



Published in final edited form as:

J Am Coll Health. 2014 ; 62(1): 10–18. doi:10.1080/07448481.2013.842171.

Understanding Tobacco-Related Attitudes Among College and Noncollege Young Adult Hookah and Cigarette Users

Youn Ok Lee, PhD¹, Sareh Bahreinifar, MPH², and Pamela M. Ling, MD, MPH^{2,3}

¹Public Health and Environment Division, RTI International, Research Triangle Park, North Carolina

²Center for Tobacco Control Research and Education, University of California, San Francisco, San Francisco, California

³Division of General Internal Medicine, Department of Medicine, University of California, San Francisco, San Francisco, California

Abstract

Objective—Examine differences in tobacco-related attitudes, hookah, and cigarette use among college and noncollege young adults.

Participants—Time-location samples of young adult bar patrons in San Diego, CA (N = 2,243), Tulsa (N = 2,095) and Oklahoma City (N = 2,200), OK, Albuquerque (N = 1,044) and Las Cruces (894), NM, between September 2009 and July 2011.

Methods—Multinomial logistic regression examined associations between hookah, cigarette use, and tobacco-related attitudes.

Results—Current college students and graduates are less likely to smoke cigarettes, but more likely to use hookah. Among current hookah users, 22.6% were hookah-only and 77.4% were dual users (cigarettes and hookah). College status is associated with different hookah use patterns, and those with anti-industry attitudes were more likely to smoke hookah.

Conclusions—Novel interventions are needed for college students using hookah. Existing strategies targeting smokers with anti-industry messages may be irrelevant to hookah users.

Keywords

alcohol; health education; hookah use; tobacco use

An estimated 100 million people worldwide use hookah daily.¹ A hookah is a waterpipe used to smoke flavored tobacco and is sometimes referred to as a narghile or shisha. Hookah smoking appears to be increasing worldwide and among college students and other young adults in the United States.²⁻⁵ Surveys of US college students show that about 40% of students reported having ever smoked hookah and between 9.3% and 17% reported smoking it within the past 30 days.⁵⁻⁷

Researchers find that hookah smoking poses health risks that are similar to those of cigarette smoking.^{8,9} Hookah smoke contains many of the same toxic chemicals that are found in cigarette smoke, including carbon monoxide; tar; and heavy metals, such as arsenic, chromium, cobalt, cadmium, nickel, and lead.¹⁰ Another source of toxicity is the charcoal

used to heat the hookah, which increases exposure to carbon monoxide and polyaromatic hydrocarbons.¹¹ Furthermore, hookah use shows comparable absorption of nicotine compared with cigarette smoking, indicating the potential for addiction.¹² The addictive potential of hookah may increase harm if hookah attracts nonsmoking young people who might not otherwise use tobacco or smokers who might otherwise quit.

Despite the data demonstrating potential health risks, many young adults perceive hookah use as distinct from, and less harmful than, cigarette smoking.¹³ In a US study using data from a large urban university, more than half of the sample (52.1%) perceived that tobacco smoking from a hookah was less addictive than cigarette smoking.⁵ Another study of college students in North Carolina reported that 97% of students believed they could quit hookah smoking any time.⁷ Overall, smokers perceive hookah use as less harmful than cigarette use because of its aesthetic appeal, including the sweet smell and taste of flavored tobacco and the belief that water “filters” smoke, therefore reducing toxicant exposure.^{5,14,15}

Perceptions associating hookah use with reduced harm among young adults may make this population particularly vulnerable to hookah use. College students may also be at higher risk considering reports suggesting that hookah's popularity is increasing in the United States as the number of commercial hookah venues (most commonly known as “hookah lounges” or “hookah bars”) grows rapidly,⁴ especially around college campuses.¹⁶ The degree to which hookah use may be attracting young people who would otherwise not use tobacco is still unknown; however, access to hookah bars is associated with hookah use.⁷ Hookah bars can be attractive places for young adults to socialize in, and those who frequent social venues like bars and clubs may be at increased risk for hookah use, as socializing is a primary reason reported for using hookah.¹⁷

In light of the potential health risks, inaccurate harm perceptions, and increasing popularity of hookah among young adults, and particularly college students, research is needed to understand patterns of hookah use and what risk factors are associated with these patterns. Comparisons of attitudes and use patterns between college students, graduates and young adults not attending college are also needed to inform college health professionals who are developing health promotion programs for students, or who may need to advise students about hookah use.

Hookah Use among Young Adult Bar Patrons

Most prior research on young adult hookah use is based on samples of college students,^{4,6,7,14,18} though there are likely important differences between young adults in college and those not attending college. For example, young adults attending college are less likely to smoke cigarettes than those not in college,¹⁹ and it is currently unknown whether this is also true for hookah use. There is some evidence that suggests that unlike the risk for cigarette smoking, the risk for hookah use is actually higher for college students than for noncollege young adults. Recent reporting has suggested that college students may be at risk for increased exposure to hookah use and hookah product marketing in light of increasing numbers of hookah venues near college campuses.¹⁶ Compared with cigarettes, little is known about hookah use among college students. Even less is known about hookah use among young adults who are not attending college for comparison. Studies that include both the college and noncollege young adult populations are needed to determine whether or not college students are a vulnerable population for hookah use.

