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Tobacco, Marijuana, and Alcohol Use in University Students: A Cluster Analysis

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Abstract

Objective—Segmentation of populations may facilitate development of targeted substance abuse prevention programs. We aimed to partition a national sample of university students according to profiles based on substance use.

Participants—We used 2008–2009 data from the National College Health Assessment from the American College Health Association. Our sample consisted of 111,245 individuals from 158 institutions.

Method—We partitioned the sample using cluster analysis according to current substance use behaviors. We examined the association of cluster membership with individual and institutional characteristics.

Results—Cluster analysis yielded six distinct clusters. Three individual factors—gender, year in school, and fraternity/sorority membership—were the most strongly associated with cluster membership.

Conclusions—In a large sample of university students, we were able to identify six distinct patterns of substance abuse. It may be valuable to target specific populations of college-aged substance users based on individual factors. However, comprehensive intervention will require a multifaceted approach.

Keywords

University; tobacco; marijuana; alcohol; cluster analysis

INTRODUCTION

Tobacco, alcohol, and marijuana are the substances most abused by university students.^{1–3} They are also the primary sources of morbidity and mortality in this population.^{4–7} Because individuals who use one of these substances often use others, many public health interventions aimed at university students address multiple substances simultaneously.^{8–11} These interventions often target specific types of individuals, such as white male fraternity students, who are at higher risk for substance use in general.^{11–13}

However, it is also the case that many individuals use one of these substances but not the others.^{4, 14–18} For example, over the past decade, tobacco use has differentiated into different forms, each of which draws a distinct set of users. While cigarette use has recently declined,^{19, 20} smoking tobacco with a hookah (waterpipe, narghile, or shisha-pipe) is an emerging trend among college students, and as many as 50% of hookah smokers do not smoke cigarettes.^{21–23} Although users perceive hookah smoking to be safer than cigarette smoking, it is estimated that a single hookah tobacco session delivers 100 times the smoke volume,²⁴ 40 times the tar,^{25, 26} 20 times the carcinogenic polycyclic aromatic hydrocarbons,²⁷ 10 times the carbon monoxide,^{25, 26} and 2 times the nicotine^{25, 26} of a single cigarette. Similarly, cigar and little cigar (cigarillo) use are increasing in this population, and cigar use only partially overlaps with cigarette use.^{28, 29}

Social marketing, a framework for the development of public health interventions, applies the principles of commercial marketing to promote healthier behaviors, such as avoidance of substance abuse. This framework states that, in order for interventions to be maximally effective, it is important to carefully tailor to “target markets” for intervention according to sociodemographic, personal, and environmental characteristics.^{30–33} For example, tobacco industry documents describe the use of segmentation of the US population into specific subgroups for whom different, successful products were developed.^{34–36} In order to optimally develop and target public health related campaigns to reduce substance use, it is similarly important to segment populations by substance use behaviors and then carefully describe the sociodemographic, personal, and environmental characteristics of each “market.” A specific statistical technique called cluster analysis is one method, commonly used by commercial marketers, to reliably divide a large group of observations into subsets according to selected characteristics.^{37–39} Cluster analyses have been used by public health researchers and practitioners to inform interventions related to behaviors such as exercise, diet, and social involvement.^{40–42} However, to our knowledge, these techniques have not been recently used to segment college populations according to current risk behaviors related to substance use.

This study had two primary purposes. First, we aimed to utilize the systematic method of cluster analysis in order to group individuals in a large, national sample of college students according to profiles based on substance use behavior. Second, we aimed to compare the individual and institutional makeup of these groups.

METHODS

Participants and Procedures

Each year, the National College Health Assessment (NCHA) of the American College Health Association (ACHA) assesses a wide variety of content areas, including substance use, in over 100,000 university students.⁴³ The NCHA is considered to be a reliable and valid assessment of college student health perceptions and behaviors, and its data has been examined frequently in peer-reviewed journal articles.^{21, 44, 45}

In 2008, the NCHA became the first large survey to assess hookah tobacco smoking along with cigarette, cigar, marijuana, and alcohol use. Here, we report the results of our secondary analysis of data derived during fall 2008 and spring 2009, the first full school year in which hookah use was assessed.

Approximately 150 institutions administer the NCHA to their students annually. All responses are confidential. Each institution is responsible for securing human subjects approval. Our analysis of the ACHA data for this purpose was approved by the University of Pittsburgh's Institutional Review Board.

The survey was administered in 2 forms.⁴³ A paper form was administered to students in randomly selected classrooms, and a Web-based form was sent via an e-mail invitation to a random sample of students identified by their institution. The e-mail invitation included an embedded unique respondent identification number, which allowed the ACHA to prevent duplicate responses from the same student or students outside the random sample. The paper-based survey accounted for about 20% of respondents and had a mean response rate of approximately 90%. Although the Web-based survey accounted for about 80% of respondents, it had a mean response rate of only about 22%. Despite its lower response rate, the Web-based survey is favored by institutions because it is less labor-intensive to administer and its results are virtually identical to those of the paper-based survey.⁴⁶

Participating institutions typically encourage survey completion by providing a small incentive to students or having a random drawing for a larger prize. Web-based surveys were generally administered over a period of 2–4 weeks, and non-responders were periodically sent reminders.

