The Association Between Problematic Drinking and ENDS Use in College Students: The Role of Alcohol Expectancies

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THE ASSOCIATION BETWEEN PROBLEMATIC DRINKING AND ENDS USE IN COLLEGE STUDENTS: THE ROLE OF ALCOHOL EXPECTANCIES

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Master of Arts

in

The Department of Psychology

by

Nina Glover
B.A., University of Houston, 2018
May 2024
Dedication

This thesis is dedicated to my God, family, friends, and ancestors. I thank you for being present when I needed it the most. To my father and mother, thank you for being my rock and everlasting source of strength and faith. To my brother thank you for all of the laughter and timely comedic relief. To my grandmother, Mary Elizabeth Davis, thank you for bestowing your wisdom, faith, and tender love on me throughout this entire process. To Bradley Byrd, I appreciate you more than words can express and thank you for being there for me during one of the lowest points of my life, as well as for speaking life into me. To my friends and cohort, thank you all for filling my cup when I didn't realize it ran empty. To my Fallbrook church family, I thank you for your beautiful prayers and words of encouragement. To my ancestors, I thank you for your resilience and faith. Your blood, sweat, tears, pain, and triumphs do not go unnoticed, and I strive to continue to center the framework of my practices around your tenacity, realness, integrity, and compassion.
Acknowledgements

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Abstract

Electronic nicotine delivery system (ENDS) use and alcohol use are prevalent among young adults and college students. Recent data indicate that ENDS use is significantly associated with alcohol consumption and hazardous drinking behavior (e.g., binge drinking). Given the perceived benefits students report that are common across ENDS and alcohol use (e.g., tension reduction), it is important to examine the role these beliefs play in the co-use of alcohol and ENDS, as both behaviors are associated with risks. In the present study, we investigated the relationship among ENDS use, alcohol use, ENDS use motives, and alcohol expectancies in undergraduate college students through an online survey. We hypothesized that: (1) ENDS use would be more prevalent among students who drink alcohol versus nondrinkers, and heavier ENDS use would be associated with higher alcohol consumption and binge drinking, as has been found in other studies; (2) greater alcohol consumption would be associated with greater endorsement of ENDS use motives and nicotine dependence; and (3) the association between ENDS and alcohol use would be mediated by positive alcohol expectancies that are empirically or theoretically also associated with ENDS use. Participants (N = 511) were largely female (76.9%), White (75.9%), and an average of 19.9 (SD = 1.3) years of age. Most participants (79.1%) reported alcohol use, with 36.4% of participants engaging in hazardous drinking, and 41.5% of participants endorsed current ENDS use. As predicted, and alcohol consumption was significantly correlated with ENDS use motives (all p’s < .001), whereas non-use of ENDS was significantly associated with greater hazardous drinking (p = .023), and ENDS use was less likely in relation to alcohol consumption (p = .044). Alcohol expectancies for Tension Reduction partially mediated the association between alcohol and ENDS use (p = .026). These findings highlight the importance of studying ENDS use in the context of alcohol use among college
students, particularly those with problematic drinking patterns. Tension Reduction expectancies appear to mutually compel ENDS use and drinking behavior in college students. This information can inform evidence-based prevention and intervention efforts with this population.

*Keywords:* ENDS, alcohol use, outcome expectancies, college students
Chapter 1. Introduction

1.1. Electronic Nicotine Delivery Systems (ENDS)

Electronic cigarette (e-cigarette) use has dramatically increased in the U.S., since they were first introduced in the country in 2007, with adolescents and young adults being the primary users. To illustrate, a report from the Surgeon General noted that e-cigarette use among high school students increased by 900 percent between 2011 and 2015 (Cullen et al., 2018). Further, e-cigarettes are currently used by more than 3 million high schoolers and 570,000 middle schoolers (Cullen et al., 2018), highlighting the staggering rise in use among youth and the significant need for clinical interventions.

Electronic nicotine delivery system (ENDS), or e-cigarettes, are battery-operated devices that vaporize a nicotine-containing and glycerol-based liquid via inhalation of the user (Etter et al., 2011; Levy et al., 2017). Developed in 2006 to reduce harmful tobacco consumption, ENDS were advertised as a smoking cessation device and a safer alternative than combustibles (i.e., cigarettes; Cahn & Siegel, 2011; Flouris & Oikonomou, 2010; Yoon et al., 2006). The design and composition of ENDS have evolved over the years (Williams & Talbot, 2019), with newer models containing novel and convenient characteristics such as rechargeable and refillable devices (e.g., JUUL; Huang et al., 2019; Pepper & Brewer, 2014). For example, first generation e-cigarettes closely resembled a combustible cigarette (i.e., cig-a-like) and supported low voltage batteries (Stratton et al., 2018). Second and third generation e-cigarettes, referred to as clearomizers and mods, respectively, supported larger, variable voltage power batteries (Brelan et al., 2017; Stratton et al., 2018). Notably, fourth generation e-cigarettes, known as pods (e.g., JUUL), support various shaped, fixed voltage batteries (Stratton et al., 2018) and are significantly more popular than previous generations of ENDS (Huang et al., 2019). Moreover, certain types of ENDS contain
sweet flavorings (e.g., chocolate, fruit; Etter et al., 2011), which are more appealing among adolescents and young adults rather than unflavored, menthol, or tobacco flavors (Audrain-McGovern et al., 2016; Goldenson et al., 2016; Schneller et al., 2019). Importantly, these data indicate the sweet, varying flavors of ENDS play a significant role in increased use among this population, highlighting a finding which is counterintuitive to the development of ENDS.

ENDS use has become increasingly common over recent years in the U.S. and is widely prevalent among young adults (Adkison et al., 2013; King et al., 2015; McMillen et al., 2014; Stanton et al., 2020; Weaver et al., 2015). While marketing efforts seemingly utilize appealing themes adolescents and young adults are receptive to (Biener & Albers, 2004; Collins et al., 2019), recent data suggest that college students appear to be particularly vulnerable. To illustrate, college students reported greater past 12-month and past month ENDS use compared to their non-college student peers in 2018 (Schulenberg et al., 2019). Moreover, nearly 30% of college students have used ENDS at least once (Saddleson et al., 2015), and 14.2% of college students reported using e-cigarettes or other vape products in the last 3 months (American College Health Association, 2021), highlighting the possible greater risk ENDS use poses to young adults enrolled in college. These rates are concerning given the decline in traditional combustibles use among young adults (Jamal et al., 2015), with only 6.8% of students reporting cigarette use in the last 3 months (American College Health Association, 2021) and 12% of student ENDS users reportedly never having tried a combustible cigarette (Sutfin et al., 2013). Further, findings suggest that ENDS use among young adults is associated with progression to combustible use (Primack et al., 2015), emphasizing the alarming impact of ENDS within this population. Although many students report ENDS use only, some students report being dual users (i.e., using combustible and electronic cigarettes) (Agarwal & Loukas, 2015; Cooper et al., 2017). Compared to non-users, experienced
college student ENDS users report associated psychosocial problems (e.g., impulsivity, low self-esteem; Grant et al., 2019), increased mental health problems (e.g., anxiety, post-traumatic stress disorder; Grant et al., 2019), illicit substance use (Grant et al., 2019), and significant negative outcomes (e.g., addiction, social stigma, health consequences; Case et al., 2016; Pokhrel et al., 2014).

