol?" – response options 0-Never, 1-Monthly or Less, 2-2 to 4 times per month, 3-2 to 3 times per week, 4-4 or more times per week). Item 2 assesses quantity of alcohol consumed ("How many drinks containing alcohol do you have on a typical day when you are drinking?"- response options 0-1 or 2, 1-3 or 4, 2-5 or 6, 3-7, 8 or 9, 4-10 or more). Items 3-8 assess alcohol related problems (e.g. "How often during the last year have you had a feeling of guilt or remorse after drinking?"- response options 0-Never, 1-Less than monthly, 2-Monthly, 3-Weekly, 4-Daily or Almost Daily). Items 9 and 10 assess alcohol

related injury ("Have you or someone else been injured as a result of your drinking?") and concern from others ("Has a relative or a friend or a doctor or other health worker been concerned about your drinking or suggested you cut down?"- response options 0-No, 2-Yes, but not in the last year, 4-Yes, in the last year). AUDIT responses in the present sample showed good reliability (alpha=0.81).

Data obtained by the AUDIT allows for validly discriminating between hazardous and non-hazardous drinkers (Saunders, et al., 1993). Responses show concurrent validity with the Drinker Inventory of Consequences (r=0.57), Alcohol-Drug Screen (r=0.58), Structured Clinical Interview for Diagnostic Statistical Manual Disorders alcohol dependence criteria (r=0.42), Obsessive Compulsive Alcohol Consumption Scale (r=0.41) and the University of Rhode Island Change Assessment Scale (r=0.24; Donovan, et al., 2006). AUDIT responses show high test-retest reliability (r=0.86; Sinclair, et al., 1992) and mean score reliability across studies (r=0.79; Shields & Caruso, 2003).

The Timeline Followback Calendar (TLFB; *see* Appendix A3; Sobell & Sobell, 1992) was used to assess alcohol consumption and usage setting. The TLFB aids participants in giving estimates of daily alcohol consumption. For the present study, participants were asked to think about the prior two-weeks, indicate if they consumed alcohol on each of the specified days, and report in what context they were consuming alcohol: At home (including around their home, such as the porch, patio, or sidewalk), at someone else's home (including around their home, such as the porch, patio, or sidewalk), outside (in a public place, such as a park, tailgating area, shopping center, or shopping area), at a bar or restaurant, at a sporting event, at work, at school, in a car, at a

religious service or activity, or other. Response options were based on the Drinking Styles Questionnaire (DSQ; Smith, et al., 1989) and expanded to include other possible venues where adults may consume alcohol. The DSQ was originally formulated to assess alcohol consumption in adolescents and responses have high concurrent validity (Smith, et al., 1995) and test-retest reliability (Cyders, et al., 2007; Fischer, et al., 2003; Fischer, et al., 2004).

To aid in consistent responding, an image depicting a mixed drink, a glass of wine, and a beer appeared with the TLFB calendar to provide participants with information about what is considered "one drink" (one mixed drink=1.5 fl oz. of 80 proof liquor, one glass of wine=5 fl oz. of wine, one beer=12 fl oz. of beer or wine cooler). They also viewed an image of a calendar with detailed descriptions on how to best recall their alcohol consumption behavior over the last two weeks (e.g. look through their text messages, fill in important dates first). Responses on the TLFB have excellent test-retest reliability for days abstinent (r =0.96), days of alcohol consumption without a binge episode (r =0.95), and days with binge episodes (r =0.94) in social drinkers (Sobell & Sobell, 1992). Responses also demonstrate high convergent validity with the Addiction Severity Index (r=0.69; DeMarce, et al, 2007).

Smoking prohibition assessment

Participants were asked to recall the place that they consume alcohol most frequently ("Where do you consume alcohol most frequently?"; *see* Appendix A4) with ten answer choices, mirroring drinking context choices given on the TLFB (*see* Alcohol Use). Participants were asked if cigarettes are prohibited where they consume alcohol

most frequently ("Are people able to smoke cigarettes where you drink most frequently without having to move to a separate area, such as outside?") with three response options ("Yes, people are able to smoke where I drink most frequently", "No, people are not able to smoke where I drink most frequently," and "Don't Know"). Participants were also given the same question and answer choices pertaining to e-cig use ("Are people able to use e-cigs where you drink most frequently without having to move to a separate area, such as outside?"). Questions were aimed to classify if the person was likely consuming alcohol where nicotine and alcohol use occur together in time and place, thus both smoking and alcohol related cues would have the possibility to be present for an individual responding yes.

Careless responding

Careless responding was assessed by the use of four "bogus items" placed throughout the test ("I have never brushed my teeth," "I do not understand a word of English," I sleep less than one hour per night," and "I have been to every country in the world"), with one item proceeding the TLFB, one preceding the AUDIT, and two proceeding a measure unrelated to the present study Participants responded to items on a 1 (agree strongly) to 7 (disagree strongly) scale. Answering a 1 or 2 on any item was considered careless responding and data for these participants was removed, as determined a priori (Meade & Craig, 2012). The following items were also used to evaluate inconsistent responding: "Do you drink alcohol?" "Which type of alcoholic drink do you prefer?" and "How many drinks containing alcohol do you have on a typical day when consuming alcohol.?" More than 1 item inconsistency, with participants

answering “I do not drink” to any of these items, resulted in data exclusion. Any participant who failed the careless responding checks did not receive the twenty-five cent bonus for attentive study completion.

Construct Definitions

Smoking Status

Smoking Status refers to four categories: cigarette users, e-cig users, both e-cig and cigarette users (dual users), and non-users. Categories were independent.

Alcohol Consumption

Alcohol consumption was conceptualized in three ways, using AUDIT scores and the TLFB responses. Anyone scoring more than 3 standard deviations away from the mean on these measures were removed during data screening as an outlier, as determined a priori.

AUDIT score was an alcohol consumption measure calculated by summing responses to the ten AUDIT items to gain a measure of problematic alcohol consumption (Saunders, et al., 1993).

Total Drinks was an alcohol consumption measure calculated by summing the number of drinks reported for each participant across the two-week TLFB and aimed to characterize risk for hazardous alcohol consumption (NIAAA, 2015).

Average Drinks was an alcohol consumption measure calculated by taking Total Drinks and dividing it by the total number of alcohol consumption days. The average number of drinks consumed by participants on alcohol consumption days allowed for the characterization of an average alcohol consumption episode. For example, binge drinkers are often classified by the total number of drinks they consume in one alcohol consumption episode (Fillmore & Jude, 2011; McCarthy, et al., 2012).

Smoking Prohibition

Smoking prohibition refers to participants' responses to the item assessing if smoking is prohibited where they consume alcohol most frequently. Individuals reporting "Don't know" to smoking prohibition were removed during data screening, as determined a priori.

E-cig Prohibition

E-cig prohibition refers to participants' responses to the item assessing if e-cigs are prohibited where they consume alcohol most frequently. Individuals reporting "Don't know" to e-cig prohibition were removed from the restricted sample during data screening, as determined a priori. Participants responding "yes" were also removed, as study hypotheses pertained to those individuals that would have the opportunity to have e-cig cues where they consume alcohol.

Procedure

All materials and procedures for the present study were approved through the Indiana University Institutional Review Board. The questionnaire items for the proposed study were entered onto Survey Monkey, an online survey development website. A unique uniform resource locator (URL) was created for the study. The URL was then posted to Amazon's MTurk and displayed as a potential project for workers. The name of the study visible to MTurk workers was "E-cigarettes, cigarettes and alcohol survey (Must consume alcohol to participate)." Workers read the following description of the study: "This questionnaire is about your alcohol consumption, smoking, and e-cig use. The study is investigating patterns of use in the general population. It takes about 15 minutes to complete. In order to participate, you must live in the United States, be 21 years or older, be able to understand English, and drink alcohol. Answering thoroughly and attentively will result in an EXTRA 25 CENTS for a total of 75 CENTS compensation." An MTurk filter was used to limit participation to workers that live in the United States and could read and answer surveys in English.