Colleges and universities are a natural resource for reaching young adult college students for inclusion in research studies; however, young adults not enrolled in college are much more difficult to recruit for comparison. One way to access both high-risk college and noncollege populations is to survey young adults who attend bars and clubs. This population is highly

likely to be exposed to tobacco advertising and promotion,¹² and according to the 2002 California Tobacco Survey, about 20% of all young adults and about 30% of those at risk for future smoking (including current smokers) were exposed to tobacco advertising and promotions in bars and clubs.²⁰ Thus, young adult bar patrons represent an understudied population that is at high risk for tobacco use, well suited for studying tobacco-related attitudes of college and noncollege young adults.

Current Tobacco Control Messaging May Not Effectively Address Hookah Use

In light of the rising popularity and potential dangers surrounding hookah use, the public health community has increased reason to address hookah smoking. Yet little research exists on the characteristics of hookah users to guide the development of interventions for reducing hookah use, particularly for college students who may be at increased risk for hookah use. The need for such interventions will likely grow if hookah vendors and venues become increasingly available near college campuses. Furthermore, research to determine how similar or distinct hookah users might be from cigarette smokers or dual users is needed because studies suggest that hookah may have distinct social and cultural characteristics that make it appealing to non-cigarette smokers.^{19,21} If college students view hookah as having significantly different characteristics from cigarettes, then the decreased risk of smoking cigarettes seen in college student populations may not apply to hookah.

While prior studies show that hookah use is positively associated with cigarette use,^{7,22} only one examines the differences between nonsmokers, hookah-only users, cigarette-only users, and dual users (hookah users who also smoke cigarettes), finding that hookah-only and dual users are demographically different from nonsmoking or cigarette-only college students.²² In addition to these demographic differences, it is important to understand differences in tobacco-related attitudes between hookah users, cigarette smokers, and dual users in order to develop effective interventions.

One message strategy with the potential to reach college students is to denormalize the tobacco industry. Several studies have demonstrated that anti-tobacco industry attitudes are strongly negatively associated with cigarette smoking and positively associated with intentions to quit among young adults.^{23,24} Anti-tobacco industry attitudes associated with exposure to the national truth campaign are also associated with intentions to quit smoking and decreased susceptibility to start smoking among young adults.²⁵ However, health messages that may apply to cigarette use may not be seen as applicable to hookah use or dual use, because hookah products have different branding and marketing. We do not yet know whether there are similar associations between anti-tobacco industry attitudes and hookah smoking, particularly because young adults may not regard hookah as a tobacco industry product, as hookah tobacco is not sold under the widely recognized cigarette brand names.

This is the first study to examine differences between nonsmokers, hookah-only users, cigarette-only users, and dual users among college attending and noncollege attending young adults. We hypothesize that 1. current college attendance will be associated with hookah use and 2. hookah users have different beliefs about tobacco and the tobacco industry than cigarette-only users

METHODS

Sample Selection

Young adults can be difficult to reach by traditional survey methods.²⁶ Researchers have used time-location sampling (TLS) to identify random samples of similarly hard-to-reach populations, such as injection drug users, that approximate probability samples.²⁷ To capture young adults at highest risk for tobacco use, we used TLS methods to collect random samples of the young adult bar-going population in 5 cities: San Diego, CA, Tulsa and Oklahoma City, OK, and Albuquerque and Las Cruces, NM. These cities were selected for the study because all had plans to implement interventions addressing young adult tobacco use and so had a need to understand tobacco use patterns in this population, including hookah use.

Data Collection

Randomized TLS strategies were used to collect a random sample of the young adult bar-going population in each city. Randomized TLS is widely used by public health professionals to collect data among hard-to-reach and “hidden” populations via venues where the target populations tend to gather or congregate, such as men who have sex with men in certain bars and dance clubs, commercial sex workers in “red light” districts, or intravenous drug users at “shooting galleries.”²⁸⁻³¹

Following the TLS protocol, we created a census of all the specific venues, days, and time intervals in which young adults attend bars. Qualitative interviews with key informants, patrons in focus groups, and bar owners were used to enumerate all bars and nightclubs popular with young adults (including the specific nights of the week and times of night), as well as local events, shows, and other venues frequented by young adults in each geographic location. Survey data collection venues and times were randomly selected from this list. By randomly selecting venues, days, and times, members of the target population have approximately equal chances of being sampled, making TLS a probability sampling method.²⁸⁻³⁰

Trained study personnel visited the selected locations at the designated randomly selected times. Permission to collect data was obtained from bar managers at every venue, and bar entry fees were paid, when applicable. Study personnel counted the total number of people present in the venue or designated sampling area (e.g., crossing an imaginary line drawn on the street in an area with foot traffic) during the data collection period and approached all individuals present at the time of sampling who appeared to be between 18 and 29 years of age. Participants whose self-reported age was between 18 and 29 were invited to complete paper-and-pencil surveys. Trained personnel explained the study, and all participants verbalized that they understood they were participating in a voluntary research study. Verbal informed consent was used to maximize convenience for the participants. Patrons who appeared to be intoxicated or who were unable or unwilling to complete the verbal informed consent procedure for any reason were not included. Detailed study information was offered to all participants in an information sheet, and all participants were given a study business card containing contact information for the study and a link to the study Web site, which also contained a copy of the informed consent form. After surveys were collected, age was cross-checked using date of birth. We focused on the young adult population and restricted analyses to adults aged 18 to 25.

