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Differentiating Externalizing versus Internalizing Behaviors as Risk Factors for Alcohol,

Marijuana, and Various Tobacco Use Among Young Adults

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Abstract

Differentiating Externalizing versus Internalizing Behaviors as Risk Factors for Alcohol,

Marijuana, and Various Tobacco Use Among Young Adults

By Jennifer Bierhoff

Introduction: Alcohol, marijuana, and tobacco use are prevalent in young adults and may be differentially associated with psychological symptoms characterized as externalizing (ADHD) or internalizing behaviors (depression, anxiety). This study examined the use of alcohol, marijuana, and various tobacco products in relation to symptoms of ADHD, depression, and anxiety.

Methods: We analyzed data from 2,397 US college students (aged 18-25) enrolled in a two-year, six-wave longitudinal study launched in 2014. Specifically, we administered the Adult ADHD Self-Report Scale, Patient Health Questionnaire – 9 item (assessing depressive symptoms), and the Zung Self-Rating Anxiety Scale in Waves 1-5 and assessed past 30-day use of alcohol, marijuana, and tobacco products (cigarettes, little cigars/cigarillos [LCCs], smokeless tobacco, e-cigarettes, hookah), as well as nicotine dependence per the Hooked-on Nicotine Checklist at Wave 6. We conducted multivariable regressions for each substance use outcome.

Results: Participants were 20.49 (SD=1.93) years old, 64.7% female, and 65.5% White. In multivariable analyses controlling for sociodemographics, alcohol use and marijuana use were predicted by higher levels of ADHD symptoms (p=.042 and p=.019, respectively). Cigarette and LCC use were predicted by higher levels of depressive (p=.001 and p=.002, respectively) and anxiety symptoms (p=.020 and p=.027, respectively). Nicotine dependence was correlated with greater anxiety symptoms (p=.026). However, smokeless tobacco use was predicted by greater ADHD symptoms (p=.050); neither e-cigarette nor hookah use were predicted by these psychological symptoms.

Conclusion: Results indicate that further research is needed to determine distinct psychological risk factors for the use of the range of substances, particularly alternative tobacco products.

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INTRODUCTION

Use of alcohol, marijuana, and tobacco are prevalent in young adults, both college students and their same aged non-college student peers (Schulenburg et al., 2017). Many young adults begin using substances in adolescence and continue that substance use into early adulthood (CDC, 2014, 2017). Substance use has been linked to a variety of different mental health problems, including externalizing behaviors, such as symptoms of ADHD, and internalizing behaviors, such as symptoms of anxiety and depression (Chan, Dennis, & Funk, 2008; Grant et al., 2004a).

Both alcohol use and marijuana use have been linked to externalizing behaviors (Colder et al., 2013). Externalizing behaviors during childhood are predictive of alcohol use, heavy drinking, problematic drinking, and marijuana use in young adulthood (Englund, Egeland, Oliva, & Collins, 2008). The directionality of these associations is unclear, with research indicating that use of these substance leads to externalizing behaviors, as well as externalizing behaviors leading to such substance use (Jun, Sacco, Bright, & Camlin, 2015, Hayatbakhsh et al., 2008).

On the other hand, tobacco use has been linked mainly with internalizing behaviors and has been found to have a bidirectional relationship with both depression and anxiety (Brook, Schuster, & Zhang, 2004; Dierker et al., 2015; Johnson et al., 2000; Windle & Windle, 2001). Although this relationship is well documented with cigarette use, there is a lack of literature examining the relationship between internalizing behaviors and alternative tobacco products. The Transdiagnostic Vulnerability model, developed by Leventhal and Zvolensky, provides a model for the association between

tobacco use and mental disorders involving internalizing behaviors such as anxiety and depression behavior (Leventhal & Zvolensky, 2015)

      This study aims to examine how the use of different substances, including alcohol, marijuana, and various tobacco products, may be associated with psychological symptoms. Specifically, we examined ADHD symptoms as externalizing behaviors, and depression and anxiety as internalizing behaviors, are associated with use of alcohol, marijuana, and various tobacco products.

LITERATURE REVIEW

      Young adults are at the greatest risk for using various substances (Substance Abuse and Mental Health Services Administration, 2015), and the use of any one substance is associated with use of other substances (Substance Abuse and Mental Health Services Administration [SAMHSA], 2015). Three most commonly used substances among US young adults are alcohol, marijuana, and tobacco (SAMHSA, 2015). Past-month alcohol use among US adults is about 60% (Park, Scott, Adams, Brindis, & Irwin, 2014). Marijuana is the most common illicit substance used in the US; 19.1% of young adults aged 18-25 report past-month marijuana use (SAMHSA, 2015). Currently, 17.0% of young adults aged 18-24 smoke cigarettes (Hu et al., 2016). Moreover, there has been a shift in the terrain of tobacco use due to increases in the availability of alternative tobacco products (ATPs; e.g., little cigars/cigarillos [LCCs], smokeless tobacco, e-cigarettes, hookah) (Etter, 2010; Knishkowy & Amitai, 2005). Young adults are the highest risk group for using ATPs (McMillen, Maduka, & Winickoff, 2012), with the rates continuing to increase largely due to misperceptions of their lower health risks (Berg et al., 2015; Etter, 2010), use as an alternative to cessation (Gartner, Hall,

Chapman, & Freeman, 2007), and potential appeal to youth (McMillen et al., 2012), among other concerns.