Measures

Smoking Behavior—The survey assessed cigarette, hookah, cigar, and marijuana use with similarly-worded items assessing frequency of use over the past 30 days. The response options for each substance were (a) never used; (b) have used, but not in the past 30 days; (c) 1–2 days; (d) 3–5 days; (e) 6–9 days; (f) 10–19 days; (g) 20–29 days; and (h) all 30 days.⁴³ The question related to cigar smoking specifically included “little cigars” which are commonly used in the young adult population.⁴⁷ For each of these substance use types, we grouped response options c through h into the category called “current use” (at least one day over the past month) which is considered the gold standard of substance use behavior in this population.⁴⁸

Alcohol Bingeing—We selected our measure of alcohol use to be bingeing, defined as having consumed 4 drinks in a single sitting for females—and 5 for males—in the past 30 days.^{45, 49, 50} We selected this outcome instead of ever use or current use because bingeing is more clinically relevant.^{45, 49, 50}

Individual Variables—To assess individual characteristics associated with substance use profiles, we used sociodemographic and other survey data routinely collected from students

on the NCHA. These data included age, gender, sexual orientation, year in school, race/ethnicity, full-time (vs. part-time) status, international status, relationship status, living arrangement, fraternity/sorority membership, and self-reported estimated current grade point average.

Institutional Variables—A representative from each institution participating in the NCHA is required to complete a survey describing a variety of institutional characteristics. Measures from this survey that were relevant for our study were geographic region, population of the campus locale, institution type (public vs. private), religious affiliation, status as a 2-year (vs. 4-year) institution, and size of student population.

Analyses

We used the Two-Step algorithm within SPSS to partition the sample.^{51, 52} This algorithm, which has been available in SPSS versions 11.5 and above, was specifically developed to correct methodological limitations of two prior algorithms: *k*-means clustering and hierarchical agglomerative techniques.⁵² It was also designed to accommodate particularly large data sets.⁵² We partitioned the sample based on five dichotomous variables representing each of the behaviors of interest in the past 30 days: smoking of cigarettes, hookah, cigars, and marijuana, and alcohol bingeing. The algorithm utilizes a log-likelihood distance measure.^{51, 52}

In order to determine the optimal number of clusters, we used the Two-Step algorithm's automatic clustering function. Output associated with the algorithm provides Schwarz's Bayesian Criterion (BIC) for each potential number of clusters, the change in BIC from the prior to the current number of clusters, the ratio of BIC changes, and the subsequent ratio of those distance measures. The optimal number of clusters is usually associated with the largest ratio of distance measures.^{51, 52} In this case, the largest ratio of distance measures was associated with a two-cluster solution only separating ever-users of any substance from non-users (Table 1). Because this solution did not help achieve the study goal of partitioning the sample according to various types of substance use, we selected the six-cluster solution, which was associated with the second-largest ratio of distance measures (Table 1). We verified the face-validity of the six-cluster solution by computing proportions of dependent variables in each cluster. Each cluster contained at least one 100% or 0% figure, suggesting good face validity.

To assess bivariable associations between cluster membership and individual and institutional characteristics, we used 2-way chi-square tests. We also computed Cramer's *V* for these analyses in order to examine effect sizes. We then used multinomial logistic regression in order to determine independent associations between descriptive variables and cluster membership. These analyses estimate a clustered robust standard error and included all descriptive variables as covariates. Multinomial logistic regression models were performed using Stata 11.1 statistical software (Stata Corporation, College Station, Texas), and two-tailed *P* values of <.05 were considered to be significant.

RESULTS

Participants

Our sample consisted of the 111,245 individuals from 158 institutions who had complete data for each of the five dichotomous outcomes of interest. In this sample, the mean age was 22 years (SD=6), and the majority of respondents were female (66%), white (71%), full-time (93%), and non-international (91%). Most of them attended public (62%), nonreligious (84%) institutions. A minority attended universities outside the US (5%), with the remainder

roughly equally representing the midwestern, northeastern, southern, and western regions of the US (Table 2).

Description of Clusters

Cluster analysis yielded a six-cluster solution (Table 3). Each cluster had at least one substance for which either 0% or 100% of the group had used within the past 30 days. However, for most clusters, individuals had used a variety of substances in various proportions. The largest cluster we labeled “Global Abstainers,” because none of them reported any of the five behaviors of interest over the past 30 days. This represented more than half of the sample ($n=59,041$, 54%). The second-largest cluster we labeled “Drinkers Who Reject All Smoking.” It consisted of the 18,718 (17%) individuals who had binged on alcohol in the past 30 days but had not smoked any substance. All individuals in the third-largest cluster, “Marijuana Users, Will Smoke Cigarettes and Drink,” had smoked marijuana. Although none of these 10,135 individuals (9%) had smoked hookah tobacco or cigars, 38% and 69% had smoked cigarettes or binged on alcohol, respectively. All 7,945 (7%) members of the next-largest cluster, “Prefer Cigars, But Will Use Other Substances Too,” had smoked cigars in the past 30 days, and subsets of this group ranging in size from 36% to 70% had used each of the other substances. The 7,561 (7%) “Cigarette Purists, But Will Drink” had all smoked cigarettes. Just over half (54%) of these individuals had binged on alcohol, yet none of them smoked any other substance. Finally, “Drawn to Hookah, Dislike Cigars” was the smallest cluster, consisting of 6,015 (6%) from the sample. All of these individuals had smoked hookah tobacco in the past 30 days and none had smoked cigars. However, cigarette, marijuana, and binge alcohol use were reported among 39%, 43%, and 62% of them, respectively.