1.1.1. ENDS Use and Perceptions

To identify and describe the role of subjective experience in motivating ENDS use, researchers have studied perceptions of risks and benefits associated with ENDS use, as well as outcome expectancies for ENDS. Outcome expectancies are beliefs individuals have regarding the reinforcing and punishing effects associated with use of a particular substance. Perceptions and outcome expectancies of ENDS use among undergraduates have been widely researched due to the significant role these cognitive constructs play in motivational models of substance use (e.g., nicotine use, tobacco use; Brandon et al., 1999; Copeland & Brandon, 2000). The link between perceived risks and benefits and behavioral patterns of substance use has been well-established among adolescents and young adults for a variety of substances, including alcohol and tobacco (Hampson et al., 2001). In general, increased perceptions of benefits are associated with initiation and continued use of substances, and increased perceptions of risks are associated with lower likelihood of use (Klein et al., 2007; Lewis et al., 2007).

Given the significant, swift increase in e-cigarette use among young adults, Copeland and colleagues developed the Risks and Benefits of E-cigarettes (e.g., RABE; Copeland et al., 2017) questionnaire to identify and assess beliefs among college students about the risks and benefits associated with ENDS use. To illustrate, college student ENDS users reportedly believe that compared to combustibles (i.e., cigarettes), ENDS are less harmful, less addictive, and a safer,
healthier alternative (Adkison et al., 2013; Cahn & Siegel, 2011; Choi & Forster, 2013; Cooper et al., 2017; Hart et al., 2017; Hershberger et al., 2017; Pearson et al., 2012). Thus, many students perceive ENDS to be more socially acceptable (Buu et al., 2020; Katz et al., 2019; Trumbo & Harper, 2013), more beneficial to their social-emotional health than cigarettes (Marx et al., 2021), and provide greater stress relief (Napolitano et al., 2020). Due to the perceived greater social impact of ENDS (Marx et al., 2021; Wallace & Roche, 2018), students’ ENDS use may increase in social contexts. In fact, in a focus group conducted among undergraduates in 2019, ENDS use was often described as a social experience, and users noted that the varying flavors contributed to the social nature of ENDS (e.g., sharing flavors in social settings; Katz et al., 2019). Notably, recent data indicate that compared to the classic tobacco flavor, preferred, fruity ENDS flavors were positively, significantly associated with greater motivation to vape (Vargas-Rivera et al., 2021) and were perceived to be less harmful to health than tobacco flavor ENDS (Pepper et al., 2016). These findings highlight the reinforcing role that flavors, particularly unique flavors, play in initiation and ongoing use of ENDS among college students (Lee et al., 2017). More specifically, the flavors apparently lessen perceived risks associated with ENDS use, and they appear to influence outcome expectancies regarding social facilitation among college student ENDS users.

Further, many dual users cite their ENDS use as a cessation tool (Foulds et al., 2011; Soule et al., 2016). Smoking cessation appears to be a notable perception regarding ENDS as an effective quitting aid among this population, with 44.5% of young adults believing that ENDS could be a useful cessation tool (Choi & Forster, 2013). Though some students perceive ENDS marketing to poorly advertise e-cigarettes as smoking cessation aids (Camenga et al., 2015), some students perceive ENDS to be less risky than combustibles due to their identified use as a
cessation tool (Katz et al., 2019). Given that ENDS were developed as a form of nicotine replacement therapy and were, therefore, intended as a cessation tool (Cahn & Siegel, 2011), it is not surprising that this belief is prevalent among college student ENDS users. The empirical support for ENDS as an efficacious smoking cessation aid, however, has been mixed. To illustrate, some studies have found a positive association between ENDS use and smoking cessation among adults (Goniewicz et al., 2013; Pokhrel et al., 2013; Vickerman et al., 2013) and adolescents (Dutra & Glantz, 2014), and one study found an association between ENDS use and an increased odds of smoking cessation at 6- and 12-month follow-up visits (Mantey et al., 2017). Alternatively, other studies found ENDS use as a negative predictor of cessation attempts use among college students (Peltier et al., 2020), suggesting that this population may not use ENDS for cessation purposes, or that when they do, it is not an effective strategy for them. Taken together, these data highlight a growing need to analyze the relationship between various outcome expectancies, risk and benefit perceptions, and e-cigarette use behaviors.

1.2. Alcohol Use among College Students

Alcohol use among undergraduates is also widely prevalent, with 78% of students in the U.S. reporting lifetime use, 75% reporting past 12-month use, and 60% reporting past-30 day use (Schulenberg et al., 2019). Further, binge drinking (e.g., five or more drinks in a row for men and four or more drinks in a row for women, at least once in the past two weeks; Wechsler & Isaac, 1992) was reported by 29% of students in 2018 (Schulenberg et al., 2019), whereas 25% of their noncollege peers reportedly engaged in binge drinking (Schulenberg et al., 2019), highlighting the greater risk that substance use poses for college students. Though many students cite positive consequences related to alcohol use, such as socializing, expressing oneself or feelings, and feeling relaxed/buzzed (Fairlie et al., 2016; Park, 2004), many experience negative consequences as well,
such as being injured, hungover, and regretted sexual activity (Fairlie et al., 2016; Park, 2004). However, data indicate that alcohol consumption among college students is associated with greater negative consequences than some undergraduates realize. To illustrate, alcohol use and binge drinking among college students is related to decreased academic performance (e.g., missed classes, low grades), fatal accidents (e.g., overdoses, car crashes), brain damage and neurocognitive deficits, and, importantly, alcohol use disorder diagnoses (Engs et al., 1996; Knight et al., 2002; White & Hingson, 2014; Zeigler et al., 2005).

Moreover, a significant determinant of continued and increased alcohol use among this population is positive alcohol expectancies (Evans & Dunn, 1995), or subjective perceptions of how individuals anticipate alcohol to positively impact them (e.g., sociability, “liquid courage”, feeling buzzed, sexual experiences, decrease negative affect; Baer, 2002; Jones et al., 2001; Lee et al., 2018; Park et al., 2013; Patrick & Maggs, 2008; Werner et al., 1995). Alternatively, many students report negative alcohol expectancies (e.g., vomiting, nausea) and a subsequent, associated decrease in alcohol consumption (Jones et al., 2001; Patrick & Maggs, 2008). Importantly, historical research suggests a causal relationship between alcohol expectancies and alcohol use (Goldman et al., 1999), suggesting an explanatory rationale for alcohol consumption and hazardous drinking behaviors among this population. This finding is concerning as students may be more likely to continue to consume alcohol despite negative consequences. Positive alcohol expectancies were reported more frequently among students who engaged in hazardous drinking behaviors than those who did not engage in hazardous drinking behaviors (Lewis & O’Neill, 2000). In fact, one study found that undergraduate college students who reported positive expectancies (e.g., sociability, sexuality) were more likely to engage in binge drinking in the past 2 weeks (McBride et al., 2014). These findings evince the problematic outcomes that are associated with alcohol use,
hazardous drinking behaviors (e.g., binge drinking), and positive alcohol expectancies among students. Given that students frequently report drinking within social contexts (Baer, 2002; LaBrie et al., 2011), it is important to further examine how positive alcohol expectancies play a role in continued use and co-use of other substances.