Substance use often co-occurs with other psychological symptoms, often characterized as externalizing or internalizing behaviors (Adler, 2015; American Psychiatric Association [APA], 2013; Chan et al., 2008; Colder et al., 2013; Grant et al., 2004a). Externalizing behaviors represent those impulsive in nature, such as ADHD (American Psychiatric Association, 2013). Internalizing behaviors include somatic symptoms, such as anxiety and depression (APA, 2013). Indeed, one study found that, among a sample of treatment seeking substance users, 78-90% had either an internalizing or externalizing disorder and 42-61% presented with symptoms of both (Chan et al., 2008). Most research examining externalizing and internalizing behaviors associated with substance use have been driven by a biobehavioral model accounting for similar biopsychosocial risk factors for mental health and substance use issues (Grant et al., 2004b). These factors may amplify the anticipated rewarding effects, as well as the actual rewarding effects of substance use (Leventhal & Zvolensky, 2015).

While alcohol and marijuana use have been found to be associated with both externalizing and internalizing behaviors, research regarding the use of these two substances have shown more robust linkages to externalizing behaviors (Brook, Lee, Brown, & Finch, 2012; Hayatbakhsh et al., 2008; Jun et al., 2015). For example, externalizing behaviors during childhood are predictive of alcohol use, heavy drinking, and problematic drinking in young adulthood (Englund et al., 2008). Moreover, research shows a bi-directional relationship between psychological risk factors and substance use (Jun et al., 2015).

Conversely, the research regarding tobacco use has more robustly established an association with internalizing behaviors, such as depression (Brook et al., 2004; Dierker et al., 2015; Windle & Windle, 2001) and anxiety (Johnson et al., 2000). The Transdiagnostic Emotion Vulnerability Framework models the association of smoking behaviors with psychological risk factors, including anxiety sensitivity, distress tolerance, and anhedonia (Leventhal & Zvolensky, 2015). The links between depression and smoking, as well as anxiety and smoking, have been shown to be bi-directional (Johnson et al., 2000; Windle & Windle, 2001). Additionally, ADHD is a risk factor for smoking; approximately 40% of people with ADHD smoke, a higher rate than in the general population (Adler, 2015).

Despite this well-developed literature, limited research has examined how these psychological symptoms, or their qualification as externalizing or internalizing behaviors, may be distinctly associated with use of alcohol, marijuana, or various tobacco products, particularly in relation to ATPs. Thus, this study examined psychological symptoms representing externalizing behaviors, specifically ADHD symptoms, and internalizing behaviors, specifically symptoms of depression and anxiety in predicting use of alcohol, marijuana, and various tobacco products. We hypothesized that greater symptoms of ADHD will predict subsequent alcohol and marijuana use and that greater depressive and anxiety symptoms will predict tobacco use outcomes.

METHODS

Procedures and Participants

This study is a secondary data analysis of Project DECOY (Berg et al, 2016). The study was approved by the Emory IRB as well as the IFC International IRBs and those of

the participating colleges and universities. Project DECOY is a mixed-methods longitudinal study, which involved self-report survey assessments every four months for two years starting in Fall, 2014. Surveys were distributed in the Fall, Spring, and Summer of each year by email.

The study population consists of 3,418 racially and ethnically diverse college students recruited from seven colleges/universities in Georgia, representing urban and rural campuses. They included two public universities, two private colleges/universities, two community/technical colleges, and one historically black university (HBCU). Eligibility criteria included English speaking/reading, aged 18-25, and enrolled at one of the seven colleges or universities. To recruit participants, researchers obtained email addresses from the college registrar for all students who met the eligibility criteria. Three thousand 18-25 year-olds were randomly selected from one private and two public universities. The remainder of the schools had 18-25 year-old student populations <3,000; thus, the entire student population of that age range at those schools were recruited.

Recruitment ranged from 48 hours to 1 week depending time needed to reach the enrollment goal. Our total response rate of 22.9% (N=3574/15,607), albeit low, was over a very short time frame and met our sampling targets. Moreover, our intent was to enroll participants who were engaged in email and were potentially more likely to be retained in the subsequent waves of data collection. Seven days after initial recruitment and completion of the baseline survey, we asked participants to confirm their participation by clicking a "confirm" button included in an email sent to them. The email reiterated the tasks involved in the study and its timeline. Once participants clicked "confirm", they

were enrolled into the study and sent their first incentive in the form of a $30 gift card via email. The confirmation rate was 95.6% (N=3418/3574).

