



**Hookah's New Popularity Among US College Students: A
Cross-Sectional Study of the Characteristics of Hookah
Smokers and Their Facebook Displays**

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3 **Hookah's New Popularity Among US College Students: A Cross-Sectional**
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6 **Study of The Characteristics of Hookah Smokers and Their Facebook**
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9 **Displays**
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ABSTRACT

Objectives: (1) To determine the prevalence of hookah use among US college students. (2) To identify substances commonly smoked in hookahs and other substance use characteristics of hookah smokers. (3) Given the powerful influence of Facebook and its potential role in promoting behaviors, to assess the prevalence of hookah references on Facebook profiles.

Design: Cross sectional study.

Setting: Two large US universities; www.Facebook.com.

Participants: 307 Facebook profiles were coded and 216 of these profile owners completed an online survey. On average, participants were 18.8 years old (SD=0.7), female (54%), Caucasian (70.4%), and approximately half were from each university.

Outcome measures: Lifetime and frequency of hookah use, substance smoked in hookah, cigarette and marijuana use, hookah references displayed on Facebook.

Results: 27.8% of participants endorsed hookah use; there were no significant differences between age, gender, race, or university for hookah use. Hookah users reported smoking tobacco (78%), hash (12%) and both tobacco and marijuana/hash (10%) in their hookah. Compared to non-hookah smokers, hookah smokers were more likely to report using cigarettes (OR=3.41,95%CI=1.2-9.64) and marijuana (OR=15.01,95%CI= 6.5-34.65). Hookah references were present on 5% of Facebook profiles.

Conclusions: More than one quarter of college students smoke hookah. Most smoke tobacco in their hookah, and hookah smoking is associated with polysubstance use. Some hookah users reference this this behavior on Facebook. Hookah may present new risks for nicotine addiction in this population.

INTRODUCTION

Tobacco use is the leading preventable cause of morbidity and mortality worldwide. Encouragingly, public health efforts have successfully decreased the prevalence of cigarette smoking in the US by half over the past 45 years.[1] This achievement is attributed to the first Surgeon General's report on smoking and health in 1964, taxation, indoor smoking bans, media advertising restrictions and counter-advertising campaigns, and increased public awareness of the harms associated with cigarette smoking.[2]

Despite this laudable public health accomplishment, the use of alternative forms of tobacco is currently rising, threatening these successful efforts. Of particular concern is the increasing popularity of hookah.[3] Hookah use, also known as shisha, narghile and waterpipe, is defined as the smoking of substances through a waterpipe such that the smoke passes through water and is cooled prior to inhalation. Smoking a waterpipe is a tradition dating back at least four centuries to origins in northern Africa and southwest Asia.[4] Until recently, smoking in this fashion remained primarily a tradition observed in Middle Eastern countries, most popular among adult men.[5]

Presently, hookah smoking is becoming an increasingly popular form of tobacco use worldwide. Spreading from the Eastern Mediterranean region, hookah use is now common in Western countries including Australia, the United Kingdom, Canada and the United States.[3] Further, hookah is becoming increasingly popular among youth. A recent global surveillance study examining time trends (1999-2008) of tobacco use in youth found an increase in hookah smoking amongst teens as young as 13-15 year olds.[3, 6] In the United States, adolescents and young adults are at the forefront of this resurgence.

