

**For final publisher version, see:** Sidani JE, Shensa A, Yabes J, Fertman C, Primack BA. Waterpipe tobacco use in college and non-college young adults in the USA. *Family Practice*. 2019;36(2):103-109. PMID: 29741621. PMCID: PMC6425466.

**Waterpipe tobacco use in college and non-college young adults in the US**  
**Running head: Non-college hookah smoking**

Article category: Epidemiology

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**Key messages**

- 29% of non-college young adults reported ever waterpipe tobacco smoking (WTS)
- 35% of young adults in college reported ever WTS
- Current WTS use rates were 3% for non-college and 7% in college
- Positive attitudes were significantly associated with increased current WTS
- Perceived peer acceptability significantly associated with increased WTS
- Prevention programs should include all young adults, not only college students

**Abstract**

**Background.** Waterpipe tobacco smoking (WTS or “hookah”) is common among adolescents and college students in the United States. However, there has not yet been a large-scale, nationally-representative study independently examining WTS among young adults who are not in college.

**Objective.** This study sought to examine associations between attitudes, normative beliefs, certain socio-demographic factors and current WTS among young adults not in college and compare them to young adults in college.

**Methods.** A total of 3131 US adults ages 18 to 30 completed an online survey about WTS behavior, attitudes, normative beliefs, and relevant socio-demographic factors. Multivariable logistic regression was used to examine independent associations between these variables and current WTS stratified by student status.

**Results.** Ever WTS was reported by 29% of young adults not in college and by 35% of those in college, and current use rates were 3% and 7%, respectively. Multivariable models demonstrated that positive attitudes and perceived peer acceptability of WTS were significantly associated with increased current WTS for both young adults not in college (AOR=2.72; 95% CI, 2.00-3.71 and AOR=2.02; 95% CI, 1.50-2.71, respectively) and young adults in college (AOR=3.37; 95% CI, 2.48-4.58 and AOR=2.05; 95% CI, 1.49-2.83, respectively). The magnitude of these associations was not significantly different when comparing individuals in college and not in college.

**Conclusions.** Among young adults, WTS is common in non-college-based populations as well as in college-based populations. Therefore, prevention programming should extend to all young adults, not only to those in college.

**Keywords:** Smokers, primary care, tobacco-water pipe, smoking / tobacco use, health promotion, health risk behaviors.

## Introduction

Known colloquially as “hookah,” the emergence of WTS in the US was recognized by researchers and health professionals around 2005 (1), although epidemiologic data on use was not yet largely available at that time. In the past decade, WTS has been popular among the young adult population, especially college students. Approximately 8–17% of college students are current waterpipe tobacco users (2,3), and approximately 35–64% report lifetime use (2,4,5). College students who are male, younger, and members of university fraternities/sororities are more likely to participate in WTS (2–4). A recent systematic review of WTS trends found that use among young people in the US increases up to 1% each year (6). Additionally, use of waterpipe tobacco among nicotine-naïve individuals is associated with increased risk of cigarette smoking initiation (7).

Many factors likely contribute to the popularity of WTS, including misperceptions about its safety and the belief that it is not addictive (8). Contrary to these misperceptions, WTS exposes users to smoke volume, tar, nicotine, and carbon monoxide in levels that are similar to or higher than that of smoking a single cigarette (9). Additionally, WTS has been associated with negative health outcomes such as respiratory and cardiac diseases (10), as well as the potential to develop dependence (11).

Evidence suggests that most individuals who participate in WTS do not admit their use to their health care provider (12). Even when physicians are aware of tobacco use, less than half of adult cigarette smokers receive advice to quit from their physicians (13), and non-cigarette tobacco users are even less likely to be given advice to quit by healthcare providers (14). However, since most users of waterpipe tobacco report that they trust health information from their physicians (15), this may be an ideal venue for both primary and secondary prevention of WTS.

