



HHS Public Access

Author manuscript

Drug Alcohol Depend. Author manuscript; available in PMC 2016 August 01.

Published in final edited form as:

Drug Alcohol Depend. 2015 August 1; 153: 359–363. doi:10.1016/j.drugalcdep.2015.05.015.

Factors Associated with Smoking Frequency among Current Waterpipe Smokers in the United States: Findings from the National College Health Assessment II

M. Rifat Haider^{1,2}, Ramzi G. Salloum³, Farahnaz Islam¹, Kasim S. Ortiz¹, Frederick R. Kates¹, and Wasim Maziak^{4,5}

¹Department of Health Services Policy and Management, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA

²Department of Public Health and Informatics, Jahangirnagar University, Savar, Dhaka, Bangladesh

³Department of Health Outcomes and Policy, University of Florida College of Medicine, Gainesville, FL, USA

⁴Stempel College of Public Health and Social Work, Florida International University, Miami, FL, USA

⁵Syrian Center for Tobacco Studies, Aleppo, Syria

Abstract

Background—Some waterpipe smokers exhibit nicotine dependent behaviors such as increased use over time and inability to quit, placing them at high risk of adverse health outcomes. This study examines the determinants of dependence by measuring frequency of use among current waterpipe smokers using a large national U.S. sample.

Methods—Data were drawn from four waves (Spring/Fall 2009 and Spring/Fall 2010) of the American College Health Association-National College Health Assessment datasets. The sample was restricted to students who smoked a waterpipe at least once in the past 30 days (N=19,323). Ordered logistic regression modeled the factors associated with higher frequency of waterpipe smoking.

Results—Among current waterpipe smokers, 6% used a waterpipe daily or almost daily (20–29 days). Daily cigarette smokers were at higher odds of smoking a waterpipe at higher frequencies compared with non-smokers of cigarettes (OR=1.81; 95% CI=1.61–2.04). There was a strong association between daily cigar smoking and higher frequency of waterpipe smoking (OR=7.77; 95% CI=5.49–11.02). Similarly, students who used marijuana had higher odds of smoking a waterpipe at higher frequencies (OR=1.57; 95% CI=1.37–1.81).

Corresponding author: Ramzi G. Salloum, Department of Health Outcomes and Policy, University of Florida College of Medicine, PO Box 100177, Gainesville, FL, 32610, Tel: +1 (352) 627-9467, Fax: +1 (352) 265-8047, rsalloum@ufl.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conclusions—Daily consumers of other addictive substances are at a higher risk of intensive waterpipe smoking and thus higher risk of waterpipe dependence. Intervention programs must incorporate methods to reduce waterpipe dependence and subsequently prevent its deleterious health effects.

Keywords

waterpipe; hookah; college students; frequency; dependence

1. INTRODUCTION

Waterpipe smoking (also known as hookah, shisha, and narghileh) is increasing in popularity in the United States, with the highest prevalence rates reported among college students (Maziak et al., 2015; Salloum et al., 2014). Waterpipe smoke contains many of the same toxicants as cigarette smoke (Shihadeh et al., 2015), and waterpipe smoking has been associated with respiratory and cardiovascular illnesses, periodontal disease, and obstetric and perinatal complications (Akl et al., 2010; El-Zaatari et al., 2015). Similar to cigarette smokers, waterpipe smokers exhibit nicotine dependent behaviors such as increased use over time, drug-seeking behaviors, withdrawal symptoms following abstinence, and inability to quit even after repeated attempts (Kassim et al., 2014; Maziak et al., 2005).

To assess the magnitude and implication of this addictive behavior, there is a need to understand dependence patterns of waterpipe smokers and identify those at high risk of becoming addicted. Waterpipe smoking delivers the same or higher doses of nicotine compared with cigarette smoking (Cobb et al., 2011; Eissenberg and Shihadeh, 2009), with daily users exposed to considerably higher levels (Maziak et al., 2011). While waterpipe smoking is mainly an intermittent tobacco use method, smoking frequency increases with prolonged use (Asfar et al., 2005). Higher frequency of waterpipe use is associated with younger age at initiation, perception of being hooked, and smoking a waterpipe in groups (Ward et al., 2007). Higher waterpipe smoking frequency is also correlated with physiological dependence, psychological craving, positive reinforcement, and higher scores on a waterpipe-specific dependence measure (Salameh et al., 2008). These results suggest that smoking frequency may be an acceptable proxy for waterpipe dependence.