Workers were given the Survey Monkey URL for the current study. Once workers signed up to participate in the study, they had three hours to complete the study. Before clicking on the survey link, participants were told to keep the current MTurk browser window open; after completing the study, workers were asked to enter a unique number in this window that was used to confirm their participation and facilitate the compensation process. Participants next clicked on the URL for the survey. They read the following information about the present study:

"You are invited to participate in a research study of alcohol consumption, smoking and electronic-cigarette use. It is part of a University study that is investigating patterns of use in the general population. The study takes approximately 15 minutes to complete and you will be paid 50 cents for your participation and an additional 25 cents for answering thoroughly and attentively for a total of 75 cents. PARTICIPATION IN THIS STUDY IS CONFIDENTIAL. As part of the study, you will be asked to provide some demographic information and answer questions about your alcohol consumption, smoking and electronic-cigarette use. Participation in this study requires that you currently live in the United States, are over the age of 21 and drink alcohol. This study is being conducted at Indiana University-Purdue University Indianapolis by Dr. Melissa A. Cyders, a faculty member in Clinical Psychology. Ms. Alexandra Hershberger, a supervised graduate student, will be aiding in the study. The purpose of this study is to examine the relationships between smoking, alcohol consumption and electronic-cigarette use."

After reading the study information, participants selected "yes" or "no" to participate in the study. Upon selecting yes, participants were asked if they drink alcohol and if they were over the age of 21. Answering "no" to either question disqualified the participant for the study and the survey window automatically closed. Answering "yes" allowed them to begin the study. Participants responded to the above-described questionnaires.

After completion, participants read "Please enter the current DATE AND TIME. For example if it is 08/15 11:14 A.M., I would enter 08151114. THIS IS YOUR SURVEY CODE. YOU WILL NOT RECEIVE COMPENSATION IF YOU SKIP THIS ITEM. Please submit your survey as soon as you fill in this question. Enter this number in

your Mechanical Turk window." Within two days, the survey code entered on Survey Monkey was matched to the survey codes entered on MTurk to verify worker participation. Additionally, careless responding items were evaluated for accuracy. All workers that provided a survey code were awarded the total of 75 cents, as those failing the random responding checks did not provide a survey code for compensation. Survey codes were erased from the data once participants were compensated through Amazon.

RESULTS

Data Cleaning

A total of 743 participants completed the survey. The first step in the primary analysis was to remove participants based on the following criteria (as determined a priori): 1) failure of random responding checks; 2) completed the study at a prior time point; 3) scored >3 SD away from the mean on AUDIT, Total Drinks, or Average Drinks; 4) did not know if there was a smoking prohibition or e-cig prohibition where they consume alcohol most frequently; and 5) reported that e-cigs were prohibited where they consume alcohol most frequently.

Fifty-one participants were excluded from data analysis for failing 2 or more random responding items. Additionally, 100 subjects were excluded from analysis for completing the survey at a previous time period as part of a larger study. As these participants had previous exposure to survey items, it was determined that this could threaten the validity of their responses to the variables of interest. Those excluded did not differ from the remaining sample in gender, ethnicity, AUDIT score ($t(689)=-0.34$, $p=.73$), Total Drinks ($t(689)=-1.03$, $p=.31$), or Average Drinks ($t(689)=-0.82$, $p=.42$). However, groups did differ in age ($t(689)=-3.32$, $p=.001$) with older individuals in the excluded group (mean age=36.45, SD=11.76), compared to the remaining sample (mean age=32.66, SD=10.32).

Next, participants' total AUDIT, Total Drinks, and Average Drinks were standardized to remove outliers, as determined a priori. A total of eight participants scored greater than 3 SD (no one scored less than 3 SD) above the mean on the AUDIT. These individuals did not vary from the rest of the sample in age, ethnicity, or gender. A total of nine participants scored greater than 3 SD (no one scored less than 3 SD) above the mean on Total Drinks. These individuals did not vary from the remaining sample in age, ethnicity, or gender. An additional 10 participants scored greater than 3 SD (no one scored less than 3 SD) above the mean on Average Drinks. The age of outliers on Average Drinks (mean=26.18, SD=5.14) was significantly lower than the remaining sample (mean=32.79, SD=10.36; $t(560)=2.10$, $p<.05$), but they did not differ in ethnicity, or gender. For smoking prohibition, 14 individuals reported "Don't Know" if smoking is prohibited where they consume alcohol and were excluded from further analyses. Those excluded did not differ from the remaining sample in age, gender or ethnicity.

Study hypotheses were concerned with the potential effects of e-cigs being allowed where alcohol is consumed. Thirty-three individuals reported "Don't Know" to e-cig prohibition, and 153 reported e-cig use was prohibited, and these individuals were thus excluded (Final Sample N=365, mean age=33.63, SD=9.91, 53.2% female, 78.9% Caucasian, *see* Table B1). These individuals did differ significantly from the remaining sample on all three drinking measures (*p's* all <.001), with those individuals reporting e-cig prohibition scoring significantly lower on all alcohol use measures.

Descriptive Analyses

The greatest percentage of the participants reported having a bachelor's degree (37.8%) followed by having some profession school (29.9%). The majority of participants' endorsed a yearly household income of $25,000 to $40,000 (26.8%). Non-users made up 26.6% of the total sample, 15.6% of the sample reported e-cig use, 21.1% of the sample reported cigarette use, and an additional 36.7% on individuals reported dual use. Table B2 provides demographic variables by smoking status.

Less than .01% of data from the AUDIT was missing at random, and was therefore imputed through linear interpolation. Data did not differ significantly before and after interpolation (p=0.34). AUDIT scores have a possible range of 0 to 40, and the range was 1 to 24 in the present sample (mean=7.23, SD=4.78). AUDIT scores showed acceptable reliability (alpha=0.81). Total Drinks ranged from 0 to 64 (mean=16.27, SD=13.60) and Average Drinks ranged from 0 to 9.5 (mean=3.02, SD=1.78). All three measures were approximately normally distributed.

The AUDIT, Total Drinks and Average Drinks were all intercorrelated (*r's* 0.51-0.61, *p's* all <.01; *see* Table B3). Being a cigarette user was significantly related to all three drinking measures (*r's* 0.12-0.19, *p's* all <.001, *see* Table B3), being an e-cig user was not significantly associated with any drinking measures, and being a dual user was significantly correlated with AUDIT scores (r=0.12, p=.02, *see* Table B3).

Next, the location in which participants consume alcohol most frequently was assessed in two ways: one single self-report item, and through the two-week TLFB. First, on the single self-report item assessing where each participant consumes alcohol most frequently, a total of 70.1% reported consuming alcohol at home most frequently, followed by 18.1% reporting consuming alcohol at a bar or restaurant most frequently. Next, based on the two-week TLFB responses, 65.2% of participants reported consuming alcohol at home most frequently and 15.9% reported consuming alcohol at a bar or restaurant most frequently. Overall 78.4% of the self-report and TLFB data matched for where each participant reported drinking most frequently (*see* Table 4). Additionally, responses to single items assessing smoking prohibition where one consumes alcohol indicated that 41.9% of the sample reported a smoking prohibition where they consume alcohol most frequently (*see* Table B4).

Hypothesis Testing

Hypothesis 1

Smoking prohibition status will significantly relate to smoking status (Etter & Bullen, 2011), such that smoking prohibition (as compared to when it is allowed) will be significantly related to a greater likelihood of being an a) e-cig user as compared to a cigarette user, b) an e-cig user as compared to a dual user, and c) a dual user as compared to a cigarette user.

Hypothesis 1 Results

Three separate hierarchical logistic regressions (*see* Table C1 and Figure D1) were conducted with the following dependent variables: e-cig use status vs. cigarette use status, e-cig use status vs. dual use status, and dual use status vs. cigarette use status. The following independent variables were entered in each analysis in steps: age, gender (dummy coded 0-male, 1-female), ethnicity (dummy coded with "Caucasian" as the reference group) were entered in step 1 and smoking prohibition (dummy coded 0-cigarettes allowed, 1-cigarettes prohibited) was entered in step 2. A p-value of .016 was considered significant to adjust for multiple comparisons.

