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Prevalence and Correlates of Waterpipe Tobacco Smoking by College Students in North Carolina

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Abstract

Background—Known most commonly in the U.S. as "hookah," waterpipe tobacco smoking appears to be growing among college students. Despite beliefs that waterpipe use is safer than cigarette smoking, research to date (albeit limited) has found health risks of waterpipe smoking are similar to those associated with cigarette smoking, including lung cancer, respiratory illness, and periodontal disease. The goals of this study were to estimate the prevalence of use among a large, multi-institution sample of college students and identify correlates of waterpipe use, including other health-risk behaviors (i.e., cigarette smoking, alcohol, marijuana, and other illicit drug use) and availability of commercial waterpipe tobacco smoking venues.

Methods—A cross-sectional sample of 3,770 college students from eight universities in North Carolina completed a web-based survey in fall 2008.

Results—Forty percent of the sample reported ever having smoked tobacco from a waterpipe, and 17% reported current (past 30-day) waterpipe tobacco smoking. Correlates associated with current waterpipe use included demographic factors (male gender, freshman class); other health-risk behaviors (daily and nondaily cigarette smoking, alcohol use, marijuana use, other illicit drug use); perceiving waterpipe tobacco smoking as less harmful than regular cigarettes; and having a commercial waterpipe venue near campus.

Conclusions—The results highlight the popularity of waterpipe tobacco smoking among college students and underscore the need for more research to assess the public health implications of this growing trend.

Keywords

hookah; waterpipe; tobacco; young adults; smoking

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1. Introduction

Waterpipes are known by different names depending on the region of the world, including hookah, narghile, arghile, and hubble-bubble (Maziak et al., 2005). In the U.S., a waterpipe is commonly known as hookah. Waterpipes involve the passage of smoke through water prior to inhalation. Although used to smoke other substances, including marijuana and hashish, waterpipes are most often used to smoke flavored tobacco, which is made by mixing shredded tobacco with honey or molasses and dried fruit. In the U.S., this sweetened, flavored tobacco mix is most commonly known as shisha.

Despite perceptions among young adults that waterpipe tobacco smoking is safer than cigarette smoking (Smith et al., 2007), studies to date do not support these perceptions (Maziak et al., 2004c; Maziak, 2008; Asfar et al., 2005). Although research is limited, the existing evidence suggests that waterpipe smoking-associated health risks are similar to those of cigarette smoking. A recent meta-analysis concluded that waterpipe tobacco smoking was significantly associated with lung cancer, respiratory illness, low birth-weight and periodontal disease (Akl et al., 2010). An analysis of mainstream waterpipe smoke (i.e., inhaled by the user) found large amounts of carcinogens, hydrocarbons, and heavy metals, including 36 times the amount of tar as in cigarette smoke (Shihadeh, 2003).

Waterpipe tobacco smoking often occurs in a social setting, among friends at a private residence, or in venues that offer ready-to-smoke waterpipes to customers. Recently, commercial waterpipe venues have proliferated in the U.S. Many such venues have opened in college towns, suggesting that college students are a target market for waterpipe venues. For example, in 2003 alone, four waterpipe tobacco smoking venues opened within five miles of Carnegie Mellon University and the University of Pittsburgh (Primack et al., 2006); similar patterns have been observed elsewhere (American Lung Association, 2007). However, research has yet to assess the association between commercial waterpipe availability and use.

There is growing evidence that smoking tobacco through a waterpipe by youth and young adults is on the rise worldwide, including the U.S. (Maziak, 2011; World Health Organization (WHO) Study Group on Tobacco Product Regulation, 2005). In a recent sample of university students in Karachi Pakistan, 54% reported ever use (Jawaid et al., 2008); while ever use was reported by 38% of a sample of British university students (Jackson and Aveyard, 2008, for a review, see Maziak, 2011).