Comparison to the Complete Sample of College Students

Compared with those in the complete sample, Global Abstainers had a higher percentage that was female (72% vs. 66%). They also had a higher percentage that were first year undergraduates (26% vs. 25%), Asian (13% vs. 10%), international students (10% vs. 9%) and those who were married (11% vs. 8%). Compared with those in the complete sample, they had a lower percentage that were White (66% vs. 71%) or members of fraternities/sororities (7% vs. 9%). In addition, compared with the complete sample Global Abstainers had a higher percentage that estimated their grade point average as “A” (43% vs. 38%). The institutional demographics of Global Abstainers were not substantially different from those of the complete sample (Table 2).

“Drawn to Hookah, Dislike Cigars” was the youngest cluster. While 81% of the Drawn to Hookah, Dislike Cigars cluster was aged 21 and under, this was only true for 66% of the complete sample. The Drawn to Hookah, Dislike Cigars cluster also had a lower percentage of students that were graduate or professional (6% vs. 15%), Black (2% vs. 5%), part-time (3% vs. 7%), or married (2% vs. 8%). Compared with the whole sample, they had more involvement in fraternities/sororities and poorer grades (Table 2). In addition, a higher percentage of these students were first year undergraduates (29% vs. 25%) and attended institutions located in the West (24% vs. 19%).

The “Marijuana Users, Will Smoke Cigarettes and Drink” cluster had a higher percentage of White (78% vs. 71%) and bisexual (5% vs. 3%) students compared with the complete sample. In addition, this cluster had a lower percentage of international (6% vs. 9%), married (4% vs. 8%), or “A” students (31% vs. 43%). Compared with the complete sample, a higher percentage of students within this cluster attended institutions from the Northeast (33% vs. 29%) (Table 2).

“Cigarette Purists, But Some Drink” were the oldest group, with a higher percentage of students aged 22 and older (53% vs. 36%) as well as a higher percentage of graduate and professional students (19% vs. 15%) compared to the complete sample. Additionally, this cluster had a greater percentage of students who were female (68% vs. 66%) and /or part-time (11% vs. 7%) students. They were also more likely to be married or cohabitating (11% vs. 8%) off-campus (65% vs. 49%). Interestingly, they had poorer self-reported grades than the sample as a whole (Table 2). In addition, there were a greater percentage of students from this cluster in the Midwest (29% vs. 23%) and in the West (15% vs. 19%).

Compared with those in the complete sample, “Drinkers Who Reject All Smoking” were more commonly ages 21 (21% vs. 15%) or 22–25 (23% vs. 20%). They were more frequently male (39% vs. 34%), White (80% vs. 71%), fraternity/sorority members (14% vs. 9%). In addition, there was a smaller percentage of these students who were Asian (7% vs. 10%) or married (5% vs. 8%). Compared with the complete sample, these individuals were more frequently from the Midwest (29% vs. 23%) and less frequently from the West (15% vs. 19%).

“Prefer Cigars, But Will Use Other Substances Too” were substantially male (61% vs. 34%) when compared with the overall sample. This cluster also had a smaller percentage of graduate or professional students (5% vs. 15%), Asians (5% vs. 10%), international students (6% vs. 9%), or married/partnered students (3% vs. 8%). Compared to the complete sample, however, there was a greater percentage of these students who were first and second year undergraduates (31% vs. 25% and 23% vs. 20%, respectively), living in a campus residence hall (44% vs. 39%) or a fraternity/sorority house (3% vs. 1%), reporting grades “C” or below (20% vs. 15%), or attending institutions in the South (27% vs. 23%).

Bivariable Associations of Cluster Membership with Individual and Institutional Variables

Two-way chi-square analyses were conducted for each of the 11 individual variables as well as for the 6 institutional yielded significant results ($p < 0.001$) for all variables, suggesting a significant relationship between each variable and cluster membership. However, due to the large size of the data set, Cramer’s V tests were also conducted to assess the magnitude, producing small effect sizes for only three personal factors: gender ($V = 0.182$); year in school ($V = 0.121$); and fraternity/sorority membership ($V = 0.104$). Among the six clusters, the group with the highest percentage of males was “Prefer Cigars, But Will Use Other Substances Too” (61%) and the group with the highest percentage of females was the “Global Abstainers” (72%). “Prefer Cigars, But Will Use Other Substances Too” also had the highest percentage of first year undergraduate students (31%), while the “Cigarette Purists, But Some Drink” group had the highest percentage of graduate or professional students (19%). The “Drinkers Who Reject All Smoking” cluster had the highest percentage of fraternity/sorority members (14%), while the “Global Abstainers” had the highest percentage of non-fraternity/sorority members (94%). All other variables, both personal and institutional, had negligible effect sizes, and thus little practical significance (Table 2).

Multivariable Associations of Cluster Membership with Individual and Institutional Variables

Multinomial logistic regression analyses were conducted using “Global Abstainers” as the reference group (Table 5). Most variables were associated with increased odds of membership to the other 5 substance use clusters. Males, members of a fraternity/sorority, individuals residing in fraternity/sorority housing and those who estimated their grade point average below an “A” were at a greatest risk compared with their counterparts. Compared with females, males had an odds ratio of 4.19 (95% CI=3.37, 4.43) to be in the “Prefer Cigars” cluster compared with the “Global Abstainers” cluster. Compared with non-

members, members of a fraternity/sorority had 1.41–1.91 times the odds of being in the various substance using clusters. There were also several variables that showed decreased odds of cluster membership. In particular, minorities, married/partnered and cohabitating individuals and students residing in a parent's home showed decreased risk of membership to the other 5 clusters and were more likely to abstain than their counterparts. For example, compared with Whites, Black individuals had adjusted odds of 0.27 (95% CI=0.22, 0.33) for being in the “Drawn to Hookah, Dislike Cigars” compared with the “Global Abstainers” cluster. Married/partnered and cohabitating individuals also had adjusted odds of 0.26 (95% CI=0.21, 0.33) for belonging in the “Drawn to Hookah, Dislike Cigars” cluster compared with the “Global Abstainers” cluster. Individuals residing in a parent or guardian's home had lower odds of being in any of the substance using clusters except for the “Cigarette Purists” cluster (AOR=0.97, 95% CI=0.87, 1.07).