1.3. Simultaneous ENDS and Alcohol Use

Although college student ENDS users frequently mention the positive perceptions of ENDS (e.g., social aspects, various flavorings), recent data suggest that ENDS use is significantly associated with greater alcohol consumption and hazardous drinking behaviors (e.g., binge drinking; Hefner et al., 2019; Littlefield et al., 2015; Roberts et al., 2018; Saddleson et al., 2015; Yang et al., 2022). For example, compared to both non-ENDS users and cigarette users, ENDS users report increased levels of alcohol use (Hershberger, Karyadi, et al., 2016), and young adult ENDS users report an increase in perceived pleasure when drinking alcohol (Thrul et al., 2019), highlighting a concerning co-use issue in this population. These data are especially alarming given the positive association between social ENDS users, rather than regular ENDS users, and greater number of total drinks, average drinks, and hazardous drinking behaviors (Hershberger, VanderVeen, et al., 2016). Further, among college students, having tried ENDS was associated with both increased levels of hazardous drinking and greater perceived benefits of ENDS use (Roys et al., 2020), emphasizing the need to analyze the effect of expectancies on simultaneous use of ENDS and alcohol among these individuals. According to Abrams and Niaura’s (1987) cognitive social learning model of alcohol use, expectancies about the effects of alcohol, including increased positive socializations, may prompt people to engage in alcohol consumption. Thus, alcohol and ENDS expectancies among college students underscore concerns related to continued use despite a plethora of negative effects. It is therefore vital to further examine the impact of
substance-related expectancies on ENDS use to help reduce both ENDS and risky alcohol use and thereby mitigate the related adverse effects on health and sociopsychological factors among college students.

In summary, ENDS use among undergraduates is increasing exponentially and is associated with elevated alcohol use and hazardous drinking behaviors. However, there are no existing studies that have identified potential mechanisms by which risky alcohol use is associated with ENDS use among college students.

1.4. The Current Study

The current study expanded upon prior work in describing the nature of co-occurring ENDS and alcohol use among college students. Specifically, in the current study, we analyzed the relationships among ENDS use, ENDS-related variables such as nicotine dependence and motives for use, alcohol use, and alcohol expectancies. We had the following hypotheses: First, we predicted that ENDS use would be significantly associated with alcohol consumption and binge drinking, as has been documented in existing literature. Second, we predicted that greater alcohol consumption would be associated with greater endorsement of ENDS use motives. Lastly, we predicted that positive alcohol expectancies (e.g., tension reduction) would mediate the association between alcohol use and ENDS use among college students. This last prediction was based on the similarity of alcohol expectancies and ENDS use motives frequently reported by college students as well as perceived outcomes that drive continued use, including reduced negative affect, such as stress and anxiety.
Chapter 2. Method

2.1. Participants

Participants \((N = 1,421)\) were recruited through the Louisiana State University (LSU) Psychology Department undergraduate research participant pool. Of the 1,421 students who initially started the survey, 65 individuals were ineligible because they did not provide informed consent, and another 23 students provided consent but did not complete any measures. These 88 students were therefore excluded. Seventeen students completed only the demographics portion of the survey and were thereby excluded. Another 783 students completed less than half of the survey so were excluded from analyses. Of the remaining 534 students, 22 were excluded because they reported an age greater than 24 years. Thus, 511 students were included in the subsequent analyses.

2.2. Procedures

The current study used secondary data collected as part of a larger study addressing tobacco use within a Brief Alcohol Screening Intervention for College Students (BASICS) that was conducted from 2016 to 2019. The study was approved by the university’s Institutional Review Board prior to data collection. Participants provided informed consent and completed a series of screening measures with 195 total questions via an online survey using surveymonkey.com. Participants were awarded course extra credit for completing the study.

2.3. Measures

The *Daily Drinking Questionnaire* (DDQ; Collins et al., 1985) is a self-report measure that assesses the quantity and frequency of alcohol consumption. Participants reported an estimated number of typical drinks consumed on each day of the week, averaged over the past 3 months. The DDQ is strongly correlated with other self-report alcohol consumption measures.
(Kivlahan et al., 1990) and has demonstrated good reliability among college students ($\alpha = .73$) (Lewis & Neighbors, 2004).

The Comprehensive Effects of Alcohol (CEOA; Fromme et al., 1993) is a self-report measure consisting of 38 items that assess expectancies and valuations. Participants selected their degree of agreement that a particular effect would likely occur to the individual respondent from drinking (i.e., expectancies) on a 4-point Likert scale (1 = disagree to 4 = agree). Participants further selected whether and to what degree each effect would be desirable or undesirable (i.e., valuations) to the individual respondent on a second 5-point Likert scale (1 = bad to 5 = good). The CEOA yields 7 primary scales: Sociability, Tension Reduction, Liquid Courage, Sexuality, Cognitive and Behavioral Impairment, Risks and Aggression, and Self-Perception. The CEOA has been shown to have adequate temporal stability, construct validity, and criterion validity (Fromme et al., 1993) and has demonstrated moderate to strong reliability ($\alpha = .66-.84$; Ham et al., 2005).

The Electronic-Wisconsin Inventory of Smoking Dependence Motives (e-WISDM; Piper et al., 2020) is a measure that accurately defines primary and secondary smoking dependencies. The e-WISDM uses a 7-point Likert scale and has 37 items that were adapted from the WISDM to be applicable to e-cigarettes (Piper et al., 2004). The e-WISDM yields 11 subscales: Affiliative Attachment, Affective Enhancement, Automaticity, Loss of Control, Cognitive Enhancement, Craving, Cue Exposure, Social/Environmental Goads, Taste, Tolerance, and Weight Control. The e-WISDM is a valid measure of dependency with strong internal consistency ($\alpha = .81-.96$; Piper et al., 2020).

To assess e-cigarette use, we created a dichotomous ENDS use variable (yes/no) by examining responses from administered e-cigarette measures in which students indicated use of
ENDS. We included responses from the following measures: the *Penn State Electronic Cigarette Dependence Index* (PS-ECDI; Foulds et al., 2015) and the *Electronic-Fagerström Test for Nicotine Dependence* (e-FTND/FTCD; Heatherton et al., 1991; Piper et al., 2020). The PS-ECDI is a measure consisting of 10 items that assess e-cigarette dependence, with scales ranging from “not dependent” to “high dependence.” The PS-ECDI has demonstrated strong validity and reliability (α = .74; Piper et al., 2020). The e-FTND has six questions aimed to record reliance on nicotine. The e-FTND has been modified from the FTND original format to apply to e-cigarettes, has demonstrated sufficient reliability (α = .51), and is strongly correlated with other self-report e-cigarette measures (Piper et al., 2020).

### 2.4. Data Analytic Strategy/Statistical Procedures

Before conducting our primary analyses, missing values analyses (MVA) were completed to mitigate statistical bias. Specifically, MVA were performed on the following variables: e-WISDM total, e-WISDM Affective Enhancement, e-WISDM Taste and Sensory Processes, and e-WISDM Social/Environmental Goads.

Preliminary analyses were conducted to assess descriptive characteristics for the overall sample and for groups of ENDS users/non-users and drinkers/non-drinkers. Analyses of variance (ANOVAs) were used for continuous variables, multivariate analyses of variance (MANOVAs) were used for measures with multiple subscales with collinearity, and chi-square analyses were used for dichotomous and categorical variables. We identified potential covariates by significant between-groups differences. We also conducted correlational analyses among all the study variables to assess for potential covariates to be used in the primary statistical analyses.

To test the first hypothesis (ENDS use would be more prevalent among students who drink alcohol versus nondrinkers), point biserial correlations and chi-square tests were conducted...
to determine whether alcohol consumption and binge drinking were associated with greater ENDS use.

To test the second hypothesis (greater alcohol consumption would be associated with greater endorsement of ENDS use motives), correlational analyses were conducted among the DDQ quantity and frequency scores and the following e-WISDM scales: Affective Enhancement, Social/Environmental Goads, and Taste.

