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Prevalence of and Associations with Waterpipe Tobacco Smoking among U.S. University Students

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Abstract

Background—Although waterpipe tobacco smoking seems to be increasing on U.S. university campuses, these data have come from convenience samples.

Purpose—We aimed to determine the prevalence of and associations with waterpipe tobacco smoking among a random sample of students.

Methods—We surveyed a random sample of graduate and undergraduate students at a large, urban university. We used multivariate modeling to determine independent associations between belief-related predictors and waterpipe tobacco smoking.

Results—Of the 647 respondents, waterpipe smoking was reported in 40.5%, over the past year in 30.6%, and over the past 30 days in 9.5%. Over half of the sample (52.1%) perceived that tobacco smoking from a waterpipe was less addictive than cigarette smoking. In fully adjusted multivariate models, 1-year waterpipe smoking was associated with low perceived harm (OR=2.54, 95% CI=1.68, 3.83), low perceived addictiveness (OR=4.64, 95% CI=3.03, 7.10), perception of high social acceptability (OR=20.00, 95% CI=6.03, 66.30), and high perception of popularity (OR=4.72, 95% CI=2.85, 7.82).

Conclusions—In this sample, lifetime waterpipe use was as common as lifetime cigarette use. Perception of harm, perception of addictiveness, social acceptability, and popularity were all strongly related to waterpipe smoking.

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Keywords

Waterpipe; Hookah; Narghile; Shisha; Tobacco; Smoking

Introduction

A waterpipe, also known as a hookah, narghile, or shisha, consists of a head into which tobacco is placed, a body that is half-filled with water, and a hose through which the user inhales. Often the tobacco is flavored (e.g., apple, coffee, mint) and sweetened. When the user inhales, smoke passes through the water and hose and into the lungs. Smoke inhalation can be substantial: a single waterpipe use episode can last 30–60 min and can involve more than one hundred inhalations, each of approximately 500 ml in volume [1,2]. Thus, while smoking a single cigarette might produce a total of approximately 500–600 ml of smoke, a single waterpipe use episode might produce about 50,000 ml of smoke [3].

Waterpipe smoke contains many of the same toxicants as cigarette smoke, including carcinogenic polycyclic aromatic hydrocarbons, carbon monoxide (CO), and nicotine [1,4]. Not surprisingly, CO is found in waterpipe users' breath [5,6] and nicotine is found in their blood [5]. Waterpipe tobacco smoking has been associated with substantial harm, including cancer, cardiovascular disease, decreased pulmonary function, and nicotine dependence [7–10].

The prevalence of this behavior seems to be growing, especially on college campuses. About 200–300 new waterpipe cafés had opened in the U.S. between 1999 and 2004, usually in college towns [11]. Media reports from over 30 U.S. states [12] and anecdotal reports in scientific journals [13] reinforce perceptions that waterpipe use among college students is growing. Finally, convenience sample surveys suggest high use rates: a survey of 411 university first-year students indicated 15.3% had used a waterpipe to smoke tobacco in the past 30 days [14], while another survey of 744 introductory psychology students revealed 20% past 30-day waterpipe tobacco smoking [15].

Unfortunately, convenience sample surveys are vulnerable to a host of response biases that might affect results. Moreover, there is little information concerning what sociodemographic and belief-related factors might be associated with waterpipe use. Because there may be a sense among users that waterpipe tobacco smoking is less risky to one's health and less dependence-producing than cigarettes [14–16], capturing users' beliefs about waterpipe use would be valuable.

The purpose of this study was to determine the 30-day, annual, and lifetime prevalence of waterpipe smoking in a random sample of students attending a major U.S. university. Additionally, we aimed to determine associations between outcome variables and sociodemographic and predictors based on the Theory of Reasoned Action [17]. We hypothesized that waterpipe smoking would be common and would be associated with (1) less concern about harm, (2) less concern about dependence, (3) greater perceived peer acceptance, and (4) greater perceived sense of popularity.