COMMENT

This analysis of a large group of university students found that about half can be grouped into one large cluster, none of whom had any of our substance use outcomes of interest in the past 30 days. It found that the remaining individuals can be divided into smaller clusters, each of which was characterized by various patterns of substance use. Although three personal factors (gender, year in school and fraternity/sorority membership) were associated with cluster membership in small effect sizes, the remaining individual factors and the institutional factors were found to have little to no practical significance when examining the demographics of cluster membership.

Our results were consistent with others who have found that many of these risk behaviors cluster together^{1–3, 53} in that the clustering algorithm first separated those with any substance use from those with none. However, ultimately the algorithm revealed a number of clusters of individuals who exhibited specific risk behavior profiles. For example, “Cigarette Purists, But Some Drink” had all smoked cigarettes in the past thirty days, but none of them had used marijuana, hookah and cigars. However, half (54%) of them had participated in binge drinking. This suggests that students belonging to this cluster might not only benefit from education and intervention focused on cigarette smoking, but may also benefit from simultaneous alcohol-related materials. Similar prevention and intervention efforts might be aimed at the “Prefer Cigars, But Will Use Other Substances Too”, of whom 100% smoked cigars within the past 30 days, but also 70% who had binged on alcohol, 44% who had used marijuana, and 91% who had used one of the other forms of tobacco (i.e., hookah and cigarettes).

It is interesting to note that more than half of the sample fell into the “Global Abstainers” category. While popular press can emphasize the relative universality of substance use among college students, the “Global Abstainers” category was by far the largest cluster obtained. Consistent with prior research, membership in this cluster was associated with female gender, while also containing higher percentages of Asian students and students with better grades compared to the general student population.^{1, 15, 28, 48, 50}

Findings regarding the “Drawn to Hookah, Dislike Cigars” cluster may help guide development of interventions to curb this emerging form of substance use. Knowing that this cluster had higher percentages of young, White, male, single individuals compared to the student population as a whole may help target educational materials so they will reach those at most risk. Fraternity/sorority members may also be valuable to target. However, it is important to note that these are only tendencies, and that many members of other sociodemographic groups also use hookah tobacco. Ultimately, comprehensive intervention will require a multifaceted approach aimed at reaching a large variety of individuals.

It is interesting that, among the many institutional variables, none was consistently associated with cluster membership. For example, although we found that individuals in the Western US seemed less involved with more established forms of substance use (“Cigarette Purists, But Some Drink” and “Drinkers Who Reject All Smoking”) but more likely to embrace the new phenomenon of hookah tobacco smoking, association between cluster membership and geographic region was weak, with a Cohen’s V of 0.055. It presents a challenge for public health practitioners to reach individuals in various cities and types of institutions.

An important practical implication of this work is that there may be utility in pre-testing college students and using this information to appropriately target substance use interventions. For example, using computer-based technology, practitioners could first obtain substance use patterns from college students and then select an appropriately tailored intervention. “Global Abstainers,” for example, may most appropriately receive education on helping substance-using friends, while “Cigarette Purists” would receive education focusing on cigarette and alcohol use, with less emphasis on hookah and marijuana. Similarly, assignment to a particular cluster pattern may help hone stylistic elements of the intervention based on sociodemographic factors such as gender, age, and marital status. For example, because compared with “Global Abstainers” those assigned to the “Prefer Cigars, But Will Use Other Substances Too” cluster are commonly male, this intervention may include font and color schemes found to be appealing to males. Enthusiasm for this approach should be tempered, however, by the fact that associations between sociodemographic factors and cluster membership were relatively weak.

Limitations

Our analysis has several limitations that deserve mention. First, although the study sample was national and large, it was not necessarily nationally representative, because schools self-select to participate. Second, the overall response rate for the Web-based form of the survey was only about 1 in 5. However, this is a standard response rate for e-mail surveys,^{54–56} prior studies have shown that ACHA data tend to match nationally representative data,⁵⁷ and our Web-based results were similar to those of paper results, which had nearly 80% response rates. Third, the ACHA survey relied on self-report of substance use and sociodemographic factors. Because the survey was confidential, however, students would have had little reason to be dishonest. Fourth, it should be emphasized that the cross-sectional nature of these data limits our ability to make causal inferences. For example, we found that, compared to the total college population, a higher number of traditional smokers live off campus. Although this may indicate that cigarette smokers are more likely to seek out off-campus housing, it may also indicate that individuals who live off campus are subsequently exposed to environmental cues and opportunities that lead to increased cigarette smoking. Finally, the sample analyzed for this study was large, thus resulting in many statistically significant relationships when analyzing the personal and institutional factors associated with cluster membership. However, for this reason we examined the practical significance of the findings using an established measure of effect size.

