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Heterogeneity of Alcohol, Tobacco, and Other Substance Use Behaviors in U.S. College Students: A Latent Class Analysis

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Abstract

Purpose—To identify subgroups of college students with distinct profiles of traditional and alternative types of tobacco, alcohol, and other substance use and to examine how demographic characteristics and academic and social activities are associated with subgroup membership.

Methods—We used latent class analysis to characterize subgroups of individuals in their fourth-year of college based on their patterns of seven substance use behaviors: extreme heavy episodic drinking (HED), cigarette use, cigar/cigarillo/little cigar use, smokeless tobacco use, hookah use, marijuana use, and non-medical prescription drug use. Demographic characteristics and academic and social activities were then incorporated as predictors of these latent classes.

Results—We identified five classes defined by unique behavior patterns: (1) Non/Low Users, (2) Non-Hookah Tobacco Users, (3) Extreme HED & Marijuana Users, (4) Hookah and Marijuana Users, and (5) Poly-Substance Users. Being male, older, and involved in sports were associated with a greater odds of being in the Poly-Substance User class compared to the Low/No User class, and participating in an honors society and reporting more positive peer relationships were associated with being in the Hookah and Marijuana User class compared to the Low/No User class.

Conclusion—Our findings of unique characteristics in the subgroups identified suggest that college substance users are a heterogeneous population requiring different targeted interventions. Of particular concern are subgroups with high rates of alternative tobacco products, as perceived risks of use may be inaccurate and this is not currently a focus of college substance use prevention interventions.

Keywords

alternative tobacco products; college students; substance use; heavy episodic drinking; cigarette use

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Introduction

The use of alcohol, traditional and alternative tobacco products, marijuana, and non-prescription drugs remains a serious threat for college students. Over one third report heavy episodic drinking (HED) in the past two weeks. More recently, a more risky behavior, extreme HED, has been found to be on the rise on college campuses, leading to an increase in hospitalizations and other negative health outcomes (Hingson & White, 2013). Additionally, non-medical prescription drug use (NMPDU) has been increasing in the last two decades and is particularly prevalent on college campuses (Dupont, 2010; McCabe, West, Teter, & Boyd, 2014). Young adults aged 18 to 24 years in general, and college students in particular, have the highest rates of NMPDU in the entire population. Despite the decreasing prevalence of cigarette use in the U.S., approximately one fifth of college students still report past-month use (14–21.0%; Johnston et al., 2014; Substance Abuse and Mental Health Services Administration, 2013). Cigarette use remains a common method to use tobacco; however, many alternative forms of tobacco use are becoming increasingly popular. In fact, the national Monitoring the Future study documents that more college students now report past-year hookah use (26.1%) than cigarette use (23.2%). Close to one-fifth (19%) of college students also report past year use of small cigars or cigarillos and roughly 1 in 20 college students report use of smokeless tobacco (4.8%; Johnston et al., 2014; SAMSHA, 2013). In light of the changing landscape and rise in extreme HED, NMPDU, and alternative tobacco products among college students, it is vital to understand how these as well as more traditional substance use behaviors cluster together in order to develop the most effective prevention strategies.

Approximately 10% of adults use multiple tobacco products (Lee, Hebert, Nonnemaker, & Kim, 2014) and their use is increasing among young adults (Fix, O'Connor, Vogl, & Smith, 2014). Many studies have shown that those who smoke cigarettes are much more likely to use other tobacco products (e.g., Sutfin et al., 2011) yet up to a quarter of alternative tobacco product users have never smoked a cigarette (Sutfin et al., 2011; Barnett, Forrest, Porter, & Curbow, 2014). Similarly, a subgroup of young adult smokers who had low probabilities of daily cigarette use but used multiple types of alternative tobacco products were identified using latent class analysis (LCA: Barnett et al., 2014) and subgroups of little cigar and hookah users who did not smoke cigarettes have also been identified (Erickson, Lenk, & Forster, 2014). This work, focused on patterns of tobacco use, suggests there may be considerable heterogeneity in young adult tobacco users.