Recent studies have examined waterpipe smoking patterns in the U.S., in particular, the correlates of current waterpipe smoking. However, most have been limited to specific geographic regions. For example, Eissenberg et al. (2008) conducted a study among college students in Virginia, revealing that 20% were current waterpipe smokers and more likely to be male, younger than 20 years, and white. A study using the 2008–2009 National College Health Assessment (NCHA) showed that 8.4% are current waterpipe smokers and that current waterpipe smoking was strongly associated with younger age, male gender, white race, and fraternity/sorority membership (Primack et al., 2013). Other studies using local/regional samples have also reported that gender, ethnicity, and cigarette use are associated with current waterpipe smoking (Smith-Simone et al., 2008; Sutfin et al., 2011). Overall, these studies have concluded that college students have some of the highest prevalence rates for waterpipe smoking (Akl et al., 2011; Maziak et al., 2015).

While we are beginning to understand waterpipe smoking patterns in the U.S. and worldwide, there is limited knowledge about dependence among waterpipe smokers. Using frequency of use as a proxy to waterpipe dependence, a study in Syria found that daily smokers – compared to weekly/monthly – were more likely to be male, smoke alone at home and less likely to share their waterpipe with others (Maziak et al., 2004). However, the extent and correlates of waterpipe dependence among the adult population in the U.S. has not been investigated. A better understanding of waterpipe smoking dependence is critically needed to inform intervention and prevention strategies among youth. Using NCHA data, this study provides national estimates of the prevalence and correlates of frequent waterpipe smoking as a proxy to dependence among U.S. college students.

2. METHODS

2.1 Data Source

The NCHA has been administered by the American College Health Association (ACHA) to assess the health and well-being of university students since 2000. The survey collects data from random samples of students at voluntarily participating universities on physical health, mental health, use and dependence on alcohol, tobacco or drugs, sex behavior and contraception practices, weight, nutrition and exercise along with student demographic information (American College Health Association, 2008). Further details on survey methodology are reported elsewhere (Jarrett et al., 2012). Our study sample was pooled from four waves (semesters) of ACHA-NCHA II datasets (Spring/Fall, 2009 and Spring/Fall, 2010) and included 247,118 respondents. For the dependence related analysis (frequency of use as a proxy), our sample was restricted to 19,323 students who smoked a waterpipe at least once in the past 30 days [Within the last 30 days, on how many days did you use tobacco from a waterpipe (hookah)?]. Approval for the study protocol was obtained from the Institutional Review Board of the University of South Carolina.

2.2 Dependent Variable

Students who smoked a waterpipe in the past 30 days were asked to report frequency of smoking by category: (1) 1–2 days, (2) 3–5 days, and (3) 6–9 days, (4) 10–19 days, (5) 20–29 days, and (6) daily. Thus, the dependent variable for the correlates of frequent waterpipe smoking was treated as an ordinal variable with six levels.

2.3 Independent Variables

The main predictor of interest was frequency of cigarette smoking, for which students were categorized as non-smokers, non-daily smokers, or daily smokers. We also included frequency of use for the following tobacco and drug products: cigar smokers (non-smokers, non-daily, or daily), smokeless tobacco use (never, non-daily, or daily), marijuana use (never, non-daily, or daily), cocaine use (never, non-daily, or daily), and alcohol use (never, non-daily, or daily). We defined participants as *non-smokers/never users* if they never used the product; *non-daily users* if they ever used the product but were not daily users; and *daily users* if they used the product every day for the past 30 days. Other covariates included in our analysis, include age (in years), gender (male or female), race/ethnicity (white, African American, Hispanic/Latino, Asian/Pacific Islanders, or other), sexual orientation

(heterosexual/straight or lesbian/gay/bisexual/transgender [LGBT]), marital status (married/partnered or not married), educational status (undergraduate or graduate/professional/other), residence (on-campus or off-campus), fraternity/sorority membership, and geographic region (Northeast, Midwest, South, or West).