Bars open and close frequently, and a venue's popularity also changes. Therefore, the list of target bars and times was updated every 2 weeks so that newly opened bars were included and bars that closed were eliminated from the list. In addition, bars that were found not matching the desired target when visited for data collection (e.g. the patrons were all too

old) were eliminated from the census during the following data collection period, in accordance with the TLS protocol.²⁸ Due to young adult venue patronage patterns, data collection was completed between 8 pm and 12 am in all sites.

Using these methods, between September 2009 and July 2011, 2,243 surveys were collected in San Diego, CA; 2,200 surveys in Oklahoma City, OK; 2,095 in Tulsa, OK; 1,044 in Albuquerque, NM; and 894 in Las Cruces, NM. Across all sites and data collection time periods, 79.1% of those within the age range invited to participate agreed to complete surveys, ranging from 63.4% in Albuquerque to 91.4% in San Diego. The data collection protocol was approved by the institutional review board (IRB) of the University of California, San Francisco.

Measures

Dependent Variables

Current Tobacco Use: Respondents reported the number of days they used hookah and the number of days they smoked cigarettes in the past 30 days. For each tobacco product, responses were coded as 0 if the respondent did not use in the past month and 1 if the respondent used the product in the past 30 days. Using these two items, we created a tobacco use measure with 4 categories: no tobacco use, hookah-only, cigarettes-only, and dual use of hookah and cigarettes.

Independent Variables

College status: College status was measured using 3 categories: graduated from college, currently in college, and never went to college/dropped out of college.

Demographics: Age was measured using 2 categories: 18- to 20-year-olds and 21- to 25-year-olds. Race/ethnicity was measured using dummy variables for 4 categories: non-Hispanic Caucasian, non-Hispanic African American, Hispanic, and non-Hispanic Other (which included Asian, Pacific Islander/Hawaiian, and American Indian/Alaska Native). Sexual orientation was coded as 1 if the respondent identified as gay, lesbian, or other sexual orientation and 0 for straight.

Anti-Secondhand Smoke (SHS): Respondents reported how much they agreed with 2 statements describing the harmful effects of SHS on a 5-point Likert scale. Consistent with prior analyses,²⁴ responses were coded as 1 if the respondent agreed completely with both statements (average score=5) and 0 if the respondent did not agree completely with both (average score <5).

Anti-Tobacco Industry: Agreement with 3 items describing support for taking action against the tobacco industry was reported on a 5-point Likert scale. Consistent with previous analyses,²⁴ responses were coded as 1 if the respondent strongly supported action against the tobacco industry (average of at least 4 out of 5 points across the three items) and 0 if the respondent did not strongly support action against the tobacco industry.

Advertising Receptivity: Respondents reported whether they would use a tobacco industry promotional item; in accord with prior studies,³² responses were coded as 1 if the respondent was receptive (would use these products) and 0 if the respondent would not use these products.

Current Binge Drinking: Current binge drinking was defined as having at least 5 drinks/shots of alcohol on 1 or more days in the past 30.

Statistical Analysis—Bivariate analyses of all variables for hookah use and cigarette use were conducted using Pearson chi-square tests. Similar to prior studies,²² multivariate multinomial logistic regression models were used to examine the relationship between use of hookah and cigarettes with age, race/ethnicity, sex, sexual orientation, education, SHS attitudes, tobacco industry attitudes, advertising receptivity, binge drinking, time, and location. Specifically, the 4 category dependent variable was used in the multinomial logistic regression. Results from the same model were calculated in reference to both “nonsmokers” and to those who used “only cigarettes” for comparison. Results with “nonsmokers” as the reference category were used to compare hookah-only users, dual users (past month hookah use and past month cigarette use), and cigarette-only users with nonsmokers. Similarly, results with “only cigarettes” as the reference category compare nonsmokers, hookah-only users, and dual users with cigarette-only users. Due to the fact that data were collected over several years and across several locations, the model included control variables for both time (data collection year) and location (data collection city).

Data from all 5 locations were combined for all analyses. To confirm that location did not have an effect, interaction terms between each location and each of the key independent variables (anti-SHS, anti-tobacco industry, and ad receptivity) were included in a full model. Only 1 of the interaction terms was statistically significant in the full model, and the Bayesian information criterion (BIC) was 13410.2 for the reduced model and 13667.2 for the full model. Based on these results, we concluded that the reduced model is preferred, and there are no consistent location-specific effects. Accordingly, we combined data from the 5 cities for these analyses without including interaction terms for location. All analyses were done using Stata 11.0.