Very little is known, however, about the full landscape of risky substance use among college students, including how more extreme HED intersects with the use of marijuana, NMPDU, and a variety of tobacco products. In general, studies focusing on the relationship between two substances find that people who use one substance have a higher likelihood of using another. For example, cigarette use and alcohol use are closely linked (Piasecki, et al., 2011) as are tobacco and marijuana use (Ramo, Liu, & Prochaska, 2012). College students who use hookah are more likely to use alcohol and marijuana (Brockman, Pumper, Christakis, & Moreno, 2012; Fielder, Carey, & Carey, 2013) as well as cocaine and other stimulants (Goodwin, et al., 2014) than non-users. These variable-centered studies, however, do not provide key information that a person-centered approach can provide about the intersection

of a whole range of risky substance use behaviors among college students, including extreme HED, traditional and alternative tobacco products, marijuana use, and non-medical prescription drug use.

A person-centered approach, such as LCA, allows for the examination of how these substance use behaviors cluster together among individuals, elucidating a broader understanding of substance use behavior patterns. While an LCA approach has been used previously to examine subgroups of substance use among young adults (Cleveland, Collins, Lanza, Greenberg, & Feinberg, 2010; Lanza, Collins, Lemmon, & Schafer, 2007; Dierker et al., 2007) and adolescents (e.g., Cranford et al., 2013), these studies have not included more contemporary measures of substance use in college populations including extreme HED and hookah use. It is important to understand how the risky behavior of extreme HED fits in with other substance use. And in the present broadening landscape of tobacco products it is vital that that multiple products are considered in understanding substance use among college students. Identifying key patterns of risky substance use during college and the factors that are associated with them can shed light on future directions for tailored intervention programs for this population.

The current study aims to identify distinct profiles of multiple types of tobacco, extreme HED, marijuana use, and NMPDU among college students, and to examine demographic, academic and social activities predictors of these profiles. To accomplish these goals, we apply LCA to a sample of fourth-year undergraduate students and include covariates to determine individual characteristics that are associated with these profiles of substance use. We focus on fourth-year college students here for several reasons. First, alternative tobacco use is a fairly recent and quickly evolving phenomenon; therefore we wanted to use the most recent available data to assess these indicators. Second, less is known about substance use among older college students as much research focuses on the transition from high school to college. However, many students in their fourth year of college are at a crucial point in the life course, preparing to transition adult social roles such as full-time employment.

Methods

Sample

Participants were part of the University Life Study (Patrick & Maggs, 2011), a web-based longitudinal study of undergraduate students at a large public university. Eligible participants were first-year, first-time, full-time students who had graduated from high school the previous spring, were under age 21, were U.S. citizens or permanent residents, and lived within 25 miles of campus. Early in the fall semester, recruitment letters with a pen and \$5 were sent to students selected using stratified random sampling. Students completed a semester survey followed by 14 consecutive daily surveys. Students who completed the semester and daily surveys received up to \$100. The study was approved by the university's institutional review board and protected by a federal Certificate of Confidentiality.

The present study used data from the last follow-up survey in the fall of 2010 when participants were in their seventh semester of college (i.e., fall of their fourth year). Of the

744 students who gave informed consent and completed a baseline survey (66% response rate), 82% ($N=608$) were followed up in the fall of 2010. In the fall of 2010, the mean age of participants was 21.5 years ($SD=0.4$) and 49% of the sample was male.

Measures

Seven substance use measures were included as latent class indicators. *Extreme heavy episodic drinking (extreme HED)* was measured by self-reports of having consumed 8 or more drinks for women and 10 or more drinks for men in a single 24-hour period in the past 12 months. This cutoff, which is twice the traditional 4 (for women) or 5 (for men) drink cutoff for heavy episodic drinking, has been suggested as an appropriate threshold to assess riskier levels of drinking compared to the traditional 4 or 5 drink cutoff that is often used (Patrick, Schulenberg, Martz, Maggs, O'Malley, & Johnston, 2013; White, Kraus, & Swartzwelder, 2006). Cigarette use, cigar/cigarillo/little cigar use (hereafter referred to as *cigar use*), and chew/snuff/dip use (hereafter referred to as *smokeless tobacco*) were all measured by self-report of any use in the past 30 days. Hookah/shisha use (hereafter referred to as *hookah use*) was measured by self-report of any use in the past 12 months. *Marijuana use* and *non-medical prescription drug use* were each measured by self-report of any use in the past 12 months. The implications of the varied reporting time frames are considered in the discussion.