2.4 Data Analyses

For descriptive statistics, we measured frequency and percentage of sample characteristics for current waterpipe smokers and not current waterpipe smokers. Multilevel ordered logistic regression was used to model the factors associated with increased frequency of smoking among current waterpipe smokers. College ID was used as the random effect in this model to account for possible confounding among students within the same institution. We tested the proportionality odds assumption (i.e., whether the distances among categories are equal) after fitting the model. Our modeling assumption was appropriate given the large sample size (Long and Freese, 2006). We also obtained similar results using an alternative ordinary least squares model (results not shown). The multilevel ordered logistic model was selected over ordinary least squares due to ease of interpretation. All analyses were performed with STATA version 13.1.

3. RESULTS

3.1 Characteristics of Current Waterpipe Smokers versus Not Current Smokers

Among current waterpipe smokers ($N=19,323$), 536 (2.8%) were daily users, and another 612 (3.2%) reported smoking on 20–29 days (almost daily) in the past month (Table 1). In terms of concurrent tobacco use, the majority of current waterpipe smokers were non-daily cigarette smokers (56.6%), and non-daily cigar smokers (62.6%). Meanwhile, 30.8% of current waterpipe smokers never smoked a cigarette. The majority of students who were not current waterpipe smokers did not smoke cigarettes (70.3%), did not smoke cigars (76.1%), never used smokeless tobacco (90.7%), never smoked marijuana (68.2%), and never used cocaine (94.7%). Almost 25% of students who did not currently smoke a waterpipe never consumed alcohol while only 3.6% of current waterpipe smokers never consumed alcohol. The majority of current waterpipe smokers in this sample were female (52.9%), white (71.5%), heterosexual (91.9%), unmarried (97.1%), at the undergraduate level (95.0%), and not members in a fraternity/sorority (85.8%). Approximately half of current waterpipe smokers (50.1%) resided on-campus whereas the majority (57.7%) of non-current waterpipe smokers resided off-campus.

3.2 Predictors of Waterpipe Smoking Frequency

Multilevel ordered logistic regression results showed that daily (OR=1.81; 95% CI=1.61–2.04) and non-daily (OR=1.24; 95% CI=1.14–1.35) cigarette smokers were at higher odds of smoking a waterpipe at higher frequencies compared with non-smokers of cigarettes. Strong correlates of high waterpipe smoking frequency included daily (OR=7.77; 95% CI=5.49–11.02) and non-daily (OR=1.11; 95% CI=1.03–1.21) cigar smoking, daily (OR=1.57; 95% CI=1.37–1.81) and non-daily (OR=1.12; 95% CI=1.03–1.21) marijuana smoking, and daily use of cocaine (OR=18.49; 95% CI=8.24–41.50). Whereas daily alcohol consumption was correlated with high waterpipe smoking frequency (OR=1.84; 95% CI=1.39–2.43), non-

daily use of alcohol was significantly associated with lower waterpipe smoking frequency (OR=0.71; 95% CI=0.59–0.85). Compared to white waterpipe smokers, African Americans (OR=1.26; 95% CI=1.00–1.58), Asians (OR=1.18; 95% CI=1.05–1.33) and students from other races/ethnic groups (OR=1.19; 95% CI=1.06–1.34) were at higher odds of smoking a waterpipe at higher frequencies. Other significant correlates of high waterpipe smoking frequency included being male (OR=1.21; 95% CI=1.13–1.30), married (OR=1.36; 95% CI=1.11–1.66), and membership in fraternities/sororities (OR=1.17; 95% CI=1.07–1.28). Correlates of low waterpipe smoking frequency included graduate/professional status (OR=0.68; 95% CI=0.56–0.84) and on-campus residence (OR=0.84; 95% CI=0.78–0.91).