For primary care physicians to address WTS among their patients, it is necessary to understand the population of interest. WTS among US college students has been intensively studied due to availability to university researchers and large-scale studies such as the National College Health Assessment. Additionally, up to one-third of college students utilize university health service centers, with 60% of those visits being for primary care (16). Therefore, primary care physicians working in the community may have more young adult patients than those at university health service centers, including

both college students and non-college young adults. However, WTS in the general US young adult population has received less attention in the literature as nationally-representative studies of the general population are more difficult to conduct. Many studies of WTS and general populations of US young adults have been convenience samples of current users recruited from WTS establishments and online WTS forums (17–19). Other studies have analyzed data from large-scale cross-sectional surveys that have included WTS as one outcome among many other tobacco-related health behaviors (20,21). Additionally, although many national studies of the general US young adult population include college student status as a predictor, they do not *separately* examine young adults who are not in college. Therefore, the results of studies of WTS behavior and perceptions among general US populations likely include college students.

College student status can be either a protective factor or a risk factor for certain health behaviors. For example, young adults who are not in college have the greatest risk for being cigarette smokers compared to young adults at 2- or 4-year colleges (22). However, studies examining alcohol use and alcohol-related problems by comparing college and non-college young adults are less clear. College students tend to have higher rates of alcohol use and alcohol-related problems, which could be due to related factors, such as living arrangement, rather than student status alone (23).

Therefore, in this study we sought to analyze data from a nationally-representative sample of adults ages 18 to 30 and assess factors related to WTS. Specifically, we sought to independently examine associations between attitudes, normative beliefs, certain socio-demographic factors and current WTS among young adults not in college and young adults in college. The results from this study will give insight into whether young adults who are not in college are also at risk for WTS, and therefore whether they should be included in prevention and cessation efforts, both in the physician's office and through outreach programming.

## Methods

### *Participants and procedures*

Participants were members of the KnowledgePanel®, a nationally-representative, probability-based, online non-volunteer access panel recruited and maintained by GfK (Growth from Knowledge). The panel was created with a combination of random digit dialing and address-based sampling, allowing recruitment from non-landline households, thus increasing the sampling frame to an estimated 97% of US households (24). Surveys are completed on the participants' personal computers, which are provided—along with internet access—by GfK if needed. To achieve a sample that is nationally-representative, GfK utilizes a weighting protocol that applies base weights and post-stratification weights based on national demographic distributions and to account for non-response, non-coverage, and under- and over-sampling.

For this study, we commissioned GfK to survey approximately 3000 US adults ages 18–30 years old in March 2013. Participants received a \$5 cash-equivalent incentive for survey completion. This study was approved by the University of Pittsburgh Institutional Review Board and was granted a Certificate of Confidentiality from the National Cancer Institutes at the National Institutes of Health.

### *Measures*

*Socio-demographic characteristics.* GfK maintains a database of key demographic information about panel members, such as age, sex, and race and ethnicity. To supplement this information, we included items to determine sexual orientation, relationship status, and current living situation, which have been associated with WTS in prior research (25,26).

*Student status.* We asked participants to indicate their student status with one item that asked, “Which of the following applies to you?” Response choices included: *current high school student*, *current college student*, *current graduate student*, and *currently not a student*. We categorized current college/university and graduate students as *college adults* and individuals not currently a student as *non-college adults*. Participants who reported being high school students were omitted. The resulting dichotomous variable—student status—served as the stratifying variable for analyses.

*Waterpipe tobacco smoking (Ever and Current WTS).* Respondents were asked to report on their ever and current WTS behavior. The term “hookah” was used instead of “waterpipe” for all survey items because this is the more popular term among the US population. If participants answered “yes” to having ever smoked tobacco from a hookah, they were then asked to report on how many days in the past 30 days they smoked tobacco from a hookah. Consistent with current tobacco use definitions (27), responses were categorized as “yes” (1 or more days) and “no” (0 days). The resulting variable—current WTS—served as the dependent variable in this study.

*Attitudes and normative beliefs.* Respondents were asked if they thought hookah tobacco smoking was attractive; romantic; fun; relaxing; harmful; and addicting on a five point Likert-type scale ranging from “Definitely No” to “Definitely Yes.” The items measuring attractive, romantic, and fun were categorized as positive attitudes, and the items measuring harmful and addicting were categorized as negative attitudes. Each attitude was analyzed individually and within a composite positive and negative attitude scale, consistent with previous research (28,29). To measure normative beliefs, respondents were presented with two items. The first asked respondents to rate how socially acceptable they thought hookah was among people their age on a four point Likert-type scale ranging from “Very socially acceptable” to “Not socially acceptable.” The other item asked respondents to estimate what percentage of people their age have ever smoked tobacco from a hookah. This variable was rescaled from a 100-point to a 10-point scale based upon the natural distribution of responses occurring at each 10% increment.