For e-cig use versus cigarette use (dummy coded 0-cigarette user, 1-e-cig user), the overall model was significant, $\chi 2=13.23$, $p=.02$, Nagelkerke's $R^2=0.13$. Consistent with my hypothesis, smoking prohibition was associated with a higher likelihood of being an e-cig user as compared to a cigarette user, OR=3.40, $p<.001$. For e-cig use versus dual use (dummy coded 0-dual users, 1-e-cig users), the overall model was significant, $\chi 2=21.10$, $p=.002$, Nagelkerke's $R^2=0.15$. Consistent with my hypothesis, smoking prohibition was associated with a higher likelihood of being an e-cig user compared to a dual user, OR=3.37, $p<.001$. For dual use versus cigarette use (dummy coded 0-cigarette users, 1-dual users), the overall model was not significant, $\chi 2=2.88$, $p=.82$, Nagelkerke's $R^2=0.02$. Contrary to my hypothesis, smoking prohibition was not associated with the likelihood of being a dual user as compared to a non-user, OR=1.00, $p=0.89$.

Hypothesis 2

Smoking prohibition status will significantly relate to alcohol consumption and problems (Kaska, et al., 2012; Picone, et al., 2004), such that smoking prohibition (as compared to when it is allowed) will be significantly associated with lower alcohol consumption and fewer alcohol problems.

Hypothesis 2 Results

Three hierarchical linear regressions (*see* Table C2 and Figure D2) were conducted to examine the relationship between smoking prohibition and each alcohol consumption measure in a separate model (AUDIT, Total Drinks, Average Drinks). Independent variables were entered in the following steps in each analysis: 1) age, gender (dummy coded 0-male, 1-female), ethnicity (dummy coded with "Caucasian" as the reference group) and 2) smoking prohibition (dummy coded 0-cigarettes allowed, 1-cigarettes prohibited). Contrary to my hypothesis, smoking prohibition was not significantly related to AUDIT scores above and beyond age, gender, and ethnicity, ΔR^2=0.001, B=-0.06, p=.21. Additionally, smoking prohibition was not significantly related to Total Drinks above and beyond age, gender, and ethnicity, ΔR^2=0.004, B=-0.07, p=.19. Finally, smoking prohibition was not significantly related to Average Drinks above and beyond age, gender, and ethnicity, ΔR^2=0.004, B=-0.02, p=.76.

Hypothesis 3

There will be a significant interaction between smoking prohibition and smoking status as relating to alcohol consumption and problems, such that smoking prohibition (as

compared to when it is allowed) will be significantly associated with lower alcohol consumption rates among cigarette users. There will be no relationship between smoking prohibition and alcohol consumption rates among e-cig and dual users.

Hypothesis 3 Results

Three Analyses of Covariance (ANCOVAs, *see* Table C3 and Figure D3) were conducted to examine the interactive effects of Smoking Status and smoking prohibition on alcohol consumption measures (AUDIT, Total Drinks, Average Drinks) in separate models, controlling for age, gender, and ethnicity.

For AUDIT scores, results revealed main effects of age, $F(1, 359)=11.96$, $p=.001$, gender, $F(1, 359)=24.71$, $p<.001$, and Smoking Status, $F(3, 549)=8.51$, $p<.001$. Younger individuals scored significantly higher on the AUDIT, $r=-0.17$, $p<.001$, and men scored significantly higher than women, $t(363)=5.59$, $p<.001$. There was a trend for a significant interaction between Smoking Status and smoking prohibition on AUDIT scores, $F(3, 359)=2.46$, $p=.06$. The interaction was probed using follow-up t-tests, as determined a priori. To correct for multiple comparisons, a p-value of less than .013 was used to determine significance. In contrast to my hypothesis, results indicate that when smoking was prohibited, e-cig users scored significantly lower on the AUDIT, $t(55)=1.98$, $p=.05$, and cigarettes users scored significantly higher on the AUDIT compared to when smoking was allowed, $t(75)=-2.37$, $p=.02$, though this effect was marginal. Consistent with my hypothesis, dual users did not score significantly different on the AUDIT by smoking prohibition, $t(132)=0.20$, $p=.84$.

For Total Drinks, the ANCOVA revealed main effects of gender, $F(1, 358)=24.90$, $p<.001$, and Smoking Status, $F(1, 358)=7.99$, $p<.001$. Men reported significantly more Total Drinks than women, $t(362)=5.28$, $p<.001$. There was no significant interaction between Smoking Status and smoking prohibition on Total Drinks, $F(3, 358)=1.55$, $p=.22$.

For Average Drinks, results revealed main effects of age, $F(1, 359)=7.13$, $p=.008$, gender, $F(1, 559)=15.02$, $p<.001$, and Smoking Status, $F(3, 359)=5.56$, $p=.001$. Younger participants reported higher Average Drinks, $r=-0.15$, $p<.001$, and men reported higher Average Drinks than women, $t(363)=4.40$, $p<.001$. There was a significant Smoking Status by smoking prohibition interaction, $F(3, 359)=7.22$, $p<.001$. The interaction was probed using follow-up t-tests, as determined a priori. Contrary to my hypothesis, e-cig users reported lower Average Drinks when smoking was prohibited than when it was allowed, $t(55)=3.26$, $p=.009$. Also contrary to my hypothesis, cigarette users reported higher Average Drinks when smoking was prohibited than when it was allowed, $t(75)=-3.49$, $p=.001$. Consistent with my hypothesis, dual users did not differ in Average Drinks by smoking prohibition, $t(132)=-1.27$, $p=.21$.

DISCUSSION

The goal of the present study was to examine three hypotheses: 1) smoking prohibition status will significantly relate to smoking status, 2) smoking prohibition status will significantly relate to alcohol consumption and problems, and 3) there will be a significant interaction between smoking prohibition and smoking status as related to alcohol consumption and problems. Present findings suggest: 1) Smoking prohibition was associated with greater likelihood of being an e-cig user than a cigarette use and with greater likelihood of being an e-cig user than a dual user; however, smoking prohibition was not associated with the likelihood of being a dual user as compared to a cigarette user. 2) Smoking prohibition was not associated with alcohol consumption or problems. 3) There was some evidence that smoking prohibition interacted with smoking status as related to alcohol consumption and problems, although findings were in the opposite direction than predicted.

Interpretive Considerations

It is of upmost importance that these findings be interpreted in the context of construct definitions, the limitations of the study design and methodology, and the characteristics of the sample. The first interpretive consideration is the way cigarette

prohibition was defined in the present sample. Unlike previous studies that examined the effect of smoking ban legislation on alcohol consumption (Kaska, et al., 2012; Wolff-Young, et al., 2012), the present study expanded this to include any self-reported smoking prohibition, including private policies (such as in the home). This was done as 1) our previous attempts to measure smoking ban legislation for participants resulted in invalid and difficult to verify responses (i.e., participants did not consistently report city and county to aid in determining the presence of a smoking ban legislation, and such legislation is inconsistently applied to different drinking establishments) and 2) including any prohibition serves as a means for targeting the association between alcohol and smoking behaviors, rather than the specific effects of legislation. The current finding that smoking prohibition was unassociated with alcohol consumption and problems is inconsistent with previous work and could have been driven in part by the difference in how smoking prohibition was defined. For example, smoking ban legislation affects public places, while smoking prohibitions, as defined in the present study, encompass any place where alcohol may be used. This distinction is important, as previous literature has found the positive effects of smoking ban legislation are on public alcohol consumption (Kaska, et al., 2012; Wolff-Young, et al., 2012).

Next, the characteristics of the present sample play an important role in data interpretation. First, the prevalence rate of e-cig use, cigarette use, and dual use are considerably high in the present sample. For example, evidence has suggested that e-cig use rates in U.S. adults is approximately 6.2% (King, et al., 2011), while the present study had a prevalence rate of approximately 15%. There are several possible explanations for an overrepresentation of smokers and e-cig users, including

1) individuals self-selected to take part in this study, which was advertised "E-cigarettes, cigarettes and alcohol survey (Must consume alcohol to participate)," thus making it possible that individuals who used e-cigs or cigarettes were attracted to this study, 2) cigarette and e-cig users are more likely to consume alcohol, and so restricting the sample to only alcohol users caused an influx in smokers in the present sample, and 3) the rates of smoking and e-cig use in the current study reflect actual rates of use. Recent research has found that high school students endorse e-cig use rates of approximately 15% (Bunnell, et al., 2015), and thus it is not completely implausible for adults to use at a similar rate. However, this does not explain why almost 35% of the sample endorsed dual use, which is well above any population based estimates. Though the explanation for the high prevalence of smokers and e-cig users in the present sample must be left to speculation, the presence of this effect still has important interpretive implications mainly that it is unlikely that these results would generalize to the overall U.S. population.