4. DISCUSSION

To our knowledge, this is the first study to report on the population determinants of waterpipe smoking frequency among current waterpipe smokers attending U.S. colleges and universities. The findings shed new light on this group of smokers, and what characterizes the potentially more dependent waterpipe users. Daily consumption of other addictive substances such as alcohol and other tobacco products, with the exception of smokeless tobacco, was strongly associated with higher frequencies of waterpipe smoking. Non-daily use of these addictive substances was also correlated with higher frequencies of waterpipe smoking, with the exception of non-daily alcohol use, which had a protective effect. Smoker characteristics associated with higher waterpipe smoking frequency included being male, African American, Asian, of other minority groups, married, undergraduate status, off-campus residence, membership in fraternities/sororities, and residence in Western states.

In prior studies of waterpipe smoking patterns in the U.S. general population, whites have been shown to have higher prevalence rates than African Americans (Grekin and Ayna, 2012). However, among current waterpipe smokers, we found African Americans, Asians and other racial/ethnic minorities to smoke more frequently. This is the first study to show that minorities may be smoking a waterpipe at higher frequencies and thus more susceptible to its harmful health effects. This is an important finding that deserves further exploration into the causes of this disparity.

While waterpipe smoking prevalence rates are higher among sexual minorities in the general adult population (Salloum et al., 2015), LGBT college students were not found to smoke at significantly higher frequencies than non-LGBT students. Among students who were current waterpipe smokers, being married was associated with increased waterpipe smoking frequency. This finding is somewhat unexpected given that waterpipe smoking prevalence rates are lower among married individuals compared with their unmarried counterparts (Primack et al., 2013). Students residing in on-campus housing were found to smoke a waterpipe at lower frequencies. This may be attributable to smoking bans in college dormitories. Meanwhile, the finding that membership in fraternities and sororities is associated with higher frequency of waterpipe smoking is consistent with prior results linking Greek membership with waterpipe smoking (Primack et al., 2013). This suggests that implementing and enforcing policies to make Greek housing and off-campus accommodations smoke-free, and including waterpipes in these bans, may reduce waterpipe smoking among these sub-groups of students.

Waterpipe smoking frequency has been shown to be associated with a variety of dependence measures including scores on a waterpipe-specific dependence scale (Aboaziza and Eissenberg, 2015; Salameh et al., 2008). Hence, the correlates of higher waterpipe smoking frequency found in this study can be directly related to characteristics of more dependent users. Furthermore, a study by DiFranza et al. (2002) found that symptoms of nicotine dependence among youth usually present at lower levels of nicotine exposure, suggesting that a substantial number of the participants in this study may be waterpipe dependent.

This study has several limitations. First, only one aspect of dependence is observed (i.e., waterpipe smoking frequency). Whereas frequency can provide an initial understanding of the determinants of dependence, tobacco dependence is a multi-dimensional concept incorporating withdrawal and drug-seeking behavior. Despite the large national sample used in this study, participating colleges and universities were self-selected and thus findings may not be generalizable. Since the sample is college-based and includes a higher proportion of females, our findings are likely to be conservative compared to population estimates. Previous research shows that 18–24 year olds not attending college have a higher rate of smoking than those who attend college (Lawrence et al., 2007) and females smoke a waterpipe less frequently than males in the general adult population (Salloum et al., 2015).

To our knowledge, this paper is the first to describe waterpipe smoking frequency and its correlates among current waterpipe smokers in the U.S. Of interest is the association between frequent waterpipe smoking and the use of other addictive substances. Understanding the patterns of waterpipe smoking in the context of multidrug use is essential to inform prevention and intervention programs, including smoking cessation efforts.