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3 Our understanding of smoking patterns among youth is incomplete. While hashish or
4 opium were once smoked in hookahs in the Middle East and India,[5, 7] smoking tobacco in
5 hookahs was popularized in the 1990s with the introduction of *maasel*, a sweetened and flavored
6 tobacco product.[3] Some reports suggest marijuana, hashish or other drugs are sometimes added
7 to hookah tobacco.[8] However, the predominate substances smoked in hookahs and other
8 substance use practices of hookah users among US teens remain unknown.
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11 Therefore, the primary purpose of this study was to investigate the lifetime prevalence of
12 hookah smoking amongst undergraduate students at two large public universities in different
13 regions of the US. The second aim of this study was to identify the specific substance use
14 practices of hookah smokers, including the predominant substance that young adults smoke in
15 their hookah, and other substance use characteristics of hookah smokers. Identifying these
16 characteristics of hookah smokers has numerous public health and clinical implications, and is a
17 necessary step in developing targeted prevention and intervention strategies.
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21 Finally, how and why hookah smoking is gaining popularity among young adults also
22 remains unclear. Many attribute hookah's popularity to its social nature; hookah use is a shared,
23 communal experience and two or more people often share a single waterpipe.[4, 6] It is also
24 possible that new forms of media are playing a role in promoting hookah smoking among young
25 adults. Recent work suggests hookah-related videos on YouTube, compared to cigarette-related
26 videos, are less likely to reference the harmful consequences of smoking nor provide anti-
27 smoking messages.[9] As the cultivation theory suggests, online videos may influence viewers'
28 opinions and perceptions; videos that fail to portray the negative consequences of hookah
29 smoking may serve to promote this behavior among young adults.[10]
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3 We hypothesize that social networking websites (SNSs) may also popularize hookah
4 smoking by serving as a venue in which young adults learn about and promote hookah use
5 among their social groups. In recent years, SNSs such as Facebook, have become a tremendously
6 popular source of social media among adolescents and young adults; Facebook is now used by
7 over 90% of college students and is the most popular SNS among university students.[11] While
8 previous studies have found associations between consuming media, such as television and
9 movies, depicting tobacco and the initiation of tobacco use, it has been argued that Facebook
10 may have greater influence than traditional media because Facebook combines the power of
11 interpersonal persuasion with the reach of mass media. [12, 13] Specifically for adolescents and
12 young adults, for whom peers are the most important source of influence, the power of
13 interpersonal persuasion cannot be underestimated.[14] Some suggest these websites may serve
14 as a media “super-peer” by promoting norms of behavior among adolescents.[15] Additionally,
15 social learning theory predicts that adolescents observe, imitate, and model behaviors they see in
16 their peers.

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18 Thus, the third objective of this study was to conduct an exploratory investigation of the
19 presence of hookah references on Facebook. As a social networking site, Facebook may provide
20 a venue for peer interaction and social networking, both of which are recognized as contributors
21 to risk behaviors.[16] Risk behaviors such as alcohol and drug use have been found to be
22 displayed on SNS profiles.[16] We therefore anticipate that hookah is also displayed online
23 within social networks, but the extent to which this is so remains unknown.

54 METHODS

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3 This study was conducted between September 2009 and December 2011 and received
4 IRB approval from both the University of Wisconsin and the University of Washington.
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7 8 **Setting and subjects** 9

10 Participants for this study attended one of two large, public universities, in the Midwest
11 and on the West Coast. Participants were recruited via the social networking website Facebook
12 (www.Facebook.com). This SNS was selected because it is the most popular SNS among our
13 target population of college students.[17] We investigated publicly available Facebook profiles
14 of these undergraduate students. Inclusion criteria required profile owners to report an age on
15 their profile between 18 and 20 years, and to show evidence of profile activity within the last 30
16 days. We only analyzed Facebook profiles for which we could confirm the profile owner's
17 identity by calling a phone number listed on either the university directory or Facebook profile.
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29 **Subject selection** 30

31 In order to reach a target sample size of 200 participants, a total of 307 Facebook profiles
32 owners were identified in 2009 and 2010 and invited to participate in the study. Eligible profiles
33 were identified by a random search of the freshmen, sophomore and junior undergraduate classes
34 at our two selected universities using the Facebook search engine. All profiles returned in the
35 search results were assessed sequentially for eligibility until the target sample size was reached.
36 Profiles were excluded if they did not meet search criteria (ie, incorrectly listed), including those
37 who were not undergraduates (N=448), did not meet the age criteria (N=313) or did not display
38 their age (N=49). Profiles were also excluded if their profiles were completely private, had any
39 one of the following sections set to private: information section, wall or photographs (N=1630),
40 or if the profile owner was not reachable for recruitment (ie, no phone number or email listed on
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3 Facebook profile or in the university directory) (N=303). Demographic data was recorded from
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5 eligible profiles.
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8 **Recruitment**