The current study focuses on participants with complete data on measures listed below (N=2,397). The participants in this sample were largely representative of the baseline sample (Berg et al., 2016) except that the current analytic sample represents more Whites and those attending private colleges but fewer attending technical colleges. Moreover, the current sample also has fewer participants reporting past 30-day LCC, e-cig, and hookah use, but more cigarette use.

Measures

Participants were administered measures assessing sociodemographic, psychosocial, and substance use characteristics. Below are the variables analyzed in the current study.

Predictors and Covariates

Sociodemographic characteristics, assessed at Wave 1 (Fall, 2014) included age, sex, sexual orientation, race, ethnicity, parental education, and school type.

Symptoms of ADHD were assessed using the Adult ADHD Self-Report Scale (Kessler et al., 2005), included at Wave 2 (Spring, 2015). The checklist consists of 6 items, and asks participants to indicate how often over the past six months they felt or conducted themselves. Sample items include "How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done" and "How often do you fidget or squirm with your hands and feet when you have to sit down for a long time". Answer options for each item include 0 (no) and 1 (yes). The total score is

computed (range: 0-6); higher scores indicate greater ADHD symptoms. Cronbach's alpha was .59.

Depressive symptoms were assessed at all six of the survey time points using the Patient Health Questionnaire – 9 item (PHQ-9) (Kroenke & Spitzer, 2002); this analysis includes the assessment at Wave 5 (Spring, 2016). The PHQ-9 asks how often participants have been bothered by several problems, such as "little interest or pleasure in doing things" and "thoughts that you would be better off dead, or of hurting yourself". Answer options for each item ranged from (0) not all to (3) nearly every day. The total score was computed (range: 0-27); higher scores indicate greater depressive symptoms. Cronbach's alpha was .86.

Symptoms of anxiety were assessed using the Zung Self-Rating Anxiety Scale (Zung, 1971), which was included at Wave 5 (Spring, 2016). The scale consists of 20 items and asks participants to report how often they felt or behaved in several ways over the past several days. Sample items include "I feel more nervous and anxious than usual" and "I feel afraid for no reason at all". Answer options ranged from (1) a little of the time to (4) most of the time. The total score was computed (range: 20-80); higher scores indicate greater anxiety symptoms. Cronbach's alpha was .83.

Primary Outcomes

Substance use was assessed at each wave using the question "During the past 30 days, on how many days have you used: alcohol? marijuana? cigarettes? little cigars or cigarillos (LCCs)? smokeless tobacco? e-cigarettes? hookah?" Answer options for each question were 0 to 30 and dichotomized as no use versus any use in the past 30 days. Current analyses include Wave 6 (Summer, 2016) reports of substance use.

Symptoms of nicotine dependence were assessed using the Hooked-on Nicotine Checklist (HONC) (Wellman et al., 2005), a 10-item questionnaire asking participants whether or not they have experienced the statement (no=0; yes=1). Sample items include "Have you ever tried to quit using tobacco or nicotine, but couldn't?" and "Do you ever have strong cravings to use tobacco or nicotine?" Only individuals reporting past four-month use of any tobacco product were instructed to complete this section (N=611). The total score is computed (range: 0-10); higher scores indicate greater nicotine dependence. This scale was administered at each wave; this analyses uses data from Wave 6 (Summer, 2016). Cronbach's alpha was .95.

Data Analysis

All data was analyzed using SPSS 24.0 statistical software. First, descriptive statistics were conducted. Second, bivariate associations were conducted for each outcome (i.e., use of alcohol, marijuana, and each tobacco product, respectively; symptoms of nicotine addiction) and each predictor variable. Lastly, binary logistic regressions were conducted to predict past 30-day use of each product; ordinary least squares regression was used to predict Hooked on Nicotine Checklist scores. All analyses were conducted using SPSS 24.0, and alpha was set at .05.

RESULTS

Descriptive Statistics

Among the 2,397 participants, the average age was 20.49 (SD=1.93); 64.7% were female, and 65.5% White (Table 1). Past-30-day use prevalence of use of the substances at Wave 6 were: 69.2% alcohol; 11.2% marijuana; 8.6% cigarettes; 4.4% LCCs; 2.2% smokeless tobacco; 3.4% e-cigarettes; and 4.4% hookah.

Alcohol Use

In bivariate analyses (Supplemental Table 1), alcohol use was significantly associated with being older (p<.001), being White or other race (p<.001), having parental education of greater than a BA (p<.001), attending a private college or university (p<.001), and higher levels of ADHD symptoms (p=.021). In multivariable analyses (Table 2), predictors of alcohol use included being older (p<.001), being female (p=.011), not being Black (<.001) and not being Asian compared to being White (p<.001), not attending a public (p<.001) or a technical school (p=.001) compared to a private school, and higher levels of ADHD symptoms (p=.042).

Marijuana Use

Bivariate analyses (Supplemental Table 1) indicated that marijuana use was significantly associated with being non-heterosexual, (p<.001), being Black or other race (p<.001), attending a public or HBCU college or university (p=.010), lower levels of depressive (p=<.001) and anxiety symptoms (p=.007), and higher levels of ADHD symptoms (p<.001). In multivariable analysis (Table 2), predictors of marijuana use included not being heterosexual (p=.010), being Black (p=.002) and other race (p=.025) versus being White, and higher levels of ADHD symptoms (p=.019).