References

- Aboaziza E, Eissenberg T. Waterpipe tobacco smoking: what is the evidence that it supports nicotine/tobacco dependence? *Tob Control*. 2015; 24(Suppl 1):i44–i53. [PubMed: 25492935]
- Akl EA, Gaddam S, Gunukula SK, Honeine R, Jaoude PA, Irani J. The effects of waterpipe tobacco smoking on health outcomes: a systematic review. *Int J Epidemiol*. 2010; 39:834–857. [PubMed: 20207606]
- Akl EA, Gunukula SK, Aleem S, Obeid R, Jaoude PA, Honeine R, Irani J. The prevalence of waterpipe tobacco smoking among the general and specific populations: a systematic review. *BMC Public Health*. 2011; 11:244. [PubMed: 21504559]
- American College Health Association. ACHA-NCHA II Sample Paper Survey (Fall 2008 to Spring 2011). 2008. from http://www.acha-ncha.org/docs/ACHA-NCHA_II_Paper_Survey_2008_SAMPLE.pdf
- Asfar T, Ward KD, Eissenberg T, Maziak W. Comparison of patterns of use, beliefs, and attitudes related to waterpipe between beginning and established smokers. *BMC Public Health*. 2005; 5:19. [PubMed: 15733316]
- Cobb CO, Shihadeh A, Weaver MF, Eissenberg T. Waterpipe tobacco smoking and cigarette smoking: a direct comparison of toxicant exposure and subjective effects. *Nicotine Tob Res*. 2011; 13:78–87. [PubMed: 21127030]
- DiFranza JR, Savageau JA, Rigotti NA, Fletcher K, Ockene JK, McNeill AD, Coleman M, Wood C. Development of symptoms of tobacco dependence in youths: 30 month follow up data from the DANDY study. *Tob Control*. 2002; 11:228–235. [PubMed: 12198274]
- Eissenberg T, Shihadeh A. Waterpipe tobacco and cigarette smoking: direct comparison of toxicant exposure. *Am J Prev Med*. 2009; 37:518–523. [PubMed: 19944918]

- Eissenberg T, Ward KD, Smith-Simone S, Maziak W. Waterpipe tobacco smoking on a U.S. College campus: prevalence and correlates. *J Adolesc Health*. 2008; 42:526–529. [PubMed: 18407049]
- El-Zaatari ZM, Chami HA, Zaatari GS. Health effects associated with waterpipe smoking. *Tob Control*. 2015; 24(Suppl 1):i31–i43. [PubMed: 25661414]
- Grekin ER, Ayna D. Waterpipe smoking among college students in the United States: a review of the literature. *J Am Coll Health*. 2012; 60:244–249. [PubMed: 22420702]
- Jarrett T, Blosnich J, Tworek C, Horn K. Hookah use among U.S. college students: results from the National College Health Assessment II. *Nicotine Tob Res*. 2012; 14:1145–1153. [PubMed: 22318687]
- Kassim S, Al-Bakri A, Al'Absi M, Croucher R. Waterpipe tobacco dependence in U.K. male adult residents: a cross-sectional study. *Nicotine Tob Res*. 2014; 16:316–325. [PubMed: 24130142]
- Lawrence D, Fagan P, Backinger CL, Gibson JT, Hartman A. Cigarette smoking patterns among young adults aged 18–24 years in the United States. *Nicotine Tob Res*. 2007; 9:687–697. [PubMed: 17558826]
- Long, JS., Freese, J. Regression models for categorical dependent variables using Stata. Stata Press; College Station, TX: 2006.
- Maziak W, Eissenberg T, Ward KD. Patterns of waterpipe use and dependence: implications for intervention development. *Pharmacol Biochem Behav*. 2005; 80:173–179. [PubMed: 15652393]
- Maziak W, Rastam S, Shihadeh AL, Bazzi A, Ibrahim I, Zaatari GS, Ward KD, Eissenberg T. Nicotine exposure in daily waterpipe smokers and its relation to puff topography. *Addict Behav*. 2011; 36:397–399. [PubMed: 21185126]
- Maziak W, Taleb ZB, Bahelah R, Islam F, Jaber R, Auf R, Salloum RG. The global epidemiology of waterpipe smoking. *Tob Control*. 2015; 24(Suppl 1):i3–i12. [PubMed: 25298368]
- Maziak W, Ward KD, Eissenberg T. Factors related to frequency of narghile (waterpipe) use: the first insights on tobacco dependence in narghile users. *Drug Alcohol Depend*. 2004; 76:101–106. [PubMed: 15380294]
- Primack BA, Shensa A, Kim KH, Carroll MV, Hoban MT, Leino EV, Eissenberg T, Dachtler KH, Fine MJ. Waterpipe smoking among U.S. university students. *Nicotine Tob Res*. 2013; 15:29–35. [PubMed: 22641433]
- Salameh P, Waked M, Aoun Z. Waterpipe smoking: construction and validation of the Lebanon Waterpipe Dependence Scale (LWDS-11). *Nicotine Tob Res*. 2008; 10:149–158. [PubMed: 18188755]
- Salloum RG, Osman A, Maziak W, Thrasher JF. How popular is waterpipe tobacco smoking? Findings from internet search queries. *Tob Control*. 2014; 23:1136/tobaccocontrol-2014-051675
- Salloum RG, Thrasher JF, Kates FR, Maziak W. Water pipe tobacco smoking in the United States: findings from the National Adult Tobacco Survey. *Prev Med*. 2015; 71:88–93. [PubMed: 25535678]
- Shihadeh A, Schubert J, Klaiany J, El Sabban M, Luch A, Saliba NA. Toxicant content, physical properties and biological activity of waterpipe tobacco smoke and its tobacco-free alternatives. *Tob Control*. 2015; 24(Suppl 1):i22–i30. [PubMed: 25666550]
- Smith-Simone S, Maziak W, Ward KD, Eissenberg T. Waterpipe tobacco smoking: knowledge, attitudes, beliefs, and behavior in two U.S. samples. *Nicotine Tob Res*. 2008; 10:393–398. [PubMed: 18236304]
- Sutfin EL, McCoy TP, Reboussin BA, Wagoner KG, Spangler J, Wolfson M. Prevalence and correlates of waterpipe tobacco smoking by college students in North Carolina. *Drug Alcohol Depend*. 2011; 115:131–136. [PubMed: 21353750]
- Ward KD, Eissenberg T, Gray JN, Srinivas V, Wilson N, Maziak W. Characteristics of U.S. waterpipe users: a preliminary report. *Nicotine Tob Res*. 2007; 9:1339–1346. [PubMed: 18058352]