To date, only six reports have focused on waterpipe tobacco smoking by U.S. college students, all within the last four years, suggesting the recent increase of this trend (Primack et al., 2008; Primack et al., 2010; Eissenberg et al., 2008; Grekin and Ayna, 2008; Smith et al., 2007; Smith-Simone et al., 2008a). Five were conducted at single institutions, and had relatively small sample sizes (ranging from 411–744), limiting generalizability. The sixth and most recent study included eight institutions across the U.S. and had a large sample size (N=8,745) (Primack et al., 2010). Current (past month) waterpipe smoking in these studies ranged from 9.5% to 20.4%. Variations in the rates of current use may represent real differences in smoking patterns, but may also reflect differences in the year of the survey and non-representative samples (four of the six studies used convenience samples). Ever-use also varied considerably, from 12.7% to 48.4%. However, even the lowest prevalence suggests that substantial numbers of college students are waterpipe users.

These studies also assessed variables associated with waterpipe use, including demographics, cigarette smoking, perceived harm and addictiveness of waterpipe smoking. Younger age (Primack et al., 2008; Eissenberg et al., 2008; Primack et al., 2010), male gender (Smith-Simone et al., 2008a; Primack et al., 2010; Eissenberg et al., 2008) and White

race (Primack et al., 2008; Eissenberg et al., 2008; Primack et al., 2010) were associated with waterpipe smoking. Among studies that assessed cigarette smoking as a correlate of waterpipe use, all found that the two were associated (Eissenberg et al., 2008; Grekin and Ayna, 2008; Primack et al., 2008). Additionally, ever and current waterpipe users were more likely to perceive waterpipe tobacco smoking as less harmful than cigarettes. Primack and colleagues (2008) also reported that over 52% of college students sampled believed waterpipes are less addictive than cigarettes.

To date, only one study has included multiple institutions, but the focus was limited to waterpipe tobacco smoking among college athletes (Primack et al., 2010). Data from larger random samples at multiple institutions are needed to better understand the spread and correlates associated with waterpipe smoking among college students. Additionally, the relationship between waterpipe smoking and other health-risk behaviors popular among college students (e.g., alcohol, marijuana, and other illicit drugs) remains unclear. Thus, the purpose of this study was: 1) to estimate the prevalence of waterpipe tobacco smoking in a large, multi-institution sample of college students; and 2) to assess correlates associated with waterpipe tobacco smoking, including demographics, other health-risk behaviors, and availability of commercial establishments for waterpipe tobacco smoking.

2. Methods

2.1 Sample

In fall 2008, a stratified random sample of undergraduate students attending eight universities in North Carolina were invited to complete a web-based survey as part of a randomized group trial of an intervention to reduce high-risk drinking behaviors and their consequences, the Study to Prevent Alcohol-Related Consequences (SPARC). Participating schools included both public and private universities (seven public and one private), ranging from 5,000 to over 40,000 students. Students from each campus were selected randomly within class year strata from undergraduate enrollment lists provided by each school. Our target sample at each university was 450 respondents, equally divided by class year, for a total of approximately 3,600 students. The number of students selected to participate was based both on power considerations for the overall SPARC trial, and the expectation from previous studies and previous waves of the survey that approximately 30–35% of the students would complete the survey within the allotted time period (Reed et al., 2006). Shortly after the target number from the eight schools was met, the website was closed.

2.2 Procedures

All randomly selected students were sent an email inviting them to participate in a web-based survey. The message included a link to a secured website where the survey could be completed. The email notification protocol, including multiple, frequent reminders for the web-based survey, was based on the approach used by Dillman (2000). Students were sent up to four emails over approximately four weeks. All who completed the survey were sent emails awarding them $15.00 in PayPal dollars. From the list of completions, one student at each school was randomly selected to receive $100. The study protocol was approved by the Wake Forest University School of Medicine Institutional Review Board.

2.3 Measures

The web-based College Drinking Survey, from which data in the present report were taken, focused on alcohol use and measured demographics, alcohol consumption behaviors, and consequences of alcohol use. The survey also assessed other health-risk behaviors, including use of tobacco, marijuana, and other drugs.

2.3.1 Demographic Characteristics—Demographics included year in school, gender, race/ethnicity, residence location (on/off-campus) and mother's and father's educational level (some college education or less vs. college degree or higher). Participants were asked about membership in Greek organizations (fraternities or sororities), as a member or a pledge, because membership in Greek organizations has been related to several health-risk behaviors among U.S. college students, including alcohol and tobacco use. Previously, we found that social smokers were more likely to be members of Greek organizations compared to heavy smokers (Sutfin et al., 2009). Monthly spending money was also assessed using six categories: less than $100, $100–$199, $200–$299, $300–$399, $400–$499, $500 or more.