Methods

Study Design, Context, and Procedures

We conducted a cross-sectional survey of a random sample of students at the University of Pittsburgh, a large urban university with approximately 16,000 undergraduate and 8,000 graduate students. The data for this study were collected via the web-based version of the

American College Health Association's (ACHA) National College Health Assessment (NCHA) [18], which is conducted each semester at selected institutions. For a fee, participating institutions can include additional items of their own design. In addition to the standard items, we added eight items addressing waterpipe tobacco smoking behaviors and beliefs.

With permission from the University Vice Provost, University Computing Services generated a list of the e-mail addresses and key demographic data for 3,600 randomly selected students. This number was selected based both on our power calculations and on guidance from the ACHA that, in their experience, response rates for e-mail surveys among university students are generally low (10–30%). We ensured that demographic data on all 3,600 would be available so that we could determine any differences between respondents and non-respondents.

This study was approved as Exempt by the University Institutional Review Board. The survey was administered April 2007 during a 3-week period. We strategically selected this time period to avoid the 30-day period following Spring Break, since some survey items asked about risk-taking behavior over the past 30 days. Students were sent an invitation e-mail detailing the specifics of the survey and a link to the instrument. The invitation stated that the survey was anonymous and that participation was voluntary. To motivate student participation, respondents completing the survey were automatically enrolled in a lottery to win cash prizes ranging from $25 to $100. Three reminder e-mails were sent to students during the 3-week period.

Measures

We collected demographic data including age in years, gender, and self-reported race. We also asked about housing arrangement (on-campus vs. off-campus), student status (undergraduate vs. graduate) and membership in a fraternity or sorority. Finally, students provided self-reported academic achievement.

We asked three dichotomous items to assess waterpipe tobacco smoking behavior: (1) have you *ever* smoked *tobacco* from a waterpipe (hookah, shisha, narghile), even one or two puffs? (yes/no); (2) during the *past year*, have you smoked *tobacco* from a waterpipe (hookah, shisha, narghile), even one or two puffs? (yes/no); and (3) during the *past 30 days*, have you smoked *tobacco* from a waterpipe (hookah, shisha, narghile), even one or two puffs? (yes/no). We underlined the word “tobacco” based on our pilot studies; some students smoke marijuana from waterpipes, and we wanted to ensure that respondents were referring only to tobacco.

We assessed beliefs related to health-related expectancies and social norms, precursors of behavioral intention according to the Theory of Reasoned Action [17]. We asked two separate items to measure students’ expectancies of the relative harm and addictiveness of smoking tobacco from a waterpipe. One item asked “Would you say that smoking from a waterpipe (hookah, shisha, narghile) is *more harmful* or *less harmful* than smoking regular cigarettes?” and provided students with five response categories ranging from “Waterpipe smoking is *much more harmful* than smoking regular cigarettes” to “Waterpipe smoking is *much less harmful* than smoking regular cigarettes.” For analysis, we collapsed survey responses into three categories: “waterpipe more harmful”; “waterpipe same harm”; “waterpipe less harmful.” A similar item asked “Would you say that smoking from a waterpipe (hookah, shisha, narghile) is *more addictive* or *less addictive* than smoking regular cigarettes?” and was collapsed similarly into three categories.

In order to measure students' normative beliefs regarding waterpipe smoking, we asked students "Among your peers, how *socially acceptable* is it to smoke tobacco from a waterpipe (hookah, shisha, narghile)?" We collapsed survey responses into three categories: "not acceptable"; "somewhat/moderately acceptable"; and "very acceptable." Also related to normative beliefs, we asked students to respond to the item "What percentage of college students do you think has *ever* smoked tobacco from a waterpipe (hookah, shisha, narghile)?" by filling in a number from 0 to 100. For analysis, we collapsed responses into tertiles.

Analysis

We first performed a descriptive analysis, comparing survey responses in the total sample and among those who had and had not smoked tobacco from a waterpipe in the past year. We then used bivariate and multivariate regression techniques to assess the association between each of the dependent variables (annual waterpipe smoking and 30-day waterpipe smoking) and the predictors (perception of harm, perception of addictiveness, acceptability, and popularity). In each of the multivariate models, we used all measured covariates. In order to determine the robustness of our results, we also ran all analyses using stepwise backward logistic regression for each outcome, using criteria for removal from the model of $p<0.15$. The tests for the main effects were considered significant for $p<0.05$.