To test the third hypothesis (positive alcohol expectancies would mediate the relationship between ENDS and alcohol use), separate hierarchical logistic regression analyses were conducted for each of the CEOA subscales of Sociability, Tension Reduction, Liquid Courage, and Sexuality, with ENDS use as the dependent variable and alcohol use (DDQ quantity scores) as a predictor, along with any identified demographic covariates entered first. According to Baron and Kenny (1986), if a significant association between the predictor and the dependent variable is reduced or becomes insignificant with the inclusion of a third variable which remains significant, the third variable is determined to be a mediator.
Chapter 3. Results

3.1. Participant Characteristics

The undergraduate student sample (N = 511) was predominantly female (76.9%), White (75.9%), and 19.9 (SD = 1.3) years of age on average (see Table 1 for participant demographics). Most participants (79.1%) reported alcohol use, with 36.4% of participants engaging in hazardous drinking, and 41.5% of participants endorsed use of ENDS. ENDS users (M = 20.1; SD = 1.2) were significantly older than non-ENDS users (M = 19.8; SD = 1.4), F(6, 504) = 3.446, p = .002. Non-ENDS users (23.7%) were more likely to engage in hazardous drinking than ENDS users (12.7%), X² (1, N = 511) = 5.15, p = .023. Drinkers were more likely to be White (79.7%) than non-White (20.3%), X² (1, N = 511) = 15.031, p < .001, and were significantly older (M = 20.1; SD = 1.3) than nondrinkers (M = 19.7; SD = 1.4), F(6, 504) = 3.008, p = .007. Students who did not complete the survey were more likely to be female (48.7%) than male (10.7%), X² (1, N = 1259) = 4.457, p = .035, were significantly younger (M = 19.6; SD = 1.3) than students who completed the survey (M = 19.9; SD = 1.3), F(1, 1257) = 22.010, p < .001, and were less likely to engage in hazardous drinking (42.8%) than students who completed the survey (25.7%), X² (1, N = 1259) = 10.545, p = .001.

As expected given research showing the association between positive alcohol expectancies and drinking patterns, the overall MANOVA for the CEOA scales was significant, F(4, 506) = 15.061, p < .001, Wilk’s λ = .894, partial η² = .106. One-way ANOVAs were subsequently conducted to test mean differences among drinkers and nondrinkers, with drinkers (M = 26.9; SD = 3.9) vs. nondrinkers (M = 23.6; SD = 5.7) reporting greater Sociability, F(1, 509) = 51.092, p < .001, Liquid Courage (drinkers M = 14.0; SD = 3.3 vs. nondrinkers M = 12.6; SD = 3.9), F(1, 509) = 14.107, p < .001, and Sexuality (drinkers M = 10.3; SD = 3.0 vs.
Among hazardous drinkers, the overall MANOVA for the CEOA scales were significant, 
\( F(4, 506) = 15.129, p < .001; \) Wilk’s \( \lambda = .893, \) partial \( \eta^2 = .107. \) One-way ANOVAs were subsequently conducted to test mean differences among hazardous drinkers and non-hazardous drinkers, with hazardous drinkers \( (M = 28.1; SD = 3.3) \) vs. non-hazardous drinkers \( (M = 25.1; SD = 4.8) \) reporting greater Sociability, \( F(1, 509) = 57.740, p < .001, \) Tension Reduction (hazardous drinkers \( M = 8.3; SD = 2.1 \) vs. non-hazardous drinkers \( M = 7.8; SD = 2.0 \) ), \( F(1, 509) = 7.382, p = .007, \) Liquid Courage (hazardous drinkers \( M = 14.7; SD = 3.2 \) vs. non-hazardous drinkers \( M = 13.2; SD = 3.5 \) ), \( F(1, 509) = 22.446, p = < .001, \) and Sexuality (hazardous drinkers
\( M = 10.9; \ SD = 2.7 \) vs. non-hazardous drinkers \( M = 9.5; \ SD = 3.2 \), \( F(1, 509) = 24.710, p = <.001 \), scale scores on the CEOA. Participant characteristics for the overall sample and by alcohol and ENDS use are displayed in Table 2.

### 3.2. Primary Analyses

#### 3.2.1. Correlations among Study Variables

Point biserial correlations among study variables indicated that age was positively correlated with ENDS use, \( r_{pb}(509) = .13, p = .003 \), such that older participants were more likely to use ENDS. Race was correlated with hazardous drinking, \( r_{pb}(509) = -.11, p = .014 \), indicating that drinkers were more likely to be White than non-white. Sex was correlated with alcohol consumption, \( r_{pb}(509) = -.12, p = .006 \), whereby males reported greater alcohol consumption and higher scores on the CEOA Tension Reduction scale than females, \( r_{pb}(509) = -.17, p < .001 \). Table 3 displays correlations among all study variables. The variables race, age, and sex were used as covariates in subsequent analyses.

#### 3.2.2. Hypothesis 1

ENDS use and alcohol consumption were significantly, negatively correlated, \( r_{pb}(509) = -.09, p = .044 \), and ENDS use and hazardous drinking were significantly, positively correlated, \( X^2(1, N = 511) = 5.154, p = .023 \), in that non-ENDS users (23.7%) engaged in more hazardous drinking than ENDS users (12.7%). Both results yielded negligible to small effect sizes (Cohen, 1988).
Table 2. Participant Characteristics for the Overall Sample and by Alcohol and ENDS Use Groups

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Overall (N = 511)</th>
<th>ENDS Use (n = 212)</th>
<th>No ENDS Use (n = 299)</th>
<th>p</th>
<th>Drinkers (n = 404)</th>
<th>Non-Drinkers (n = 107)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race (N, %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>White</td>
<td>388, 75.9%</td>
<td>160, 75.5%</td>
<td>228, 76.3%</td>
<td>.838</td>
<td>322, 79.7%</td>
<td>66, 61.7%</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Non-White</td>
<td>123, 24.1%</td>
<td>52, 24.5%</td>
<td>71, 23.7%</td>
<td>.838</td>
<td>82, 20.3%</td>
<td>41, 38.3%</td>
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<tr>
<td>Sex (N, %)</td>
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<tr>
<td>Male</td>
<td>118, 23.1%</td>
<td>46, 21.7%</td>
<td>72, 24.1%</td>
<td>.529</td>
<td>86, 21.3%</td>
<td>32, 29.9%</td>
<td>.060</td>
</tr>
<tr>
<td>Female</td>
<td>393, 76.9%</td>
<td>166, 78.3%</td>
<td>227, 75.9%</td>
<td>.529</td>
<td>318, 78.7%</td>
<td>75, 70.1%</td>
<td>.060</td>
</tr>
<tr>
<td>Age (years) M (SD)</td>
<td>19.9 (1.3)</td>
<td>20.1 (1.2)</td>
<td>19.8 (1.4)</td>
<td>.002</td>
<td>20.1 (1.3)</td>
<td>19.7 (1.4)</td>
<td>.007</td>
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<tr>
<td>DDQ average # of drinks per week</td>
<td>0.9 (1.0)</td>
<td>0.8 (0.9)</td>
<td>1.0 (1.1)</td>
<td>.872</td>
<td>1.2 (1.0)</td>
<td>1.2 (1.0)</td>
<td>-</td>
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<tr>
<td>DDQ &gt;4-5 drinks per occasion</td>
<td>0.4 (0.5)</td>
<td>0.3 (0.5)</td>
<td>0.4 (0.5)</td>
<td>.023</td>
<td>0.4 (0.5)</td>
<td>-</td>
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<tr>
<td>e-WISDM Total</td>
<td>25.7 (28.6)</td>
<td>27.1 (30.1)</td>
<td>11.0 (0.1)</td>
<td>.431</td>
<td>28.6 (31.6)</td>
<td>16.7 (12.5)</td>
<td>.950</td>
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<tr>
<td>e-WISDM AE</td>
<td>1.7 (1.4)</td>
<td>1.8 (1.4)</td>
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<td>.555</td>
<td>1.8 (1.4)</td>
<td>1.4 (1.2)</td>
<td>.447</td>
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<tr>
<td>e-WISDM Taste</td>
<td>2.3 (2.0)</td>
<td>2.5 (2.0)</td>
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<td>2.5 (2.0)</td>
<td>1.7 (1.6)</td>
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<tr>
<td>e-WISDM Social</td>
<td>2.8 (2.0)</td>
<td>3.1 (2.1)</td>
<td>1.0 (0.1)</td>
<td>&lt;.001</td>
<td>3.0 (2.1)</td>
<td>2.2 (1.7)</td>
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<tr>
<td>CEOA Sociability</td>
<td>23.5 (5.7)</td>
<td>26.4 (4.3)</td>
<td>26.1 (4.7)</td>
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<td>26.9 (3.9)</td>
<td>23.6 (5.7)</td>
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<tr>
<td>CEOA Tension Reduction</td>
<td>8.0 (2.1)</td>
<td>8.2 (2.0)</td>
<td>7.8 (2.1)</td>
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<td>8.0 (2.0)</td>
<td>7.8 (2.4)</td>
<td>.181</td>
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<tr>
<td>CEOA Liquid Courage</td>
<td>12.6 (3.9)</td>
<td>13.5 (3.5)</td>
<td>13.9 (3.5)</td>
<td>.549</td>
<td>14.0 (3.3)</td>
<td>12.6 (3.9)</td>
<td>.049</td>
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<tr>
<td>CEOA Sexuality</td>
<td>8.9 (3.3)</td>
<td>10.0 (3.0)</td>
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<td>.481</td>
<td>10.2 (3.0)</td>
<td>8.9 (3.3)</td>
<td>.001</td>
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</tbody>
</table>