Highlights

- This is the first study of waterpipe smoking frequency and its correlates in the US
- Among a US sample of college students, 6% used a waterpipe daily or almost daily
- Daily use of addictive substances was associated with frequent waterpipe smoking
- Being male and African American were associated with frequent waterpipe smoking

Table 1

Characteristics of Current Waterpipe Smokers versus Non-Smokers: National College Health Assessment II (2009–2010)

Characteristics	Current Waterpipe Smokers* N = 19,323 (7.8%) n (%) **	Not Current Waterpipe Smokers N = 225,977 (91.4%) n (%)
Waterpipe smoking frequency, in days		
1–2	12,063 (62.4)	-
3–5	3,421 (17.7)	-
6–9	1,589 (8.22)	-
10–19	1,102 (5.7)	-
20–29	612 (3.2)	-
Daily	536 (2.8)	-
Cigarette smoking status		
Non-smoker	5,921 (30.8)	158,542 (70.3)
Non-daily	10,884 (56.6)	57,198 (25.4)
Daily	2,434 (12.7)	9,775 (4.3)
Cigar smoking status		
Non-smoker	6,809 (35.6)	171,562 (76.1)
Non-daily	11,993 (62.6)	53,386 (23.7)
Daily	349 (1.8)	378 (0.2)
Smokeless tobacco use		
Never	14,131 (73.8)	203,490 (90.7)
Non-daily	4,555 (23.8)	19,334 (8.6)
Daily	452 (2.4)	1,600 (0.7)
Marijuana use		
Never	5,358 (27.9)	153,461 (68.2)
Non-daily	12,217 (63.6)	68,018 (30.2)
Daily	1,627 (8.5)	3,592 (1.6)
Cocaine use		
Never	16,306 (84.8)	213,221 (94.7)
Non-daily	2,728 (14.2)	11,890 (5.3)
Daily	185 (1.0)	75 (0.03)
Alcohol use		
Never	695 (3.6)	51,802 (23.1)
Non-daily	17,845 (93.2)	170,842 (76.1)
Daily	598 (3.1)	1,966 (0.9)
Age, in years		
18–20	12,395 (66.2)	109,296 (49.5)
21–24	5,474 (29.2)	71,420 (32.3)
25 +	870 (4.6)	40,212 (18.2)
Gender		
Female	9,913 (52.9)	144,834 (65.5)