Conclusions

In conclusion, this study found that half of a large sample of university students had not smoked tobacco or marijuana or engaged in binge drinking in the past 30 days. Furthermore, the remaining students were reliably clustered into groups based on specific risk-behavior patterns. Although gender, year in school and fraternity/sorority membership varied with cluster membership, the other individual and institutional factors had less practical significance. These findings may help inform various substance abuse prevention and treatment programs targeting particular health behaviors.

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Table 1

Results of the Cluster Analysis

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change from Prior Cluster	Ratio of BIC Changes	Ratio of Distance Measures
1	460,283			
2	279,190	-181,094	1.000	2.467 ^a
3	205,820	-73,369	0.405	1.923
4	167,695	-38,126	0.211	1.099
5	133,020	-34,675	0.191	1.244
6	105,147	-27,873	0.154	2.144 ^b
7	92,179	-12,968	0.072	1.225
8	81,604	-10,575	0.058	1.077
9	71,794	-9,811	0.054	1.020
10	62,172	-9,622	0.053	1.054
11	53,042	-9,130	0.050	1.343
12	46,260	-6,781	0.037	1.396
13	41,420	-4,841	0.027	1.000
14	36,580	-4,839	0.027	1.160
15	32,417	-4,164	0.023	1.097

^a Largest Ratio. Because two clusters were not sufficient to achieve study aims, this solution was not acceptable.

^b Second-largest ratio.

Table 2

Composition of the Six Clusters by Substance Use

Cluster Label	N (Column %)	Hookah ^d	Cigarette ^a	Cigar ^d	Marijuana ^a	Binge Alcohol ^b
Global Abstainers	59,041 (54.0)	0%	0%	0%	0%	0%
Drawn to Hookah, Dislike Cigars	6,015 (5.5)	100%	39%	0%	43%	62%
Marijuana Users, Will Smoke Cigarettes and Drink	10,135 (9.3)	0%	38%	0%	100%	69%
Cigarette Purists, But Some Drink	7,561 (6.9)	0%	100%	0%	0%	54%
Drinkers who Reject All Smoking	18,718 (17.1)	0%	0%	0%	0%	100%
Prefer Cigars, But Will Use Other Substances Too	7,945 (7.3)	36%	55%	100%	44%	70%

^aUse of the substance in the past 30 days.^bFive or more drinks in a single sitting (four for females) in the past 2 weeks.

Table 3

Total Population and Cluster Demographic Information for Individual Characteristics

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	P	V
	All Participants ^a								
	N = 111,245	n = 59,041 (54%)	n = 6,015 (6%)	n = 10,135 (9%)	n = 7,561 (7%)	n = 18,718 (17%)	n = 7,945 (7%)		
Individual characteristic	n (%)								
Age		(%)	(%)	(%)	(%)	(%)	(%)	<.001	0.096
18	16,311 (15)	16	19	14	7	11	18		
19	20,691 (19)	19	23	20	12	17	24		
20	19,199 (17)	17	23	19	14	17	20		
21	17,088 (15)	13	17	18	15	21	16		
22-25	22,197 (20)	19	15	21	26	23	17		
26-30	8,617 (8)	8	3	6	15	7	4		
>= 31	7,142 (6)	9	1	3	12	3	2		
Gender ^b								<.001	0.182
Female	72,760 (66)	72	63	63	68	61	39		
Male	37,703 (34)	29	37	37	32	39	61		
Sexual orientation								<.001	0.055
Heterosexual	104,508 (95)	96	93	92	92	96	93		
Gay/Lesbian	2,540 (2)	2	3	3	4	2	2		
Bi-sexual	3,176 (3)	2	5	5	4	2	4		
Year in school								<.001	0.121
1st year undergraduate	27,316 (25)	26	29	24	18	20	31		
2nd year undergraduate	21,531 (20)	19	24	22	16	19	23		
3rd year undergraduate	21,779 (20)	19	22	21	21	22	20		
4th year undergraduate	17,233 (16)	14	15	18	17	20	15		

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	P	V
	All Participants ^a	Global Abstainers n = 59,041 (54%)	Drawn to Hookah, Dislike Cigars n = 6,015 (6%)	Marijuana Users, Will Smoke Cigarettes and Drink n = 10,135 (9%)	Cigarette Purists, But Some Drink n = 7,561 (7%)	Drinkers Who Reject All Smoking n = 18,718 (17%)	Prefer Cigars, But Will Use Other Substances Too n = 7,945 (7%)		
	N = 111,245	4	3	6	8	5	5		
5th year or more undergraduate	5,269 (5)								
Graduate or professional	15,944 (15)	17	6	9	19	14	5		
Non-degree/non-credit seeking	958 (1)	1	0	1	2	1	1		
Race/ethnicity								<.001	0.081
White, Non-Hispanic ^c	79,075 (71)	66	73	78	76	80	77		
Black, Non-Hispanic	5,383 (5)	7	2	3	2	3	4		
Hispanic	6,634 (6)	7	6	5	5	5	5		
Asian	11,247 (10)	13	9	4	9	7	5		
Other ^d	8,863 (8)	8	10	9	8	6	9		
Full-time student								<.001	0.070
No	7,845 (7)	8	3	6	11	5	5		
Yes	102,395 (93)	92	97	94	89	95	95		
International student								<.001	0.056
No	100,160 (91)	90	91	94	89	92	94		
Yes	9,823 (9)	10	9	6	11	8	6		
Relationship/marital status								<.001	0.087
Not in a relationship	53,185 (49)	47	57	51	45	50	56		
In a relationship, not cohabitating	39,228 (36)	36	38	37	33	39	35		
In a relationship and cohabitating	7,108 (7)	6	4	9	11	7	6		
Married/partnered and cohabitating	8,904 (8)	11	2	4	11	5	3		
Residence								<.001	0.091
Campus residence hall	42,665 (39)	41	45	36	24	36	44		
Fraternity/sorority house	1,301 (1)	1	2	2	1	2	3		
Parent/guardian's home	12,692 (12)	14	8	9	11	8	8		