2.3.2 Waterpipe Tobacco Smoking—In the section of the survey focused on tobacco use, students were asked several questions about waterpipe use adapted from Maziak and colleagues (2005) and Ward and colleagues (2007), including: *Have you ever smoked a waterpipe (also known as hookah, shisha, narghile), even one or two puffs* (yes/no). Ever-users were then asked age of initiation, use in past month (Ward et al., 2007), and waterpipe smoking location, including own house/apartment/dorm room, friend's house/apartment/dorm room, at a party, at a café or restaurant, or other location. Quit attitudes and behavior were assessed with two items: *Do you think you can quit waterpipe smoking anytime you want?* (yes/no); and *Do you intend to quit waterpipe smoking?* Response options were not at all, in the next month, in the next 6 months, in the future.

2.3.3 Harm Perceptions—Participants were asked: *Compared with a regular cigarette, how harmful do you think waterpipes (also known as hookah, shisha, narghile) are*? Response options were: less harmful, as harmful, and more harmful (Smith et al., 2007).

2.3.4 Cigarette Smoking—Using standard items from Youth Risk Behavior Surveillance System (Centers for Disease Control and Prevention, 2006), age of smoking initiation (used to gauge if students had ever smoked a whole cigarette) and the number of days smoked in the past month were assessed. Responses to age of initiation were: I have never smoked a whole cigarette, age 8 or younger, each individual age between 9 and 21, and 22 or older. Responses to the number of days smoked were: 0 days, 1–2 days, 3–5 days, 6–9 days, 10–19 days, 20–29 days, and all 30 days. Using these two items, four categories were created to represent cigarette smoking behavior: never smoker (never smoked a whole cigarette), former or experimenter (smoked a whole cigarette in lifetime, but not in the past 30 days), current nondaily (smoked on between 1 and 29 of the past 30 days), and current daily (smoked on all of the past 30 days).

2.3.5 Health-risk Behaviors—Students were asked about past month marijuana use (yes/no), past month alcohol use (yes/no) and lifetime illegal drug use, including any form of cocaine, methamphetamines, hallucinogens, flunitrazepam (Rohypnol), 3–4-methylenedioxymethamphetamine (Ecstasy), or prescription drugs without a prescription (yes/no).

2.3.6 School-level Variables—School-level variables were type of institution (public/private) and presence of a commercial waterpipe venue within 10 miles of the campus (yes/no). Nineteen commercial waterpipe venues (including restaurants, bars, and cafés) were identified in North Carolina using several sources, including hookah-bars.com (an on-line directory updated monthly) and local newspaper and phone book searches. Using these data, we found that three of the eight schools had one or more commercial waterpipe venue within 10 miles of the campus.

2.4 Statistical Analyses

Sample demographics, health-risk behaviors, and school-level characteristics were explored using descriptive statistics. The prevalence of current waterpipe tobacco smoking was estimated by school to examine variation in use. Mixed-effects logistic regression was used to fit a multivariable model of current waterpipe tobacco use (outcome) that included demographics, health-risk behaviors, harm perceptions, and school-level covariates. Campus was treated as a random effect to account for the intra-campus correlation of use (Donner et al., 1981; Murray and Short, 1995; Murray and Short, 1996). Adjusted odds ratios (AOR) and their 95% confidence intervals were calculated for the independent variables. All analyses were performed using Stata v10.1 (StataCorp, Inc., College Station, TX). A two-sided p-value < 0.05 was considered statistically significant.

3. Results

The survey was completed by 3,770 students. The response rate across all eight schools was 26.9% and ranged from 18.0% to 44.1%. There were proportionally more females (63%) in our sample, which is similar to the overall undergraduate population at the eight universities (59.8% female) (Table 1). Respondents were evenly divided among class years and 80% of respondents were White. Fourteen percent were members or pledges of a Greek organization. Student demographics and self-reported behaviors also are shown in Table 1.