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10 The 307 profile owners with profiles that met inclusion criteria were called on the phone.
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12 After verifying the profile owner's identity, the study was explained to the profile owner and
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14 permission was requested to send an email that contained further information about the study. If
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16 the participant consented to receive the email, an email was sent that provided detailed
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18 information about the study as well as a link to an online survey. The survey was administered
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20 online via a Catalyst WebQ online survey engine. Survey respondents were provided a \$15
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22 iTunes gift card as compensation.
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27 **Survey**

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29 The online survey evaluated hookah use. Participants were asked about their lifetime
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31 experience using hookah. Those who reported ever using hookah were also questioned about
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33 their frequency of use; answer options included never, monthly or less, 2-4 times a month, 2-3
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35 times a week, 4 or more times a week. Participants were also asked what substances they
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37 typically smoked in their hookah; answer options included tobacco, marijuana, hash, a mix of
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39 marijuana/hash and tobacco. All participants were also questioned about their lifetime experience
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41 and frequency of use of marijuana and cigarettes, with similar answer options for frequency as
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43 described above.
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48 **Facebook Profile Coding**

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50 To investigate the presence of hookah references on college student's Facebook profiles, all
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52 profiles were evaluated once by one of three trained coders using our research codebook. We
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54 have used this codebook in our previous work evaluating the display of health risk behavior
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3 references on SNS profiles.[18, 19] In order to determine whether hookah references were
4 present, coders viewed all publicly accessible elements of the Facebook profile including profile
5 owners' tagged pictures, profile pictures, information sections, and their Wall. Both images and
6 text were coded and hookah reference data included the coder's typewritten description of any
7 image references or verbatim text from profiles usually found in the form of status updates or in
8 info section. If present, identifiable information was removed from text references. One year of
9 profile data was assessed for each participant, starting from the date of evaluation and going back
10 to the same date, one year prior.
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22 Profiles were categorized into one of two groups. Profiles with one or more references to
23 hookah use were classified as hookah "Displayers". Example references included personal
24 photographs in which the profile owner was smoking a hookah, or text references describing
25 smoking hookah. Only photographs that contained the profile owner with a clearly identifiable
26 hookah and text references that explicitly mentioned the word hookah or a synonym of hookah,
27 such as shisha or narghile, were coded. Profiles without any hookah references were considered
28 "Non-Displayers".
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39 Because of infrequent references to hookah on Facebook, interater agreement was used to
40 assess coder reliability. A 20% random subsample of profiles was evaluated by all three coders
41 and we found 96% interrater reliability.
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46 Analysis

47 Demographic characteristics, frequency and prevalence of hookah use, and Facebook
48 displays of hookah were summarized using descriptive statistics. Bivariate logistic regression
49 was used to examine covariates of lifetime hookah use (outcome); odds ratios and their 95%
50 confidence intervals were obtained for independent variables including age, gender,
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race/ethnicity, university, and substance use. We also fit a multivariate model of lifetime hookah use that included age, gender, race/ethnicity, university, and substance use covariates. Bivariate comparisons between demographic characteristics and hookah Displayer/Non-Displayer groups were conducted using Fisher's exact tests and Chi squared tests. All statistical analyses were conducted using STATA version 11.0 (Statacorp, College Station, TX). A two-sided p-value $p < 0.05$ was considered statistically significant.

RESULTS

Subjects

A total of 307 profile owners were invited to participate in this study. All 307 participants profiles were coded for references to hookah use, and 216 (70% response rate) participants completed all survey questions with viable answers and were included in our analyses. Participants had an average age of 18.8 years (SD 0.7), were 54.2% female and 70.4% Caucasian. Approximately half of participants were from each university. See Table 1 for further details. (Table 1)

Table 1. Descriptive characteristics of survey respondents (n=216)