Demographics

Gender and *age* (in years) were measured by self-report and included as covariates.

Social and academic activities

Academic and social activities were also included as covariates. *Current GPA* for the most recently completed semester was assessed by self-report.

Self-reports of involvement in four types of activities in the seventh semester were included (yes/no, coded 1/0): *Honors society* participation; *Academic professional organization* participation; *Sports involvement*, any involvement in intercollegiate or intramural sports; and *Greek involvement*, measured as participation in any sorority or fraternity activities. We included two measures of academic and social time use: *Time spent doing school work* and *Time spent partying*. These were measured using daily reports across a 14-day window. Participants reported time use by 10 categories ranging from up to 30 minutes to 10+ hours; responses were recoded to the midpoint of each category (e.g., 1–2 hours was recoded as 1.5 hours; see Greene & Maggs, 2014) and then an average across the 14 days was computed for each participant. *Peer relationships* were measured using the peer relations subscale of the Offer self-image questionnaire (Offer, Ostrov, & Howard, 1977), a nine-item six-point scale (e.g., “Being together with other people gives me a good feeling,” “I find it extremely hard to make friends,” $\alpha = 0.72$). A mean of the nine items was calculated with a higher mean score indicating better peer relationships.

Analysis

We used LCA to characterize subgroups of individuals based on their patterns across seven substance use behaviors including extreme HED, traditional tobacco use (e.g. cigarette use),

alternative tobacco use (e.g., hookah use), marijuana use, and non-medical prescription drug use. We estimated models ranging from one to six classes and relied on information criteria, where lower values reflect more optimal balance between model fit and parsimony and empirical and theoretical knowledge of substance use, to select the final model (Collins & Lanza, 2010). Demographic characteristics and measures of academic and social activities were then included as predictors of latent class membership. Specifically, multinomial regression with a latent class outcome was used to estimate the association between each covariate and latent class membership. Specifically, an exponentiated multinomial regression coefficient represents the change in odds of belonging to a particular latent class relative to the reference class (in this case, the lowest use class) corresponding to a one-unit change on the covariate. PROC LCA, which relies on maximum likelihood estimation, was used in SAS 9.3 was used for all analyses (Lanza, et al., 2013; PROC LCA & PROC LTA, 2013).

Results

Table 1 presents descriptive statistics for the seven substance use behaviors and the covariates. In students' fourth year, extreme HED was the most frequently reported substance use behavior at 44% in the prior 12 months. Marijuana and hookah use were the next most frequent with 29% and 21% of students reporting them in the past 12 months, respectively. Other forms of tobacco use including cigarettes, cigars, and smokeless tobacco were each used by less than 20% of the sample in the past 30 days. With respect to students' activities, approximately 13% reported involvement in honors societies, 19% in academic professional organizations, 28% sports, and 15% Greek student organizations.

Substance use latent classes

Latent class membership was estimated using seven dichotomous indicators of substance use behavior; model fit information for models with one through six classes appears in Table 2, suggesting that three to five latent classes is optimal. A careful inspection of the class interpretations, along with the fact that the BIC is known to err on the side of identifying too few classes (Dziak, Lanza, & Tan, 2014), led us to select five classes as optimal. The prevalence of the five classes and the probabilities of reporting each substance use behavior given latent class are presented in Table 3 and depicted in Figure 1. The largest class (*Non/Low Users*, 61.8% of the sample) was characterized by low levels of extreme HED (15.0%) and little tobacco, marijuana, or NMPDU. A second class (*Non-Hookah Tobacco Users*, 6.8%) was distinguished by higher probabilities of cigar use (45.5%) as well as somewhat elevated probabilities of smokeless tobacco (29.8%) and cigarette use (28.0%), but virtually no hookah use and very low probabilities of illegal substance use. The third and fourth classes each represented roughly 12–14% of the sample. The *Extreme HED & Marijuana Users* class (12.0%) was characterized by high levels of extreme HED (68.2%) and marijuana use (90.8%). This class also had somewhat elevated probabilities of NMPDU (37.6%) and cigarette use (43.2%), but low probabilities of other tobacco use. The *Hookah & Marijuana Users* (12.9%) were characterized primarily by hookah use (83.4%), with about half reporting marijuana use in the prior 12 months. This class also had somewhat elevated probabilities of cigar use (36.0%), and a similar number had engaged in extreme

HED (36.0%) as in the total sample. The fifth and smallest class, *Poly-Substance Users* (5.6%), was distinct in that each of the seven substances had a high (over 50%) probability of use. The probabilities of use of four of the seven substances, including hookah, were greater than 75% in this class.