Cigarette Use

Per bivariate analyses (Supplemental Table 1), cigarette use was significantly associated with being male (p=.001), being non-hetero-sexual orientation (p=.010), being White, Asian, or other race (p=.011), attending a private or technical school (p<.001), and higher levels of symptoms of ADHD (p=.003), depression (p<.001), and anxiety (p<.001). In multivariable analysis, significant predictors of cigarette use included being

male (p<.001), attending a technical school (p<.001) versus a private school, and higher levels of depressive (p=.001) and anxiety symptoms (p=.020).

LCC Use

In bivariate analyses (Supplemental Table 1), LCC use was significantly associated with being non-heterosexual, (p<.001), being Black (p<.001), having parental education of less than a BA, (p<.001), attending a public, HBCU, or technical college or university (p<.001), and higher levels of symptoms of depression (p<.001) and anxiety (p<.001). Multivariable analysis (Table 2) indicated that predictors of LCC use included being male (p=.021), not being heterosexual (p=.017), being Black (p=.001), attending a public (p=.044) versus private school, and higher levels of symptoms of depression (p=.002) and anxiety (p=.027).

Smokeless Tobacco Use

Bivariate analyses (Supplemental Table 1) indicated that smokeless tobacco use was associated with being male (p<.001) and having parental education of a BA or more (p=.002). In multivariable analysis (Table 2), predictors of smokeless tobacco use included being older p=.024), being male (p<.001), having parental education of a BA or more (p=.032), attending a public (p=.032) or a HBCU (p=.017) versus a private school, and higher levels of ADHD symptoms (p=.050).

E-cigarette Use

In bivariate analyses (Supplemental Table 1), e-cigarette use was significantly associated with being male (p=.018) and higher levels of ADHD (p=.005). Multivariable analysis (Table 2) indicated that predictors of e-cigarette use included being male (p=.002).

Hookah Use

Bivariate analyses (Supplemental Table 1) indicated that hookah use was significantly associated with being Hispanic (p=.008), Black, or other race (p<.001), having parental education of less than a BA (p=.010), attending a public or HBCU college or university (p<.001), and higher levels of anxiety symptoms (p=.035). In multivariable analysis (Table 2), predictors of hookah use included being non-Hispanic (p=.021) and attending a public (p=.005) or HBCU (p=.001) versus a private school.

Hooked on Nicotine Checklist Scores

Bivariate analyses (Supplemental Table 1) indicated that higher Hooked on Nicotine Checklist scores were associated with being older (p=.001), lower parental education (p=.008), attending a public or technical college (p=.001), and higher levels of symptoms of ADHD (p=.010), depression (p<.001), and anxiety (p<.001). Multivariable analysis (Table 2) indicated that predictors of higher Hooked on Nicotine Checklist scores included being younger (p=.043), being Black (p=.002) or other (p=.047) compared to White, attending a technical (p=.001) or HBCU college or university (p=.017) versus a private school, and higher levels of anxiety symptoms (p=.026).

DISCUSSION

The results of this study reinforced the literature indicating that alcohol and marijuana use are more strongly associated with ADHD symptomatology (Brook et al., 2012; Hayatbakhsh et al., 2008; Jun et al., 2015), while use of tobacco, specifically cigarettes and LCCs, is more strongly associated with symptoms of depression and anxiety (Brook et al., 2004; Dierker et al., 2015; Johnson et al., 2000; Windle & Windle, 2001). However, hypotheses regarding other ATPs were not supported.

Supporting our hypotheses and prior research (Brook et al., 2012; Hayatbakhsh et al., 2008; Jun et al., 2015), this study found that both alcohol and marijuana use is predicted by ADHD symptoms, but not by symptoms of depression or anxiety. Moreover, previous literature suggests that alcohol and marijuana use have been shown to be predictors and outcomes of these externalizing behaviors (Brook et al., 2012; Hayatbakhsh et al., 2008; Jun et al., 2015), and future research using data from this parent study could further explore bi-directionality.

Also, consistent with our hypotheses and previous literature (Brook et al., 2004; Dierker et al., 2015; Johnson et al., 2000; Leventhal & Zvolensky, 2015; Windle & Windle, 2001), this study found that use of some tobacco products, specifically cigarettes and LCCs, is predicted by symptoms of depression and anxiety. Additionally, greater anxiety symptoms also predicted greater symptoms of nicotine dependence; depressive symptoms were also marginally predictive of greater nicotine dependence. While this relationship between such internalizing behaviors and cigarette smoking has been robustly supported in the literature (Brook et al., 2004; Dierker et al., 2015; Johnson et al., 2000; Leventhal & Zvolensky, 2015; Windle & Windle, 2001), there has been limited research documenting associations between these psychological factors and ATPs. Some prior research has found perceived stress, but not depressive symptoms, to be cross-sectionally associated with LCC use (Sterling, Berg, Thomas, Glantz, & Ahluwalia, 2013).