Self-selection not only likely resulted in a disproportionate amounts of smokers and e-cig users, but also likely in the unintended recruitment of those with strong opinions on e-cigs, cigarettes, or alcohol, thus potentially biasing study findings. For example, a culture has developed around the use of e-cigs, which includes the growth of a specified language between users, social support to other users, conventions that provide information and e-cig products, and an extension of these cultural practices to online communities (McQueen, et al., 2011). It is likely members of the e-cig culture are highly identified with this group, and it may follow that that those involved in this culture would be attracted to the present study, perhaps seeing it as a means of supporting their group. Though there is no research to date examining how those involved in the e-cig culture

may vary from other populations, it is plausible that there are fundamental differences, such as in personality characteristics. This being said, recent research has found that individuals of all smoking statuses appear to have positive beliefs about e-cigs, compared to cigarettes, particularly for health benefits, smoking cessation benefits and social benefits (Hershberger, et al., under review). Thus the potential biasing effect of being a part of the e-cig culture may not necessarily or solely reflect stronger positive beliefs about e-cigs, but also other factors, such as frequency of use, context of use, and perhaps a tendency to answer in a way in line with their group values, such as by selectively trying to give the best impression of e-cigs as possible. This would further limit the extent to which the results would replicate in a better approximated U.S. population based sample.

Also affecting the generalizability of the results, the present study consisted of predominately Caucasian individuals. Though studies have found e-cig use prevalence to be higher among Caucasians (e.g. King, et al., 2011), research should examine the role that racial and/or ethnic backgrounds play in e-cig use, particularly in how e-cig use may be differentially associated with alcohol use by these factors. As alcohol consumption varies by race (NIAAA, 2006), it is further plausible that race may impact the e-cig/alcohol use connection. This is of great importance, as ethnic and racial minorities have disparate consequences from alcohol use, particularly in disease progression, compared to Caucasian individuals (NIAAA, 2006). For example African Americans are less likely to consume alcohol, but at higher risk for sustaining alcohol related problems, likely a result of limited access to treatment (Wells, et al., 2001). Additionally, Hispanic individuals are more likely to die from cirrhosis than Non-Hispanic Caucasian

individuals (NIAAA, 2002). Further, recent research has found that African Americans pay greater attention to smoking cues than Caucasians (Robinson et al., 2015), thus this may perpetuate their problematic alcohol use. Any information on disease maintenance in minorities (e.g. co e-cig use with alcohol) could aid in preventative programs, and is thus an important avenue of future research. Additionally, though the age range and gender make-up of the present sample were representative of the U.S. population, results could not serve as a means of characterizing specific at risk groups, such as adolescents or males, which are both more likely to have more problematic alcohol consumptions and be an e-cig user (Hershberger, et al., 2016).

Another important characteristic of the sample was that participants were recruited from MTurk. Previous studies have found that MTurk workers are less extroverted, less open to experience and score lower on measures of self-esteem. These factors could have potentially impacted the constructs of interest in the proposed study, such as less extroverted individuals spending less time consuming alcohol at bars and restaurant. This could have provided an under-sampling of individuals that drink in bars and restaurants, compared to the general population. Valuable information can be gained from MTurk and it is an easily obtained, efficient, and cost-effective method by which to examine the initial hypotheses proposed in this project, but such limitations should be kept in the forefront.

In addition to the implications of variable conceptualizations and characteristics of the sample, there are considerable aspects of the study design and methodology that limit the inferences that can be drawn from the present findings. First, due to the cross-sectional nature of this study, directions of the observed effects cannot be established.

Additionally, there may be common risk factors that predict both e-cig use and alcohol use, such as personality traits (e.g. sensation seeking, urgency) or psychological disorders (e.g. depression, anxiety), which were not assessed in the present study. Also, e-cig and cigarette use were assessed through single face-valid items. It is possible that study outcomes might differ if cigarette and e-cig use were measured on a continuum (e.g., amount used in a week) rather than a dichotomy. Despite this possible limitation, the measurement of e-cig use remains quite subjective and difficult to measure, thus as a preliminary investigation of e-cig use, alcohol use, and smoking prohibitions, knowledge based solely on smoking status is likely a viable starting point and perhaps less subject to interpretation error (i.e. one either does or does not use an e-cig). Next, although "bogus items" were included in the survey, validity of online survey data can be questionable. "Bogus items" were included between the scales and used a different response scale, which may have drawn participant's attention to them, thus underestimating the amount of random responders. However, 100% of those failing the random responding checks were missing more than 75% of their data, which appeared to occur systematically at the end of the survey; as such, it was likely these individuals began the study and did not complete the study, rather than responding randomly.

Hypothesis Interpretation

While being mindful of study limitations, there are some intriguing findings from the present study. Findings for hypothesis 1 suggest 1) self-reported smoking prohibition was related to a higher likelihood of being an e-cig user than a cigarette user, 2) smoking prohibition was related to a higher likelihood of being an e-cig user than a dual user, and

3) there was no effect of smoking prohibition on the likelihood of being a dual user as compared to a cigarette user. Among the current participants, who all reported being able to use e-cigs where they consume alcohol, smoking prohibition was related to increased likelihood of being an e-cig user, suggesting viability to the theory that individuals might be using e-cigs as a means of circumnavigating smoking prohibitions. However, given study limitations, experimental and longitudinal research would be required to discern this. It is possible that 1) the higher likelihood of being an e-cig user preceded smoking prohibitions (i.e., self-selection into drinking context that allow e-cigs but do not allow cigarettes), 2) smoking prohibitions resulted in a higher likelihood of e-cig use, or 3) the observed effect is the result of an unmeasured variable. Additionally, although I expected a higher likelihood of being a dual user than a cigarette user, given that individuals report using e-cigs to circumnavigate smoking bans (Etter & Bullen, 2011), this was not supported.

Next, hypothesis 2 was not supported, as there was no effect of smoking prohibition on alcohol consumption, although previous research has found cigarette bans resulted in decreased alcohol consumption (Kaska, et al., 2012; Wolff-Young, et al., 2012). However, important study distinctions may help explain these discrepancies. First, previous findings of decreased alcohol use pertain specifically to those that drink in public. The present study was composed of 70% private drinkers, and it is possible that public versus private drinking could serve as an important moderator. Additionally, the conceptualization of cigarette prohibition included any area where alcohol could be consumed, while previous literature examined drinking in bars and restaurants. This further supports the idea that public versus private drinking could be an important factor

to consider in future studies. Additionally, the present study, unlike previous studies, was composed of a disproportionate number of smokers and e-cig using participants, making it further unlikely that these results are comparable to population-based studies.

Of importance, previous work has not considered whether e-cigs are allowed where one consumes alcohol; work showing that smoking prohibition leads to reduced alcohol consumption and problems was done prior to the advent of e-cigs and does not limit the effects to individuals who can use e-cigs where they consume alcohol. It is possible that the protective effect of smoking prohibitions on alcohol consumption and problems is not as strong when e-cigs can be used where drinking occurs. The current data support the viability of such a theory, but much more work is needed to better establish the effect of e-cig use on the effectiveness of smoking prohibitions to reduce alcohol consumption and problems, as sample and methodological concerns with the current study could limit the robustness of this finding. Importantly, null results for this analysis should be interpreted with caution and only seen as initial preliminary evidence suggesting future research. The current study's limited power could have increased the likelihood for null results and type II error (i.e., failure to reject a false null hypothesis), thus leading to an inaccurate determination of the lack of relationship between smoking prohibitions and alcohol consumption and problems.

Last, although there was some evidence of an interaction between smoking status and smoking prohibition as related to alcohol consumption and problems, hypothesis 3 was not supported, as the interaction was in the opposite direction hypothesized. Surprisingly, smoking prohibition was related to a trend for e-cig users to report lower alcohol use and cigarette users to report higher alcohol use. Such findings are especially

intriguing, as previous literature has found the opposite pattern for cigarette users: cigarette users have been found to report lower alcohol use when cigarettes are prohibited (Kaska, et al., 2012; Wolff-Young, et al., 2012). As previously discussed, there are differences in the conceptualization of cigarette prohibition, unmeasured factors, such as public and private drinking, and sample characteristics that make it difficult to compare the present study to previous research. Additionally, the present study measure e-cig use, which has not been previously assessed as related to smoking prohibition, and could also play a role in the discrepant findings. It should also be noted that a priori power analyses indicated approximately 35 individuals were needed per cell for this analysis, and some cells in this interaction analysis had as few as 23 individuals (e-cig users reporting smoking prohibited). Overall, it is possible that the observed effect is the true effect; however, it is also quite likely that the effect in the current sample is spurious and would not replicate. Future work should oversample individuals at each level of the independent variables (smoking prohibition and smoking status) in order to provide a more robust examination of this hypothesis.