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	P	V
	All Participants ^a	n = 59,041 (54%)	n = 6,015 (6%)	n = 10,135 (9%)	n = 7,561 (7%)	n = 18,718 (17%)	n = 7,945 (7%)		
	N = 111,245	45	45	54	65	54	46		
Other ^e	53,785 (49)							<.001	0.104
Member of fraternity/sorority									
No	99,758 (91)	94	88	89	91	86	87		
Yes	10,014 (9)	7	12	11	9	14	13		
Grades									
A	42,214 (38)	43	32	31	34	36	26	<.001	0.085
B	51,584 (47)	44	52	51	50	50	54		
C and below	16,367 (15)	13	16	18	18	14	20		

^aData do not always sum to total sample sizes because of missing data. Percentages are based on the total for each category and may not total 100 due to rounding.

^bBecause of the small sample size, transgender was not included in multivariable analyses.

^cIncludes Middle Eastern ethnicity.

^dAlaskan Native, American Indian, Hawaiian Native, biracial, and multiracial.

^eIncludes institution-owned noncampus student residences.

Table 4
Total Population and Cluster Demographic Information for Institutional Characteristics

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	P	V
	All Participants ^a	Global Abstainers n = 59,041 (54%)	Drawn to Hookah, Dislike Cigars n = 6,015 (6%)	Marijuana Users, Will Smoke Cigarettes and Drink n = 10,135 (9%)	Cigarette Purists, But Some Drink n = 7,561 (7%)	Drinkers Who Reject All Smoking n = 18,718 (17%)	Prefer Cigars, But Will Use Other Substances Too n = 7,945 (7%)		
	N = 111,245								
Institutional characteristic	n (%)								
(n Institutions) ^b									
Region		(%)	(%)	(%)	(%)	(%)	(%)	<.001	0.055
Midwest (42)	25,604 (23)	21	19	20	29	29	25		
Northeast (44)	32,748 (29)	29	32	33	30	29	25		
South (38)	25,941 (23)	24	22	21	22	20	27		
West (28)	21,181 (19)	20	24	19	15	15	19		
Outside U.S. (6)	5,771 (5)	5	3	7	5	6	4		
Locale population								<.001	0.040
<10,000 (28)	9,460 (9)	9	6	6	7	9	10		
10,000–49,999 (9)	18,401 (17)	16	17	18	16	18	19		
50,000–249,999 (68)	46,851 (42)	41	44	46	44	42	46		
250,000–499,999 (33)	5,736 (5)	6	4	4	5	5	5		
>= 500,000 (20)	30,797 (28)	29	29	27	29	27	21		
Institution type								<.001	0.034
Private (60)	42,444 (38)	39	41	36	35	39	35		
Public (98)	68,801 (62)	61	59	64	65	61	65		
Religious affiliation								<.001	0.040
No (130)	93,466 (84)	84	84	88	87	83	82		
Yes (28)	17,770 (16)	16	17	13	13	17	18		
Two-year institution								<.001	0.061

		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	
	All Participants ^a	Global Abstainers n = 59,041 (54%)	Drawn to Hookah, Dislike Cigars n = 6,015 (6%)	Marijuana Users, Will Smoke Cigarettes and Drink n = 10,135 (9%)	Cigarette Purists, But Some Drink n = 7,561 (7%)	Drinkers Who Reject All Smoking n = 18,718 (17%)	Prefer Cigars, But Will Use Other Substances Too n = 7,945 (7%)	P
	N = 111,245							V
No (148)	105,293 (95)	95	96	94	90	96	94	
Yes (10)	5,952 (5)	5	4	6	10	4	6	
Student population								0.033
< 2,500 (24)	9,790 (9)	9	10	10	7	8	11	
2,500–4,999 (21)	12,134 (11)	11	8	9	12	12	10	
5,000–9,999 (34)	22,200 (20)	20	19	19	17	21	22	
10,000–19,999 (42)	26,828 (24)	23	23	25	28	25	25	
>= 20,000 (37)	40,293 (36)	37	39	37	38	35	31	

^aData do not always sum to total sample sizes because of missing data. Percentages are based on the total for each category and may not total 100 due to rounding.

^bThe total number of institutions was 158.

Table 5

Multivariable associations between individual and institutional characteristics and cluster membership^a

