Original investigation

Assessing and Predicting Susceptibility to Waterpipe Tobacco Use Among College Students

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Abstract

Introduction: College youth susceptible to waterpipe tobacco smoking (WTS) represent an important target to intervene upon in order to prevent their uptake of this product. This study examined the performance of a 4-item susceptibility measure to WTS to predict future waterpipe use and correlates of susceptibility.

Methods: A cohort of college students from 11 university campuses in North Carolina and Virginia completed an online survey in 2012 and again in 2013 that assessed WTS susceptibility and subsequent waterpipe use. Tobacco use, marijuana use, binge drinking, and sensation seeking were also assessed.

Results: Overall, 964 students who reported having never used waterpipe tobacco in 2012 completed the online surveys both years. Overall, about 27% of college youth were susceptible to WTS each year. Participants susceptible in 2012 were 2.5 times more likely to report having used waterpipe tobacco the subsequent year than non-susceptible participants after controlling for significant correlates of waterpipe use. Correlates of susceptibility were: being male, past 30 day cigarette smoking, use of other tobacco products, binge drinking and marijuana use, as well as higher sensation seeking.

Conclusions: A 4-item WTS susceptibility measure predicts future WTS. This measure can be used to identify and intervene upon susceptible college youth to curb further exploration of WTS. Indeed, a nontrivial proportion of college students found susceptible go on to use waterpipe tobacco within a year.

Introduction

A waterpipe (also referred to as shisha, hookah, narghile, kalkan, and hubble-bubble) is a nicotine delivery device in which tobacco smoke passes through water before it is inhaled. Epidemiological and laboratory data suggest that waterpipe smoke is no less dangerous than cigarette smoke. For example, waterpipe tobacco smoking (WTS) is related to many of the same tobacco-caused diseases as cigarette smoking, such as cancer, poorer pulmonary function (FEV1), and heart disease.^{1–5}

Despite the health risks and addictive potential associated with WTS, the use of this product continues to spread in the United States, especially among youth and young adults, including college students.⁶ Based on surveys conducted across 152 universities during 2008–2009, of the 105,102 participants, 8.4% were current users and 30.5% ever used waterpipe.⁷ Similarly, in the 2009–2010 National Adult Tobacco Survey comprised of 118,000 adults, prevalence of WTS was 7.8% among 18–24 year olds.⁸ However, rates of use differ by region. For example, across eight universities in North

Carolina, in 2008 prevalence of WTS was 17.4% during the last month and 40.8% ever used.⁹

Identifying characteristics that can predict prospectively which college students are willing to try waterpipe is critical to the design of targeted interventions to prevent uptake. Unfortunately, studies exploring prospective predictors of initiation are rare. Overall, the proportion of college students, mostly first or second year students, who initiate WTS has ranged from 13% to 23%.^{10–13} Predictors in initiation include alcohol consumption (drinks per week), pre-college marijuana use, having more positive attitudes towards WTS and seeing the behavior as normative (i.e., socially acceptable).^{10–12} Decreased likelihood of initiation is predicted by having negative attitudes towards WTS, and responding with a “don’t know” to questions asking which product, cigarettes or waterpipe, contained more nicotine, tar, and carcinogens—overall, knowledge score was not predictive.¹³ These findings are consistent with cross-sectional results showing that attitudes and norms are related to WTS and intentions to use^{14–17} (for reviews, see Akl et al.¹⁸; Grekin and Ayna⁶).

Perhaps one of the strongest predictors of initiation of waterpipe use is a person’s intentions to try the product. Several social cognitive theories indicate intentions as the proximal determinant of behavior,^{19,20} including WTS.^{14,16} For example, capitalizing on intention-behavior relations, Pierce and colleagues assessed adolescents’ susceptibility to cigarette tobacco use.²¹ Youth were defined as susceptible if they do not adamantly oppose cigarette use in various situations (e.g., a friend’s offer). Youth found to be susceptible are at least two times more likely than non-susceptible youth to initiate smoking^{21–23} and are at increased risk for becoming established smokers.²⁴ Thus, susceptibility to WTS should be a critical construct to explore due to the strong theoretical underpinning (i.e., intention-behavior relations) and highly promising findings in predicting smoking behaviors among youth.