RESULTS

Most prior studies have examined hookah users as a single group, usually defined by hookah use irrespective of co-use with cigarettes. In this sample, 21.3% of the respondents reported current 30-day hookah use. Among current hookah users, 22.6% were hookah only users, and 77.4% were dual users of both cigarettes and hookah (Figure 1). We found significant demographic differences when distinguishing between hookah-only users and dual users in terms of college status and sex. Specifically, hookah-only users were more likely to be in college (64.9%) compared with dual users (54.7%) and cigarette-only users (44.3%, $P < .001$). We found that the majority of hookah users (57%) were current college students and that 84.5% of hookah-only users and 73.7% of dual users were college students or graduates. In terms of sex, 52.7% of hookah-only users were male, whereas 69.1% of dual users were male ($P < .001$). Frequencies for all variables across tobacco use types are reported in Table 1.

Comparing hookah-only users, cigarette-only users, and dual users with nonsmokers

Results from an adjusted multinomial regression model comparing hookah-only users, cigarette-only users, and dual users in reference to nonsmokers are reported in Table 2. Comparing the adjusted relative risk ratios (RRR), results show that being in college and having graduated from college were negatively associated with both cigarette-only use and dual use relative to nonsmoking. The association between college status and hookah-only use was not significantly different than that for nonsmokers. This suggests that unlike the negative association between college status and cigarette use, college going young adults were as likely to be hookah-only users as they were to be nonsmokers.

The associations between anti-SHS attitudes, anti-tobacco industry attitudes, and receptivity to tobacco marketing are different for the 4 smoking types. Both cigarette-only users and dual users were significantly different from nonsmokers in terms of all 3 tobacco-related

attitudes. Relative to nonsmokers, those having strong anti-tobacco industry attitudes and strongly believing in the dangers of SHS were less likely to be cigarette-only users or dual users, whereas those who are receptive to tobacco marketing were more likely to be cigarette-only users or dual users. In contrast, hookah-only users and nonsmokers were not significantly different in their beliefs about the dangers of SHS. For both strong anti-tobacco industry attitudes and receptivity to tobacco marketing, hookah-only users showed similar, but lower, odds as the other smoker types.

Hookah-only users, cigarette-only users, and dual users were also significantly different from nonsmokers in terms of binge drinking. Binge drinking was positively associated with each of the 3 smoking types relative to nonsmokers, with the RRR being the highest (RRR=4.41, $P<.001$) for dual users.

Comparing hookah-only users and dual users with cigarette-only users

To compare tobacco-related attitudes among smokers, we adjusted the reference category in the same model to compare hookah-only users and dual users with cigarette-only users using multinomial regression (Table 3). Current college students had significantly higher risk of being hookah-only users (RRR=2.53, $p<.001$) or dual users (RRR=1.34, $p<.01$) compared with cigarette-only users. College graduates were also more likely to be hookah-only users than cigarette-only users. College graduates risk of being dual users was not statistically different from their risk of being cigarette-only users.

Comparing hookah-only users to cigarette-only users, those with strong anti-tobacco industry attitudes were more likely to be hookah-only users, whereas those who were receptive to tobacco marketing were more likely to be cigarette-only users. This suggests that tobacco marketing and denormalization messages may not influence hookah-only users in the same way that they affect cigarette-only users. However, beliefs about the dangers of SHS did not differ significantly between hookah-only users and cigarette-only users. Compared with cigarette-only users, dual users were less likely to strongly believe in the dangers of SHS. On the other hand, dual users were significantly more receptive to tobacco marketing than cigarette-only users. Anti-tobacco industry attitudes did not differ significantly between dual users and cigarette-only users.

Binge drinking was also positively associated with dual use compared with cigarette-only use.

COMMENT

Our findings support the focus on college young adult populations for hookah use and suggest that messages tailored by type of tobacco product used may be needed. We hypothesized that college students would be more likely to use hookah. Confirming this, significantly larger proportions of college students reported using hookah than both cigarettes alone and nonsmoking. Furthermore, we found that current college students and college graduates were at greater risk for using hookah (with or without cigarettes) than using cigarettes alone relative to noncollege young adults.

Among college-going young adults, currently being in college was more strongly associated with hookah-only and dual use than was having graduated from college. Our data are not longitudinal, so it is not possible to discern trajectories of hookah and cigarette use over time. However, our sample includes young adults who were currently in college and those who have graduated from college, which allows for comparison between these groups. Comparing young adults currently in college with those who have graduated may suggest tobacco use trends for future longitudinal study.

Our findings suggest 2 possible interpretations for the stronger association between current college status and hookah use: (1) the college environment in particular favors hookah use, and/or (2) there is a cohort effect among young people who are currently in college compared with those who have already graduated from college. It is possible that both of these factors could influence hookah use; that the college environment increasingly favors hookah use more so than in the past and that hookah use is becoming increasingly popular with cohorts over time. This would be consistent with increasing young adult exposure to hookah use as disproportionate numbers of hookah bars open near college campuses. However, our data do not allow for empirical analysis of these possibilities, and we recommend that future longitudinal research explore these issues. This is particularly important because the availability of hookahs and hookah bars may be rapidly increasing near college campuses. In addition, we confirmed prior findings that hookah use is associated with younger age, sex, cigarette smoking, and binge drinking.^{2,15,22} In our samples, hookah-only users were more evenly split between males and females, whereas dual users were predominately male.