	Drawn to Hookah, Dislike Cigars		Marijuana Users, Will Smoke Cigarettes and Drink		Cigarette Purists, But Some Drink		Drinkers Who Reject All Smoking		Prefer Cigars, But Will Use Other Substances Too	
	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P
Individual characteristic										
Age		<.001		<.001		<.001		<.001		<.001
18	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
19	1.00 (0.90–1.12)		1.08 (0.98–1.19)		1.22 (1.07–1.39) **		1.02 (0.94–1.10)		1.01 (0.92–1.11)	
20	1.00 (0.87–1.16)		1.07 (0.94–1.20)		1.58 (1.35–1.83) ***		1.04 (0.94–1.15)		0.98 (0.86–1.11)	
21	0.84 (0.71–0.99) *		1.12 (0.98–1.29)		2.24 (1.90–2.63) ***		1.41 (1.26–1.58) ***		0.91 (0.78–1.06)	
22–25	0.63 (0.50–0.72) ***		1.04 (0.90–1.19)		3.11 (2.65–3.64) ***		1.19 (1.06–1.34) **		0.77 (0.65–0.90) **	
26–30	0.37 (0.29–0.48) ***		0.98 (0.83–1.16)		5.11 (4.32–6.05) ***		1.12 (0.98–1.28)		0.61 (0.50–0.75) ***	
>= 31	0.07 (0.06–0.12) ***		0.44 (0.36–0.53) ***		3.84 (3.22–4.57) ***		0.56 (0.48–0.65) ***		0.32 (0.25–0.40) ***	
Gender^c										
Female	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Male	1.58 (1.49–1.68) ***		1.56 (1.48–1.64) ***		1.13 (1.06–1.20) ***		1.70 (1.64–1.77) ***		4.19 (3.37–4.43) ***	
Sexual orientation										
Heterosexual	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Gay/Lesbian	1.21 (1.00–1.46) *		1.30 (1.13–1.51) ***		1.83 (1.58–2.10) ***		0.83 (0.73–0.95) **		1.00 (0.84–1.19)	
Bi-sexual	1.98 (1.71–2.29) ***		2.13 (1.90–2.40) ***		1.89 (1.65–2.16) ***		0.87 (0.76–0.99) *		1.25 (1.06–1.46) ***	
Year in school										
1st Year undergraduate	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
2nd Year undergraduate	1.04 (0.93–1.16)		0.95 (0.87–1.04)		0.85 (0.76–0.94) **		1.12 (1.04–1.21) **		0.94 (0.86–1.04)	
3rd Year undergraduate	0.95 (0.83–1.10)		0.85 (0.76–0.95) **		0.77 (0.68–0.87) ***		1.11 (1.01–1.22) *		0.80 (0.71–0.91) **	
4th Year undergraduate	1.17 (0.99–1.38)		0.97 (0.85–1.11)		0.66 (0.58–0.76) ***		1.30 (1.17–1.45) ***		0.95 (0.82–1.10)	
5th Year undergraduate	1.06 (0.84–1.33)		1.11 (0.95–1.31)		0.74 (0.64–0.87) ***		1.32 (1.15–1.50) ***		0.98 (0.81–1.17)	

	Drawn to Hookah, Dislike Cigars		Marijuana Users, Will Smoke Cigarettes and Drink		Cigarette Purists, But Some Drink		Drinkers Who Reject All Smoking		Prefer Cigars, But Will Use Other Substances Too	
	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P
Graduate/professional	0.54 (0.44–0.67)	***	0.55 (0.48–0.65)	***	0.47 (0.40–0.54)	***	1.09 (0.97–1.23)		0.47 (0.39–0.56)	***
Non-credit/degree seeking	0.46 (0.27–0.79)	**	0.79 (0.60–1.05)		0.59 (0.46–0.75)	***	0.79 (0.62–1.02)		0.66 (0.46–0.94)	*
Race/ethnicity										
White, Non-Hispanic ^d	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Black, Non-Hispanic	0.27 (0.22–0.33)	***	0.38 (0.33–0.44)	***	0.23 (0.19–0.27)	***	0.35 (0.31–0.39)	***	0.44 (0.38–0.51)	***
Hispanic	0.75 (0.67–0.85)	***	0.71 (0.64–0.79)	***	0.68 (0.60–0.77)	***	0.75 (0.69–0.82)	***	0.76 (0.67–0.86)	***
Asian	0.52 (0.47–0.58)	***	0.28 (0.25–0.31)	***	0.61 (0.56–0.67)	***	0.46 (0.43–0.50)	***	0.38 (0.34–0.43)	***
Other ^e	0.96 (0.87–1.06)	*	0.86 (0.79–0.94)	**	0.82 (0.74–0.91)	***	0.63 (0.59–0.69)	***	0.93 (0.85–1.03)	
Full-time student										
No	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Yes	1.13 (0.95–1.33)		1.02 (0.91–1.13)		1.03 (0.94–1.14)		1.02 (0.94–1.12)		0.93 (0.81–1.06)	
International student										
No	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Yes	1.12 (1.01–1.25)	*	0.75 (0.68–0.82)	***	1.25 (1.14–1.37)	***	0.90 (0.84–0.96)	**	0.84 (0.75–0.94)	**
Relationship/marital status										
Not in a relationship	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
In a relationship, not cohabitating	0.90 (0.85–0.96)	**	0.93 (0.88–0.98)	**	0.89 (0.83–0.94)	***	0.96 (0.92–1.00)	*	0.86 (0.81–0.91)	***
In a relationship and cohabitating	0.57 (0.50–0.66)	***	1.04 (0.95–1.13)		1.00 (0.91–1.11)		0.78 (0.72–0.85)	***	0.80 (0.71–0.90)	***
Married/partnered and cohabitating	0.26 (0.21–0.33)	***	0.37 (0.32–0.42)	***	0.47 (0.43–0.52)	***	0.41 (0.37–0.44)	***	0.29 (0.33–0.45)	***
Residence										
Campus residence hall	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Fraternity/sorority house	2.33 (1.81–3.00)	***	2.30 (1.84–2.88)	***	2.25 (1.71–2.97)	***	1.94 (1.63–2.31)	***	2.65 (2.12–3.31)	***
Parent/guardian's home	0.60 (0.53–0.67)	***	0.69 (0.63–0.76)	***	0.97 (0.87–1.07)		0.61 (0.57–0.66)	***	0.55 (0.49–0.62)	***
Other ^f	1.78 (1.64–1.93)	***	1.93 (1.80–2.06)	***	1.86 (1.72–2.02)	***	1.49 (1.41–1.57)	***	1.67 (1.55–1.80)	***
Member of fraternity/sorority										