### *Data analysis*

We included all individuals who had complete responses for the stratifying and dependent variables. We examined the data for patterns of missingness, comparing the socio-demographic characteristics of those with missing data and those without. We assessed the model for multicollinearity calculating the variance inflation factor (VIF) among the socio-demographic covariates. We then described our sample in terms of socio-demographic composition using weighted percentages. Univariate analyses, stratified by student status, used Rao-Scott Chi-square tests to assess associations between socio-demographic covariates and current WTS. Using logistic regression, we then assessed the

independent association between each attitude, normative belief, and current WTS, controlling for socio-demographic characteristics and stratifying by student status. Additionally, we assessed the multivariable association between each socio-demographic factor and current WTS, controlling for all other socio-demographics. Finally, we conducted post-estimate Adjusted Wald tests to compare the magnitude of any associations that were significant for both students and non-students.

All statistical analyses were computed using Stata 14.0. Study-specific weights were applied to all analyses to adjust for non-response, under-, and over-sampling. These weights were study-specific and provided by GfK.

## Results

Of the 3254 individuals surveyed, 3236 (99.4%) had complete data on the items measuring student status and WTS. There were no significant differences between individuals with missing data on the student or WTS items and those without in terms of socio-demographic composition. Additionally, 105 high school students (3%) were omitted from analyses. Thus, we arrived at a nationally-representative final sample of 3131 US young adults age 18–30. There was no evidence of multicollinearity among socio-demographic covariates with VIFs ranging from 1.01 to 1.18.

### *Socio-demographic characteristics*

The majority of the sample self-identified as heterosexual (92%) and White, non-Hispanic (57%). Participants averaged 24 years of age and approximately half of the sample was female (52%) and single (46%). Complete sample socio-demographic characteristics are reported in **Table 1**.

### *Socio-demographic characteristics, student status, and current WTS: results of bivariable analyses*

Approximately 42% of the sample reported being currently enrolled in college (college adults) and 58% were not enrolled in college (non-college adults). Of those in college, approximately 75% reported full-time status. Both ever and current WTS prevalence rates differed significantly between non-college and college adults ( $P < 0.001$  and  $P < 0.001$ , respectively). For non-college adults, 29% (95% CI, 26%-33%) reported ever WTS and 3% (95% CI, 2%-5%) reported current WTS. For college adults, 35% (95% CI, 31%-38%) reported ever WTS and 7% (95% CI, 6%-9%) reported current WTS. Non-college adults reported smoking, on average, 0.8 days (SE = 0.2) in the past 30; whereas college adults reported smoking WTS, on average, 1.6 days (SE = 0.4) in the past 30. Among non-college adults, current WTS was significantly associated with age ( $P < 0.001$ ) and relationship status ( $P < 0.001$ ). Among college adults, current WTS was associated with sexual orientation ( $P = 0.01$ ; **Table 1**).

### *Attitudes and normative beliefs, student status, and current WTS: results of multivariable analyses*

In independent multivariable models, each of the individual positive attitude items was significantly associated with current WTS for both non-college and college adults (**Table 2**). Additionally,

having an overall positive attitude towards WTS was associated with current WTS for both non-college adults (AOR=2.72; 95% CI, 2.00-3.71] and college adults (AOR=3.37; 95% CI, 2.48-4.58). Independent multivariable models found that believing that hookah seems addicting was protective against current WTS for college adults only (AOR=0.70; 95% CI, 0.60-0.82). Likewise, an overall negative attitude towards WTS was protective against current WTS for both non-college (AOR=0.82; 95% CI, 0.67-1.00) and college students (AOR=0.76; 95% CI, 0.65-0.89). For normative beliefs, believing that a greater percentage of peers smoke tobacco from a hookah was significantly associated with current WTS among college adults only (AOR=1.14; 95% CI, 1.05-1.25), whereas believing that hookah is acceptable among one's peers was significantly associated with current WTS for both non-college and college adults (AOR=2.02; 95% CI, 1.50-2.71 and AOR=2.05; 95% CI, 1.49-2.83, respectively). There was no significant difference in the magnitude of these associations when comparing college and non-college adults (**Table 2**).