Almost one-fifth (17.4%) of the sample reported current (past 30-day) waterpipe tobacco smoking, compared to a quarter (24.9%) reporting current cigarette smoking. More than one-third (40.3%) of the sample reported ever having smoked tobacco from a waterpipe. In comparison, 46.6% reported ever smoking a cigarette. Among ever waterpipe users, the mean age of initiation was 17.9 years (SD=1.6). Compared to a regular cigarette, 17% of the 3,770 students reported smoking tobacco from a waterpipe was more harmful, 51% reported it was as harmful, and 32% reported it was less harmful. Prevalence of current waterpipe tobacco smoking varied by school and ranged from 6% to 30% (see Table 2). Among the top three schools in waterpipe use, all had a commercial waterpipe venue in the community. Thirty-nine percent of current users reported having smoked a waterpipe at their own residence, 63% at a friend's residence, 34% at a party, 32% at a café or restaurant, and 9% at another location in the past 30 days. Sixty-five percent of current waterpipe users from the three campuses with a waterpipe venue in the community reported smoking in a commercial venue. Prevalence estimates were also obtained after weighting the sample data by class year and institution size, which resulted in a weighted past 30-day waterpipe tobacco smoking prevalence of 17.5%, current cigarette smoking of 25.0%, ever waterpipe tobacco smoking of 40.8%, and ever cigarette smoking of 46.3%.

Among current waterpipe users, 97% reported that they could quit waterpipe smoking any time they wanted. However, only 53% reported plans to quit. Of those who planned to quit waterpipe smoking, 18% planned to quit in the next month, 2% planned to quit in the next six months, and 33% planned to quit sometime in the future.

Multivariable analyses indicated that males were more likely than females to be current waterpipe smokers ($p<.001$; see Table 3). Compared with freshmen, all other classes were less likely to be current waterpipe smokers. Availability of commercial waterpipe venues was significantly associated with increased odds of waterpipe use ($p=.014$). Those who perceived smoking tobacco from a waterpipe as less harmful than cigarette smoking were more likely to be current waterpipe users, compared to those who perceived smoking tobacco from a waterpipe as equally (AOR = 2.66, $p<.001$) or more harmful (AOR = 2.32, $p<.001$) than a regular cigarette. Marijuana use, other illicit drug use, and past 30-day drinking were also associated with current waterpipe use ($p<.001$) (Table 3).

As shown in Table 4, 66% of current waterpipe users had also smoked marijuana and 49% of current marijuana smokers had also smoked tobacco from a waterpipe in the past month. Among current waterpipe users, 55.4% were also current cigarette smokers. However, 44.6% of current waterpipe users were not current smokers and 22% of current waterpipe users had never tried a cigarette, suggesting, that for about a fifth, smoking tobacco from a waterpipe may have been their first form of tobacco use.

4. Discussion

Our large sample of undergraduate students from eight universities in North Carolina reported high rates of lifetime waterpipe tobacco smoking. In fact, almost as many students reported ever smoking tobacco from a waterpipe as had ever tried a cigarette. Current waterpipe smoking was reported by almost a fifth of the sample, while a quarter of the sample reported current cigarette smoking. These results suggest that waterpipe tobacco smoking is a popular activity among college students and is almost as common as cigarette smoking. Given the substantial health risks, waterpipe tobacco smoking should be considered a significant public health concern.

Rates of current waterpipe use varied considerably across schools, ranging from 9% to 30%, and may reflect different commercial access to waterpipe products. Sites with the highest rates of waterpipe use were more likely to have one or more commercial waterpipe venue in the community surrounding the institution. In multivariable models, current waterpipe smoking was also associated with the presence of a commercial waterpipe venue within a 10-mile radius of the campus. Waterpipe venues are highly concentrated around universities and likely target students (Primack et al., 2006; American Lung Association, 2007). In our sample, a third of current waterpipe users reported smoking a waterpipe in a commercial venue in the past month. Among students at the three campuses with a waterpipe venue in the community, two thirds reported smoking in a commercial venue in the past month. Application of strong smoke-free indoor air policies to commercial waterpipe venues, as suggested by the WHO (2005), is one potential policy that may reduce waterpipe tobacco smoking by young adults. Currently, in several states with strong smoke-free indoor air laws, there are exemptions for waterpipe venues and other tobacco retail shops (American Lung Association, 2007). More research is needed to assess the impact of commercial waterpipe venues on initiation and continued waterpipe tobacco smoking by adolescents and young adults, to make a strong case for including these establishments in smoke-free indoor air laws.