Future Directions

Given the present findings, there are several implications for future research, particularly in examining 1) the effects of smoking ban legislation on alcohol consumption and smoking status, particularly assessing for e-cig use, 2) the effects of e-cig ban legislation on alcohol consumption and smoking status, 3) e-cig use as a cue for alcohol use, and 4) efficacy of e-cigs for smoking cessation in alcohol dependent populations.

First, though research has found that smoking ban legislation has resulted in decreased smoking and alcohol consumption (Kaska, et al., 2012; Wolff-Young, et al., 2012), present findings warrant reexamining these findings, taking into account e-cig use. Given that there is a higher likelihood of being an e-cig user when smoking is banned and no effect of smoking prohibition on alcohol consumption, this could mean that e-cig use is undoing the positive effects of the smoking ban, though this cannot be established due to limitations of the present study. Future research should examine changes in smoking, e-cig use, and alcohol use over time in areas with a smoking prohibition, specifically in areas that allow e-cigs. If longitudinal data shows increases in e-cig use and alcohol use where smoking is banned, this may suggest 1) individuals are using e-cigs to circumnavigate smoking bans and 2) e-cigs could be perpetuating alcohol use.

Extending this idea, smoking, e-cig use and alcohol consumption should be examined in areas with and without e-cig ban legislation. This could perhaps be a more direct, naturalistic way of examining whether allowing the use of e-cigs is related to higher alcohol use or changes in smoking behaviors. Further interesting would be to assess smoking, e-cig and alcohol consumption behavior in a town both before and after the implementation of an e-cig ban. If findings indicate that e-cig use and alcohol consumption decrease after the implementation of an e-cig ban, this further suggests that individuals were using e-cigs to circumnavigate smoking bans and that e-cigs were perpetuating alcohol use. Such findings would also aid in determining the direction of the effect of e-cig prohibitions on both smoking behaviors and alcohol use, with decreases in e-cig and alcohol use following e-cig ban implementation being indicative of an e-cig to alcohol relationship.

In addition to field investigations of the relationship between e-cig use and alcohol use, naturalistic studies would provide invaluable information on this relationship. For example, ecological momentary assessment (EMA) would give e-cig users the real-time ability to track their e-cig use and alcohol use. Such information would illustrate in-the-moment evidence of co-use, less constrained by limitations of the lab, although EMA has its own limitations, such as the act of recording ones behavior potentially changing the nature of the behavior. Further on this line, controlling whether or not participants can use their e-cig while they drink in their naturalistic setting would provide evidence for the relationship between e-cig use and alcohol use.

Naturalistic examinations could provide ecologically valid evidence for a relationship between smoking prohibitions, e-cig use and alcohol use. It is also important to consider collecting laboratory evidence which provides a controlled setting to observe the effects of limiting and allowing e-cig use. Thus, another important area for e-cig and alcohol research involves the *ad libitum* (ad lib) paradigm, in which participants are given free access to alcohol (e.g. Weafer and Fillmore, 2013). Giving e-cig users free access to alcohol, both with and without access to an e-cig would aid in determining if e-cigs could be increasing alcohol use. It is also viable to give e-cig users ad lib access to an e-cig, both with and without a dosage of alcohol, and determine if alcohol increases e-cig use. Another approach, similar, yet distinct from the ad lib paradigm, is intravenous (IV) alcohol infusion paradigm. Participants are given access to alcohol, but alcohol consumption is not oral, but rather through IV ethanol delivery. This procedure allows for the controlling of individual differences that effect alcohol use (e.g. alcohol absorption, height and weight) thus there is more control over alcohol administration. Similar

procedures to the ad lib paradigm could be employed using IV alcohol infusions (e-cig or no e-cig access with alcohol at both sessions and alcohol or placebo dosage with e-cig at both session). Further, the combination of these ad lib and IV alcohol infusion studies would aid in determining the direction of the relationship between e-cig use and alcohol use. It is likely this relationship is bidirectional due to their mutually reinforcing properties, however effect sizes may vary as well as individual factors that may make one direction more important for some (e.g. those high in sensation seeking at higher risk for the alcohol to e-cig use relationship, thus a need to target alcohol use primarily in treatment).

Another interesting area of research extending form the idea of smoking and e-cig prohibitions effects on drinking and smoking behaviors would be to investigate the efficacy of e-cigs for smoking cessation in alcohol dependent individuals. It would first be important to consider what typical outcomes one would expect from using e-cigs for cessation. Perhaps most salient, there should be a reduction and ultimate cessation of cigarette use. Another factor closely coupled with such a reduction in cigarette use, and most relevant to the present study, is that there is an interaction between cigarette use and alcohol use in cessation treatment. (e.g. (Kahler, et al, 2008; Kalman, et al, 2010; Lisha, et al., 2014; Cooney, et al., 2015). For example, 41.5% of individuals endorse consuming alcohol prior to smoking lapse (Kahler, et al., 2010). Drinking relapse episodes have shown to be predicted by a prior high urge to smoke (Cooney, et al., 2007), and lower confidence in resisting urge to smoke (Holt, et al., 2011). One would thus expect that if e-cigs were to be an effective means of smoking cessation, individuals would show similar improvement in their alcohol consumption, as in other smoking cessation treatments (e.g.

combined nicotine patch and gum; Cooney, et al, 2009), in addition to reduced cigarette use. It is possible that the use of e-cigs could not only inhibit cessation of cigarette use, but also increase or perpetuate alcohol use, which has tremendous negative implications for substance dependent groups, making this a prime avenue of future research.

Each of the described avenues for future experimental laboratory and longitudinal research has important implications for treatment. If e-cigs cue alcohol craving and ultimately use, individuals in alcohol treatment are likely to see poor alcohol use outcomes while using an e-cig. Thus e-cig use would potentially not be recommended for individuals with or at risk for alcohol related problems. Additionally, if alcohol cues e-cig use, this not only increases the intake of nicotine, but also potentially harmful substances contained within e-liquid.

Though the long-term goal of this research is to inform treatment implications and recommendation formation are of upmost importance, at this time, the state of e-cig literature and their likely potential of having negative health effects is too early to make strong recommendations. However, I see many avenues of future concern that should be examined for e-cig effects. Of particular concern may be examining the costs and benefits of e-cig ban legislation where alcohol is consumed. One means of examining this effect in future studies would be to examine alcohol use before and after the implementation of smoke-free e-cig legislation in a particular area (e.g. a county). Further, this should be examined by smoking status.

Conclusion

Findings from the present study supported a relationship between smoking prohibition and increased likelihood of e-cig use, but did not support a relationship between smoking prohibition and alcohol consumption. Though results were contrary to previous work, this is likely driven by the inclusion of only participants who could use e-cigs where they consume alcohol, the conceptualization and measurement of smoking prohibition, sample characteristics, unmeasured moderators, and underpowered analyses; thus findings should be interpreted with caution and only as initial evidence for the theory the e-cigs might be being used as a replacement for cigarettes when smoking is prohibited. In fact, although current findings contradict emerging literature highlighting a link between e-cig and alcohol use, this could indicate that the effect of smoking prohibition on reduced alcohol consumption and problems is being changed by the advent of e-cigs. Results of future longitudinal and experimental studies could potentially affect e-cigs viability as a smoking cessation tool for individuals with alcohol related problems or disorders. If e-cigs serve as a cue for alcohol consumption, this would increase consumption in individuals with alcohol use disorders or displaying problematic alcohol consumption, and thus could be causing undue harm. Overall, treatment providers should begin discussing the use of e-cigs with their clients and patients. Additionally, future research examining the effect of smoking and e-cig prohibition on alcohol consumption should be conducted to inform future smoking and e-cig ban legislation recommendations

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APPENDICES

Appendix A: Study Materials

A1. Demographics

1. How old are you (in years)?

2. What is your gender?
Male
Female
Other (please specify)

3. Which race do you most identify with or consider yourself to be?
White/Caucasian
Hispanic/Latino
Black/African American
Asian/ Pacific Islander
Native American/Alaskan Native
Don't know
Other (please specify)

4. Have you ever been a cigarette smoker?
Yes, currently
Yes, in the past
No

5. Do you currently use an electronic cigarette?
Yes, currently
No

A2. Alcohol Use Disorder Identification Test (AUDIT)

1. How often do you have a drink containing alcohol?

Never
Monthly or less
2 to 4 times per month
2 to 3 times per week
4 or more times per week

2. How many drinks containing alcohol do you have on a typical day when you are drinking?

None-I do not drink
1 or 2
3 or 4
5 or 6
7, 8 or 9
10 or more

3. How often do you have six or more drinks on one occasion?

Never
Less than monthly
Monthly
Weekly
Daily or Almost Daily

4. How often during the last year have you found that you were not able to stop drinking once you had started?

Never
Less than monthly
Monthly
Weekly
Daily or Almost Daily

5. How often during the last year have you failed to do what was normally expected from you because of drinking?

Never
Less than monthly
Monthly
Weekly
Daily or Almost Daily

6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?