Note. e-WISDM Total = Total score on the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM AE = Affective Enhancement scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM Taste = Taste and Sensory Process scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM Social = Social/Environmental Goads scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; CEOA = Comprehensive Effects of Alcohol; DDQ average # of drinks per week = weekly average of drinks score of the Daily Drinking Questionnaire; DDQ >4-5 drinks = weekly average of drinks totaling 4 or more (women) or 5 or more (men) score of the Daily Drinking Questionnaire used to determine hazardous drinking.
Table 3. Correlations among Study Variables

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<td>-0.03</td>
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<td>-0.00</td>
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<td>-0.03</td>
<td>-0.01</td>
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<td>-0.04</td>
<td>0.01</td>
<td>0.01</td>
<td>0.04</td>
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<td>-0.17**</td>
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<td>-0.05</td>
<td>-0.12**</td>
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<td>7. e-WISDM Social</td>
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<td>of drinks per occasion</td>
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<td>14. ENDS Use</td>
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</tbody>
</table>

Note. e-WISDM Total = Total score on the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM AE = Affective Enhancement scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM Taste = Taste and Sensory Process scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM Social = Social/Environmental Goads scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; CEOA = Comprehensive Effects of Alcohol; DDQ average # of drinks per week = weekly average of drinks score of the Daily Drinking Questionnaire; DDQ >4-5 drinks = weekly average of drinks totaling 4 or more (women) or 5 or more (men) score of the Daily Drinking Questionnaire used to determine hazardous drinking; ENDS Use = compilation of scores from the e-FTND total, e-WISDM total, e-WISDM Affective Enhancement, e-WISDM Taste and Sensory Processes, e-WISDM Social/Environmental Goads, and PS-ECDI total. *p <.05. **p < .01. †Male = 1, Female = 2.
3.2.3. Hypothesis 2

Greater alcohol consumption was significantly, positively correlated with greater endorsement of ENDS use motives of Affective Enhancement, \( r(509) = .22, p < .001 \), Taste and Sensory Processes, \( r(509) = .27, p < .001 \), and Social/Environmental Goads \( r(509) = .25, p < .001 \), though yielded small effect sizes (Cohen, 1988). Correlations among all study variables are presented in Table 3.

3.2.4. Hypothesis 3

Among ENDS users, the overall MANOVA for the CEOA scales were significant, \( F(4, 506) = 2.785, p = .026 \); Wilk’s \( \lambda = .978 \), partial \( \eta^2 = .022 \). One-way ANOVAs were subsequently conducted to test mean differences among ENDS users and non-ENDS users, with ENDS users \((M = 26.4; SD = 4.3)\) vs. non-ENDS users \((M = 26.1; SD = 4.7)\) reporting greater Sociability, \( F(1, 509) = 0.457, p = .499 \) and Tension Reduction (ENDS users \( M = 8.2; SD = 2.0 \) vs. non-ENDS users \( M = 7.8; SD = 2.1 \)), \( F(1, 509) = 3.795, p = .025 \), scale scores on the CEOA. Non-ENDS users \((M = 14.0; SD = 3.5)\) vs. ENDS users \((M = 13.5; SD = 3.5)\) reported greater Liquid Courage, \( F(1, 509) = 1.834, p = .176 \), and Sexuality (non-ENDS users \( M = 10.0; SD = 3.2 \) vs. ENDS users \( M = 10.0; SD = 3.0 \)), \( F(1, 509) = 0.010, p = .919 \), scale scores on the CEOA.

Because ENDS users reported significantly higher scores than non-users on the CEOA Tension Reduction scale, we conducted regression analyses testing the respective mediational role of the CEOA Tension Reduction scale only, which included the demographic variables age, race, and sex identified as covariates entered as predictors in step 1 of the analysis. In step 2, alcohol use (DDQ scores for average number of drinks per week) was entered, and in step 3, the respective CEOA scale scores were entered with ENDS use (yes/no) as the dependent variable. For Tension Reduction, age \( (\beta = .20, \text{ Wald test} = 8.91, p = .003) \) was a significant predictor on
step 1. On step 2, age ($\beta = .22$, Wald test = 9.65, $p = .002$) and alcohol use ($\beta = -.24$, Wald test = 4.44, $p = .035$) were significant predictors for the model. Notably, on step 3, age ($\beta = .21$, Wald test = 9.01, $p = .003$) and alcohol use ($\beta = -.21$, Wald test = 5.49, $p = .019$) significantly predicted ENDS use, and the CEOA Tension Reduction scale score ($\beta = .10$, Wald test = 4.93, $p = .026$) significantly, partially mediated the relationship between alcohol and ENDS use, indicating both the independent variable (alcohol use) and mediator (Tension Reduction) significantly predicted the dependent variable (ENDS use); see Figure 1. Results for the mediation models are presented in Table 4.

![Diagram](image)

Figure 1. Tension Reduction expectancies partially mediate the association between drinking and ENDS use.

Note. Path diagrams for i. the total effect of drinking on ENDS use and ii. the indirect effect of drinking on ENDS use through the alcohol expectancy of tension reduction.

* $p < .05$. ** $p < .01$. 
Table 4. Logistic regression analysis with CEOA Tension Reduction scale as a partial mediator between alcohol and ENDS use.