Our study also suggests that college campuses are an efficient way to reach current hookah users, particularly those who smoke hookah exclusively, as 84.5% of hookah-only smokers were college students or graduates. However, among the respondents currently in college, dual users of both hookah and cigarettes outnumbered hookah-only users by about 3 to 1, so college health professionals need to address both hookah-only use and dual use. In addition, we found that hookah-only users were attitudinally differ from cigarette-only users and dual users of hookah and cigarettes and thus may require tailored messages. We found evidence that supported our second hypothesis: hookah users have different beliefs about tobacco and the tobacco industry than cigarette-only users. Differences between hookah-only users and cigarette-only users suggest that hookah may be attracting a population of young people who might not otherwise use tobacco. The attitudinal differences between hookah-only users and dual users also suggest there may be distinct processes leading to initiation into hookah use. One explanation is that hookah products' distinctiveness from cigarettes and the tobacco industry may make hookah attractive to some nonsmokers. Another is that perceived similarities between smoking cigarettes and smoking tobacco using hookahs may make dual use attractive to some smokers. This suggests that college health professionals should develop programs or educational materials addressing hookah use among college students. Such programs need to address college student attitudes that hookah use is different from cigarette smoking, and that it is disconnected from the tobacco industry. While the hookah sellers and manufacturers are largely distinct from the traditional cigarette companies, attention could still be drawn to the use of promotional strategies known to appeal to the young (such as fruit flavors), use of social and cultural practices related to hookah that normalize use, and downplaying the health effects of hookah use.

Limitations

This study uses cross-sectional data and cannot be used to establish causal relationships explaining hookah use patterns. Use of these products should be studied longitudinally among college students and noncollege young adults to determine the whether hookah may be attracting new tobacco users or discouraging cigarette smokers from quitting. Research is needed to determine what about the college student experience explains the increased association between currently attending college and using hookah. Our study did not include measures of the health effects or perceptions of health effects related to hookah use, and all measures of tobacco use were self-reported. However, self-reported cigarette use has been extensively studied and found to be highly consistent with biochemical validation, and currently there is no biomarker for hookah use. These findings are also limited to the young adult population in bars and clubs and may not generalize to the larger populations of

college attending and noncollege attending young adults. However, the young adult bar-going population is an important focus for research into hookah use because of the social and venue-based nature of hookah smoking, and the high rates of young adult hookah use. Additionally, data were collected over the course of several years and in several locations and may not generalize to all contexts. We attempted to control for potential time and location bias by testing for location-specific effects and including control variables for both time and location in regression models.

Conclusions

We found that attending college was positively associated with both hookah-only and dual use. These results suggest that while noncollege attending young adults may be at increased risk for current cigarette use, college students may be at increased risk for hookah use, especially hookah-only use. Novel interventions should be developed since existing strategies and messages largely target cigarette smokers and some of these messages may be viewed as irrelevant for hookah. Tailored interventions for hookah use should address the widespread misperceptions regarding the health risks of hookah, and the possibility that hookah use could lead to nicotine addiction and/or dual use in this high-risk population. Our findings suggest several possible recommendations for addressing hookah use.

These results support the conclusion that hookah-only users have different attitudes than nonsmokers and cigarette-only users, particularly because hookah-only users do not associate their hookah use with the tobacco industry and are less receptive to tobacco advertising. Therefore, antitobacco messages that emphasize tobacco industry denormalization may also need to associate hookah with the tobacco industry to be effective. Framing hookah as a tobacco product that is aggressively promoted by an industry may increase the relevance of denormalization messages for hookah users. While not the subject of this study, similar to their differing attitudes about hookah and the tobacco industry, it may be that many young adults do not consider hookah use to be smoking or hookah users to be smokers. To reach hookah users, interventions may need to address the perception that hookah is not a tobacco product. College health professionals are starting to develop educational materials addressing myths about the safety of hookah use, and these materials should also help students to recognize that hookah use is frequently a form of tobacco use. College administrators should support the message that hookah use is not acceptable on campus, and ensure that hookah can be included in campus tobacco-free policies to help to address the misperception that hookah use is not tobacco use.

Because hookah users do not differ from smokers in beliefs about the dangers of SHS, they may be more receptive to messages addressing this issue. Education about the dangers of exposure to hookah smoke may also resonate with college student hookah users. Future research should also explore the effectiveness other hookah-specific messaging (such as carbon monoxide exposure or infectious disease risk) among both hookah-only and dual users. Additionally, our findings highlight the continued importance of alcohol use and bar settings as risk factors for all types of tobacco use in the college student population, particularly for dual use. The proximity of hookah bars to colleges, as well as campus policies about hookah use, may also affect the social acceptability of hookah use among college students. College health professionals should ensure that campus smoke-free or tobacco-free policies allow the inclusion of hookah as a tobacco product.

Further research is needed to better understand the increased risk for hookah use among college students suggested by our findings. Longitudinal data on trajectories of use among college and noncollege young adults may help explain the degree to which exposure to hookah use and hookah marketing near college campuses might influence hookah use.

Given the increasing popularity of hookah use, surveillance studies should be adequately powered to monitor hookah-only and dual use trends among college students.