Hypotheses related to the more novel outcomes – those related to ATPs – were not supported, despite previous literature (Enofe, Berg, & Nehl, 2014) indicating that, controlling for cigarette smoking status, use of ATPs was associated with greater levels

of depressive symptoms. Interestingly, smokeless tobacco use was predicted by higher levels of ADHD symptoms, which contradicts our hypotheses. However, at the bivariate level, none of the psychological symptoms were significantly associated with smokeless tobacco use. Moreover, neither e-cigarette use nor hookah use was predicted by any of the psychological symptoms. However, at the bivariate level, e-cigarettes were significantly associated with ADHD symptoms and hookah use was significantly associated with depressive symptoms. It is important to note the small subsamples who reported use of smokeless tobacco, e-cigarettes, or hookah and that there were marginally significant associations between smokeless tobacco use and higher anxiety, as well as hookah and greater symptoms of anxiety. As such, larger samples of ATP users are needed to further explore these psychological risk factors. Additionally, the bivariate associations show that due to the large number of variables included in the multivariate analyses, some variables that were associated at the bivariate level may not have been significant predictors in the regression models, and some variables that were not significantly associated at the bivariate level may have become significant predictors when other variables were included.

Implications

Results of this study have implications for research and clinical practice. In regards to future research, this study furthers the research on tobacco use in relation to internalizing behaviors and the utility of the Transdiagnostic Emotion Vulnerability Framework by expanding it to ATPs, showing the applicability to LCCs. More research is needed regarding the connection between internalizing behaviors and ATPs. In practice, this study has the potential to frame preventative substance use programs

through targeting specific groups with high psychological risk factors specific to different substance use behaviors.

Limitations

There are limitations to the current study. This study included Georgia college students aged 18-25 with complete data for these analyses, which limits the generalizability. There were small sample sizes for some of the subgroups (e.g., ATP users, certain racial/ethnic groups). In addition, this study did not include other potential factors that might predict substance use. Lastly, data was self-reported and thus subject to social desirability and recall bias.

Conclusions

Results indicated that externalizing behaviors, specifically ADHD symptoms, were predictive of alcohol and marijuana use, and that internalizing behaviors, specifically symptoms of depression and anxiety, were predictive of cigarette and LCC use in college students. However, smokeless tobacco, e-cigarette, and hookah use did not demonstrate expected findings in relation to these psychological factors. Further work is needed to determine additional psychological risk factors and common underlying mechanisms serving as risk factors for the use of the range of substances.

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Table 1. Participant Characteristics, N=2,397

Variable	Total N (%) or M (SD)
Sociodemographics	
Age (SD)	20.49 (1.93)
Gender (%)	
Male	845 (35.3)
Female	1552 (64.7)
Sexual Orientation (%)	
Heterosexual	2179 (91.6)
Other	199 (8.4)
Ethnicity (%)	
Non-Hispanic	2197 (92.2)
Hispanic	187 (7.8)
Race (%)	
White	1549 (65.5)
Black	516 (21.8)
Asian	164 (6.9)
Other	136 (5.8)
Parental Ed (%)	
Less than BA	1076 (45.3)
BA or more	1297 (54.7)
School Type (%)	
Private	1074 (44.7)
Public	675 (28.1)
Tech	398 (16.6)
HBCU	254 (10.6)
Psychological Factors	
ADHD (SD)	1.96 (1.56)
Depression (SD)	6.21 (5.24)
Anxiety (SD)	35.06 (8.27)

