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## Psychological Risk Factors for Alcohol, Cannabis, and Various Tobacco Use Among Young Adults: A Longitudinal Analysis

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### Abstract

**Background**—Alcohol, cannabis, and tobacco use are prevalent in young adults and may be differentially related to psychological symptoms characterized as externalizing or internalizing.

**Objectives**—This study examined the use of alcohol, cannabis, and various tobacco products in relation to externalizing (ADHD) versus internalizing factors (depression, anxiety), hypothesizing alcohol and cannabis use are associated with externalizing factors whereas tobacco use is related to internalizing factors.

**Methods**—Data from a two-year longitudinal study of 2,397 US college students (aged 18–25) launched in 2014 were analyzed. Adult ADHD Self-Report Scale, Patient Health Questionnaire – 9 item (assessing depressive symptoms), and the Zung Self-Rating Anxiety Scale scores were examined in relation to subsequent past 30-day use of alcohol, cannabis, and tobacco products (cigarettes, little cigars/cigarillos, smokeless tobacco, e-cigarettes, hookah), as well as nicotine dependence per the Hooked on Nicotine Checklist.

**Results**—Participants were 20.49 (SD=1.93) years old, 64.7% female, and 65.5% White. In multivariable analyses, greater ADHD symptoms predicted alcohol and cannabis use ( $p=.042$  and  $p=.019$ , respectively). Cigarette and little cigar/cigarillo use were predicted by greater depressive ( $p=.001$  and  $p=.002$ , respectively) and anxiety symptoms ( $p=.020$  and  $p=.027$ , respectively). Nicotine dependence was correlated with greater anxiety symptoms ( $p=.026$ ). Counter to hypotheses, smokeless tobacco use was predicted by greater ADHD symptoms ( $p=.050$ ); neither e-cigarette nor hookah use were predicted by these psychological symptoms.

**Conclusions/Importance**—Research examining risk factors for tobacco use must distinguish among the various tobacco products. Moreover, interventions may need to differentially target use of distinct substances, including among the range of tobacco products.

### Keywords

Substance use; Young adults; Risk factors; Tobacco use; Cannabis use; Alcohol use

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### DISCLOSURE OF INTERESTS

The authors declare no conflicts of interest.

## INTRODUCTION

Young adults are at the greatest risk for using various substances (Substance Abuse and Mental Health Services Administration [SAMHSA], 2016), and the use of any one substance is associated with use of other substances (SAMHSA, 2016). Three most commonly used substances among US young adults are alcohol, cannabis, and tobacco (SAMHSA, 2016). Past-month use of alcohol, cannabis, and tobacco is 58.3%, 19.8%, and 26.7%, respectively (SAMHSA, 2016).

In relation to latter, 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, smokeless tobacco, e-cigarettes, hookah) (Wang et al., 2018). The 2017 National Health Interview Survey indicated that particularly high rates of alternative tobacco use among young adults (those 18 to 24), with 10.4% recently using cigarettes, 4.3% cigar products, 2.9% smokeless tobacco, 5.2% e-cigarettes, and 2.5% hookah (Wang et al., 2018). These rates are continuing to increase (Wang et al., 2018), largely due to beliefs that these products have lower health risks (Berg et al., 2015; Etter, 2010), use as an alternative to cessation (Berg et al., 2014; Gartner, Hall, Chapman, & Freeman, 2007), and potential appeal to youth (Berg, Haardörfer, Wagener, Windle, & Kegler, 2018; Getachew et al., 2018; McMillen, Maduka, & Winickoff, 2012), among other concerns.