Never
Less than monthly

Monthly
Weekly
Daily or Almost Daily

7. How often during the last year have you had a feeling of guilt or remorse after a drinking session?

Never
Less than monthly
Monthly
Weekly
Daily or Almost Daily

8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?

Never
Less than monthly
Monthly
Weekly
Daily or Almost Daily

9. Have you or someone else been injured as a result of your drinking?

No
Yes, but not in the last year
Yes, during the last year

10. Has a relative or a friend or a doctor or another health worker been concerned about your drinking or suggest you cut down?

No
Yes, but not in the last year
Yes, during the last year

Scoring:
A score of 8 or more is associated with harmful or hazardous drinking, a score of 13 or more in women, and 15 or more in men, is likely to indicate alcohol dependence.

A3. Timeline Followback Calendar and Directions

Participants read and completed the following as part of the Timeline Followback measure.

Try and think about your alcohol use over the last 2 weeks. Sometimes it is helpful if you identify meaningful days FIRST and then work around that day. For example, if your friend's birthday was last week and you can quickly recall if you consumed alcohol on that date or not, fill that date in first. Then, you can fill in the days around it. It is also helpful to look through your cellphone (text messages, phone calls, your personal calendar) to help you recall your alcohol use. For each date that has passed, please select how may alcohol drinks you consumed on that date (0-30) Next, please select where you consumed the alcoholic beverages-the choices for th0:lk sz e setting in which you consumed alcohol are provided in the drop down menu. If you consumed alcohol at more than one location on a particular date, please select the location where you consumed the majority of your alcohol that day. Finally, please select if WHILE DRINKING you smoked cigarettes, an e-cigarette, both, or neither.

Here is a calendar of the last 2 weeks*. Use this to help guide you in recalling your drinking over the last 2 weeks. Also pictured are what we consider "standard drinks". Use these descriptions of standard drinks to help you decide how many drinks you had each day.

December

Sun	Mon	Tues	Wed	Thurs	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13

Please fill in the amount of alcohol you drank and in what setting you drank for the following days. Also, indicate if you smoked cigarettes or an e-cigarette WHILE DRINKING.

	Number of Alcoholic Drinks Consumed	Location where alcohol was consumed	Smoking and E-cig Use while Drinking
Saturday, January 10**			
Friday, January 11			
Thursday, January 12			
Wednesday, January 13			
Tuesday, January 14			
Monday, January 15			
Sunday, January 16			
Saturday, January 17			
Friday, January 18			
Thursday, January 19			
Wednesday, January 20			
Tuesday, January 21			
Monday, January 22			
Sunday, January 23			
Saturday, January 24			

*Calendar dates varied. Participants varied dates for the previous two weeks from which they began the study, with calendar dates updated daily by the primary investigator.
**Dates varied. Participants varied dates for the previous two weeks from which they began the study, with calendar dates updated daily by the primary investigator.

A4. Smoke-Free Policy Assessment

1. Where do you drink most often?
At home (including around your home, such as the porch, patio, or sidewalk)
At someone else's home (including around their home, such as the porch, patio, or sidewalk)
Outside (In public places, such as parks, tailgating areas, in a shopping center, or shopping area)
At a bar or restaurant
At a sporting event
At work
At school
In a car
At a religious service or activity
Other-please specify

2. Are people able to smoke cigarettes where you drink most often (as noted above), without having to move to a separate smoking area, such as outside
Yes
No
Don't know

3. Are people able to use e-cigarettes where you drink most often (as noted above), without having to move to a separate smoking area, such as outside
Yes
No
Don't know

Appendix B: Descriptive Tables

Table B1. Demographics

	Total N	Male	Female	Caucasian	Hispanic	Asian	African American	American Indian	Other
Age Mean	365	31.95	33.23	33.32[a]	28.35[ab]	28.90	33.04[b]	27	25
SD		9.34	10.37	10.25	7.27	7.72	9.10	-	2.64
Ethnicity									
Caucasian	288	138	150						
Hispanic	31	13	18						
Asian	10	5	5						
African American	29	12	17						
American Indian	1		1						
Other	3		3						

Note: No significant differences for age by smoking status

Table B2.Demographic Variables by Smoking Status

	Non-Smoker	E-cig Only	Cig Only	Dual
Age Mean (SD)	31.26 (9.30)	31.26 (9.13)	33.51 (10.61)	33.70 (10.17)
Male	42	24	35	70
Female	55	33	42	64
Ethnicity				
Caucasian	77	45	64	102
Hispanic	6	7	8	10
Asian	4	1	1	4
African American	8	2	4	15
American Indian	1			
Other	1	2		

Note: No significant differences for age by smoking status.

Table B3. Correlation with Alcohol Use Measures

	AUDIT	Total Drinks (14 days)	Average Drinks per drinking Day
Audit	-	-	-
Total drinks	0.61**	-	-
Average drinks per drinking day	0.51**	0.59*	-
Non-Smoker	-0.21**	-0.21**	-0.14*
E-cig Only	-0.04	-0.04	-0.01
Cig Only	0.12*	0.19**	0.13*
Dual User	0.12*	0.06	0.02
Age	-0.16**	0.02	-0.15**
Gender	-0.28**	-0.27**	-0.23**

Note. Smoking status and gender variables reflect point biserial correlations; all others reflect Pearson's *r* correlations. Gender was dummy coded (0-male, 1-female) and Smoking Status was dummy coded (0-not of that smoking status, 1-member of that smoking status) *p<0.01, **p<.001

Table B4. Smoking prohibition and Alcohol Consumption Location by Smoking Status

	Non-Smoker	E-cig Only	Cig Only	Dual
Smoking Allowed	39	23	54	96
Smoking Prohibited	58	34	23	38
Self-Report Question				
Home*	64	37	53	102
Other's Home *	9	5	12	11
Outside	1	0	0	0
Bar or Restaurant	22	14	11	19
Sporting Event	0	0	0	1
TLFB				
Home*	55	37	54	92
Other's Home *	7	4	9	8
Outside	0	0	0	2
Bar or Restaurant	24	9	10	15
Sporting Event	0	0	0	2

Note. Number of participants by smoking status and smoking prohibition, responses to the single self-report item of alcohol consumption location and responses the place the participant drank most often according to the 14-day TLFB.