Variable	Percent (n)		
	Total	Hookah Non-Users (n=153)	Hookah Users (n=60)
Age (yr) ^a			
18	35.7% (77)	36.5% (57)	33.3% (20)
19	50.9% (110)	48.1% (75)	58.3% (35)
20	13.4% (29)	15.4% (24)	8.33% (5)
Gender			
Male	47.2% (102)	45.5% (71)	51.7% (31)
Female	52.8% (114)	54.5% (85)	48.3% (29)
State			
Washington	46.8% (101)	47.4% (74)	45.0% (27)
Wisconsin	53.2% (115)	52.6% (82)	55.0% (33)
Race/Ethnicity ^b			
Caucasian	70.4% (150)	68.0% (104)	76.7% (46)
African American	0%	0%	0%

Asian/Pacific Islander	18.8% (40)	20.9% (32)	13.3% (8)
Hispanic	2.3% (5)	2.6% (4)	1.7% (1)
Other/Multiracial	8.5% (18)	8.5% (13)	8.3% (5)
^a Overall mean (SD), 18.8 (0.7) years			
^b 3 missing values			

Survey Results

Prevalence of hookah use

Lifetime hookah use was reported by 27.8% of participants (Table 2). Participants who reported ever using hookah were on average 18.8 (SD 0.6) years of age, and tended to be male (51.7%) and White (76.7%) (Table 1). There were no significant differences between age, gender, race, or university for hookah use. Of those who endorsed ever smoking hookah, 78.3% smoked hookah monthly or less and 21.6% were current users who reported smoking hookah more than once per month.

Table 2. Survey Results: Endorsement of Substance Use

Variable	Percent (n)		
	Total	Hookah Non-Users	Hookah Users
Hookah	27.8% (60)	0%	100% (60)
Cigarettes	16.2% (35)	7.1% (11)	40% (24)
Marijuana ^a	30.7% (66)	13.6% (21)	75% (45)
^a 3 missing values			

Hookah users engagement with other substances

Of those who reported ever using hookah, 40% reported ever smoking cigarettes, of whom 42.7% endorsed smoking cigarettes more than once a month. Most (75%) hookah users reported ever using marijuana, of whom 51% reported using marijuana more than once per month. No hookah users endorsed cigarette use only; among hookah users who endorsed cigarette use, 33.3% also reported smoking marijuana. (Table 2)

Multivariate modeling of lifetime hookah use indicated that those who endorsed hookah use were more likely to report other substance use. Hookah users were more likely to use cigarettes (OR=3.41, $p<0.05$) and marijuana (OR=15.01, $p<0.001$) compared to non-hookah smokers. (Table 3)

Table 3. Multivariate logistic regression modeling of lifetime hookah use (n=216)

Variable	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
Age	0.92 (0.58-1.44)	0.86 (0.47-1.57)
Gender	0.78 (0.43-1.42)	1.22 (0.55-2.70)
Race		
Caucasian	Reference group	Reference group
Asian/Pacific Islander	0.57 (0.24-1.32)	0.59 (0.18-1.99)
Hispanic	0.57 (0.60-5.20)	0.19 (.02-2.45)
Other/Multiracial	0.87 (0.29-2.58)	2.25 (0.58-8.75)
University	1.1 (0.61-2.00)	0.95 (0.40-2.26)
Cigarettes	8.79 (3.94-19.59)	3.41 (1.20-9.64)**
Marijuana	19.14 (9.10-40.27)	15.01 (6.50-34.65)**

* Odds ratios were adjusted for all other variables in the table
 ** $p<0.05$

Facebook results

Hookah references were present on 5.3% of Facebook profiles. There were no significant differences in hookah display between gender, race, or university. Examples of hookah references included personal images of profile owners smoking a hookah, downloaded images of icons saying “ I ♥ HOOKAH”, or status updates such as “Tonight is a hookah type of night, I love nights like these” and “Skippin’ class all day, goin’ hookah shopping, fun!”