Substance use often co-occurs with other psychological symptoms, often characterized as externalizing or internalizing symptoms or behaviors (Adler, 2015; American Psychiatric Association [APA], 2013; Chan, Dennis, & Funk, 2008; Colder et al., 2013; Grant et al., 2004a). Externalizing behaviors or symptoms represent those impulsive in nature, such as those characteristic of attention deficit disorder – previously termed attention deficit hyperactivity disorder (ADHD) – which include difficulty focusing, staying organized, thinking before acting, or a range of related symptoms (APA, 2013). Internalizing symptoms include those associated with depression (i.e., characterized by feelings of sadness, little interest or pleasure in doing things, and/or a range of other symptoms) or anxiety (i.e., characterized by feelings of tension, worried thoughts, and/or physiological symptoms) (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). Additionally, research has found that having a diagnosis of ADHD was related to later substance use as well as abuse and/or dependence (Lee, Humphreys, Flory, Liu, & Glass, 2011; Wilens et al., 2011). Moreover, research shows a bi-directional relationship between psychological risk factors and substance use (Johnson et al., 2000; Jun, Sacco, Bright, & Camlin, 2015; Windle & Windle, 2001). 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 cannabis use has been found to be associated with both externalizing and internalizing behaviors, research regarding the use of these two substances has shown more robust linkages to externalizing behaviors, particularly ADHD symptoms and/or diagnoses (Baker, Prevatt, & Proctor, 2012; Brook, Lee, Brown, & Finch, 2012; Charach, Yeung, Climans, & Lillie, 2011; Hayatbakhsh et al., 2008; Jun et al., 2015). For example, one longitudinal study found that externalizing behaviors during childhood were predictive of alcohol use, heavy drinking, and problematic drinking in young adulthood (Englund, Egeland, Oliva, & Collins, 2008). Another study found that trajectories of worsening inattention symptoms and delinquency (and less apparent improvement in hyperactivity–impulsivity) were associated with higher rates of early adult binge drinking and cannabis use (Howard et al., 2015). These are just a few specific examples of the broader literature supporting the link between ADHD symptoms and use of alcohol and cannabis.

Robust associations have been shown between tobacco use across products and psychological distress (Wang et al., 2018). However, research has more robustly established associations with internalizing symptoms, particularly those characteristic of depression (Brook, Schuster, & Zhang, 2004; Dierker et al., 2015; Windle & Windle, 2001) and anxiety (Johnson et al., 2000; Leventhal & Zvolensky, 2015). Moreover, these associations 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). However, limited research has examined how these psychological symptoms, or their qualification as externalizing or internalizing behaviors, may be distinctly associated with use of ATPs (Enofe, Berg, & Nehl, 2014). For example, some research has documented associations between little cigars/ cigarillos and depressive symptoms (Sterling, Berg, Thomas, Glantz, & Ahluwalia, 2013), as well as hookah use and depression and anxiety (Goodwin et al., 2014).

In addition, sociodemographic factors such as age, sex, sexual orientation, race/ethnicity, and socioeconomic status, as well as contextual factors (e.g., school setting) have been shown to be associated with both substance use (Berg et al., 2011; Brook, Zhang, & Brook, 2011; Harris, Gordon-Larsen, Chantala, & Udry, 2006; Sanem, Berg, An, Kirch, & Lust, 2009; Wang et al., 2018; Wu, Zhu, & Swartz, 2016) and psychological risk factors (Baker et al., 2012; Harris et al., 2006; Reeves et al., 2011). Thus, examining these factors in the context of the association between psychological risk factors and substance use is critical.

Informed by the aforementioned literature, this study aimed to elaborate on the existing literature regarding psychological risk factors – characterized as externalizing or internalizing symptoms – related to use of distinct substances, including the various ATPs, among young adults. Specifically, we examined symptoms of ADHD, depression, and anxiety as predictors of alcohol, cannabis, and various tobacco product use, as well as nicotine dependence, in a sample of young adult college students. We hypothesized that greater symptoms of ADHD predicts subsequent alcohol and cannabis use and that greater depressive and anxiety symptoms predict subsequent tobacco use and higher nicotine dependence.

## 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 baseline sample size goal within each school (which was determined for the parent study examining subgroup differences in tobacco use over the two-year period). Our total response rate of 22.9% (N=3,574/15,607), 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 of the N=3,418 [or 70.1%]). Those not included in these analyses are those who did not participate in data collection at Waves 2, 5, or 6, vast majority of which represent those who did not participate in Wave 6 data collection. The participants in this sample were largely representative of the baseline sample (Berg, Haardorfer, et al., 2016), except 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 little cigar/cigarillo, e-cigarette, 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 range from (0) never to (4) very often. The total score is computed (range: 0–24); higher scores indicate greater levels of ADHD symptomatology. Cronbach’s alpha for this scale in this study 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 at all to (3) nearly every day. The total score was computed (range: 0–27). Higher scores indicate greater levels of depressive symptomatology. Scores of 0 to 4 indicate no or minimal symptomatology, 5 to 9 mild, 10 to 14 moderate, 15 to 19 moderately severe, and 20 to 27 severe. Cronbach’s alpha for the PHQ-9 in the current study 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 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 levels of anxiety symptomatology. Cronbach’s alpha for this scale in the current study 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 (cannabis)? cigarettes? little cigars or cigarillos? smokeless tobacco? e-cigarettes? Hookah/waterpipe?” Answer options for each question were 0 to 30 and dichotomized as no 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. 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

First, descriptive statistics were conducted. Second, bivariate associations were conducted for each outcome (i.e., use of alcohol, cannabis, and each tobacco product, respectively; symptoms of nicotine addiction) and each predictor variable (i.e., sociodemographics; ADHD, depressive, and anxiety symptomatology). Lastly, in conducting multivariable analyses, binary logistic regressions were used 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 included in these analyses, 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% cannabis; 8.6% cigarettes; 4.4% little cigars/cigarillos; 2.2% smokeless tobacco; 3.4% e-cigarettes; and 4.4% hookah.