Appendix C: Main Finding Tables

Table C1. Hypothesis 1: Relationship between Smoking Status and Smoking Prohibition

	B	Wald	Sig.	Exp(B)	Lower	Upper
1. E-cig vs. Cigarette						
Step 1						
Age	-0.02	0.81	.37	0.98	0.95	1.02
Gender	0.24	0.41	.52	1.27	0.61	2.65
Hispanic	0.02	0.00	.97	1.02	0.32	3.24
African American	-0.08	0.01	.92	0.92	0.19	4.41
Step 2						
Smoking Ban	1.22	10.71	**<.001**	3.40	1.63	7.06
2. E-cig vs dual						
Age	-0.03	2.53	.11	0.97	0.94	1.01
Gender	0.41	1.40	.24	1.50	0.77	2.95
Hispanic	0.35	0.41	.52	1.43	0.48	4.21
African American	-0.68	0.98	.32	0.50	0.13	1.96
Asian	-0.19	0.03	.87	0.83	0.09	7.85
Step 2						
Smoking Ban	1.21	12.76	**<.001**	3.37	1.73	6.55
3. Dual vs Cig						
Age	0.00	0.02	.89	1.00	0.97	1.03
Gender	-0.25	0.71	.40	0.78	0.44	1.39
Hispanic	-0.25	0.23	.63	0.78	0.28	2.15
African American	0.57	1.08	.30	1.77	0.60	5.19
Asian	0.81	0.51	.48	2.25	0.24	20.79
Step 2						
Smoking Ban	0.00	0.02	.89	1.00	0.97	1.03

Note: Hierarchical logistic regressions conducted with smoking prohibition as the independent variable for all models (Dummy coded 0-cigarettes allowed, 1-cigarettes prohibited). Smoking status was coded as the dependent variable in the following ways: Model 1 (0-cigarette user, 1-e-cig user), Model 2 (0-dual user, 1-e-cig user), and Model 3 (0-cigarette user, 1-dual user). The overall Model 1 was significant, $\chi 2=13.23$, p=.02. Nagelkerke's $R^2= 0.13$. The overall Model 2 was significant, $\chi 2=21.10$, p=.002. Nagelkerke's $R^2= 0.15$. The overall Model 3 was non-significant, $\chi 2=2.88$, p=.82. Nagelkerke's $R^2= 0.02$. Significant relationships were determined using $p<0.016$ criteria and are bolded.

Table C2. Hypothesis 2: Relationship between Smoking Prohibition and Alcohol Consumption Measures

	b (95% CI Lower bound to Upper Bound)	*B*	*t*	*p*	R^2	*F*	*p*
AUDIT							
Step 1							
Hispanic	-0.49 (-2.20 to 1.22)	-0.03	-0.56	.58			
Asian	-1.60 (-4.54 to 1.26)	-0.06	-1.11	.27			
African American	0.32 (-1.40 to 2.05)	0.02	0.36	.72			
Other	-1.53 (-7.90 to 4.88)	-0.02	-0.47	.64			
Gender	-2.62 (-3.58 to -1.68)	-0.27	-5.39	**<.001**			
Age	-.08 (-0.13 to -0.03)	-0.16	-3.10	**.002**			
Step 2					0.11	5.61	**<.001**
Smoking Prohibition	-0.62 (-1.60 to 0.34)	-0.06	-1.27	.21			
Total Drinks							
Step 1							
Hispanic	-3.69 (-8.61 to 1.22)	-0.08	-1.48	.14			
Asian	-0.88 (-9.21 to 7.46)	-0.01	-0.21	.84			
African American	0.75 (-4.20 to 5.72)	0.02	0.29	.77			
Other	-5.80 (-24.24 to 12.58)	-0.03	-0.62	.53			
Gender	-7.21 (-9.97 to -4.46)	-0.27	-5.15	<.001			
Age	0.02 (-0.12 to 0.16)	0.02	0.34	.74			
Step 2					0.09	4.12	**<.001**
Smoking Prohibition	-1.85 (-4.62 to 0.92)	-0.07	-1.30	.19			
Average Drinks							
Step 1							
Hispanic	0.17 (-0.48 to 0.81)	0.03	0.51	.61			
Asian	0.30 (-0.98 to 1.39)	0.03	0.53	.59			
African American	-0.49 (-1.14 to 0.17)	-0.02	-0.44	.66			
Other	-0.27 (-2.69 to 2.14)	-0.01	-0.22	.83			
Gender	-0.73 (-1.09 to 0.37)	-0.21	-3.99	<.001			
Age	-0.02 (-0.04 to -0.006)	-0.14	-2.16	.009			
Step 2					0.08	3.66	**<.001**
Smoking Prohibition	-0.06 (-0.42 to 0.31)	-0.02	-0.30	.76			

Note. Hierarchical Linear Regression examining the association between smoking prohibitions (0-smoking allowed, 1-smoking prohibited) and alcohol consumption measures (AUDIT, total drinks, average drinks). Significant relationships were determined using $p<0.05$ criteria and are bolded.

Table C3. Interactive effects of Smoking Prohibition and Smoking Status on Alcohol Measures

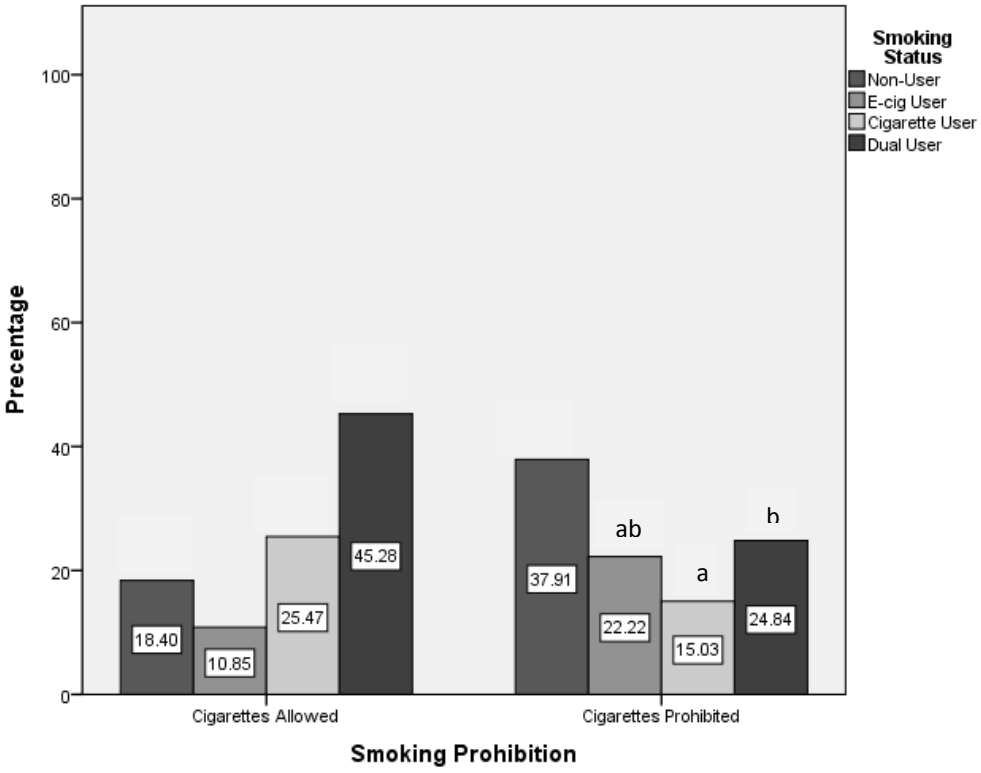
	F	*df*	*p*	Allowed Mean(SD)	Prohibited Mean (SD)	*p*
AUDIT						
Age	11.96	1, 359	**.001**			
Gender	24.71	1, 359	**<.001**			
Ethnicity	0.17	1, 359	.68			
Prohibition	0.04	1, 359	.84			
Smoking Status	8.51	3, 559	**<.001**			
Non-Smoker				5.64 (3.54)	5.48 (3.36)	.84
E-cig Only				8.37 (5.18)	5.78 (4.61)	.05
Cigarette Only				7.46 (4.85)	10.48 (5.67)	.02
Dual User				8.03 (5.11)	7.84 (4.58)	.84
Smoking Status x Prohibition	2.46	3, 359	.06			
Total Drinks						
Age	0.005	1, 359	.94			
Gender	24.9	1, 359	**<.001**			
Ethnicity	1.40	1, 359	.24			
Prohibition	0.88	1, 359	.33			
Smoking Status	7.20	3, 359	**<.001**			
Non-Smoker				10.51 (9.43)	12.21 (9.37)	.45
E-cig Only				19.70 (13.26)	12.12 (7.78)	**.002**
Cigarette Only				21.06 (18.08)	21.73 (16.22)	.88
Dual User				17.27 (13.40)	17.43 (14.51)	.95
Smoking Status x Prohibition	1.55	3, 358	.2			
Average Drinks						
Age	7.13	1, 359	**.008**			
Gender	15.02	1, 359	**<.001**			
Ethnicity	0.05	1, 359	.89			
Prohibition	0.02	1, 359	.93			
Smoking Status	5.56	3, 359	**.001**			
Non-Smoker				2.76 (1.73)	2.51 (1.41)	.82
E-cig Only				3.97 (2.04)	2.35 (1.70)	**.009**
Cigarette Only				3.03 (1.38)	4.48 (2.22)	**.001**
Dual User				2.95 (1.71)	3.39 (1.97)	.21
Smoking Status x Prohibition	7.22	3, 359	**<.001**			

Note. Analyses of Covariance (ANCOVA), controlling for age, gender, and ethnicity, to examine the conditional effects of smoking status (non-user, e-cig only user, cigarette only user, dual user) on smoking prohibition to predict alcohol use measures. Significant p-values bolded and determined on the 0.013 level.