DISCUSSION

This study explored characteristics of college student hookah smokers and evaluated the presence of hookah references displayed on university students’ Facebook pages. More than one quarter of college students reported smoking hookah and this prevalence estimate is consistent

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3 with those found in other studies.[20-22] To our knowledge, this is the first study to survey
4 college students about what substances they smoke in their hookah. The majority of hookah
5 smokers reported smoking tobacco in their hookah, yet more than 20% reported experience with
6 using marijuana or hash in their hookah. These findings support the rising popularity and
7 diversity of hookah use among young adults in the US.
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15 The finding that so many students are smoking hookah, and specifically smoking tobacco
16 in their hookah, is cause for clinical and public health concern. Although the health effects of
17 hookah have not been studied nearly as extensively as cigarettes, smoking tobacco in a waterpipe
18 is associated with negative health outcomes similar to those associated with cigarette use. Studies
19 compare hookah to cigarettes and illustrate that both forms of tobacco use expose smokers to
20 toxicants associated with cardiovascular and lung disease, including carbon monoxide and
21 polycyclic aromatic hydrocarbons.[3, 23] Further, hookah use significantly increases one's risk
22 for lung cancer, respiratory illness, low birthweight and periodontal disease.[24] Lastly,
23 preliminary research shows hookah use may be associated with nicotine dependence and could
24 be a gateway drug to cigarette smoking.[3, 25]
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39 These negative health consequences of hookah use are compounded by the many
40 misperceptions and incorrect beliefs and attitudes held by hookah users. Many hookah smokers
41 underestimate the health risks and addictive properties of hookah use. Contrary to the published
42 harms of hookah use, college students and young adults believe smoking tobacco in a waterpipe
43 is less harmful and less addictive than cigarettes and believe they can quit anytime.[26, 27]
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50 Similar to other studies, we found that hookah users were more likely than non-hookah
51 users to engage in substance use (separate from their hookah smoking) such as marijuana,
52 cigarettes and other psychoactive drugs.[21, 22, 28] Due to the cross-sectional nature of this
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3 study, we are unable to determine the temporal sequence of hookah smoking and the use of other
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5 substances. However, it may not be surprising that hookah smokers also engage in other
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7 substance use behaviors. Previous research supports that engagement in one risk behavior is
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9 often associated with an increased likelihood of engaging in other risk behaviors.[29] This may
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11 be especially true for hookah, cigarettes, and marijuana, all different means of smoking. It may
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13 be that once a college student decides to engage in a smoking behavior, they may be open to a
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15 variety of smoking behaviors. Further, given that college students report smoking both tobacco
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17 and marijuana in their hookah and independently as well, these results suggest marijuana
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19 prevention efforts may be effectively paired with tobacco prevention strategies.
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25 To the best of our knowledge, this is also the first study to investigate hookah use using
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27 Facebook. Our findings show more than 5% of college student profiles display references to
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29 hookah on Facebook. While hookah references on SNSs have not yet been extensively studied,
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31 other research illustrates that adolescents display references to other risk behaviors such as
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33 alcohol and substance use on their SNS profile.[16] These displays of various risk behaviors may
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35 represent engagement in that behavior, consideration of engagement in the behavior, boastful
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37 claims, or nonsense.[16] College students who display references to intoxication or problem
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39 drinking on their Facebook profile were more likely to meet clinical criteria for problem drinking
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41 compared to those who do not display such references.[30] Additionally, adolescents interpret
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43 alcohol displays on SNSs to be influential and valid representations of alcohol use.[31] Thus,
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45 these displays are meaningful. Given the social nature of hookah smoking, the social dimension
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47 of Facebook may be a salient factor in popularizing hookah use. Since students mainly initiate
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49 and practice hookah use with friends, Facebook may allow them to find such friends. Further
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51 research exploring this idea is necessary.
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There are several potential limitations to this study. First, participants were recruited from two universities. As cultural factors may be important in understanding hookah use across the US, it is possible that these two universities do not provide a representative sample. However, given our participants were selected from large geographically distinct state universities and that our prevalence estimates are consistent with other studies' estimates, this suggests our sample was representative. Second, we evaluated profiles from only one SNS and participants were limited to those who maintained a public Facebook profile and allowed their phone numbers to be listed either in the university directory or on Facebook. The extent to which findings could be generalized to profiles that have their security set to private, to profiles on other SNSs, or to younger adolescent populations is not known. It is important to note that SNS profile privacy settings are not permanent; profile owners may change their privacy settings at any time or to reflect what security upgrades are offered by Facebook. It is unclear whether profile owners who maintained a private profile at the time of this study would be more likely, or less likely, to display hookah references. Lastly, our findings are also limited in that our study sample included very few minority and no African American participants, which is consistent with the demographic of our universities.