<table>
<thead>
<tr>
<th></th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.20**</td>
<td>.22**</td>
<td>.21**</td>
</tr>
<tr>
<td>Race</td>
<td>-.01</td>
<td>.03</td>
<td>.01</td>
</tr>
<tr>
<td>Sex</td>
<td>.15</td>
<td>.10</td>
<td>.18</td>
</tr>
<tr>
<td>DDQ average # of drinks per week</td>
<td>-.24*</td>
<td>-.21*</td>
<td></td>
</tr>
<tr>
<td>CEOA Tension Reduction scale score</td>
<td></td>
<td></td>
<td>.10*</td>
</tr>
</tbody>
</table>

Note. *p < .05. **p < .01.
Values are standardized beta coefficients.

3.3. Exploratory Analyses

Given the disproportionate participant characteristics in the primary analyses, we conducted exploratory analyses among White females (N = 297). We also excluded students older than 22 years of age as they accounted for only 2% of our sample, as well as giving consideration to extant literature indicating trends in alcohol use and its related problems have been stable among college students aged 18-20 over recent years (Hingson et al., 2009). See Table 5 for participant characteristics.

ENDS use and alcohol consumption, $r(295) = -.09$, $p = .121$, were statistically nonsignificant and negatively correlated in the opposite direction than hypothesized, a similar indicated in the first hypothesis of our primary analyses. ENDS use and hazardous drinking, $X^2 (1, N = 297) = 1.984$, $p = .159$, were statistically nonsignificant and positively correlated, with non-ENDS users (24.9%) engaging in more hazardous drinking than ENDS users (15.2%).

Greater alcohol consumption was significantly, positively correlated with greater endorsement of ENDS use motives of Affective Enhancement, $r(295) = .18$, $p < .05$, Taste and Sensory Processes, $r(295) = .19$, $p < .05$, and Social/Environmental Goads $r(295) = .22$, $p < .01$. Correlations among all study variables for White females are presented in Table 6.
Table 5. Participant Characteristics among White females and by Alcohol and ENDS Use Groups

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>White females (N = 297)</th>
<th>ENDS Use (n = 127)</th>
<th>No ENDS Use (n = 170)</th>
<th>p</th>
<th>Drinkers (n = 252)</th>
<th>Non-Drinkers (n = 45)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) M (SD)</td>
<td>19.8 (1.2)</td>
<td>20.1 (1.2)</td>
<td>19.8 (1.4)</td>
<td>.002</td>
<td>19.9 (1.3)</td>
<td>19.6 (1.1)</td>
<td>.145</td>
</tr>
<tr>
<td>DDQ average # of drinks per week</td>
<td>0.9 (0.9)</td>
<td>0.9 (0.8)</td>
<td>0.9 (0.0)</td>
<td>.351</td>
<td>1.1 (0.9)</td>
<td>-</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>DDQ &gt;4 drinks per occasion</td>
<td>0.4 (0.5)</td>
<td>0.4 (0.5)</td>
<td>0.4 (0.5)</td>
<td>.160</td>
<td>0.5 (0.5)</td>
<td>-</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>e-FTND</td>
<td>2.0 (1.6)</td>
<td>2.1 (1.6)</td>
<td>-</td>
<td>.004</td>
<td>2.0 (1.5)</td>
<td>1.9 (1.9)</td>
<td>.800</td>
</tr>
<tr>
<td>e-WISDM Total</td>
<td>26.3 (26.1)</td>
<td>28.8 (27.3)</td>
<td>11.0 (0.1)</td>
<td>.003</td>
<td>28.1 (27.8)</td>
<td>18.4 (14.1)</td>
<td>.081</td>
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<td>e-WISDM AE</td>
<td>1.7 (1.4)</td>
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<td>.010</td>
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<td>2.0 (2.0)</td>
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<td>e-WISDM Social</td>
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<td>1.0 (0.1)</td>
<td>&lt;.001</td>
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<td>2.6 (2.0)</td>
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<td>26.5 (4.1)</td>
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<td>.181</td>
<td>27.0 (3.9)</td>
<td>24.2 (4.7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CEOA Tension Reduction</td>
<td>7.8 (2.1)</td>
<td>8.1 (2.0)</td>
<td>7.6 (2.2)</td>
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<td>7.8 (2.0)</td>
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<td>13.5 (3.2)</td>
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<td>13.7 (3.1)</td>
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<td>10.0 (3.0)</td>
<td>10.0 (3.0)</td>
<td>.508</td>
<td>10.0 (2.9)</td>
<td>8.6 (3.0)</td>
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</table>

Note. e-FTND = Electronic-Fagerström Test for Nicotine Dependence; e-WISDM Total = Total score on the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM AE = Affective Enhancement scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM Taste = Taste and Sensory Process scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM Social = Social/Environmental Goads scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; CEOA = Comprehensive Effects of Alcohol; DDQ average # of drinks per week = weekly average of drinks score of the Daily Drinking Questionnaire; DDQ >4 drinks = weekly average of drinks totaling 4 or more score of the Daily Drinking Questionnaire used to determine hazardous drinking.
Table 6. Study Variable Correlations among White females

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<td>1. Age</td>
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</tr>
<tr>
<td>3. e-WISDM Total</td>
<td>-</td>
<td>.63</td>
<td>**</td>
<td>.59</td>
<td>**</td>
<td>.56</td>
<td>**</td>
<td>.24</td>
<td>*</td>
<td>.09</td>
<td>.08</td>
<td>- .02</td>
<td>.11</td>
</tr>
<tr>
<td>4. e-WISDM AE</td>
<td>-</td>
<td>.66</td>
<td>**</td>
<td>.50</td>
<td>**</td>
<td>.21</td>
<td>*</td>
<td>-.06</td>
<td>-.00</td>
<td>.03</td>
<td>.11</td>
<td>.18</td>
<td>*</td>
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<tr>
<td>5. e-WISDM Taste</td>
<td>-</td>
<td>.61</td>
<td>*</td>
<td>.29</td>
<td>**</td>
<td>.14</td>
<td>.09</td>
<td>.11</td>
<td>.21</td>
<td>*</td>
<td>.19</td>
<td>*</td>
<td>.18</td>
</tr>
<tr>
<td>6. e-WISDM Social</td>
<td>-</td>
<td>.40</td>
<td>**</td>
<td>.24</td>
<td>**</td>
<td>.19</td>
<td>*</td>
<td>.10</td>
<td>.19</td>
<td>*</td>
<td>.22</td>
<td>**</td>
<td>.17</td>
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<tr>
<td>7. ENDS Use (yes/no)</td>
<td>-</td>
<td>.08</td>
<td>.11</td>
<td>.02</td>
<td>.04</td>
<td>-.05</td>
<td>-.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. CEOA Sociability</td>
<td>-</td>
<td>.40</td>
<td>**</td>
<td>.61</td>
<td>**</td>
<td>.47</td>
<td>**</td>
<td>.32</td>
<td>**</td>
<td>.37</td>
<td>**</td>
<td></td>
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<tr>
<td>9. CEOA Tension</td>
<td>-</td>
<td>.42</td>
<td>**</td>
<td>.39</td>
<td>**</td>
<td>.13</td>
<td>*</td>
<td>.10</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10. CEOA Liquid</td>
<td>-</td>
<td>.62</td>
<td>**</td>
<td>.28</td>
<td>**</td>
<td>.24</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>11. CEOA Sexuality</td>
<td>-</td>
<td>.28</td>
<td>**</td>
<td>.25</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12. DDQ average # of drinks per week</td>
<td>-</td>
<td>.70</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>13. DDQ &gt;4 drinks</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