Acknowledgments

Funding

The National Cancer Institute RO1-CA87472, R25T-113710, and U01-CA154240. Early years of the research were supported by California's Tobacco-Related Disease Research Program (TRDRP) and the Flight Attendant Medical Research Institute (FAMRI). The funding agencies played no part in the selection of topic, design, analysis, or interpretation of our study.

REFERENCES

1. Rogers JM. Tobacco and pregnancy: overview of exposures and effects. *Birth Defects Res C Embryo Today*. Mar; 2008 84(1):1–15. [PubMed: 18383133]
2. Smith JR, Edland SD, Novotny TE, Hofstetter CR, White MM, Lindsay SP, Al-Delaimy WK. Increasing hookah use in California. *Am J Public Health*. 2011:e1–e3. doi:10.2105/AJPH.2011.300196.
3. Cobb C, Ward KD, Maziak W, Shihadeh AL, Eissenberg T. Waterpipe tobacco smoking: an emerging health crisis in the United States. *Am J Health Behav*. May-Jun;2010 34(3):275–285. [PubMed: 20001185]
4. Grekin ER, Ayna D. Argileh use among college students in the United States: an emerging trend. *J Stud Alcohol Drugs*. May; 2008 69(3):472–475. [PubMed: 18432392]
5. Primack BA, Sidani J, Agarwal AA, Shadel WG, Donny EC, Eissenberg TE. Prevalence of and associations with waterpipe tobacco smoking among U.S. university students. *Ann Behav Med*. Aug; 2008 36(1):81–86. [PubMed: 18719977]
6. Ahmed B, Jacob P 3rd, Allen F, Benowitz N. Attitudes and practices of hookah smokers in the San Francisco Bay Area. *J Psychoactive Drugs*. Apr-Jun;2011 43(2):146–152. [PubMed: 21858960]
7. 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*. May 1; 2011 115(1-2):131–136. [PubMed: 21353750]
8. Eissenberg T, Shihadeh A. Waterpipe tobacco and cigarette smoking: direct comparison of toxicant exposure. *Am J Prev Med*. Dec; 2009 37(6):518–523. [PubMed: 19944918]
9. Maziak W, Rastam S, Ibrahim I, Ward KD, Shihadeh A, Eissenberg T. CO exposure, puff topography, and subjective effects in waterpipe tobacco smokers. *Nicotine Tob Res*. Jul; 2009 11(7):806–811. [PubMed: 19420278]
10. Shihadeh A. Investigation of mainstream smoke aerosol of the argileh water pipe. *Food Chem Toxicol*. Jan; 2003 41(1):143–152. [PubMed: 12453738]
11. Monzer B, Sepetdjian E, Saliba N, Shihadeh A. Charcoal emissions as a source of CO and carcinogenic PAH in mainstream narghile waterpipe smoke. *Food Chem Toxicol*. Sep; 2008 46(9):2991–2995. [PubMed: 18573302]
12. Jacob P 3rd, Abu Raddaha AH, Dempsey D, Havel C, Peng M, Yu L, Benowitz NL. Nicotine, carbon monoxide, and carcinogen exposure after a single use of a water pipe. *Cancer Epidemiol Biomarkers Prev*. Nov; 2011 20(11):2345–2353. [PubMed: 21908725]
13. Smith SY, Curbow B, Stillman FA. Harm perception of nicotine products in college freshmen. *Nicotine Tob Res*. Sep; 2007 9(9):977–982. [PubMed: 17763115]
14. Eissenberg T, Ward KD, Smith-Simone S, Maziak W. Waterpipe tobacco smoking on a U.S. College campus: prevalence and correlates. *J Adolesc Health*. May; 2008 42(5):526–529. [PubMed: 18407049]
15. 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*. Feb; 2008 10(2):393–398. [PubMed: 18236304]
16. Quenqua D. Putting a crimp in the hookah. *New York Times*. May.2011 2011 30A1:A1.