Predictors of latent class membership

Table 4 presents LCA multinomial regression analyses to examine predictors of latent class membership with the Non/Low User class specified as the reference. This class was used because it was by far the largest class (61.8%), representing the majority of this sample. Compared to the Non/Low User class, males were more likely to be in the Non-Hookah Tobacco Users and Poly-Substance Users classes and less likely to be in the Extreme HED & Marijuana Users class. Different types of academic and social activities were associated with different substance use classes. Focusing first on social activity predictors, students who spent more time partying were more likely to be in all four substance-using classes as compared to in the Non-Low User class. Sports-involved students were more likely to be in the Non-Hookah Tobacco Users class or the Poly-Substance Users class as compared to the Non/Low User class, while those involved in Greek organizations were more likely to be in the Extreme HED & Marijuana Users class or the Poly-Substance User class. Students who felt better about their peer relationships were more likely to be in the Hookah & Marijuana Users class. Turning to academic predictors, current GPA, time spent doing school work, and involvement in academic/professional organizations were not significantly associated with substance use latent class membership, and surprisingly, those involved in honors societies were more likely to be in the Hookah & Marijuana User class compared to The Non/Low Users class.

Discussion

Although the majority of students were in the Low/No User class, considerable heterogeneity remained in the almost two-fifths of the sample classified by the LCA into four diverse groups of substance users. Corroborating previous research showing a decrease in cigarette use among young adults (particularly college students) and an increase in alternative tobacco products (Johnston et al., 2014), this study suggests that profiles of substance use among college students are substantially characterized by use of alternative tobacco products. Higher-than-average probabilities of alternative tobacco products were evident in three of the classes: the Poly-Substance Users, the Hookah & Marijuana Users, and the Non-Hookah Tobacco Users. Cigarette use, on the other hand, was only prominent in the small Poly-Substance Users class and somewhat evident in the Hookah and Marijuana Users class. Additionally, there were two classes with substantial levels of extreme HED and NMPDU: the Poly-Substance Users and the Extreme HED and Marijuana Users.

This suggests more attention should be paid to the heterogeneity of these substance use behaviors. For example, hookah users were represented in two distinct classes: the Hookah & Marijuana User class and the Poly-Substance Users class. Previous variable-centered research examining substance use correlates of hookah use suggests that hookah users are more likely to use marijuana, cigarettes, alternative tobacco products, and alcohol (Goodwin

et al., 2014; Hampson et al., 2013; Fielder et al., 2013). However, the present study suggests that this may not be true for all hookah users. While the Poly-Substance Users class appears to be at highest risk, there are other subgroups of individuals who are also engaging in dangerous substance use behaviors including extreme levels of HED, hookah, and NMPDU.

There were also many differences in demographic and social predictors by class supporting the idea that although all four groups reported significant substance use behaviors, they are composed of distinct types of college students. Whereas students involved in honors societies were more likely to be in the Hookah & Marijuana Users class than the Non/Low Users class, very different predictors—namely participation in Greek organizations and sports—predicted Poly-Substance Users class membership. This suggests substance use prevention efforts need to focus on more typical places such as Greek and athletic organizations which are known to have participants who engage in greater amounts of substance use (White & Hingson, 2014), but also more unlikely organizations such as honor societies. On the other hand, Poly-Substance Users and Extreme HED and Marijuana Users were more similar to each other, suggesting that similar intervention strategies could be used to reach these subgroups.