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Despite these limitations, our findings have important implications. First, this is the first study to illustrate that hookah use goes beyond tobacco. We found that some students also smoke marijuana and hash in their hookah. With this understanding, future prevention and intervention methods may pair existing tobacco and marijuana strategies when targeting college hookah smokers. Second, we found that hookah use is also emerging on Facebook profiles, which may promote the illusion that it is a socially acceptable behavior and safe alternative to cigarettes. Future research is needed to determine whether Facebook may be helpful for

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3 screening in clinical settings. Along with a better understanding of how adolescents learn about
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5 hookah, these results may help providers assess college students who are at risk for or are
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7 engaging in hookah use.
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10 11 12 **WHAT THIS PAPER ADDS**

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14
15 Hookah smoking is a popular alternative form of tobacco use among US college students.
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17 However, patterns of use and characteristics of young hookah smokers remain unclear, as does
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19 why hookah is particularly attractive to this population. This paper adds to our understanding of
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21 hookah use by investigating the prevalence of hookah smoking among college students and by
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23 identifying the predominate substances college students smoke in a hookah, their use of other
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25 substances, and how hookah is displayed on their Facebook profiles. Hookah may present new
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27 risks for nicotine addiction in this population and our results have implications for the content
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29 and perhaps venue of future interventions.
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36 37 **ACKNOWLEDGEMENTS**

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41 data collection.
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46 47 **COMPETING INTERESTS**

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49 The authors have no competing interests.
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CONTRIBUTORSHIP STATEMENT

As the first author, I, Libby Brockman, contributed to this paper by designing the project, and by acquiring, analyzing and interpreting the data for this study. I also provided statistical expertise and drafted the manuscript. My co-authors contributed as follows: Megan A Pumper actively participated in data collection, and provided technical support as well as a critical revision of the manuscript for important intellectual content. Dimitri A Christakis provided statistical expertise, administrative/technical/material support, and critical revisions of the manuscript for important intellectual content. Megan A Moreno contributed to this paper by providing conception and design efforts, funding, administrative/technical/material support, supervision, and a critical revision of the manuscript for important intellectual content.

DATA SHARING STATEMENT

We do not have any additional, unpublished data from this study.

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest
Outcome data	15*	Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.



Hookah's New Popularity Among US College Students: A Pilot Study of the Characteristics of Hookah Smokers and Their Facebook Displays

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Hookah's New Popularity Among US College Students: A Pilot Study of The Characteristics of Hookah Smokers and Their Facebook Displays

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Keywords: Hookah, tobacco, smoking, college students, social networking website

Word Count: 3,502

ABSTRACT

Objectives: (1) To confirm the prevalence of hookah use among US college students. (2) To identify substances commonly smoked in hookahs and other substance use characteristics of hookah smokers. (3) Given the powerful influence of Facebook and its potential role in promoting behaviors, to assess the prevalence of hookah references on Facebook profiles.

Design: Cross sectional study.

Setting: Two large US universities; www.Facebook.com.

Participants: 307 Facebook profiles were coded and 216 of these profile owners completed an online survey. On average, participants were 18.8 years old (SD=0.7), female (54%), Caucasian (70.4%), and approximately half were from each university.

Outcome measures: Lifetime and frequency of hookah use, substance smoked in hookah, cigarette and marijuana use, hookah references displayed on Facebook.

Results: 27.8% of participants endorsed hookah use; there were no significant differences between age, gender, race, or university for hookah use. Hookah users reported smoking tobacco (78%), hash (12%) and both tobacco and marijuana/hash (10%) in their hookah. Compared to non-hookah smokers, hookah smokers were more likely to report using cigarettes (OR=3.41,95%CI=1.2-9.64) and marijuana (OR=15.01,95%CI= 6.5-34.65). Hookah references were present on 5% of Facebook profiles.