Results

Of the 3,600 students to whom offers of participation were sent, 61 e-mails were returned as undeliverable. Of the remaining 3,539 students, 660 (18.6%) completed the questionnaire. Since 13 of the 660 respondents did not respond to the outcome variables, 647 (98.0%) had complete evaluable data for this study. Compared with non-respondents, respondents were younger (20.9 vs. 21.4, $p<0.001$), more likely to be female (65.6% vs. 50.5%, $p<0.001$), and more likely to be Caucasian (85.4% vs. 80.7%, $p=0.004$). Of the respondents, 39.9% lived on campus, and 8.5% reported being a member of a fraternity or sorority.

Of the sample, 41.0% reported ever smoking tobacco from a waterpipe, 30.6% reported past year smoking, and 9.5% reported 30-day smoking. Cigarette smoking was reported in 39.6% of participants, and 21.5% reported cigarette smoking in the past 30 days. Of those who had smoked tobacco from a waterpipe in the past year, 35.4% had never smoked a cigarette ($p<0.001$, Table 1). Over 40% (41.1%) of the sample agreed or strongly agreed that they intend to smoke tobacco from a waterpipe in the future. Intention to smoke in the future was stated by 87.8% of annual users and 20.5% of non-users ($p<0.001$, Table 1).

About a third (33.1%) believed that waterpipe smoking was less harmful than cigarette smoking, and over half (52.1%) believed that waterpipe smoking was less addictive than cigarette smoking. Of the sample, 36.4% considered waterpipe smoking as "very socially acceptable." The mean student estimate as to the percentage of peers who had smoked from a waterpipe was 43.3% (SD 24.1%).

In fully adjusted multivariate models (Table 2), 1-year waterpipe smoking was associated with low perceived harm (OR=2.54, 95% CI=1.68, 3.83) and low perceived addictiveness (OR=4.64, 95% CI=3.03, 7.10). Odds ratios for 1-year waterpipe smoking were higher for those who believed its social acceptability was moderate (OR=8.07, 95% CI= 2.45, 26.62) or high (OR=20.00, 95% CI=6.03, 66.30), compared with those who believed its social acceptability was low. Similarly, odds ratios were increased for those who believed it was moderately (OR=3.34, 95% CI=2.04, 5.50) or highly (OR=4.72, 95% CI=2.85, 7.82) popular, compared with those who believed it was not popular.

Results and levels of significance were generally similar when conducting the same analyses using 30-day waterpipe smoking as the outcome (Table 2). However, results related to the influence of perceived acceptability and impression of waterpipe popularity were not as dramatic (Table 2). In order to test the robustness of our results, we also ran all analyses using stepwise backward regression, which yielded similar results.

Discussion

In this sample, lifetime prevalence of waterpipe tobacco smoking was comparable to lifetime prevalence of cigarette smoking. Interestingly, among those participants who had tried smoking tobacco with a waterpipe, over one third (35.4%) reported never having smoked cigarettes. These findings are consistent with previous U.S.-based surveys suggesting that although waterpipe tobacco use is more common among cigarette smokers than non-smokers, a sizable portion of waterpipe users do not otherwise smoke tobacco [15,19]. The consequences of waterpipe tobacco use may differ between these two populations. In cigarette smokers, waterpipe use may substitute for cigarettes and even potentially decrease cigarette exposure. It is unlikely that this would reduce overall risk of disease, as waterpipe tobacco also carries risk for both harm and dependence [8,20]. Alternatively, if waterpipe tobacco smoking is a supplement to cigarette smoking, it may increase the total tobacco exposure in cigarette smokers, potentially elevating both their level of dependence and their risk for tobacco-related disease.