	Drawn to Hookah, Dislike Cigars		Marijuana Users, Will Smoke Cigarettes and Drink		Cigarette Purists, But Some Drink		Drinkers Who Reject All Smoking		Prefer Cigars, But Will Use Other Substances Too	
	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P
No	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Yes	1.78 (1.61–1.96) ***		1.70 (1.56–1.85) ***		1.41 (1.28–1.56) ***		1.92 (1.80–2.04) ***		1.91 (1.75–2.10) ***	
Grades										
A	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
B	1.49 (1.39–1.59) ***		1.52 (1.44–1.61) ***		1.59 (1.50–1.69) ***		1.38 (1.33–1.44) ***		1.73 (1.63–1.84) ***	
C and below	1.71 (1.56–1.87) ***		1.91 (1.77–2.05) ***		1.96 (1.81–2.12) ***		1.43 (1.35–1.52) ***		2.20 (2.03–2.39) ***	
Individual characteristic (n Institutions) ^c										
Region		0.003		0.027		<.001		.001		0.032
Midwest (42)	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Northeast (44)	1.11 (0.78–1.56)		1.38 (0.97–1.96)		0.80 (0.63–1.01)		0.73 (0.55–0.95) *		0.81 (0.62–1.05)	
South (38)	0.91 (0.67–1.25)		0.92 (0.67–1.29)		0.71 (0.57–.88) **		0.58 (0.45–0.74) ***		0.95 (0.74–1.21)	
West (28)	1.37 (0.97–1.93)		0.93 (0.67–1.34)		0.46 (0.36–0.59) ***		0.54 (0.41–0.71) ***		0.76 (0.58–1.00) *	
Outside U.S. (6)	0.58 (0.31–1.09)		1.39 (0.73–2.66)		0.61 (0.40–0.94) *		0.78 (0.47–1.28)		0.68 (0.42–1.10)	
Locale population										
<10,000 (28)	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
10,000–49,999 (9)	1.85 (1.19–2.88) **		1.86 (1.18–2.94) **		1.24 (0.91–1.69)		1.23 (0.87–1.75)		1.05 (0.75–1.47)	
50,000–249,999 (68)	1.85 (1.22–2.79) **		2.05 (1.18–2.94) **		1.25 (0.94–1.67)		1.18 (0.85–1.75)		1.02 (0.75–1.40)	
250,000–499,999 (33)	1.46 (0.79–2.68)		1.28 (0.67–2.41)		1.12 (0.74–1.71)		0.91 (0.56–1.46)		0.83 (0.52–1.32)	
>= 500,000 (20)	1.91 (1.17–3.12) *		1.88 (1.13–3.12) *		1.40 (0.99–1.97)		0.97 (0.66–1.43)		0.74 (0.51–1.08)	
Institution type										
Private (60)	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Public (98)	0.76 (0.52–1.13)		1.15 (0.76–1.72)		1.44 (1.09–1.90) *		1.02 (0.74–1.39)		1.19 (0.88–1.61)	
Religious affiliation										
No (130)	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	

	Drawn to Hookah, Dislike Cigars		Marijuana Users, Will Smoke Cigarettes and Drink		Cigarette Purists, But Some Drink		Drinkers Who Reject All Smoking		Prefer Cigars, But Will Use Other Substances Too	
	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P	AOR (95% CI) ^b	P
Yes (28)	0.69 (0.46–1.02)		0.75 (0.50–1.13)		1.12 (0.84–1.48)		1.02 (0.75–1.40)		1.16 (0.86–1.57)	
Two-year institution										
No (148)	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Yes (10)	0.61 (0.37–1.02)		1.07 (0.63–1.79)		2.20 (1.56–3.09) ***		0.79 (0.53–1.18)		1.13 (0.77–1.68)	
Student population										
< 2,500 (24)	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
2,500–4,999 (21)	0.77 (0.49–1.22)		0.74 (0.46–1.19)		1.03 (0.75–1.43)		1.16 (0.81–1.66)		0.82 (0.58–1.17)	
5,000–9,999 (34)	0.81 (0.53–1.23)		0.78 (0.50–1.21)		0.88 (0.65–1.19)		1.20 (0.86–1.68)		0.84 (0.61–1.17)	
10,000–19,999 (42)	0.93 (0.58–1.48)		0.74 (0.46–1.20)		0.98 (0.70–1.43)		1.31 (0.90–1.90)		0.79 (0.55–1.14)	
>= 20,000 (37)	1.06 (0.64–1.76)		0.80 (0.47–1.35)		0.97 (0.68–1.39)		1.22 (0.82–1.83)		0.78 (0.53–1.15)	

* p < .05,

** p < .01,

*** p < .001

^a Adjusted for nesting; cluster 1 (Global Abstainers) was used as the reference group.

^b OR= odds ratio; CI= confidence interval; adjusted for all variables in the table.

^c Because of the small sample size, transgender was not included in multivariable analyses.

^d Includes Middle Eastern ethnicity.

^e Alaskan Native, American Indian, Hawaiian Native, biracial, and multiracial.

^f Includes institution-owned noncampus student residences.

^g The total number of institutions was 158.