Note. e-FTND = Electronic-Fagerström Test for Nicotine Dependence; e-WISDM Total = Total score on the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM AE = Affective Enhancement scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM Taste = Taste and Sensory Process scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; e-WISDM Social = Social/Environmental Goads scale of the Electronic-Wisconsin Inventory of Smoking Dependence Motives; CEOA = Comprehensive Effects of Alcohol; DDQ average # of drinks per week = weekly average of drinks score of the Daily Drinking Questionnaire; DDQ >4 drinks = weekly average of drinks totaling 4 or more score of the Daily Drinking Questionnaire used to determine hazardous drinking; ENDS Use = compilation of scores from the e-FTND total, e-WISDM total, e-WISDM Affective Enhancement, e-WISDM Taste and Sensory Processes, and e-WISDM Social/Environmental Goads. *p < .05. **p < .01.
Among White females ENDS users, the overall MANOVA for the CEOA scales were not significant, \((F(4, 292) = 1.247, p = .291\); Wilk’s \(\lambda = .983\), partial \(\eta^2 = .017\). One-way ANOVAs were subsequently conducted to test mean differences among ENDS users and non-ENDS users, with ENDS users \((M = 27.0; SD = 3.8)\) vs. non-ENDS users \((M = 26.3; SD = 4.3)\) reporting greater Sociability, \(F(1, 295) = 1.801, p = .181\), Tension Reduction (ENDS users \(M = 8.1; SD = 2.0\) vs. non-ENDS users \(M = 7.6; SD = 2.2\)), \(F(1, 295) = 3.560, p = .030\), Liquid Courage (ENDS users \(M = 13.6; SD = 3.3\) vs. non-ENDS users \(M = 13.5; SD = 3.2\)), \(F(1, 295) = 0.100, p = .752\), and Sexuality (ENDS users \(M = 10.0; SD = 3.0\) vs. non-ENDS users \(M = 9.7; SD = 3.0\)), \(F(1, 295) = 0.439, p = .508\), scale scores on the CEOA.

Due to White female ENDS users reporting significantly higher scores than non-users on the CEOA Tension Reduction scale, we conducted additional regression analyses testing the respective mediational role of the CEOA Tension Reduction scale only, which included the demographic variable age identified as a covariate entered as a predictor in step 1 of the analysis. On step 2, alcohol use (DDQ scores for average number of drinks per week) was entered, and on step 3, the respective CEOA scale scores were entered with ENDS use (yes/no) as the dependent variable. For Tension Reduction, age \((\beta = .35, \text{ Wald test } = 12.35, p < .001)\) was a significant predictor on step 1. On step 2, age \((\beta = .35, \text{ Wald test } = 12.53, p < .001)\) was a significant predictor for the model, but alcohol use \((\beta = -.15, \text{ Wald test } = 1.06, p = .304)\) was an insignificant predictor. On step 3, age \((\beta = .35, \text{ Wald test } = 12.10, p < .001)\) significantly predicted ENDS use, but alcohol use \((\beta = -.18, \text{ Wald test } = 1.59, p = .207)\) did not predict ENDS use. Notably, the CEOA Tension Reduction scale score \((\beta = .11, \text{ Wald test } = 3.60, p = .058)\) did not mediate the relationship between alcohol and ENDS use, yielded a negligibly significant
value, and trended in the same direction as our primary analyses. Results for the mediation models are presented in Table 7.

Table 7. Logistic regression analysis with CEOA Tension Reduction scale as a mediator between alcohol and ENDS use among White females.

<table>
<thead>
<tr>
<th></th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.35***</td>
<td>.35***</td>
<td>.35***</td>
</tr>
<tr>
<td>DDQ average # of drinks per week</td>
<td></td>
<td>-.15</td>
<td>-.18</td>
</tr>
<tr>
<td>CEOA Tension Reduction scale score</td>
<td></td>
<td></td>
<td>.11</td>
</tr>
</tbody>
</table>

Note. *p < .05. **p < .01. ***p < .001. Values are standardized beta coefficients.
Chapter 4. Discussion

4.1. Findings and Implications

The purpose of the current study was to examine how alcohol and ENDS use-related variables are associated with patterns of alcohol and ENDS use among college students. Specifically, we analyzed the relationship between ENDS use, ENDS-related variables, alcohol use, and positive alcohol expectancies, as well as whether positive alcohol expectancies mediated the relation between alcohol use and ENDS use.

Results indicated that ENDS use was significantly less likely in relation to alcohol consumption yet significantly more likely in relation to hazardous drinking, and the relationship between alcohol consumption and ENDS use yielded a negative correlation. Further, there was no significant difference observed in ENDS use among students who drink versus students who do not drink, and non-ENDS users engaged in hazardous drinking at greater rates than ENDS users. These data suggest that these students may not be engaging in simultaneous substance use as frequently as their peers at other institutions. Though inconsistent with existing literature [e.g., see Hefner et al. (2019); Littlefield et al. (2015)], findings with the current sample indicate students in this study may be less vulnerable for risky co-substance use behaviors as compared to peers in other studies. There are a few possible explanations for this outcome. Our sample was primarily female, and data indicate that males typically engage in greater levels of hazardous drinking than females (McBride et al., 2014; Sundin et al., 2021; Terry-McElrath & Patrick, 2016). Alternatively, some of these students may not perceive significant benefits from engaging in non-hazardous alcohol use and ENDS use. Rather, it may be that these students are still engaging in simultaneous substance use in that they are smoking combustible cigarettes and
drinking alcohol, which is a pattern more common than dual ENDS use and alcohol use among young adults (Rass et al., 2015; Thrul et al., 2019).

Lastly, the relation between increased alcohol consumption and decreased ENDS use revealed a negative association, with negligible to small effect sizes. Though extant literature substantially indicates a significant, positive correlation between drinking/hazardous drinking and ENDS use (Hefner et al., 2019; Littlefield et al., 2015; Roberts et al., 2018; Yang et al., 2022), our unique findings highlight that there may be a complex relation that exists and warrants further investigation into the dynamics of ENDS and alcohol use among college students. Firstly, it may be that findings from other studies differed from ours due to varying methodologies. Particularly, we did not utilize a continuous measure of ENDS in our analyses, unlike other studies (Littlefield et al., 2015; Roberts et al., 2018; Yang et al., 2022), and by using a binary ENDS use variable, we may have lost contextual information about ENDS use among college students. Contextual information, such as quantity, frequency, intensity of use, may be important for understanding how ENDS use is related to alcohol use and associated problems. Moreover, many studies not only assessed ENDS use but also ENDS use patterns (e.g., reason for use in the past 30 days, ENDS device features, and flavor; Chen, 2018; Soule et al., 2016; Yang et al., 2022), ENDS use perceptions and knowledge (Hefner et al., 2019; Marx et al., 2021; Vargas-Rivera et al., 2021), and negative psychosocial and health outcomes (Grant et al., 2019; Pokhrel et al., 2014), thus potentially influencing the relation between alcohol and ENDS use by the addition of other variables. Secondly, this finding may be due to our sample being unique in that it consisted of participant regional and cultural differences that contrast with other studies. Though most studies consisted of college students, recruitment regions differed vastly across studies and from ours (i.e., southeastern), including northeastern (Hefner et al., 2019), mid-
Atlantic (Marx et al., 2021), Pacific (Pokhrel et al., 2014; Thrul et al., 2019), Midwestern (Grant et al., 2019), and southern (Littlefield et al., 2015) regions of the U.S., in addition to international recruitment (e.g., Canada, Australia, United Kingdom, Poland; Adkison et al., 2013; Goniewicz et al., 2013); these geographical differences may account for ENDS use variance amongst college students. Thirdly, several governmental policies and academic institutions have effectuated significant efforts to decrease substance use across campuses within the past few decades. Specifically, the U.S. Department of Education established the Higher Education Center for Alcohol and Other Drug Prevention in 1993 as an initiative to assist college campuses in implementing environmental management and harm reduction strategies (DeJong & Langenbahn, 1997; DeJong et al., 1998). Since then, universities across the nation have enacted various interventions and literacy campaigns that have demonstrated success in providing psychoeducation and reducing substance use, particularly alcohol and ENDS use, among this population (Escoto et al., 2021; King et al., 2020; White et al., 2006). As such, our unique finding may be a result of the policy and procedural advancement of informing students about the harmful effects of alcohol use, hazardous drinking, and ENDS use.