Table 2. Multivariable Regression Examining Correlates of Substance Use, N=2,397

Variable	Alcohol Use N=1,658/2,397			Marijuana Use N= 268/2,397			Cigarette Use N=207/2,397			LCC Use N=105/2,397		
	OR	CI	p	OR	CI	p	OR	CI	p	OR	CI	p
Sociodemographics												
Age	1.21	1.15, 1.28	<.001	1.02	0.94, 1.09	.695	1.02	0.94, 1.11	.599	1.03	0.92, 1.16	.622
Gender												
Male	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Female	1.31	1.06, 1.62	.011	1.04	0.76, 1.41	.819	0.51	0.36, 0.72	<.001	0.57	0.35, 0.92	.021
Sexual Orientation												
Heterosexual	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Other	1.35	0.94, 1.94	.104	1.74	1.14, 2.65	.010	1.36	0.83, 2.24	.299	2.02	1.14, 3.60	.017
Ethnicity												
Non-Hispanic	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Hispanic	0.80	0.54, 1.18	.264	0.93	0.53, 1.63	.796	0.67	0.33, 1.35	.259	0.52	0.15, 1.85	.314
Race			<.001			.002			.130			.005
White	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Black	0.59	0.44, 0.79	<.001	1.88	1.25, 2.83	.002	0.62	0.36, 1.07	.087	2.70	1.54, 4.74	.001
Asian	0.48	0.33, 0.69	<.001	0.66	0.33, 1.30	.227	1.29	0.71, 2.34	.402	0.83	0.25, 2.80	.761
Other	1.07	0.68, 1.69	.775	1.903	1.08, 3.35	.025	1.50	0.79, 2.82	.217	0.91	0.26, 3.25	.885
Parental Ed												
Less than BA	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
BA or more	1.24	1.00, 1.52	.048	1.06	0.78, 1.44	.729	0.90	0.63, 1.28	.553	0.75	0.46, 1.22	.249
School Type			<.001			.176			<.001			.180
Private	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Public	0.66	0.52, 0.84	.001	1.00	0.71, 1.40	.976	1.14	0.76, 1.72	.520	1.89	1.02, 3.52	.044
Tech	0.46	0.34, 0.63	<.001	0.63	0.39, 1.01	.057	2.91	1.85, 4.57	<.001	2.02	0.97, 4.21	.060
HBCU	0.82	0.54, 1.26	.369	1.10	0.62, 1.95	.754	0.84	0.33, 2.16	.713	2.03	0.87, 4.73	.100
Psychological Factors												
ADHD	1.07	1.00, 1.14	.042	1.11	1.02, 1.22	.019	1.04	0.94, 1.15	.428	0.98	0.86, 1.13	.815
Depression	1.01	0.99, 1.03	.253	1.02	1.00, 1.05	.111	1.05	1.02, 1.09	.001	1.06	1.02, 1.11	.002
Anxiety	1.00	0.99, 1.01	.966	1.01	0.99, 1.03	.247	1.02	1.00, 1.04	.020	1.03	1.00, 1.06	.027
R^2	.080			.051			.087			.120		

Table 2 (Continued). Multivariable Regression Examining Correlates of Substance Use, N=2,397

Variable	Smokeless Tobacco Use N=53/2,397			E-cigarette Use N=82/2,397			Hookah Use N=106/2,397			HONC Scores N=611/2,397		
	OR	CI	p	OR	CI	p	OR	CI	p	B	CI	p
Sociodemographics												
Age	0.83	0.70, 0.98	.024	0.96	0.85, 1.09	.527	1.04	0.93, 1.17	.523	0.13	0.00, 0.27	.043
Gender												
Male	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Female	0.03	0.01, 0.10	<.001	0.44	0.27, 0.75	.002	0.68	0.42, 1.10	.115	-0.26	-0.77, 0.25	.320
Sexual Orientation												
Hetero	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Other	0.19	0.03, 1.45	.110	1.58	0.75, 3.32	.228	1.34	0.70, 2.57	.384	0.10	-0.62, 0.81	.786
Ethnicity												
Non-Hispanic	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Hispanic	0.22	0.03, 1.78	.157	1.70	0.75, 3.88	.206	2.36	1.14, 4.90	.021	-0.27	-1.07, 0.54	.514
Race			.310			.870			.331			
White	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Black	0.43	0.12, 1.35	.194	0.71	0.30, 1.67	.433	1.75	0.92, 3.33	.090	-1.155	-1.88, -0.43	.002
Asian	0.34	0.08, 1.49	.153	1.07	0.40, 2.83	.895	1.09	0.38, 3.18	.870	-0.12	-1.13, 0.90	.825
Other	1.14	0.25, 5.24	.864	1.10	0.42, 2.92	.845	1.55	0.66, 3.65	.318	-0.95	-1.89, -0.01	.047
Parental Ed												
Less than BA	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
BA or more	2.21	1.07, 4.57	.032	0.83	0.49, 1.43	.509	0.85	0.53, 1.35	.484	-0.27	-0.78, 0.25	.305
School Type			.037			.379			.001			
Private	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Public	2.04	1.06, 3.93	.032	1.32	0.73, 2.38	.363	2.27	1.30, 4.01	.005	0.52	-0.03, 1.07	.066
Tech	2.63	0.87, 7.93	.086	1.84	0.87, 3.88	.110	0.88	0.37, 2.13	.782	1.32	0.57, 2.07	.001
HBCU	8.25	1.46, 46.50	.017	0.91	0.21, 3.86	.894	4.02	1.73, 9.34	.001	1.24	0.22, 2.25	.017
Psychological Factors												
ADHD	0.82	0.66, 1.00	.050	1.16	0.99, 1.35	.066	1.05	0.91, 1.20	.525	0.12	-0.02, 0.27	.102
Depression	0.95	0.92, 1.05	.630	0.97	0.92, 1.03	.349	1.00	0.96, 1.05	.894	0.04	0.00, 0.09	.067
Anxiety	1.04	1.00, 1.08	.051	1.02	0.99, 1.05	.218	1.02	1.00, 1.05	.076	0.03	0.00, 0.06	.026
R^2	.243			.048			.090			.079		

Supplemental Table 1. Descriptive Statistics and Bivariate Analyses Examining Correlates of Substance Use, N=2,397