Conclusions: More than one quarter of college students smoke hookah. Most smoke tobacco in their hookah, and hookah smoking is associated with polysubstance use. Some hookah users reference this this behavior on Facebook. Hookah may present new risks for nicotine addiction in this population.

INTRODUCTION

Tobacco use is the leading preventable cause of morbidity and mortality worldwide. Encouragingly, public health efforts have successfully decreased the prevalence of cigarette smoking in the US by half over the past 45 years.[1] This achievement is attributed to the first Surgeon General's report on smoking and health in 1964, taxation, indoor smoking bans, media advertising restrictions and counter-advertising campaigns, and increased public awareness of the harms associated with cigarette smoking.[2]

Despite this laudable public health accomplishment, the use of alternative forms of tobacco is currently rising, threatening these successful efforts. Of particular concern is the increasing popularity of hookah.[3] Hookah use, also known as shisha, narghile and waterpipe, is defined as the smoking of substances through a waterpipe such that the smoke passes through water and is cooled prior to inhalation. Smoking a waterpipe is a tradition dating back at least four centuries to origins in northern Africa and southwest Asia.[4] Until recently, smoking in this fashion remained primarily a tradition observed in Middle Eastern countries, most popular among adult men.[5]

Presently, hookah smoking is becoming an increasingly popular form of tobacco use worldwide. Spreading from the Eastern Mediterranean region, hookah use is now common in Western countries including Australia, the United Kingdom, Canada and the United States.[3] Further, hookah is becoming increasingly popular among youth. A recent global surveillance study examining time trends (1999-2008) of tobacco use in youth found an increase in hookah smoking amongst teens as young as 13-15 year olds.[3 6] In the United States, adolescents and young adults are at the forefront of this resurgence.

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3 The understanding of hookah smoking patterns among youth remains incomplete.
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5 Current estimates suggest 15-41% of undergraduate college students smoke hookah.[7-11]
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8 However, while hashish or opium were once smoked in hookahs in the Middle East and India,[5
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10 12] smoking tobacco in hookahs was popularized in the 1990s with the introduction of *maasel*, a
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12 sweetened and flavored tobacco product.[3] Some reports suggest marijuana, hashish or other
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14 drugs are sometimes added to hookah tobacco.[13] However, the predominate substances
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16 smoked in hookahs and other substance use practices of hookah users among US teens remain
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18 unknown.
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22 Therefore, the primary purpose of this pilot study was to confirm the lifetime prevalence
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24 of hookah smoking amongst undergraduate students at two large public universities in different
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26 regions of the US. The second aim of this study was to identify the specific substance use
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28 practices of hookah smokers, including the predominant substance that young adults smoke in
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30 their hookah, and other substance use characteristics of hookah smokers. Identifying these
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32 characteristics of hookah smokers has numerous public health and clinical implications, and is a
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34 necessary step in developing targeted prevention and intervention strategies.
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39 Finally, how and why hookah smoking is gaining popularity among young adults also
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41 remains unclear. Many attribute hookah's popularity to its social nature; hookah use is a shared,
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43 communal experience and two or more people often share a single waterpipe.[4 6] It is also
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45 possible that new forms of media are playing a role in promoting hookah smoking among young
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47 adults. Recent work suggests hookah-related videos on YouTube, compared to cigarette-related
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49 videos, are less likely to reference the harmful consequences of smoking nor provide anti-
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51 smoking messages.[14] As the cultivation theory suggests, online videos may influence viewers'
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3 opinions and perceptions; videos that fail to portray the negative consequences of hookah
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5 smoking may serve to promote this behavior among young adults.[15]
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8 The authors hypothesize that social networking websites (SNSs) may also popularize
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10 hookah smoking by serving as a venue in which young adults learn about and promote hookah
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12 use among their social groups. In recent years, SNSs such as Facebook, have become a
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14 tremendously popular source of social media among adolescents and young adults; Facebook is
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16 now used by over 90% of college students and is the most popular SNS among university
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18 students.[16] While previous studies have found associations between consuming media, such as
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20 television and movies, depicting tobacco and the initiation of tobacco use, it has been argued that
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22 Facebook may have greater influence than traditional media because Facebook combines the
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24 power of interpersonal persuasion with the reach of mass media. [17 18] Specifically for
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26 adolescents and young adults, for whom peers are the most important source of influence, the
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28 power of interpersonal persuasion cannot be underestimated.[19] Some suggest these websites
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30 may serve as a media “super-peer” by promoting norms of behavior among adolescents.[20]
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32 Additionally, social learning theory predicts that adolescents observe, imitate, and model
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34 behaviors they see in their peers.
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40 Thus, the third objective of this study was to conduct a pilot investigation of the presence
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42 of hookah references on Facebook. As a social networking site, Facebook may provide a venue
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44 for peer interaction and social networking, both of which are recognized as contributors to risk
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46 behaviors.[21] Risk behaviors such as alcohol and drug use have been found to be displayed on
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48 SNS profiles.[21] It is therefore possible that hookah is also displayed online within social
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50 networks, but the extent to which this is so remains unknown.
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METHODS