*Socio-demographic characteristics, student status, and current WTS: results of multivariable analyses*

In multivariable models assessing odds of current WTS, increased age and being married or in a domestic partnership (compared to being single) were associated with decreased odds of current WTS (AOR=0.86; 95% CI, 0.78-0.94 and AOR=0.27; 95% CI, 0.08-0.88, respectively) among non-college adults. Among college adults, identifying as bisexual was associated with greater than three times the odds of current WTS compared with those who identified as heterosexual (AOR=3.28; 95% CI, 1.28-8.40; **Table 2**).

## Discussion

In this nationally-representative study of US young adults, ever and current WTS rates were higher among college adults than non-college adults. We also found that attitudes and normative beliefs are significantly associated with WTS among both non-college and college adults. However, different socio-demographic risk factors were associated with current WTS in each population.

Rates of both ever WTS and current WTS were higher in college adults than in non-college adults (35% vs. 29% and 7% vs. 3%, respectively). It is not surprising that WTS rates among college adults are higher than their non-college counterparts, as many WTS establishments are located close to college campuses and WTS tends to be marketed toward younger populations (30).

However, the WTS rates among non-college adults are high enough to warrant attention. These rates are consistent with other alternative tobacco products (ATPs) in non-college populations. Approximately 4% of non-college adults are current users of e-cigarettes (31), and approximately 3% of non-school adults are current users of smokeless tobacco (32). Additionally, use of ATPs in the non-college population is associated with concurrent cigarette use (31). Thus, potential WTS prevention interventions may benefit from addressing poly-tobacco use, which is considered to be a specific risk for the working adult and non-college populations (33).

Positive attitudes toward WTS were significantly associated with current WTS for both non-college and college adults. Although this is consistent with prior research of college students (28,34), to our knowledge this is the first study to confirm this association independently in non-college young adults. There was no significant difference in the magnitude of these associations when comparing non-college and college adults, suggesting that prevention and intervention programming addressing positive attitudes towards WTS may benefit both populations. This is also true for positive normative beliefs—for which both populations had significantly higher odds of current WTS if they perceived WTS to be acceptable among their peers—which is also consistent with prior research (35). Primary care physicians may utilize this information in their prevention messaging to patients, including correcting misperceptions about WTS such as the belief that WTS is non-addictive and a safe alternative to traditional cigarette smoking.

Different socio-demographic characteristics were associated with current WTS for the non-college and college populations. Among college adults, being bisexual was significantly associated with *increased* risk for current WTS, which is consistent with research in this area (25). Among non-college adults, older age and being married or in a domestic partnership were associated with significantly *decreased* risk of current WTS compared to younger age and single relationship status. This is similar to use of other tobacco products among adults (36,31).

Results from this study suggest that all young adults, regardless of student status, may benefit from prevention and intervention programming, particularly programming that focuses on positive attitudes toward WTS and favorable normative beliefs towards WTS. Historically, targeted prevention and intervention efforts for young adults not in college have been a challenge in public health. Unlike college-based populations, they are not a “captive” audience that can be easily targeted. One potential opportunity for intervention with this population would be to focus on the workplace. A recent Cochrane review found that smoking cessation workplace interventions that included employees in the design and implementation of the interventions, as well as tailored their materials to the specific population, exhibited the most effectiveness (37).

Prevention and cessation efforts conducted in physician and other healthcare offices may also be of value. WTS users report that physician advice to quit is a motivating factor for quitting (38). However, it is unclear whether physicians have adequate training to address WTS with their patients. Medical students report less knowledge and less cessation training on ATPs—including WTS—compared to cigarettes (39). Future research should further examine the availability of educational programming about ATPs to physicians and physicians-in-training. The results of this study suggest that it may be valuable to screen for WTS—and possibly other non-cigarette tobacco products—among young adult patients regardless of college student status.