The effects of waterpipe use in non-smokers are particularly worrisome because it engages them in tobacco use when they may have otherwise remained tobacco naïve. Waterpipe tobacco smoking may expose these individuals to pharmacologically active nicotine doses in a sweet-tasting and easily inhaled vehicle. Whether this waterpipe use puts them at risk for nicotine dependence—either resulting from waterpipe tobacco itself or as a “gateway” to cigarette use—is unknown and clearly deserves further study.

Although the overall and annual rates of waterpipe smoking were high (>40% and >30% respectively), the 30-day rate of waterpipe use was lower (9.5%) than some other estimates [14,15]. One potential explanation is that we studied a random and not a convenience sample. The samples in those convenience studies may have been more inclined to engage in experimental and/or risk-taking behavior such as waterpipe smoking than the overall student body. Another explanation has to do with our sampling period, which was chosen specifically so that it would not intersect with spring break, fraternity rush, or other times that are traditionally associated with spikes in risk-taking behavior. In the process, as the remaining time for our survey was immediately before final exams, we may have biased our 30-day estimate in the low direction. In any case, our results suggest that while waterpipe smoking may be as common as cigarette smoking in terms of lifetime use, cigarette smoking remains more common using past 30-day use estimates.

Consistent with previous research [15], most waterpipe users believed that waterpipe use was neither as harmful nor as addictive as cigarette use. These perceptions of reduced risk may help explain why some individuals who do not smoke cigarettes are willing to engage in waterpipe tobacco use. Interestingly, compared with perceived addictiveness, perceived harm was less strongly related to waterpipe use in the multivariate models. Future research should investigate whether perceived harm may be less influential than perceived addictiveness in a student's decision to smoke waterpipe.

Perceived peer acceptability and perceived popularity of waterpipe smoking were also strong predictors of use. This result is consistent with literature showing that adolescent smokers are more likely to perceive smoking as more accepted and normative [21]. These

results suggest that educational interventions aimed at reducing perceived peer acceptability and popularity may be effective.

Although we sent students three follow-up reminder e-mails, the response rate was only 18.6%, potentially introducing response bias. However, response rates with college students are generally in the 10–30% for this type of survey [22–24]. Fortunately, we accurately predicted a relatively low response rate and had (1) powered our study appropriately and (2) ensured that demographic data on respondents and non-respondents would be available. Those data showed that our respondents were more likely to be younger, Caucasian, and female; however, this bias is a known limitation of this type of research, since previous surveys of college students demonstrate that these students are more likely to respond [25,26]. Still, this may have artificially inflated our results, since we found users were more likely to be young and Caucasian. Another important limitation of this study is that it used cross-sectional data, so causality or temporal relationships cannot be inferred from the results, and future longitundal research will be necessary to investigate these issues. However, these data provide a crucial starting point for such studies.

To our knowledge, this study provides the first data from a random sample of U.S. university students demonstrating that waterpipe smoking can be extremely common in this setting. In our sample, lifetime waterpipe use was as common as lifetime cigarette use. We also found that a large proportion (>40%) of students in our sample intend to smoke tobacco from a waterpipe in the future and that these students perceived waterpipe tobacco smoking as less harmful than cigarette smoking, less addictive than cigarette smoking, and highly socially acceptable. It will be instructive to conduct future studies determining if these findings are corroborated among more diverse samples.