As hypothesized, greater alcohol consumption was significantly, positively correlated with greater endorsement of the following motives to use ENDS: Affective Enhancement, Taste and Sensory Processes, and Social/Environmental Goads. These findings suggest that among college students, individuals who drink more report greater motivation to use ENDS due to the taste/flavors, the belief that ENDS will alleviate negative affect, and may be more prone to use ENDS when they are in social contexts. These outcomes are consistent with existing data, as many students endorse motives to use ENDS related to their taste (Vargas-Rivera et al., 2021), being in social settings (Katz et al., 2019), and the perceived benefit of increased emotional
mood (Marx et al., 2021). Given that this sample of students who engage in greater levels of drinking most likely hold positive perceptions and expectancies regarding their alcohol consumption (Lewis & O'Neill, 2000), it is possible that these beliefs regarding the favorable outcomes of alcohol use may translate to favorable outcomes of ENDS use.

We found that alcohol expectancies for Tension Reduction partially mediated the association between drinking and ENDS use, which partially supports our third hypothesis. Outcome expectancies are described in the literature as intervening variables that predict various alcohol use patterns and are often identified as mediators between interpersonal or psychosocial variables and drinking. To our knowledge, this is the first test for mediation between two substances (i.e., alcohol and nicotine) by expectancies that are common across the substances (e.g., Tension Reduction). Shrout and Bolger (2002) discuss three ways in which one may obtain partial versus complete mediation results: (1) $X$ (drinking) may really have a direct effect upon $Y$ (ENDS use) in addition to its indirect effect on $Y$ through $M$ (alcohol expectancies); (2) drinking may have no direct effect on ENDS use, but may have indirect effects on ENDS use through alcohol expectancies and another mediating variable not included in the model. In this case, the indirect effect of drinking on ENDS use through the other variable will be mistaken as being a direct effect of drinking on ENDS use; and (3) there may be two subsets of subjects. In the one subset there may be only a direct effect of drinking on ENDS use, and in the second subset there may be only an indirect effect of drinking on ENDS use through alcohol expectancies. Of the three scenarios, the first seems highly plausible, in that there are likely multiple paths by which drinking and ENDS use may be associated in college students, including availability of these products in retail and social contexts, exposure through peers, as well as through the indirect influence of beliefs regarding tension and stress reduction. Scenario three may also apply to
these findings given the range of alcohol consumption patterns (e.g., social, problematic, hazardous/binge) that may define subsets with different ENDS use patterns. There was evidence of this in the current sample in that hazardous drinkers were less likely to endorse ENDS use.

Our finding that Tension Reduction expectancies functioned as a partial mediator, despite the lack of association between ENDS use and alcohol expectancies, Liquid Courage, Sociability, and Sexuality, is consistent with existing literature, demonstrating a strong predictive relationship tension/stress reduction has with drinking. For example, in exploring the association between alcohol expectancies, drinking behaviors, coping strategies, and drinking motives, Hasking and colleagues (2011) discovered that expectancies for tension reduction mediated the relationship between avoidant coping and drinking behaviors. Though we did not assess coping strategies, this finding suggests that there is a strong link between tension reduction and alcohol use in this sample. Given our added variable of ENDS use, and the fact that some students report using ENDS to manage stress (Napolitano et al., 2020), the mediating alcohol expectancy of tension reduction supports our hypothesis in that it accounts, at least in part, for the association between ENDS and alcohol use.

4.2. Study Limitations

The present study has several limitations. First, all study measures were administered online which may have allowed for extraneous influences on participants’ responses. This is particularly worrisome, given the large number of participants we had to exclude based on incomplete data and failed informed consent protocol as evidence they were distracted from the study tasks. Second, there were significant differences in survey completion based on age, where non-completers were younger than completers. Given that younger students tend to report more hazardous drinking compared to older students (Wechsler et al., 2000), having less participants
from this target population in our analyses is suboptimal. Third, all study measures were self-report inventories, and this method invariance could result in inflated associations among study variables based on methodology alone. Future studies should have participants complete measures in a controlled, distraction-free setting and include biochemical markers of nicotine use, clinician-administered assessments, and other objective measures to improve internal validity. A fourth limitation is the demographic composition of the current sample in which the large majority of participants were White and female. This notable lack of racial diversity along with so few of the participants being male pose a threat to external validity and how well the current results generalize to other college students and other populations of young adults. Further, the exploratory analyses findings in which we restricted the age, race, and sex allowed us to have more confidence in the results from our primary analyses. Future studies should recruit samples comprised of more diverse racial/ethnic backgrounds to determine whether sociocultural factors play a role in the association of alcohol use and ENDS use. Lastly, the use of a binary ENDS use variable, coupled with our exclusion of 910 participants, is a limitation because we potentially lost meaningful, contextual data about ENDS use among college students, which could have significantly influenced our findings and contributed to more generalizable results. Future studies should utilize both binary and continuous measures of ENDS.

4.3. Conclusion and Future Directions

Results have important clinical implications that can help inform research and interventions. The present findings of Tension Reduction expectancies partially mediating the association between alcohol use and ENDS use highlight the importance of negative affect reduction in motivating use of both alcohol and ENDS. Existing research in alcohol and nicotine self-administration consistently points to relief of negative mood and stress as compelling use
and is a critical factor in motivational models of substance use (Baker et al., 2004; Wetter et al., 1994). Alcohol and ENDS interventions for college students should be tailored with components targeting negative affect (e.g., anxiety, stress) reduction. Such interventions may improve their efficacy by providing psychoeducation regarding maladaptive thoughts about relying on alcohol or nicotine for tension reduction and assist students in developing alternate coping strategies for stress management.
Appendix. Institutional Review Board Approval

TO: Copeland, Amy
LSUAM | Col of HSS | Psychology

FROM: Alex Cohen
Chair, Institutional Review Board

DATE: 22-Sep-2020

RE: 3740

TITLE: Alcohol Use, E-cigarette Use, and Smoking in College Students

New Protocol/Modification/Continuation: Modification

Review Type: Expedited Review

Risk Factor: Minimal

Review Date: 21-Sep-2020

Status: Approved

Approval Date: 21-Sep-2020

Approval Expiration Date:

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 2000

By: Alex Cohen, Chairman

Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU’s Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submission of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
8. SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc.
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Buu, A., Hu, Y. H., Wong, S. W., & Lin, H. C. (2020). Comparing American college and noncollege young adults on e-cigarette use patterns including polysubstance use and


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https://doi.org/10.1016/j.addbeh.2021.106841

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https://doi.org/10.1080/07448481.2013.776052


Vita

Nina Glover was born and raised in Houston, Texas. She graduated Cum Laude with her Bachelor of Arts in Psychology and a minor in African American Studies from the University of Houston in 2018. During her time as an undergraduate and after graduation, she was the project coordinator of several studies examining various mechanisms of anxiety sensitivity and substance use. In 2020, Nina enrolled in the Clinical Psychology doctoral program at Louisiana State University. She plans to receive her Master of Arts degree in May of 2024 and her Ph.D. in 2026.