	Total	Alcohol Use			Marijuana Use			Cigarette Use			LCC Use		
		No	Yes		No	Yes		No	Yes		No	Yes	
	N=2,397	N=739	N=1,658		N=2,129	N=268		N=2,190	N=207		N=2,292	N=105	
Variable	N (%) or M (SD)	N (%) or M (SD)	N (%) or M (SD)	p	N (%) or M (SD)	N (%) or M (SD)	p	N (%) or M (SD)	N (%) or M (SD)	p	N (%) or M (SD)	N (%) or M (SD)	p
Sociodemographics													
Age	20.49 (1.93)	20.08 (2.00)	20.67 (1.88)	<.001	20.51 (1.93)	20.44 (1.93)	.569	20.47 (1.93)	20.64 (1.93)	.233	20.48 (1.94)	20.57 (1.77)	.66
Gender (%)				.288			.468			.001			.83
Male	845 (35.3)	272 (36.8)	573 (34.6)		723 (35.5)	89 (33.2)		751 (34.3)	94 (45.4)		807 (35.2)	38 (36.2)	
Female	1552 (64.7)	467 (63.2)	1085 (65.4)		1316 (64.5)	179 (66.8)		1439 (65.7)	113 (54.6)		1485 (64.8)	67 (63.8)	
Sex. Orientation (%)				.141			<.001			.010			<.0
Heterosexual	2179 (91.6)	679 (92.9)	1500 (91.1)		1878 (92.6)	228 (85.7)		2000 (92.1)	179 (86.9)		2096 (92.2)	83 (79.8)	
Other	199 (8.4)	52 (7.1)	147 (8.9)		149 (7.4)	38 (14.3)		172 (7.9)	27 (13.1)		178 (7.8)	21 (20.2)	
Ethnicity (%)				.572			.485			.545			.05
Non-Hispanic	2197 (92.2)	673 (91.7)	1524 (92.4)		1870 (92.2)	242 (91.0%)		2004 (92.1)	193 (93.2)		2096 (91.9)	101 (97.1)	
Hispanic	187 (7.8)	61 (8.3)	126 (7.6)		158 (7.8)	24 (9.0)		173 (7.9)	14 (6.8)		184 (8.1)	3 (2.9)	
Race (%)				<.001			<.001			.011			<.0
White	1549 (65.5)	423 (58.0)	1126 (68.8)		1364 (67.7)	151 (58.1)		1405 (65.0)	144 (70.9)		1501 (66.4)	48 (45.3)	
Black	516 (21.8)	206 (28.3)	310 (18.9)		396 (19.6)	77 (29.6)		489 (22.6)	27 (13.3)		465 (20.6)	51 (48.1)	
Asian	164 (6.9)	65 (8.9)	99 (6.1)		146 (7.2)	12 (4.6)		14 (6.9)	15 (7.4)		161 (7.1)	3 (2.8)	
Other	136 (5.8)	35 (4.8)	101 (6.2)		110 (5.5)	20 (7.7)		119 (5.5)	17 (8.4)		132 (5.8)	4 (3.8)	
Parental Ed (%)				<.001			.597			.208			<.0
Less than BA	1076 (45.3)	379 (52.1)	697 (42.4)		915 (45.3)	125 (47.0)		974 (44.9)	102 (49.5)		1010 (44.5)	66 (64.1)	
BA or more (%)	1297 (54.7)	349 (47.9)	948 (57.6)		1106 (54.7)	141 (53.0)		1193 (55.1)	104 (50.5)		1260 (55.5)	37 (35.9)	
School Type (%)				<.001			.010			<.001			<.0
Private	1074 (44.7)	265 (35.8)	809 (48.7)		934 (45.7)	117 (43.7)		995 (45.4)	79 (38.0)		1052 (45.8)	22 (20.8)	
Public	675 (28.1)	228 (30.8)	447 (26.9)		568 (27.8)	81 (30.2)		616 (28.1)	59 (28.4)		639 (27.8)	36 (34.0)	
Tech	398 (16.6)	156 (21.1)	242 (14.6)		356 (17.4)	32 (11.9)		337 (15.4)	61 (29.3)		375 (16.3)	23 (21.7)	
HBCU	254 (10.6)	91 (12.3)	163 (9.8)		185 (9.1)	38 (14.2)		245 (11.2)	9 (4.3)		229 (10.0)	25 (23.6)	
Psychological Factors													
ADHD (SD)	1.96 (1.56)	1.85 (1.61)	2.01 (1.59)	.021	1.92 (1.57)	2.32 (1.70)	<.001	1.93 (1.59)	2.28 (1.68)	.003	1.95 (1.60)	2.18 (1.52)	.15
Depression (SD)	6.21 (5.24)	6.09 (5.54)	6.26 (5.10)	.453	5.98 (4.98)	7.39 (6.18)	<.001	6.03 (5.07)	8.12 (6.51)	<.001	6.11 (5.81)	8.49 (5.98)	<.0
Anxiety (SD)	35.06 (8.27)	35.13 (8.23)	35.03 (8.28)	.797	34.76 (8.09)	26.22 (9.05)	.007	34.81 (8.19)	37.75 (8.67)	<.001	34.92 (8.24)	38.24 (8.26)	<.0