In our sample, several characteristics were significantly related to current waterpipe tobacco smoking among college students. Males were more likely than females to be current waterpipe smokers. This finding has been reported in other samples of college students in the U.S. (Eissenberg et al., 2008) and elsewhere (Chaaya et al., 2004). Compared with freshmen, all other classes were less likely to be current waterpipe smokers. This may be because tobacco use is legal in the U.S. for those under 21 and may therefore be an appealing outlet for the youngest college students, who are not old enough to drink alcohol legally and may not be able to enter venues where proof of age is required. Eissenberg and colleagues (2008) also found higher rates of current waterpipe use among those less than 20 years old.

Several health-risk behaviors were associated with waterpipe smoking. Current waterpipe smoking was strongly associated with cigarette smoking. Among current waterpipe users, 55.4% were also current cigarette smokers. However, 22% had never tried a cigarette, suggesting that for about a fifth of the sample, waterpipe tobacco may have been their first tobacco product. Marijuana use, other illicit drug use, and past 30-day drinking were also

associated with current waterpipe use. Because these data are cross sectional, the temporal sequence of these behaviors cannot be determined. However, almost two-thirds of current waterpipe users had also smoked marijuana in the past month, and about half of current marijuana smokers had smoked waterpipe in the past month. These results reveal considerable overlap in behaviors and highlight the need for longitudinal data to assess whether waterpipe use is, for some, a gateway to cigarette smoking and/or marijuana use.

Consistent with previous research (Primack et al., 2008; Smith-Simone et al., 2008b), current waterpipe users were more likely to perceive that tobacco smoked from a waterpipe is less harmful than a regular cigarette, an erroneous belief shared by almost a third of the entire sample (Maziak et al., 2004b; Ward et al., 2006; WHO, 2005). Some research suggests college students incorrectly believe that the water in the waterpipe filters out *all* harmful agents, rendering waterpipe tobacco smoking healthier than cigarette smoking (Maziak et al., 2004a). More research is needed to clarify the nature of such misperceptions about the health effects of waterpipe smoking, so that appropriate interventions to correct the misperceptions can be developed and implemented.

This study was limited to students from one state, and at least one study has shown regional variation in tobacco use among college students (Wechsler et al., 1998). Therefore, the ability to generalize our results may be limited. The response rate for the web survey was relatively low; however, it was similar to rates in other studies of college students' health-risk behaviors (Reed et al., 2006; McCabe et al., 2006). Historically, response rates have been considered an indicator of sample representativeness; however, recent research suggests that response rates are not a good estimate of nonresponse bias (Lee et al., 2009; Curtin et al., 2000; Ketter et al., 2000; Merkle and Edelman, 2002; Groves and Peytcheva, 2008). To estimate possible nonresponse bias, we compared demographics of our sample with publicly available school-level demographics for each participating university, using data from the Statistical Abstracts of Higher Education in North Carolina. Our sample was quite similar to the overall student population at each participating school with respect to gender and percent of freshmen. On average, our sample schools had only 3.4% less male students than in the population (mean=−3.38%, median=−3.57%) and only 2.4% less freshmen students than in the population (mean=−2.41%, median =−0.38%). Because waterpipe use was more common among males and freshmen, who may be slightly underrepresented in our sample, our sample estimates may be somewhat conservative.

Finally, although the waterpipe questions were embedded on a survey page specific to tobacco use, because the items did not expressly ask about smoking *tobacco* from a waterpipe, we cannot be certain what substances students smoked. Future studies should consider using the following item: "Have you ever smoked tobacco from a waterpipe (also known as hookah, shisha, narghile), even one or two puffs?" In addition, future studies should address the various substances that students may be smoking from waterpipes including flavored tobacco, herbal (non-tobacco) shisha, marijuana, K2 (Spice) or others.