This study has some limitations. First, because the data collection was cross-sectional, directionality of effects cannot be determined. Second, the data were collected via self-report, and it is possible that some respondents could have been untruthful or biased in their recall. Finally, this study did not assess use of other tobacco products and/or other substances, which could be associated with use of

waterpipe tobacco. Future research studies may wish to incorporate this into their assessments and analyses.

## **Conclusions**

In conclusion, we found that ever WTS is relatively common among both college and non-college young adults. Positive attitudes toward WTS were associated with increased odds of current WTS for both groups. Prevention and intervention programs targeting attitudes toward WTS and that include workplace- and healthcare-related focuses may be of particular value.

## **Acknowledgement**

We acknowledge Michelle Woods for editorial assistance.

## **Declaration**

Funding: This work was supported by the National Cancer Institute at the National Institutes of Health (R01-CA140150), awarded to BP. The funding agencies had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data; and preparation, review, or approval of the manuscript.

Ethical approval: This study was approved by the University of Pittsburgh Institutional Review Board and was granted a Certificate of Confidentiality from the National Cancer Institutes at the National Institutes of Health.

Conflict of interest: none.

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**Table 1.** Bivariable associations between socio-demographic characteristics and current waterpipe tobacco smoking (WTS) from a 2013 nationally-representative online survey of 3131 US adults ages 18 to 30, stratified by student status.

Socio-demographic characteristic	Whole sample ( <i>N</i> = 3131) Column % <sup>c</sup>	Current WTS <sup>a</sup>			
		Non-college adult ( <i>N</i> = 70; 3.2% <sup>c</sup> [4.0% <sup>d</sup> ])		College adult <sup>b</sup> ( <i>N</i> = 132; 7.3% <sup>c</sup> [9.7% <sup>d</sup> ])	
		Column % <sup>c</sup>	Column % <sup>c</sup>	Column % <sup>c</sup>	<i>P</i> <sup>e</sup>
Age, <i>y</i> , <i>m</i> ( <i>SE</i> )	24.4 (0.1)	23.8 (0.4)	<b>&lt;0.001</b>	22.2 (0.4)	0.26
Sex			0.99		0.67
Female	51.7	51.5		54.8	
Male	48.3	48.5		45.2	
Sexual orientation			0.30		<b>0.01</b>
Heterosexual	92.2	87.4		86.4	
Gay/lesbian	3.7	4.6		2.5	
Bisexual	4.1	8.0		11.2	
Race/ethnicity			0.11		0.76
White, non-Hispanic	57.1	52.7		50.8	
Black, non-Hispanic	13.4	10.0		11.2	
Hispanic	20.2	34.6		23.5	
Other <sup>f</sup>	9.4	2.8		14.5	
Relationship status			<b>&lt;0.001</b>		0.47
Single <sup>g</sup>	46.0	56.4		60.4	
Committed relationship	27.1	33.9		32.4	
Married/domestic partnership	26.9	9.6		7.3	
Living situation			0.07		0.75
Parent/guardian	31.5	37.4		40.5	
Significant other	35.4	23.0		17.6	
Alone	13.7	20.3		14.7	
With friends	19.4	19.4		27.2	

<sup>a</sup> Defined as having taken at least one puff in the past 30 days

<sup>b</sup> College adults include undergraduate and graduate levels

<sup>c</sup> Percentages are based upon survey weighted estimates for current WTS. Columns may not total 100 due to rounding

<sup>d</sup> Percentages are based upon raw, unweighted data.

<sup>e</sup> *P* values derived from Rao-Scott Chi-square tests for categorical variables and the adjusted Wald test for mean age.

<sup>f</sup> Includes Multiracial

<sup>g</sup> Includes separated, divorced, and widowed

**Table 2.** Multivariable associations between perceptions, socio-demographic characteristics, and current waterpipe tobacco smoking (WTS) from a 2013 nationally-representative online survey of 3131 US adults ages 18 to 30, stratified by student status.