Appendix D: Main Findings Figures

Figure D1.

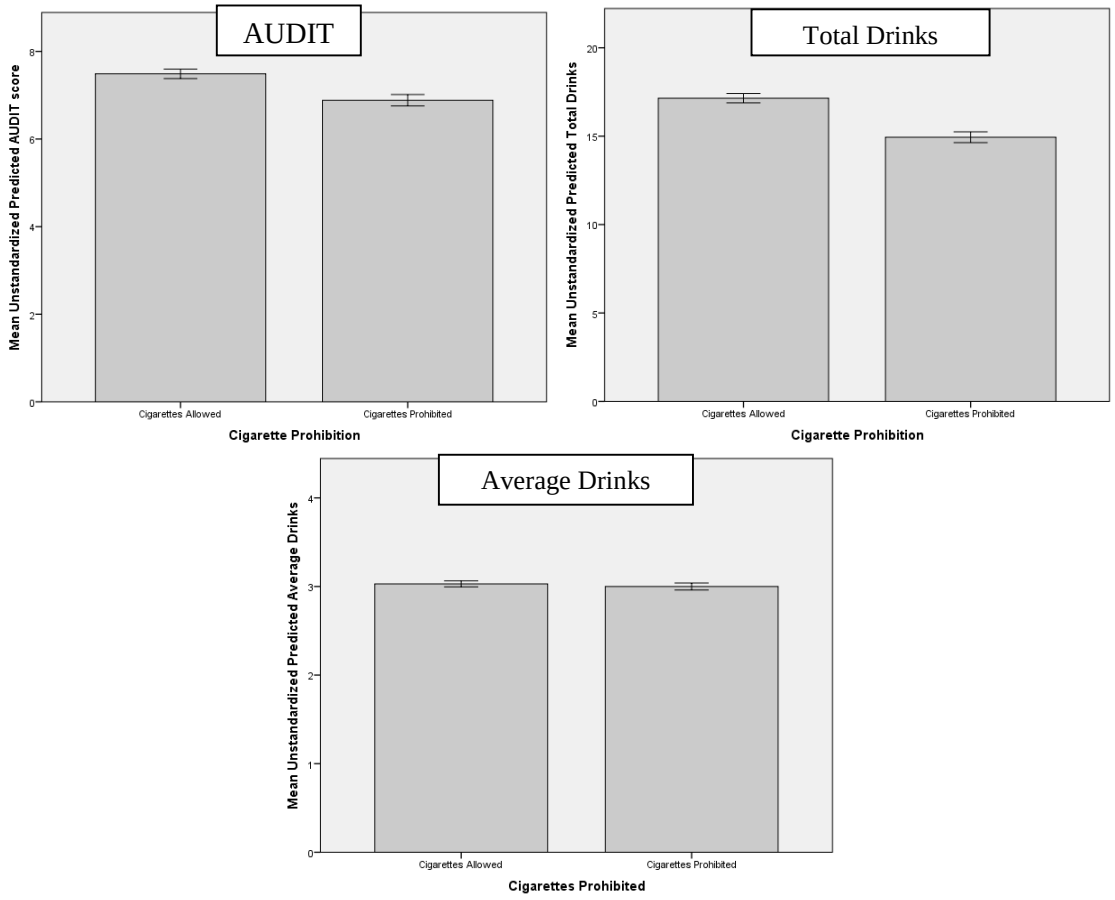
Percentage of individuals per smoking status where cigarettes are allowed versus prohibited



Hypothesis 1: Percentage of individuals by Smoking Status within each level of smoking prohibition in the Restricted Sample. [a] OR=3.40, $p<.001$, [b] OR=3.37, $p<.001$

Figure D2.

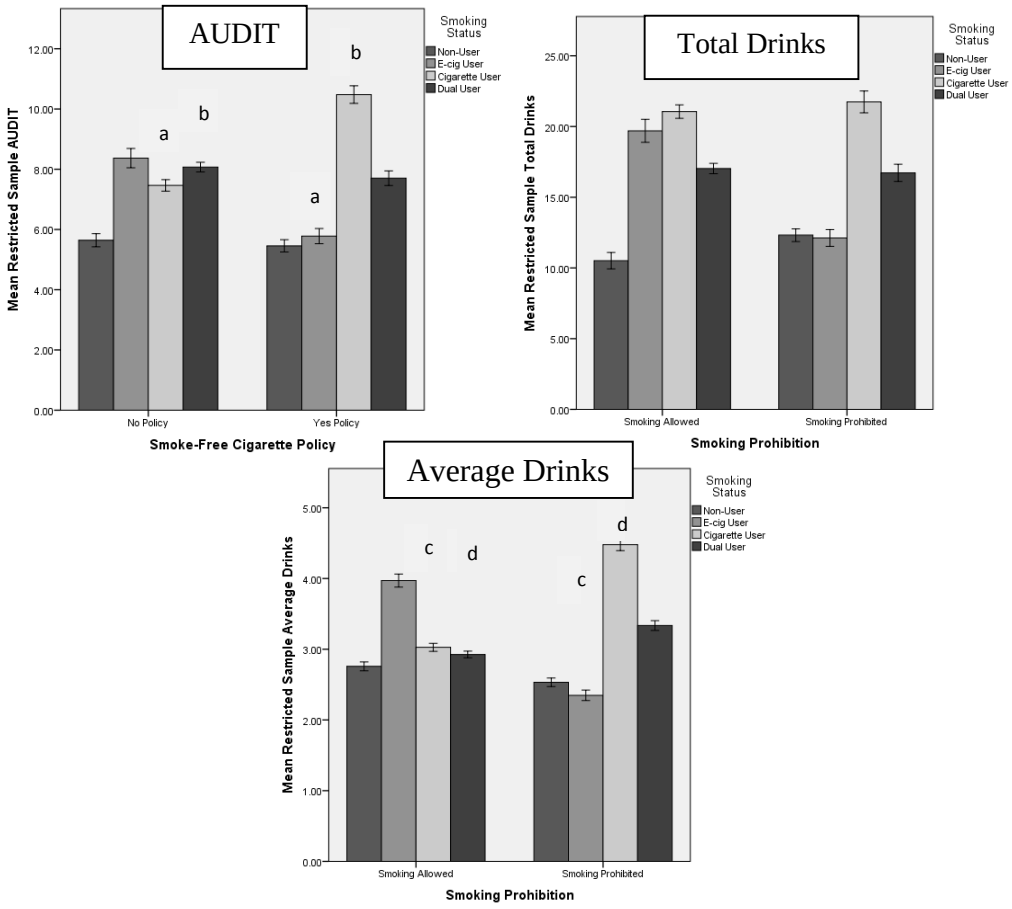
Predicted mean alcohol consumption scores where cigarettes are allowed versus prohibited



Hypothesis 2: Relationship between smoking prohibition and AUDIT (top left), $t(363)=1.18$, $p=.24.$, $d=0.13$, Total Drinks (top right), $t(363)=1.63$, $p<.10.$, $d=0.13$, and Average Drinks (bottom middle), $t(363)=0.30$, $p=.77$, $d=0.03$.

Figure D3

Estimated mean alcohol consumption scores for smoking prohibition by Smoking Status



. Hypothesis 3: Estimated mean alcohol consumption scores from ANCOVA, controlling for age, gender, and ethnicity, for smoking prohibition by Smoking Status as related to AUDIT (top left), [a] $t(55)=1.98$, $p=.05$, [b] $t(75)=-2.37$, $p=.02$, Average Drinks (top right), and Total Drinks (bottom center), [c] $t(55)=3.26$, $p=.009$, [d] $t(75)=-3.49$, $p=.001$. A p-value of less than .013 was used to determine significance.