17. Maziak W, Eissenberg T, Rastam S, Hammal F, Asfar T, Bachir ME, Fouad MF, Ward KD. Beliefs and attitudes related to narghile (waterpipe) smoking among university students in Syria. *Ann Epidemiol*. Oct; 2004 14(9):646–654. [PubMed: 15380795]
18. Lipkus IM, Eissenberg T, Schwartz-Bloom RD, Prokhorov AV, Levy J. Affecting perceptions of harm and addiction among college waterpipe tobacco smokers. *Nicotine Tob Res*. Apr 6.2011
19. Nasim A, Blank MD, Cobb CO, Eissenberg T. A multiple indicators and multiple causes model of alternative tobacco use. *Am J Health Behav*. Jan; 2013 37(1):25–31. [PubMed: 22943098]
20. Gilpin EA, White VM, Pierce JP. How effective are tobacco industry bar and club marketing efforts in reaching young adults? *Tob Control*. 2005; 14:186–192. [PubMed: 15923469]
21. Maziak W, Eissenberg T, Ward KD. Patterns of waterpipe use and dependence: implications for intervention development. *Pharmacol Biochem Behav*. Jan; 2005 80(1):173–179. [PubMed: 15652393]
22. 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*. Feb 7.2012
23. Ling PM, Neilands TB, Glantz SA. The effect of support for action against the tobacco industry on smoking among young adults. *Am J Public Health*. Aug; 2007 97(8):1449–1456. [PubMed: 17600255]
24. Ling PM, Neilands TB, Glantz SA. Young adult smoking behavior: a national survey. *Am J Prev Med*. May; 2009 36(5):389–394. e382. [PubMed: 19269128]
25. Richardson AK, Green M, Xiao H, Sokol N, Vallone D. Evidence for truth®: the young adult response to a youth-focused anti-smoking media campaign. *Am J Prev Med*. 2010; 39(6):500–506. [PubMed: 21084069]
26. Blumberg, SJ.; Luke, JV. [15 Aug, 2008] Wireless substitution: early release of estimates based on data from the National Health Interview Survey. Jul-Dec. May 14. 2006 Available at <http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless200705.pdf>.
27. Raymond, HF.; Ick, T.; Grasso, M.; Vaudrey, J.; McFarland, W. Resource guide: time location sampling. San Francisco Department of Public Health HIV Epidemiology Section, Behavioral Surveillance Unit; San Francisco: Sep. 2007
28. [25 Feb, 2011] Resource guide: time location sampling (TLS). Available at <http://globalhealthsciences.ucsf.edu/PPHG/assets/docs/tls-res-guide-2nd-edition.pdf>.
29. Magnani R, Sabin K, Saidel T, Heckathorn D. Review of sampling hard-to-reach and hidden populations for HIV surveillance. *AIDS*. 2005; 19(Suppl 2):S67–S72. [PubMed: 15930843]
30. Muhib FB, Lin LS, Stueve A, Miller RL, Ford WL, Johnson WD, Smith PJ. A venue-based method for sampling hard-to-reach populations. *Public Health Rep*. 2001; 116(1):216–222. [PubMed: 11889287]
31. MacKellar D, Valleroy L, Karon J, Lemp G, Janssen R. The young men's survey: methods for estimating HIV seroprevalence and risk factors among young. *Public Health Rep*. 1996; 111(6): 138–144. [PubMed: 8862170]
32. Gilpin EA, White MM, Messer K, Pierce JP. Receptivity to tobacco advertising and promotions among young adolescents as a predictor of established smoking in young adulthood. *Am J Public Health*. Aug; 2007 97(8):1489–1495. [PubMed: 17600271]