This is one of the first studies in the U.S. to report prevalence and correlates of waterpipe tobacco smoking from a large, multi-institution, random sample of students. Our findings highlight the popularity of this form of tobacco use among college students and underscore the need for national prevalence data. Additionally, our findings emphasize the association between waterpipe tobacco smoking and cigarette use. The mild nature of the smoke and the flavored tobacco may appeal to non-smokers and lead to their introduction to tobacco. These results also reveal the considerable overlap in waterpipe and marijuana use, and highlight the need for longitudinal data to assess whether waterpipe use, for some, is a gateway to cigarette and marijuana use. Finally, this study is the first in the U.S. to report a relationship between commercial waterpipe access and young adults' use. Despite the fact that waterpipe

smoking continues to increase in popularity around the world, national and international tobacco control strategies, including the Framework Convention on Tobacco Control, have yet to clearly specify waterpipe tobacco smoking (Maziak, 2008; Maziak, 2011). Cross-national research on prevalence, associations with other forms of tobacco and marijuana, and the relationship between commercial access and waterpipe tobacco smoking would provide much needed evidence for the development of strong global policies and interventions to address waterpipe tobacco smoking.

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Table 1

Demographic Characteristics of the Sample (*N*=3,770)

	Overall N (%)*	Current waterpipe tobacco smokers (N=656, 17.4%) N (% of waterpipe users)*
Demographic Characteristics		
Gender		
Male	1,379 (37)	328 (50)
Female	2,379 (63)	325 (50)
Race/Ethnicity		
African-American	322 (9)	22 (3)
Asian/Pacific Islander	74 (2)	14 (2)
Hispanic	159 (4)	32 (5)
Other	207 (5)	22 (3)
White	2,997 (80)	565 (86)
Class year		
Freshman	890 (24)	186 (28)
Sophomore	972 (26)	182 (28)
Junior	861 (23)	145 (22)
Senior/5th year	987 (26)	136 (21)
Residence location		
On-campus	1,843 (49)	304 (46)
Off-campus	1,926 (51)	352 (54)
Greek member/pledge		
Yes	527 (14)	90 (14)
No	3,243 (86)	566 (86)
Monthly spending money		
Less than $100	1,010 (27)	140 (21)
$100–$199	1,184 (31)	213 (32)
$200–$299	677 (18)	132 (20)
$300–$399	351 (9)	80 (12)
$400–$499	165 (4)	37 (6)
$500 or more	328 (9)	48 (7)
Mother's highest education		
4 year college degree or higher	1,857 (49)	378 (58)
Some college or less	1,828 (48)	265 (40)
Father's highest education		
4 year college degree or higher	1,839 (49)	391 (60)
Some college or less	1,782 (47)	243 (37)

	Overall N (%)*	Current waterpipe tobacco smokers (N=656, 17.4%) N (% of waterpipe users)*
Health-Risk Behaviors		
Cigarette smoker type	1,990 (53)	145 (22)
Never smoker	802 (21)	146 (22)
Former/experimenter	678 (18)	261 (40)
Current nondaily	256 (7)	102 (16)
Current daily		
Lifetime Illegal drug use		
Yes	213 (6)	146 (22)
No	3,482 (92)	488 (74)
Past 30 day marijuana user		
Yes	880 (23)	429 (65)
No	2,856 (76)	221 (34)
Past 30 day drinker		
Yes	2,669 (71)	607 (92)
No	1,078 (29)	49 (7)
Harm Perceptions		
Waterpipe vs. cigarette		
Less harmful	1,174 (31)	358 (55)
As harmful	1,881 (50)	216 (33)
More harmful	659 (17)	78 (12)
School-Level Variables		
Private university	530 (14)	73 (11)
Commercial waterpipe venue in community	1,498 (40)	360 (55)

*Categorical totals may differ from sample totals due to missing responses.