This study also suggests that the majority of college students do not fit the traditional profile for which substance use interventions are often tailored. Additionally, the fact that a subgroup of individuals is characterized by using hookah and marijuana but low levels of alternative tobacco products and NMPDU may suggest that these individuals perceive hookah and marijuana use to be more socially acceptable (Eissenberg et al., 2008; Heinz et al., 2013) or to have lower health risks compared to other tobacco products (Heinz et al., 2013; Jawad, McEwen, McNeill, & Shahab, 2013). Further research is needed to understand whether risk perceptions vary within these different subgroups.

Several predictors either were associated with membership in a substance-using group but did not differentiate between these groups, or did not predict group membership at all. The very proximal variable assessing time spent partying was greater for all subgroups compared to the Non/Low User subgroup, consistent with variable-centered research (Barnes, Hoffman, Welte, Farrell, & Dintcheff, 2007). However, this was also one of the strongest predictors of being in any one of the four higher using subgroups suggesting that an important universal substance use prevention strategy may be to engage college students in other positive social activities and alternative activities. Previous research has documented the effectiveness of this strategy in reducing drinking (Fenzel, 2005; Patrick, Maggs, & Osgood, 2010). However, two academic predictors—time spent doing schoolwork and GPA—did not differentiate any of the substance-using classes from the Low/Non-Users class. Students may have sufficient time to engage in some substance use without affecting their academic success (Greene & Maggs, 2014). Measures of frequency or intensity of substance use as well as experienced consequences might be more sensitive indicators of potential impacts on achievement.

Limitations

This study makes a significant contribution to the substance use literature by characterizing profiles of risky substance use behavior among college students; however there are some

limitations. First, a more in-depth measure of substance use frequency or intensity would permit more fine-grained analyses. The present analysis only assessed whether the substance was used or not. Second, newer tobacco products such as e-cigarettes were not assessed; however, currently their prevalence remains fairly low among young adults (Erickson et al., 2014; Sutfin, McCoy, Morrell, Hoepfner, & Wolfson, 2013). Third, we were not able to distinguish between different types of NMPDU such as stimulant or opiate types. However, the prevalence of NMPDs was very low and removing this indicator did not result in substantial changes to the class structures. Although measures were available, other types of illegal substance use (e.g., cocaine, heroin, steroids) were not included in the analyses as the prevalence was very low and their inclusion did not change the results or further distinguish the classes. Third, marijuana, hookah, and non-medical prescription drug use were assessed in the past 12 months while extreme HED, cigarette use, cigar use, and smokeless tobacco in the past 30 days. Ideally, the same time frame would be used across all substances to make comparisons more equivalent. However, those substance use behaviors that were measured in the past 12 months are typically are not engaged in as frequently as those that we measured in the past 30 days. For example, cigarettes are typically smoked multiple times a day or at least multiple times a week. However, hookah may be only smoked on special social occasions (Fielder et al., 2013). By having a broader time period for these less frequent behaviors we were able to capture more individuals who used the substance. Still, findings should be considered in light of this limitation. Finally, this study focused on undergraduate students at a single institution in 2010. Further studies are needed to determine if these subgroups generalize to other young adult populations such as students at other institutions, non-college populations, and different states where legality and availability of specific substances vary.

Future directions

Further research is needed to understand distinct substance use groups. For example, knowledge about whether the substance using subgroups have distinct typical or context-specific motivations for use could be useful for targeting interventions. Further research should also use longitudinal data to examine the temporal ordering of when these substances are initiated, how individuals move in and out of these groups across high school and young adulthood, and whether short- and long-term consequences of substance use might be different by subgroup.

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Figure 1.
Probabilities of substance use behaviors by latent class

Table 1

Sample Characteristics (N=608)

	%
Substance use behaviors	
Extreme heavy episodic drinking	43.67
Cigarette use	15.02
Cigar/cigarillo/little cigar use	15.07
Smokeless tobacco use	5.95
Hookah use	21.80
Marijuana use	29.07
Non-medical prescription drug use	9.47
Demographics	
Male	49.19
Age (mean (SD))	21.48 (0.42)
Academic and social involvement	
Current GPA ^a (mean (SD))	3.20 (0.59)
Honors society involvement	12.66
Academic prof. organization involvement	18.66
Sports involvement	27.78
Greek involvement	14.80
Time spent partying (hours/average day) (mean (SD))	0.50 (0.59)
Time spent doing school work (hours/average day) (mean (SD))	3.03 (1.80)
Peer relationships (range 0–6)	3.45 (0.91)