Supplemental Table 1 (Continued). Descriptive Statistics and Bivariate Analyses Examining Correlates of Substance Use, N=2,397

Variable	Total N=2,397 N (%) or M (SD)	Smokeless Tobacco Use No N=2,344 N (%) or M (SD)	Yes N=53 N (%) or M (SD)	p	E-cigarette Use No N=2,315 N (%) or M (SD)	Yes N=82 N (%) or M (SD)	p	Hookah Use No N=2,291 N (%) or M (SD)	Yes N=106 N (%) or M (SD)	p	HONC Scores, N=611 M (SD) or r	p
Sociodemographics												
Age (SD)	20.49 (1.93)	20.50 (1.94)	19.98 (1.42)	.054	20.49 (1.94)	20.29 (1.68)	.354	20.48 (1.94)	20.56 (1.72)	.702	.13	.001
Gender (%)				<.001			.018			.779		.686
Male	845 (35.3)	796 (34.0)	49 (92.5)		806 (34.8)	39 (47.6)		807 (35.2)	38 (36.5)		1.39 (2.79)	
Female	1552 (64.7)	1548 (66.0)	4 (7.5)		1509 (65.2)	43 (52.4)		1486 (64.8)	66 (63.5)		1.48 (2.89)	
Sexual Orientation (%)				.090			.203			.120		.083
Heterosexual	2179 (91.6)	2128 (91.5)	51 (98.1)		2107 (91.8)	72 (87.8)		2088 (91.8)	91 (87.5)		1.37 (2.75)	
Other	199 (8.4)	198 (8.5)	1 (1.9)		189 (8.2)	10 (12.2)		186 (8.2)	13 (12.5)		1.99 (3.43)	
Ethnicity (%)				.103			.125			.008		.144
Non-Hispanic	2197 (92.2)	2145 (92.0)	52 (98.1)		2126 (92.3)	71 (87.7)		2110 (92.5)	87 (85.3)		1.50 (2.88)	
Hispanic	187 (7.8)	186 (8.0)	1 (1.9)		177 (7.7)	10 (12.3)		172 (7.5)	15 (14.7)		0.91 (2.40)	
Race (%)				.085			.141			<.001		.104
White	1549 (65.5)	1506 (65.1)	43 (81.1)		1492 (65.3)	57 (70.4)		1505 (66.5)	44 (43.6)		1.65 (3.05)	
Black	516 (21.8)	511 (22.1)	5 (9.4)		505 (22.1)	11 (13.6)		473 (20.9)	43 (42.6)		1.16 (2.45)	
Asian	164 (6.9)	162 (7.0)	2 (3.8)		159 (7.0)	5 (6.2)		160 (7.1)	4 (4.0)		1.19 (2.65)	
Other	136 (5.8)	133 (5.8)	3 (5.7)		128 (5.6)	8 (9.9)		126 (5.6)	10 (9.9)		0.76 (1.97)	
Parental Ed (%)				.002			.951			.010		.008
Less than BA	1076 (45.3)	1063 (45.8)	13 (24.5)		1039 (45.3)	37 (45.7)		1016 (44.8)	60 (57.7)		1.77 (3.18)	
BA or more	1297 (54.7)	1257 (54.2)	40 (75.5)		1253 (54.7)	44 (54.3)		1253 (55.2)	44 (42.3)		1.16 (2.48)	
School Type (%)				.057			.226			<.001		<.001
Private	1074 (44.7)	1052 (44.8)	22 (41.5%)		1040 (44.8%)	34 (41.5%)		1049 (45.7%)	25 (24.0)		0.90 (2.20)	
Public	675 (28.1)	652 (27.8)	23 (43.4%)		647 (27.9%)	28 (34.1%)		634 (27.6%)	41 (39.4)		1.53 (2.94)	
Tech	398 (16.6)	393 (16.7)	5 (9.4%)		382 (16.5%)	16 (19.5%)		389 (16.9%)	9 (8.7)		2.53 (3.58)	
HBCU	254 (10.6)	251 (10.7)	3 (5.7%)		250 (10.8%)	4 (4.9%)		225 (9.8%)	29 (27.9)		1.34 (2.75)	
Psychological Factors												
ADHD (SD)	1.96 (1.56)	1.97 (1.60)	1.69 (1.55)	.217	1.95 (1.58)	2.46 (1.86)	.005	1.95 (1.59)	2.17 (1.66)	.187	.11	.010
Depression (SD)	6.21 (5.24)	6.24 (5.25)	5.0 (4.61)	.111	6.19 (5.22)	6.66 (5.64)	.431	34.99 (8.21)	36.80 (9.25)	.035	.16	<.001
Anxiety (SD)	35.06 (8.27)	35.06 (8.29)	35.29 (7.38)	.841	35.01 (8.26)	36.47 (8.28)	.134	6.18 (5.22)	6.92 (5.57)	.156	.17	<.001