Table 2

Prevalence of Current Waterpipe Tobacco Smoking and Number of Commercial Waterpipe Venues by University

University	Prevalence of Current Waterpipe Smoking (%)	# of Waterpipe Venues in Community
1	13.9	0
2	30.0	1
3	16.4	2
4	25.0	3
5	22.9	0
6	6.0	0
7	13.3	0
8	9.3	0

Table 3

Multivariable Mixed-effects Logistic Regression Modeling of Past 30-Day Waterpipe Tobacco Smoking (*N*=3,770)

Characteristic*	AOR	95% CI	*P*-value
Demographics			
Gender (male vs. female)	1.55	1.24, 1.93	<0.001
Race/Ethnicity			4 df p=0.315
African-American	0.76	0.42, 1.35	0.344
Asian/Pacific Islander	1.70	0.72, 4.02	0.223
Hispanic	0.99	0.59, 1.68	0.981
Other	0.62	0.33, 1.16	0.132
White[RC]	-	-	-
Class year			4 df p<0.001
Freshman[RC]	-	-	-
Sophomore	0.71	0.52, 0.96	0.028
Junior	0.61	0.43, 0.87	0.006
Senior	0.38	0.26, 0.56	<0.001
5th yr.	0.42	0.23, 0.76	0.004
Residence location (on- vs. off-campus)	0.91	0.68, 1.22	0.536
Greek member/pledge (yes vs. no)	0.95	0.69, 1.30	0.747
Monthly spending money			5 df p=0.521
Less than $100[RC]	-	-	-
$100–$199	0.94	0.69, 1.26	0.661
$200–$299	1.06	0.76, 1.49	0.729
$300–$399	1.12	0.75, 1.67	0.585
$400–$499	1.38	0.81, 2.33	0.237
$500 or more	0.80	0.50, 1.28	0.349
Mother's highest education			
4 year college degree or higher	0.98	0.77, 1.26	0.894
Some college or less[RC]	-	-	-
Father's highest education			
4 year college degree or higher	1.05	0.81, 1.35	0.722
Some college or less[RC]	-	-	-
Health-Risk Behaviors			
Cigarette smoker type			3 df p<0.001
Never smoker [RC]	-	-	-

Characteristic*	AOR	95% CI	*P*-value
Former/experimenter	1.95	1.45, 2.63	<0.001
Current nondaily	2.59	1.92, 3.49	<0.001
Current daily	2.80	1.85, 4.23	<0.001
Lifetime illegal drug use (yes vs. no)	3.13	2.14, 4.56	<0.001
Past 30-day marijuana use (yes vs. no)	4.43	3.46, 5.66	<0.001
Past 30-day drinking (yes vs. no)	2.20	1.52, 3.17	<0.001
Harm Perceptions			
Waterpipe vs. cigarette			2 df p<0.001
Less harmful	2.66	2.10, 3.38	<0.001
As harmful RC	-	-	-
More harmful	1.15	0.82, 1.61	0.431
School-Level Variables			
Private university (yes vs. no)	0.84	0.48, 1.47	0.537
Commercial waterpipe venue in community (yes vs. no)	1.60	1.10, 2.33	0.014

*Also adjusted for school as a random effect; RC = reference category

Table 4

Cross-tabulations of Cigarette and Marijuana Use with Current Waterpipe Use

	Current Waterpipe Use				Current Waterpipe Use		
Current Cigarette Smoking	**No**	**Yes**	**Total**	**Current Marijuana Smoking**	**No**	**Yes**	**Total**
No	2,506[a]	292	2,798	**No**	2,610	221	2,831
	89.6%[b]	10.4%	100%		92.2%	7.8%	100%
	81.7%[c]	44.6%	75.2%		85.4%	34.0%	76.4%
Yes	562	363	925	**Yes**	447	429	876
	60.8%	39.2%	100%		51.0%	49.0%	100%
	18.3%	55.4%	24.9%		14.6%	66.0%	23.6%
Total	3,068	655	3,723	**Total**	3,057	650	3,707
	82.4%	17.6%	100%		82.5%	17.5%	100%
	100%	100%	100%		100%	100%	100%
	$\chi^2(df=1)=397.9$				$\chi^2(df=1)=784.0$		
	$p<.001$				$p<.001$		
	Cramer's $V=.33$				Cramer's $V=.46$		
	$n=47$ missing				$n=63$ missing		

Note.

[a] Frequency;

[b] Row percentage;

[c] Column percentage.