^a grade point average

Table 2

Model fit information for competing latent class models (N=608)

Number of classes	G ²	df	AIC	BIC	Entropy
1	670.05	120	684.05	714.95	1.00
2	188.80	112	218.80	285.02	0.76
3	128.76	104	174.76	276.31	0.76
4	93.60	96	155.60	292.47	0.77
5*	72.83	88	150.83	323.02	0.81
6	62.93	80	156.93	364.44	0.86

* Selected as final model. Note. df=degrees of freedom; AIC= Akaike Information Criterion; BIC=Bayesian Information Criterion; G²=goodness of fit.

Table 3

Proportion of Substance Use Behaviors by Latent Class (N=608)

Substance Use Behaviors	Overall Sample 100%	Non/Low Users 61.8%, n=376	Non-Hookah Tobacco Users 6.8%, n=42	Extreme HED & Marijuana Users 12.0%, n=73	Hookah & Marijuana Users 13.7%, n=83	Poly-Substance Users 5.6%, n=34
Extreme Heavy Episodic Drinking	0.437	0.150	0.428	0.682	0.360	0.716
Cigarette use	0.150	0.016	0.280	0.432	0.191	0.776
Cigar/cigarillo/little cigar use	0.151	0.009	0.455	0.121	0.360	0.905
Smokeless tobacco use	0.060	0.0001	0.298	0.0004	0.001	0.694
Hookah use	0.218	0.033	0.013	0.290	0.834	0.840
Marijuana use	0.291	0.082	0.098	0.908	0.504	0.994
Non-medical prescription drug use	0.095	0.005	0.001	0.376	0.111	0.555

Table 4

Latent Class Bivariate Regression: Predictors of Latent Class Membership (N=608)

Predictors	Non/Low Use (REF.)	Non-Hookah Tobacco OR (95% CI)	Extreme HED & Marijuana OR (95% CI)	Hookah & Marijuana OR (95% CI)	Poly-substance Use OR (95% CI)	Overall p-value ^a
Demographics						
Male	REF.	7.01 (1.36, 36.03)*	0.40 (0.16, 0.98)*	1.22 (0.58, 2.57)	9.48 (2.44, 36.87)*	<0.01
Age	REF.	4.31 (1.15, 16.09)*	1.75 (0.75, 4.11)	0.82 (0.37, 1.79)	1.67 (0.66, 4.19)	0.10
Academic and Social Involvement						
Current GPA	REF.	1.31 (0.57, 3.04)	1.03 (0.56, 1.91)	0.87 (0.53, 1.42)	0.57 (0.34, 0.97)	0.33
Honors society	REF.	0.01(0.00, >999)	1.66 (0.67, 4.12)	2.62 (1.28, 5.36)*	0.29 (0.04, 2.01)	<0.01
Academic/professional organization	REF.	0.95 (0.31, 2.87)	0.80 (0.33, 1.91)	0.69 (0.30, 1.61)	1.00 (0.39, 2.59)	0.89
Sports	REF.	6.07 (2.10, 17.54)*	1.43 (0.62, 3.30)	1.39 (0.65, 2.98)	3.77 (1.71, 8.32)*	<0.01
Greek	REF.	0.96 (0.23, 4.12)	3.77 (1.64, 8.66)*	1.06 (0.35, 2.19)	5.35 (2.14, 13.39)*	<0.01
Time spent partying	REF.	8.84 (4.50, 17.39)*	11.55 (5.51, 24.20)*	8.13 (3.78, 17.46)*	13.31 (6.11, 28.99)*	<0.01
Time spent doing school work	REF.	0.84 (0.63, 1.13)	0.83 (0.67, 1.03)	1.03 (0.85, 1.25)	0.84 (0.64, 1.09)	0.21
Peer relationships	REF.	1.33 (0.76, 2.32)	1.40 (0.83, 2.38)	2.52 (1.56, 4.06)*	1.28 (0.79, 2.09)	<0.01

* p<0.05,

^a p-value reflects test of overall association between predictor and latent class membership based on likelihood ratio difference test