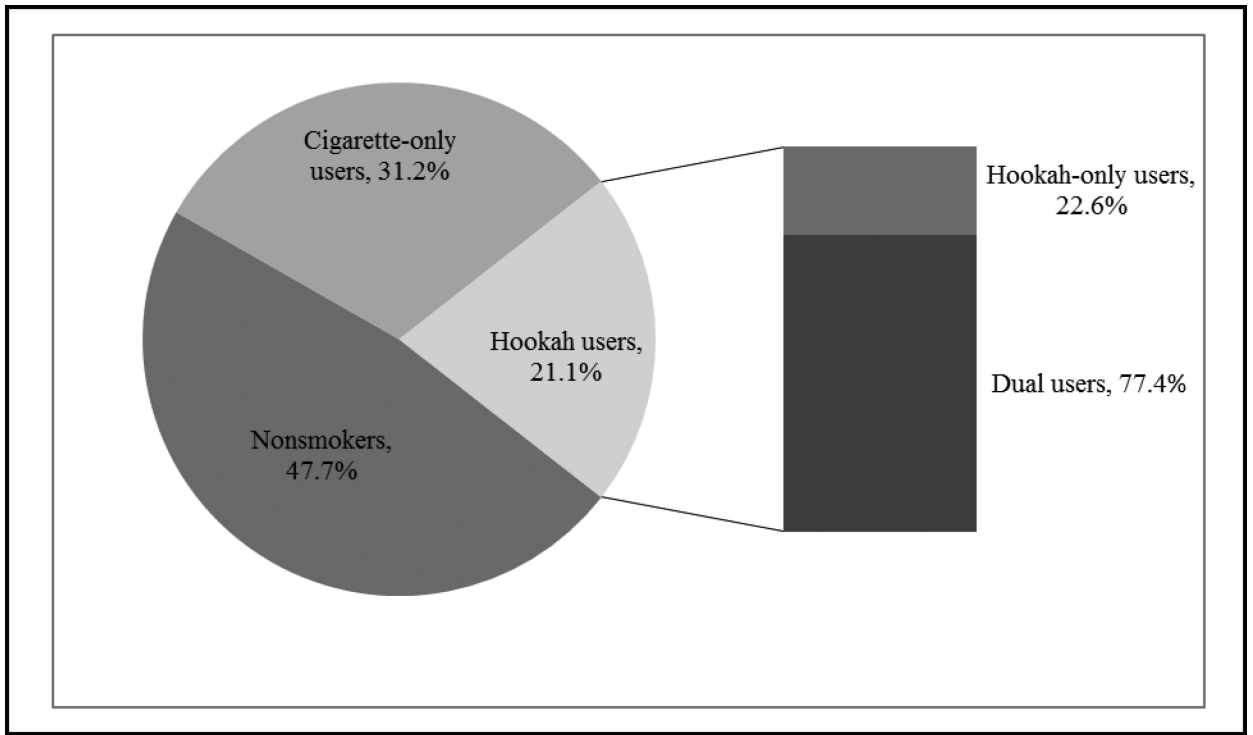


Figure 1.
Percentages of types of young adult past 30-day hookah users

Table 1

Demographic characteristics and attitudes for hookah and cigarette users

Characteristic/Attitude	Nonsmoker	Hookah-Only User	Cigarette-Only User	Dual User	Total
	N = 3,219 (47.7%)	N = 322 (4.8%)	N = 2,109 (31.2%)	N = 1,104 (16.3%)	N = 6,754 (100.0%)
College Status ^{***}					
Graduated	29.5	19.6	26.5	19.0	26.4
In college	54.7	64.9	44.3	54.7	51.9
No college/dropout	15.8	15.5	29.2	26.3	21.7
Age ^{***}					
18–20	7.1	12.8	5.9	13.7	8.1
21–25	92.9	87.2	94.1	86.3	91.9
Race/Ethnicity ^{***}					
Caucasian	50.4	48.1	58.2	49.7	52.6
African American	6.4	6.5	4.8	3.6	5.4
Other ^a	16.04	17.4	17.8	21.1	17.5
Hispanic	27.2	28.0	19.3	25.6	24.5
Sex ^{***}					
Male	45.0	52.7	49.9	61.9	49.6
Female	55.0	47.3	50.1	38.1	50.4
Sexual Orientation ^{***}					
LGBT	8.7	13.1	14.4	17.4	12.1
Straight	91.4	86.9	85.6	82.6	87.9
Cigarette Smoking ^{***}					
Daily	0.0	0.0	36.8	34.8	17.2
Non-daily	0.0	0.0	63.2	65.2	30.4
Not in past month	100.00	100.00	0.0	0.0	52.5
Anti-SHS ^{***}	46.5	34.6	28.6	21.0	36.2
Anti-Tobacco Industry ^{***}	47.8	36.3	19.2	19.5	33.8
Receptive to Tobacco Advertising ^{***}	17.2	25.0	36.0	43.3	27.6
Binge Drinking ^{***}	59.5	75.7	78.5	87.5	70.7

^a Asian, Pacific Islander, American Indian, and Other LGBT = lesbian, gay, bisexual, transgendered; SHS = secondhand smoke

P<.001

Table 2

Comparing hookah-only users, cigarette-only users, and dual users with nonsmokers by college status, tobacco-related attitudes, and binge drinking

Characteristic/Attitude	Nonsmoker	Hookah-Only User	Cigarette-Only User	Dual User
	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
College Status				
In college	Ref	1.35 (.95–1.91)	.53 (.45–.63) ***	.72 (.59–.88) ***
Graduated	Ref	.80 (.53–1.21)	.52 (.43–.62) ***	.47 (.37–.60) ***
No college	Ref	Ref	Ref	Ref
Anti-SHS	Ref	.80 (.61–1.04)	.77 (.67–.89) ***	.58 (.48–.70) ***
Anti-Tobacco Industry	Ref	.72 (.56–.94) *	.33 (.28–.38) ***	.39 (.32–.47) ***
Ad Receptivity	Ref	1.37 (1.03–1.82) *	1.95 (1.69–2.25) ***	2.45 (2.06–2.90) ***
Binge Drinking	Ref	2.15 (1.63–2.85) ***	2.17 (1.89–2.50) ***	4.41 (3.56–5.47) ***

Notes: The three categories “Hookah-Only User,” “Cigarette-Only User,” and “Dual User” are compared with the omitted reference category of “Nonsmoker.” The model also adjusted for sex, sexual orientation, age, ethnicity, year, and location, although results are not displayed in the table.

CI = confidence interval; RRR = relative risk ratio; SHS = secondhand smoke

**P<.01

* P<.05

*** P<.001

Table 3

Comparing hookah-only users and dual users with cigarette-only users by college status, tobacco-related attitudes, and binge drinking

Characteristic/Attitude	Hookah-Only User	Dual User	Cigarette-Only User
	RRR (95% CI)	RRR (95% CI)	
College Status			
In college	2.53 (1.79–3.59) ***	1.34 (1.12–1.63) **	Ref
Graduated	1.54 (1.02–2.34) *	.92 (.73–1.16)	Ref
No college	Ref	Ref	Ref
Anti-SHS	1.03 (.78–1.36)	.76 (.62–.92) **	Ref
Anti-Tobacco Industry	2.21 (1.70–2.92) ***	1.18 (.96–1.45)	Ref
Ad Receptivity	.70 (.52–.93) *	1.25 (1.06–1.48) **	Ref
Binge Drinking	.99 (.74–1.33)	2.03 (1.63–2.54) ***	Ref

Notes: The three categories “Nonsmoker,” “Hookah-Only User,” and “Dual User” are compared with the omitted reference category of “Cigarette-Only User.” The model included a category for “Nonsmoker;” results are not displayed in the table. The model also controlled for sex, sexual orientation, age, ethnicity, time, and location, although results are not displayed in the table.

CI = confidence interval; RRR = relative risk ratio; SHS = secondhand smoke

* P<.05

** P<.01

*** P<.001