Susceptibility to waterpipe tobacco use has been investigated among college populations in only a few studies; these studies have been limited by reporting results from a single institution assessing susceptibility using a single item. For example, Nuzzo and colleagues²⁵ assessed susceptibility among students at a single university ($N = 852$), using a single question: “Do you intend to smoke tobacco from a hookah sometime in the rest of your life?” with response options of definitely yes, probably yes, probably no, and definitely no. Students were classified as susceptible if they responded with anything other than “definitely no.” Among the 725 non-waterpipe users, 51% were found to be susceptible.^{14,25} The sample used in a second study¹⁵ was even more limited, consisting of a sample of 143 introductory psychology students at a single university and also used a single item: intention to try waterpipe soon. Heinz and colleagues found that among never users, 13% reported an intention to try waterpipe soon.¹⁵

A key issue is substantiating that among non-waterpipe users, their intentions to try waterpipe, and specifically susceptibility to WTS, does predict future use. To this end, the primary study goal is to determine whether a four-item susceptibility measure mirrored after assessment of susceptibility for cigarette smoking among adolescents, as conceived by Pierce and colleagues, is associated prospectively with WTS among college students with and without controlling for factors related to WTS. These other factors include number of other tobacco products used (i.e., polyuse), alcohol use, marijuana use, race, gender, and sensation seeking.^{6,7,26,27} A secondary goal is to explore how these correlates of WTS are associated with susceptibility to WTS. We hypothesized that our measure of

susceptibility will be a positive predictor of subsequent waterpipe tobacco use.

Methods

Sample

Data for this paper are from the *Smokeless Tobacco Use in College Students* study. The study follows a cohort of college students from 11 colleges in North Carolina ($n = 7$) and Virginia ($n = 4$) beginning in their freshman year. The goal of that study is to assess trajectories of smokeless tobacco use during the course of college. Nine are public schools and two are private. Five schools are in rural communities, four are in suburban communities, and two are in urban communities. Additional details about the parent study can be found elsewhere.^{28,29}

To identify potential members of the cohort, a screener survey of all freshmen was conducted at the 11 colleges in the fall of 2010.²⁸ Overall 10,528 freshmen completed the screener (response rate of 35.6%). The screener assessed gender, smokeless tobacco use, cigarette smoking, physical activity, hours of sleep, and use of alcoholic energy drinks. From this sample, we oversampled smokeless tobacco users, current cigarette smokers and males, along with a random sample of all other students to enroll in the cohort. Overall, 4,902 freshmen were invited to participate from the screener survey with 3,146 completing the survey for a response rate of 64.2%.²⁹ Cohort participants completed surveys in the fall and spring of their first 2 years of college and then annually (in the fall) during the third and fourth years. Reasons for not completing a survey were not assessed.

Data concerning hookah use and susceptibility were derived from the fall survey of students’ junior and senior years (i.e., Fall of 2012 and 2013) when the survey items on hookah susceptibility were added. Of the original cohort of 3,146 participants, 2,516 completed the 2012 survey (80% response rate) and 2,500 completed the 2013 survey (79.5% response rate), that is during their junior and senior year. There were 2,375 participants who completed both surveys. Results reported here are based on a subset of the 2,375 that responded to questions about WTS both years and reported not having ever used waterpipe tobacco during 2012 for an analysis sample size of 964.

Procedure

Students were sent an email invitation that included information about the survey and a link to a secure website to complete the survey. Non-responders received up to three email reminders, a phone call and a text reminder. The study protocol was approved by the Institutional Review Board (specific name left out for blind review). Additional privacy protection was secured by the issuance of a Certificate of Confidentiality by the Department of Health and Human Services. Some participating schools also chose to seek their own institutional IRB approvals. Participants received a \$35 incentive for completing the Fall 2012 survey and \$40 for completing the Fall 2013 survey.

Measures

The surveys measured demographics, hookah use and susceptibility, tobacco use, other substance use, and sensation seeking. Below we describe the measures included in this report.

Demographic Characteristics

Demographics included gender, race (coded as White vs. Non-White), and ethnicity (coded as Hispanic vs. non-Hispanic).

Hookah Use and Susceptibility

Hookah use was measured with one item: "Have you ever smoked tobacco from a waterpipe (also known as hookah, shisha, narghile), even one of two puffs?" Response options included: Yes, in the past week; Yes, in the past 30 days, but more than 1 week ago; Yes, in the past 6 months, but more than 30 days ago; Yes, in the past year, but more than 6 months ago; Yes, more than a year ago; No, never. Hookah use was coded as use in the past year defined by collapsing categories "Yes, in the past week; Yes, in the past 30 days, but more than 1 week ago; Yes, in the past 6 months, but more than 30 days ago; Yes, in the past year, but more than 6 months ago;" and comparing them to the categories "Yes, more than a year ago; No, never."