Perceptions	Current WTS		P-value <sup>b</sup>
	Non-college adult AOR (95% CI) <sup>a</sup>	College adult AOR (95% CI) <sup>a</sup>	
Positive attitudes <sup>c</sup>			
Hookah seems attractive	<b>1.99 (1.46-2.72)</b>	<b>2.02 (1.65-2.47)</b>	0.99
Hookah seems romantic	<b>1.75 (1.33-2.31)</b>	<b>2.35 (1.84-3.01)</b>	0.15
Hookah seems fun	<b>2.31 (1.74-3.06)</b>	<b>2.75 (2.01-3.75)</b>	0.53
Hookah seems relaxing	<b>2.45 (1.76-3.41)</b>	<b>2.73 (1.98-3.76)</b>	0.66
<i>Overall positive attitude</i>	<b>2.72 (2.00-3.71)</b>	<b>3.37 (2.48-4.58)</b>	0.46
Negative attitudes <sup>c</sup>			
Hookah seems harmful	0.82 (0.66-1.02)	0.89 (0.77-1.04)	
Hookah seems addicting	0.86 (0.67-1.10)	<b>0.70 (0.60-0.82)</b>	
<i>Overall negative attitude</i>	<b>0.82 (0.67-1.00)</b>	<b>0.76 (0.65-0.89)</b>	0.55
Normative beliefs			
Perceived prevalence of WTS among peers. <sup>d</sup>	1.10 (0.96-1.26)	<b>1.14 (1.05-1.25)</b>	
Perceived acceptability of WTS among peers. <sup>e</sup>	<b>2.02 (1.50-2.71)</b>	<b>2.05 (1.49-2.83)</b>	0.98
Socio-demographic characteristic	Non-college adult AOR (95% CI) <sup>a</sup>	College adult AOR (95% CI) <sup>a</sup>	
Age, y	<b>0.86 (0.78-0.94)</b>	0.96 (0.88-1.06)	
Sex			
Female	1 [Reference]	1 [Reference]	
Male	0.93 (0.43-2.01)	0.95 (0.53-1.72)	
Sexual orientation			
Heterosexual	1 [Reference]	1 [Reference]	
Gay/lesbian	0.88 (0.27-2.89)	0.69 (0.14-3.37)	
Bisexual	1.64 (0.50-5.32)	<b>3.28 (1.28-8.40)</b>	
Race/ethnicity			
White, non-Hispanic	1 [Reference]	1 [Reference]	
Black, non-Hispanic	0.68 (0.19-2.43)	0.72 (0.24-2.13)	
Hispanic	1.86 (0.75-4.62)	1.15 (0.61-2.14)	
Other, non-Hispanic <sup>f</sup>	0.38 (0.10-1.46)	1.40 (0.56-3.52)	
Relationship Status			
Single <sup>g</sup>	1 [Reference]	1 [Reference]	
Committed relationship	1.12 (0.49-2.55)	0.89 (0.47-1.68)	
Married/domestic partnership	<b>0.27 (0.08-0.88)</b>	0.59 (0.15-2.41)	
Living situation			
Parent/guardian	1 [Reference]	1 [Reference]	
Significant other	0.99(0.35-2.84)	1.02 (0.33-3.15)	
Alone	1.63 (0.57-4.65)	1.30 (0.53-3.17)	
With friends	1.81 (0.58-5.64)	0.77 (0.42-1.43)	

Note: Bolded values indicate significance.

<sup>a</sup> AOR = adjusted odds ratio; CI = confidence interval. Adjusted for all socio-demographic variables presented in the table.

<sup>b</sup> P value derived from post-estimate adjusted Wald tests assessing the difference in significant odds ratios between non-college and college adults.

<sup>c</sup> Associated odds ratios represent the odds for each unit of increase in the independent variable.

<sup>d</sup> Each point on this scale corresponds with a 10-point increment in percentage. For example, 0=0%, 1=10%, 2=20%, etc.

<sup>e</sup> Responses to this item are based upon a 4-level response scale ranging from “not” to “very.” Associated odds ratios represent the increase in odds for each unit of increase on this scale.

<sup>f</sup> Includes multiracial

<sup>9</sup> Includes separated, divorced, and widowed