### Bivariate Results

In bivariate analyses (Supplemental Table 1), alcohol use was significantly associated with higher levels of ADHD symptoms ( $p=.021$ ). Cannabis use was significantly associated with lower levels of depressive ( $p<.001$ ) and anxiety symptoms ( $p=.007$ ), as well as higher levels of ADHD symptoms ( $p<.001$ ). Cigarette use was significantly associated with higher levels of symptoms of ADHD ( $p=.003$ ), depression ( $p<.001$ ), and anxiety ( $p<.001$ ). Little cigar/cigarillo use was significantly associated with higher levels of symptoms of depression ( $p<.001$ ) and anxiety ( $p<.001$ ). Smokeless tobacco use was not associated with any of the three psychological factors. E-cigarette use was significantly associated with higher levels of ADHD symptoms ( $p=.005$ ). Hookah use was significantly associated with higher levels of anxiety symptoms ( $p=.035$ ). Hooked on Nicotine Checklist scores among past-four month tobacco users were associated with higher levels of symptoms of ADHD ( $p=.010$ ), depression ( $p<.001$ ), and anxiety ( $p<.001$ ). Bivariate findings regarding correlates of substance use outcomes are also displayed in Supplemental Table 1.

### Multivariate Results

In multivariable analyses (Table 2), predictors of alcohol use included higher levels of ADHD symptoms (OR=1.07,  $p=.042$ ). Similarly, cannabis use was predicted by higher levels of ADHD symptoms (OR=1.11,  $p=.019$ ). Predictors of cigarette use included higher levels of depressive (OR=1.05,  $p=.001$ ) and anxiety symptoms (OR=1.02,  $p=.020$ ). Little cigar/cigarillo use was predicted by higher levels of symptoms of depression (OR=1.06,  $p=.002$ ) and anxiety (OR=1.03,  $p=.027$ ). Predictors of smokeless tobacco use included higher levels of ADHD symptoms (OR=0.82,  $p=.050$ ). Neither e-cigarette nor hookah use were predicted by any of the psychological factors. Predictors of higher Hooked on Nicotine



Checklist scores among past-four month tobacco users included higher levels of anxiety symptoms ( $B=0.02$ ,  $p=.026$ ).

Regarding sociodemographic factors, predictors of alcohol use included being older ( $p<.001$ ), being female ( $p=.011$ ), not being Black ( $p<.001$ ) and not being Asian compared to being White ( $p<.001$ ), and not attending a public ( $p<.001$ ) or a technical school ( $p=.001$ ) compared to a private school. Predictors of cannabis use included not being heterosexual ( $p=.010$ ) and being Black ( $p=.002$ ) or other race ( $p=.025$ ) versus being White. Predictors of cigarette use included being male ( $p<.001$ ) and attending a technical school ( $p<.001$ ) versus a private school. Predictors of little cigar/cigarillo use included being male ( $p=.021$ ), not being heterosexual ( $p=.017$ ), being Black ( $p=.001$ ), and attending a public ( $p=.044$ ) versus private school. Predictors of smokeless tobacco use included being older ( $p=.024$ ), being male ( $p<.001$ ), having parental education of a BA or more ( $p=.032$ ), and attending a public ( $p=.032$ ) or a HBCU ( $p=.017$ ) versus a private school. Predictors of e-cigarette use included being male ( $p=.002$ ). Predictors of hookah use included being Hispanic ( $p=.021$ ) and attending a public ( $p=.005$ ) or HBCU ( $p=.001$ ) versus a private school. Predictors of higher Hooked on Nicotine Checklist scores among past-four month tobacco users included being older ( $p=.043$ ), being White compared to being Black ( $p=.002$ ) or other ( $p=.047$ ), and attending a technical ( $p=.001$ ) or HBCU college or university ( $p=.017$ ) versus a private school.