Susceptibility to WTS was measured using four items adapted from Pierce and colleagues.^{21,30,31} The main modification was replacing references to, "cigarette" in the original items to "tobacco from waterpipe." Items included: "Do you think that you will smoke tobacco from a waterpipe soon?" "Do you think that you will smoke tobacco from a waterpipe in the next year?" "Do you think that in the future you might experiment with waterpipe tobacco smoking?" "If one of your best friends asked you to smoke tobacco from a waterpipe, would you?" Response options included: "Definitely Yes"; "Probably Yes"; "Definitely No"; "Probably No"; "Don't Know." Participants were considered susceptible if they gave a response other than "Definitely No" to any item ($\alpha = 0.93$ in 2012 and 0.94 in 2013).

Use of Other Tobacco Products, Alcohol, and Marijuana

Participants who reported past 30 day cigarette smoking were considered current smokers. We also measured past 30 day use of other tobacco products that included: smokeless tobacco, cigarillos, pipes, bidis, kretek, gutkha, and e-cigarettes. Students were asked about past month marijuana use (yes/no), as well as past 30 day binge drinking (five or more drinks in a row for males, four for females).

Sensation Seeking

Sensation seeking was measured using the Brief Sensation Seeking Scale.³² Participants expressed level of agreement to eight items (e.g., "I would like to explore new places and prefer friends who are exciting and unpredictable"), using five-point Likert scales (1 = strongly disagree to 5 = strongly agree). Total sensation seeking scores were calculated from the average of all items for individuals who answered a minimum of five questions on the scale, with possible mean range from 1 to 5 ($\alpha = 0.81$). Sensation seeking was analyzed as a continuous variable.

Statistical Analysis

Due to the oversampling of males, ever smokeless tobacco users and current cigarette smokers in recruiting the cohort, sampling weights were computed to reflect the screened population of freshman students from which the sample was drawn. Sampling weights were calculated independently for each school using the approach of Pfeffermann and colleagues³³ to account for the complex survey design (i.e., students were sampled within schools). Prevalence and mean estimates for WTS, other drug use and behavioral characteristics were computed using these weights. Bivariate and multivariable mixed-effects logistic regression analyses accounting for both sampling weights and within-school correlation were performed for each outcome using the statistical procedure generalized linear latent and mixed models in Stata Version 12. Variables significant at $p < .25$ in bivariate analyses were included in multivariable modeling.³⁴ Traditional levels such as 0.05 used as a cut-off for inclusion in multivariable models can fail to identify important variables.³⁵ Final

models are presented that include predictors significant at $p < .05$ in the multivariable model.

Results

Sample Characteristics

Table 1 presents the 2012 characteristics of our sample of college students who had not engaged in WTS at baseline ($N = 964$). Overall, 82% of the sample participants were Caucasian with 93% being non-Hispanic; 52% of the sample were women. Close to 5% of the sample smoked cigarettes; about 4% used other tobacco products. Binge drinking during the last month occurred in about 37% the sample, while past 30 day use of marijuana occurred in about 8% of the sample.

Susceptibility to Use

Responses to the susceptibility items and overall levels of susceptibility during 2012 and 2013 are reported in Table 2. Among students who reported never having engaged in WTS, 27.5%_{wt} were susceptible in 2012. Among the 797 who still reported never engaging in WTS at the next survey in 2013, 27.5%_{wt} were also susceptible. Overall, about 14%_{wt} of students were susceptible in both 2012 and 2013. Among the four scale items, during both years the question, "If one of your best friends asked you to smoke tobacco from a waterpipe, would you?" received the highest "yes" response; the item, "Do you think that you will smoke tobacco from a waterpipe soon?" received the most "no" response.