Characteristics	Current Waterpipe Smokers* N = 19,323 (7.8%) n (%) **	Not Current Waterpipe Smokers N = 225,977 (91.4%) n (%)
Male	8,825 (47.1)	76,298 (34.5)
Race		
White	13,441 (71.5)	151,912 (68.6)
African American	451 (2.4)	12,223 (5.5)
Hispanic/Latino	1,430 (7.6)	15,141 (6.8)
Asian/Pacific Islander	1,713 (9.1)	26,092 (11.8)
Other	1,759 (9.4)	15,997 (7.2)
Sexual orientation		
Heterosexual	16,889 (91.9)	205,650 (94.8)
Lesbian, gay, bisexual, or transgender	1,485 (8.1)	11,289 (5.2)
Marital status		
Not married	18,261 (97.1)	197,726 (89.2)
Married/partnered	546 (2.9)	23,853 (10.8)
Education		
Undergraduate	17,846 (95.0)	188,549 (85.4)
Graduate/professional/other	943 (5.0)	32,276 (14.6)
Residence		
Off-Campus	9,396 (49.9)	127,930 (57.7)
On-Campus	9,425 (50.1)	93,874 (42.3)
Fraternity/sorority		
Member	2,651 (14.2)	200,626 (91.0)
Non-member	16,072 (85.8)	19,854 (9.0)
Geographical region		
Northeast	4,277 (23.0)	52,845 (24.9)
Midwest	3,241 (17.4)	37,947 (17.9)
South	4,805 (25.8)	57,649 (27.1)
West	6,302 (33.8)	64,002 (30.1)

* Smoked waterpipe at least once in the past 30 days

** Some columns may not sum up to 100% due to missing values

Table 2

Multilevel Ordered Logistic Regression Model of Waterpipe Smoking Frequency*

Fixed Effects**	Odds Ratio	95% CI
Cigarette smoking status		
Non-smoker	1.00	
Non-daily	1.24	1.14–1.35
Daily	1.81	1.61–2.04
Cigar smoking status		
Non-smoker	1.00	-
Non-daily	1.11	1.03–1.21
Daily	7.77	5.49–11.02
Smokeless tobacco use		
Never	1.00	-
Non-daily	1.00	0.92–1.09
Daily	1.18	0.91–1.53
Marijuana use		
Never	1.00	-
Non-daily	1.12	1.03–1.21
Daily	1.57	1.37–1.81
Cocaine use		
Never	1.00	-
Non-daily	1.03	0.93–1.13
Daily	18.49	8.24–41.50
Alcohol use		
Never	1.00	-
Non-daily	0.71	0.59–0.85
Daily	1.84	1.39–2.43
Age, in years		
18–20	1.00	-
21–24	0.79	0.73–0.86
25 +	0.74	0.60–0.90
Gender		
Female	1.00	-
Male	1.21	1.13–1.30
Race		
White	1.00	-
African American	1.26	1.00–1.58
Hispanic/Latino	0.96	0.84–1.09
Asian/Pacific Islander	1.18	1.05–1.33
Other	1.19	1.06–1.34
Sexual orientation		
Heterosexual	1.00	-

Fixed Effects**	Odds Ratio	95% CI
Lesbian, gay, bisexual, or transgender	0.98	0.87–1.11
Marital status		
Not married	1.00	-
Married/partnered	1.36	1.11–1.66
Education		
Undergraduate	1.00	-
Graduate/professional/other	0.68	0.56–0.84
Residence		
Off-Campus Housing	1.00	-
On-Campus Housing	0.84	0.78–0.91
Fraternity/sorority		
Non-member	1.00	-
Member	1.17	1.07–1.28
Geographic region		
Northeast	1.00	-
Midwest	0.96	0.84–1.10
South	1.05	0.92–1.18
West	1.19	1.06–1.35

* Waterpipe smoking frequency categories: 1= 1–2 days; 2= 3–5 days; 3= 6–9 days; 4= 10–19 days; 5= 20–29 days; 6= daily

** Random effect: College ID; variance = 0.06; 95% CI = 0.04 – 0.09