## DISCUSSION

The results of this study reinforced the extant literature indicating that alcohol and cannabis use are strongly associated with ADHD symptomatology (i.e., externalizing symptoms) (Brook et al., 2012; Hayatbakhsh et al., 2008; Jun et al., 2015), while use of tobacco, specifically cigarettes and little cigars/cigarillos, is more strongly associated with symptoms of depression and anxiety (i.e., internalizing symptoms) (Brook et al., 2004; Dierker et al., 2015; Johnson et al., 2000; Windle & Windle, 2001). However, hypotheses that ATP use would be associated with symptoms of depression and anxiety, but not ADHD symptoms, were not supported. The possible reasons for these unanticipated findings may be related to different reasons for using the various ATPs, as indicated in prior research (Wong, Haardörfer, Windle, & Berg, 2017), or due to the small number of young adults using some of these ATPs in this sample, among other possibilities.

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 cannabis use were predicted by ADHD symptoms, but not by symptoms of depression or anxiety. Moreover, previous literature suggests that alcohol and cannabis use have been shown to be predictors and outcomes of these externalizing symptoms (Brook et al., 2012; Hayatbakhsh et al., 2008; Jun et al., 2015), and future research using data from this parent study could further explore bidirectionality.

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 little cigars/

cigarillos, was 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.

Hypotheses related to the more novel outcomes – those related to ATPs – were largely not supported, despite previous literature (Enofe et al., 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. Moreover, neither e-cigarette use nor hookah use was predicted by any of the psychological symptoms. As previously noted, this may be a result of the fact that our sample included small proportions who reported use of smokeless tobacco, e-cigarettes, or hookah; indeed, 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.

An important consideration in interpreting these results is polysubstance use. Previously published results from these data indicated that differing profiles of substance use behaviors were unrelated to depressive symptoms (Haardörfer et al., 2016); however, these analyses did not include ADHD or anxiety symptoms. These results indicated that social influences were critical factors influencing substance use profiles. Thus, the current results could be further elaborated upon by examining substance use profiles exclusively in relation to psychological symptoms, as well as how such symptoms interact with social influences regarding substance use.

In regards to sociodemographic correlates of alcohol and cannabis use, greater likelihood of alcohol use was associated with older age, potentially related to increased contexts in which young adults have access to alcohol as they reach the legal age of alcohol consumption. Being White was also correlated with greater odds of alcohol use, which coincides with prior research (Derefinko et al., 2016; Park, McCoy, Erasquin, & Bartlett, 2018). Interestingly, two factors – being female and attending a private (versus other type of) college/university – were also associated with greater odds of alcohol use. This may be related to accounting for psychological risk factors in this study. Being a sexual minority and racial minority – specifically Black or “other” – was associated with greater odds of cannabis use, which has been shown in prior research (Chen & Jacobson, 2012; Derefinko et al., 2016; Goldbach, Tanner-Smith, Bagwell, & Dunlap, 2014; Park et al., 2018).

Regarding sociodemographic associations with tobacco use behaviors, age was positively related to greater likelihood of smokeless tobacco use, as well as with levels of nicotine dependence among recent users, which may potentially result from chronic or increasing use of any particular tobacco product over time. Whites also showed higher levels of nicotine dependence symptoms. In terms of sex, as in prior research (American College Health Association [ACHA], 2016; Berg, Haardörfer, et al., 2016; Enofe et al., 2014; SAMHSA, 2016; Wang et al., 2018), this study documented higher prevalence of tobacco use behavior across most tobacco products among men versus women. Sexual minorities were more likely to use little cigars/cigarillos (Blosnich, Lee, & Horn, 2013; Goldbach et al., 2014; King,



Dube, & Tynan, 2013) In terms of racial/ethnic groups, consistent with prior research (ACHA, 2016; SAMHSA, 2016; Wang et al., 2018), Whites demonstrated higher use rates of cigarettes relative to other racial/ethnic groups, while Blacks demonstrated higher likelihood of using little cigars/cigarillos (Haardörfer et al., 2016; Pacek, Malcolm, & Martins, 2012; Sterling et al., 2013; Wang et al., 2018; Wu et al., 2016). Hispanics versus non-Hispanics showed higher rates of hookah use; other literature has showed higher prevalence of hookah use among Whites, Asians, and Hispanics (Amrock, Gordon, Zelikoff, & Weitzman, 2014; Jarrett, Blossnich, Tworek, & Horn, 2012; McMillen et al., 2012). Interestingly, higher parental education predicted smokeless tobacco use, which contradicts other data (Wang et al., 2018). In terms of school setting and tobacco use, technical college students demonstrated higher likelihood of cigarette use and higher nicotine dependence symptoms (among tobacco users), which coincides with prior research (Berg et al., 2011; Berg, Haardörfer, et al., 2016; Sanem et al., 2009). However, distinct patterns or use rates across the other tobacco products in relation to college setting have been less extensively explored and/or documented. Given findings regarding differences across school settings, the contexts (e.g., policies, social norms, marketing, proximal access) that influence these tobacco use behaviors on college campuses warrant further consideration.