Hookah Use and Susceptibility to Use

We examined the proportion of participants who engaged in WTS during 2013 based on their susceptibility status during 2012. Among participants susceptible during 2012, 4.8%_{wt} engaged in WTS within the last 30 of days of taking the 2013 survey compared to 2.2%_{wt} who

Table 1. Sample Characteristics of Never Hookah Users in 2012 ($N = 964$)

Characteristic	<i>n</i> (%) or mean $\pm$ SD
Gender	
Male	465 (48.2)
Female	499 (51.8)
Race	
Non-White	173 (18.2)
White	777 (81.8)
Ethnicity	
Hispanic	63 (6.6)
Non-Hispanic	893 (93.4)
Past 30 day cigarette use	
Yes	67 (4.6)
No	892 (95.4)
Past 30 day other tobacco use	
Yes	56 (4.1)
No	878 (95.9)
Past 30 day binge drinking	
Yes	379 (37.2)
No	580 (62.8)
Past 30 day marijuana use	
Yes	89 (7.8)
No	868 (92.2)
Sensation seeking	2.8 $\pm$ 0.03

Note. Percentages and means are weighted except for gender, race, and ethnicity.

were not susceptible ($p = .068$). Further, among participants susceptible during 2012, 20.5%_{wt} engaged in WTS within the last year of taking the 2013 survey compared to 7.4%_{wt} who were not susceptible ($p < .0001$).

We expected participants who were susceptible during 2012 to be more likely to engage in WTS between the 2012 and 2013 surveys, even after controlling for other significant bivariate predictors. The other significant bivariate predictors were: past 30 day other tobacco use, cigarette smoking, binge drinking, and marijuana use as well being higher on sensation seeking (Table 3). In the multivariable model, only past 30 day marijuana use and higher sensation seeking scores were significant. More specifically, there was a 72% increased

odds of past year hookah smoking for every additional point in the average sensation seeking score (Table 3). Controlling for these predictors, participants susceptible in 2012 had 2.5 times the odds of reporting having engaged in WTS within a year of completing the 2013 survey (Table 3).

Correlates of Susceptibility During 2012

We explored factors that discriminated between participants susceptible and not susceptible to waterpipe tobacco use. During 2012, in bivariate analyses, participants found to be susceptible (compared to those that were not susceptible) were more likely to: be male, be

Table 2. Responses to Susceptibility Scale Items and Overall Susceptibility in 2012 and 2013 ($N = 964$)

Susceptibility item	2012 n (%) _{wt}	2013 n (%) _{wt}
Do you think that you will smoke tobacco from a waterpipe soon?		
Yes	163 (14.9)	128 (16.2)
No	781 (85.1)	656 (83.8)
Do you think that you will smoke tobacco from a waterpipe in the next year?		
Yes	180 (17.6)	149 (18.8)
No	755 (82.4)	640 (81.2)
Do you think that in the future you might experiment with waterpipe tobacco-smoking?		
Yes	207 (21.4)	176 (22.0)
No	728 (78.6)	607 (78.0)
If one of your best friends asked you to smoke tobacco from a waterpipe, would you?		
Yes	244 (24.2)	205 (25.3)
No	702 (75.7)	585 (74.7)
Overall susceptible to waterpipe		
Yes	281 (27.5)	225 (27.5)
No	683 (70.8)	572 (72.5)

Table 3. Predictors of Past Year Hookah Use in 2013 Among Never Hookah Users in 2012

	Bivariate model	Final multivariable model
	Odds ratio (95% CI), p value	Odds ratio (95% CI), p value
Susceptible in 2012	3.37 (1.85, 6.14), <.001	2.52 (1.39, 4.60), <.002
Male	1.29 (0.85, 1.95), .236	
Non-White	1.01 (0.59, 1.70), .983	
Hispanic	1.04 (0.41, 2.61), .935	
Past 30 day other tobacco use	4.39 (2.38, 8.09), <.001	
Past 30 day cigarette smoking	3.46 (1.69, 7.11), <.001	
Past 30 day binge drinking	3.07 (1.39, 6.74), <.005	
Past 30 day marijuana use	5.56 (2.64, 11.69), <.001	3.50 (1.53, 8.01), <.003
Sensation seeking	2.22 (1.73, 2.85), <.001	1.72 (1.30, 2.27), <.001