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Table 1

Sample characteristics by waterpipe smoking*

Characteristic	Has not smoked waterpipe[a] (%) *N*=449	Has smoked waterpipe[a] (%) *N*=198	Total sample (%) *N*=647	*P*
Age, mean (SD)	21.2 (2.1)	20.2 (1.7)	20.9 (2.0)	<0.001
Gender				
Male	34.0	35.2	34.4	0.77
Female	66.0	64.8	65.6	
Race				
White	83.2	90.4	85.4	0.016
Nonwhite	16.9	9.6	14.6	
Lives on campus				
No	63.7	52.0	60.1	0.005
Yes	36.3	48.0	39.9	
Undergraduate				
No	28.5	10.1	22.8	<0.001
Yes	71.5	89.9	77.2	
Member of fraternity/sorority				
No	93.5	87.2	91.6	0.009
Yes	6.6	12.8	8.5	
Grades				
A's	43.3	36.4	41.2	0.24
B's	46.9	53.5	48.9	
C's or below	9.9	10.1	9.9	
Has ever smoked cigarettes				
No	71.4	35.4	60.3	<0.001
Yes	28.6	64.7	39.7	
Has smoked cigarettes in the past 30 days				
No	76.6	41.9	69.3	<0.001
Yes	23.4	58.1	30.7	
Intends to smoke from a waterpipe in the future				
No	79.5	12.2	58.9	<0.001
Yes	20.5	87.8	41.1	
Harm (versus cigarettes)				
Waterpipe more harmful	24.7	20.8	23.5	<0.001
Waterpipe same harm	48.2	32.5	43.4	
Waterpipe less harm	27.1	46.7	33.1	
Addictiveness (versus cigarettes)				
Waterpipe more addictive	11.0	3.0	8.6	<0.001
Waterpipe same addictiveness	48.8	18.2	39.4	
Waterpipe less addictive	40.2	78.8	52.1	
Peer acceptability				
Not acceptable	17.2	1.5	12.4	<0.001

Characteristic	Has not smoked waterpipe[a] (%) *N*=449	Has smoked waterpipe[a] (%) *N*=198	Total sample (%) *N*=647	*P*
Somewhat/moderately Acceptable	55.8	40.9	51.2	
Very acceptable	27.0	57.6	36.4	
Impression of waterpipe popularity				
Lowest third (thinks waterpipe is not popular)	46.6	16.2	37.3	<0.001
Middle third	30.0	38.1	32.5	
Highest third (thinks waterpipe very popular)	23.4	45.7	30.3	

Percentages do not always add to 100 due to rounding.

[a] In the past year

Table 2

Associations between waterpipe smoking and predictors

Predictor	OR (95% CI) for past year waterpipe tobacco smoking		OR (95% CI) for 30-day waterpipe tobacco smoking	
	Unadjusted	Adjusted[a]	Unadjusted	Adjusted[a]
Harm (versus cigarettes)				
Waterpipe more harmful	1.25 (0.79, 1.97)	1.48 (0.92, 2.39)	1.30 (0.60, 2.79)	1.48 (0.67, 3.26)
Waterpipe same harm	1.0	1.0	1.0	1.0
Waterpipe less harmful	2.55 (1.73, 3.77)**	2.54 (1.68, 3.83)**	2.67 (1.44, 4.96)*	2.47 (1.29, 4.73)*
Addictiveness (versus cigarettes)				
Waterpipe more addictive	0.73 (0.29, 1.85)	0.90 (0.35, 2.32)	0.82 (0.18, 3.82)	1.02 (0.22, 4.86)
Waterpipe same addictiveness	1.0	1.0	1.0	1.0
Waterpipe less addictive	5.25 (3.48, 7.94)**	4.64 (3.03, 7.10)**	3.67 (1.87, 7.23)**	2.99 (1.49, 5.99)*
Peer acceptability				
Not acceptable	1.0	1.0	1.0	1.0
Somewhat/moderately acceptable	8.3 (2.55, 27.07)**	8.07 (2.45, 26.62)*	1.62 (0.36, 7.33)	1.41 (0.31, 6.43)
Very acceptable	24.18 (7.42, 78.81)**	20.00 (6.03, 66.30)**	9.44 (2.24, 39.85)*	6.23 (1.44, 26.99)*
Impression of waterpipe popularity				
Lowest third (thinks waterpipe is not popular)	1.0	1.0	1.0	1.0
Middle third	3.65 (2.29, 5.82)**	3.34 (2.04, 5.50)**	2.33 (1.10, 4.96)*	2.24 (0.98, 5.16)
Highest third (thinks waterpipe very popular)	5.60 (3.51, 8.93)**	4.72 (2.85, 7.82)**	3.67 (1.78, 7.56)**	3.10 (1.37, 7.03)*

[a] Adjusted for age, gender, race, living arrangement (on- or off-campus), membership in a fraternity/sorority, and self-reported grades.

* $p<0.05$

** $p<0.001$