### Implications

Results of this study have implications for research and clinical practice. In regards to future research, this study furthers the research on substance use in relation to externalizing and internalizing behaviors, and expands what is known about the connection between internalizing behaviors and tobacco use to apply to use of little cigars/cigarillos. More research is needed regarding the connection between externalizing and internalizing behaviors and ATPs, as well as patterns of polysubstance use. 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), limiting the extent to which analyses were powered to detect associations. 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 cannabis use, and that internalizing behaviors, specifically symptoms of depression and anxiety, were predictive of cigarette and little cigar/cigarillo 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.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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We would like to thank [omitted for blind review].

### HUMAN SUBJECTS STATEMENT

This study was approved by the Institutional Review Boards of [omitted for blind review].

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**Table 1.**

## Participant Characteristics, N=2,397

Variable	Total N (%) or M (SD)
<i>Sociodemographics</i>	
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)
<i>Psychological Factors</i>	
ADHD (SD)	1.96 (1.56)
Depression (SD)	6.21 (5.24)
Anxiety (SD)	35.06 (8.27)

Note: PHQ-9 scores indicated that 56.9% reported no/minimal symptoms, 24.1% mild, 10.9% moderate, 5.1% moderately severe, and 3.1% severe.



**Table 2.**

Multivariable Regression Examining Correlates of Substance Use

Variable	Alcohol Use			Cannabis Use			Cigarette Use			Little Cigar/Cigarillo Use		
	OR	CI	P	OR	CI	P	OR	CI	P	OR	CI	P
<i>Sociodemographics</i>												
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
<i>Sexual Orientation</i>												
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
<i>Ethnicity</i>												
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
<i>Race</i>												
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	1.90	1.08, 3.35	.025	1.50	0.79, 2.82	.217	0.91	0.26, 3.25	.885
<i>Parental Ed</i>												
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
<i>School Type</i>												
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
<i>Psychological Factors</i>												
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

Variable	Alcohol Use			Cannabis Use			Cigarette Use			Little Cigar/Cigarillo Use		
	OR	CI	P	OR	CI	P	OR	CI	P	OR	CI	P
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
<b>R<sup>2</sup></b>	.080			.051			.087			.120		
Variable	Smokeless Tobacco Use			E-cigarette Use			Hookah Use			HONC Scores*		
	OR	CI	P	OR	CI	P	OR	CI	P	B	CI	P
<i>Sociodemographics</i>												
Age	0.83	0.70, 0.98	<b>.024</b>	0.96	0.85, 1.09	.527	1.04	0.93, 1.17	.523	0.13	0.00, 0.27	<b>.043</b>
Gender												
Male	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Female	0.03	0.01, 0.10	<b>&lt;.001</b>	0.44	0.27, 0.75	<b>.002</b>	0.68	0.42, 1.10	.115	-0.26	-0.77, 0.25	.320
<i>Sexual Orientation</i>												
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
<i>Ethnicity</i>												
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	<b>.021</b>	-0.27	-1.07, 0.54	.514
<i>Race</i>												
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	-1.16	-1.88, -0.43	<b>.002</b>
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	<b>.047</b>
<i>Parental Ed</i>												
Less than BA	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
BA or more	2.21	1.07, 4.57	<b>.032</b>	0.83	0.49, 1.43	.509	0.85	0.53, 1.35	.484	-0.27	-0.78, 0.25	.305
<i>School Type</i>												
Private	Ref	--	--	Ref	--	--	Ref	--	--	Ref	--	--
Public	2.04	1.06, 3.93	<b>.032</b>	1.32	0.73, 2.38	.363	2.27	1.30, 4.01	<b>.005</b>	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	<b>.001</b>
HBCU	8.25	1.46, 46.50	<b>.017</b>	0.91	0.21, 3.86	.894	4.02	1.73, 9.34	<b>.001</b>	1.24	0.22, 2.25	<b>.017</b>

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Variable	Alcohol Use			Cannabis Use			Cigarette Use			Little Cigar/Cigarillo Use		
	OR	CI	p	OR	CI	p	OR	CI	p	OR	CI	p
<i>Psychological Factors</i>												
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
<b>R<sup>2</sup></b>		.243			.048			.090			.079	

\* Among past-four month tobacco users.