Table 4. Cross-Sectional Correlates of Susceptibility to Waterpipe in 2012

	Bivariate model	Final multivariable model
	Odds ratio (95% CI), p value	Odds ratio (95% CI), p value
Male	1.55 (1.19, 2.02), <.001	
Non-White	0.77 (0.47, 1.29), .325	
Hispanic	1.54 (0.95, 2.48), .078	
Past 30 day other tobacco	4.97 (2.88, 8.57), <.001	6.14 (3.54, 10.64), <.001
Past 30 day cigarette smoking	5.54 (2.25, 13.66), <.001	
Past 30 day binge drinking	2.79 (2.00, 3.90), <.001	2.21 (1.55, 3.16), <.001
Past 30 day marijuana use	3.89 (2.37, 6.37), <.001	
Sensation seeking	1.90 (1.51, 2.37), <.001	1.56 (1.21, 2.00), <.001

engaged in past 30 day use of cigarettes and other tobacco products, past 30 day binge drinking and marijuana use, as well as were higher on sensation seeking (Table 4). In the multivariable model, past 30 day use of other tobacco products, past 30 day binge drinking, and higher sensation seeking scores continued to predict susceptibility status. For every 1-point increase in the average sensation seeking score, there was a 56% increase in odds of susceptibility.

Discussion

We examined how well a four-item susceptibility measure of waterpipe use, modeled after a validated measure of susceptibility to cigarette smoking, predicted WTS among a large sample of college students. Overall, the scale showed evidence of predictive validity, especially after controlling for several variables found related to WTS. These other variables, which continued to predict WTS in the multivariable model, included past 30 marijuana use and sensation seeking. Further we found that during 2012 and 2013, close to 28% of the sample who never used waterpipe tobacco were found susceptible within each year. These findings suggest that the proportion of college juniors and seniors found susceptibility to WTS is not trivial.

The percentage of college students found susceptible in this study is lower than the 51% reported by Nuzzo and colleagues²⁵ but higher than the 13% found by Heinz and colleagues.¹⁵ Difference may stem from the number of questions posed; others have used a single item compared to our four-item measure. Wording of the time frame to consider waterpipe use also vary between our measures and that of Nuzzo and colleagues.²⁵ Whereas our measures asked participants to consider waterpipe tobacco use within a period of a year, the time frame provided by the question posed by Nuzzo and colleagues was during the person's lifetime. Further, our findings are based on a sample derived from students from multiple campuses, unlike prior studies. In addition, unlike the other studies, our results were based on college juniors and seniors.

Our findings concerning the proportion of college students found susceptible suggest a large target group for intervention with a potential large public health effect. Indeed, college students found to be susceptible were 2.5 times more likely to smoke waterpipe the next year compared to those found non susceptible. Among those found susceptible during 2012, about 20% reported smoking waterpipe the next year, of which about 5% reported smoking within the last 30 days. How quickly these participants smoked their first waterpipe after the 2012 assessment is unfortunately unknown.

Findings suggest that interventions targeting susceptible youth may need to attend to several factors. For example, future waterpipe use was predicted by past 30 day marijuana use and higher scores on sensation seeking.³⁶ Youth higher in sensation seeking may find the sensory aspect of waterpipe (e.g., flavoring of tobacco) within the social context of use, especially appealing. Moreover, they may be persuaded unduly by ads that highlight novel and sensory experiences. Hence, one strategy to use among susceptible youth to curb use is to target factors that appeal to high sensation seekers.

There are several limitations to our study. First, our results are limited to junior and senior college students residing in the Southern United States who were oversampled for smokeless tobacco history and current cigarette smoking. How well the susceptibility items perform targeting non-college youth or younger college students with similar characteristics is unknown. With respect to potential mediators, we did not assess factors found to influence WTS such as norms, attitudes, and perceived risks.

Future research should explore the relationship between susceptibility and WTS taking into account these mediators. Further, researchers should consider whether the ability to predict future WTS is enhanced by incorporating additional measures not captured in our survey, such as stage of change. For example, Prokhorov and colleagues³⁷ best predicted future cigarette smoking in youth by combining measures of susceptibility and stage of change (e.g., being susceptible and thinking of smoking a cigarette during the next six months). That combined assessment may also be useful to determine the rapidity with which susceptible college students begin engaging in WTS. Moreover, more research is needed to determine what factor are associated with those youth found susceptible and never engage in WTS compared to those who go on to use this product. In these research endeavors, our findings suggest that our measure of susceptibility can be a useful tool to identify and then intervene upon college youth who might experiment with WTS, a highly vulnerable group that has yet to receive much attention to curb the spread of waterpipe tobacco use.

Funding

The research on which the paper is based is supported by award R01CA141643 from the National Cancer Institute. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute or the National Institutes of Health.

Declaration of Interests

None declared.

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