This study was conducted between September 2009 and December 2011 and received IRB approval from both the University of Wisconsin and the University of Washington.

Setting

Participants for this study attended one of two large, public universities, in the Midwest and on the West Coast. Participants were recruited via the social networking website Facebook (www.Facebook.com). This SNS was selected because it is the most popular SNS among the target population of college students.[22]

Subject selection

The Facebook search engine was used to identify random public profiles registered within either university network that listed a graduation year indicating the profile owner was a freshman, sophomore or junior student. Inclusion criteria required profile owners to report an age on their profile between 18 and 20 years and to show evidence of profile activity within the last 30 days.

In order to reach a target survey sample size of 200 participants, a total of 307 eligible Facebook profiles were identified in 2009 and 2010 and invited to participate in the study. All profiles returned in the search results were assessed sequentially for eligibility until the target sample size was reached. Profiles were excluded if they did not meet search criteria (ie, incorrectly listed), including those who were not undergraduates (N=448), did not meet the age criteria (N=313) or did not display their age (N=49). Profiles were also excluded if their profiles were completely private, had any one of the following sections set to private: information section, wall or photographs (N=1630), or if the profile owner was not reachable for recruitment

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3 (ie, no phone number or email listed on Facebook profile or in the university directory) (N=303).
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6 Demographic data was recorded from eligible profiles.
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8 **Recruitment**

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10 The 307 profile owners with profiles that met inclusion criteria were called on the phone.
11
12 The phone call served two purposes. First, profile owners identity and age were verified. Second,
13 eligible students were then recruited to participate in the online survey. Survey invites were only
14 sent to profile owners whose identity could be confirmed over the phone. The study was
15 explained to the profile owner and permission was requested to send an email that contained
16 further information about the study. If the participant consented to receive the email, an email
17 was sent that provided detailed information about the study as well as a link to an online survey.
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19 The survey was administered online via a Catalyst WebQ online survey engine. Survey
20 respondents were provided a \$15 iTunes gift card as compensation.
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31 **Survey**

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34 The online survey evaluated hookah use. Participants were asked about their lifetime
35 experience using hookah. Those who reported ever using hookah were also questioned about
36 their frequency of use; answer options included never, monthly or less, 2-4 times a month, 2-3
37 times a week, 4 or more times a week. Participants were also asked what substances they
38 typically smoked in their hookah; answer options included tobacco, marijuana, hash, a mix of
39 marijuana/hash and tobacco. All participants were also questioned about their lifetime experience
40 and frequency of use of marijuana and cigarettes, with similar answer options for frequency as
41 described above.
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52 **Facebook Profile Coding**

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3 To investigate the presence of hookah references on college student's Facebook profiles, all
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5 307 profiles were evaluated once by one of three trained coders using a research codebook. This
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7 codebook has been previously used to evaluating the display of other health risk behavior
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9 references on SNS profiles such as alcohol and violence.[23 24] The codebook was adapted for
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11 this to code for references to hookah. In order to determine whether hookah references were
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13 present, coders viewed all publicly accessible elements of the Facebook profile including profile
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15 owners' tagged pictures, profile pictures, information sections, and their Wall. Both images and
16
17 text were coded and hookah reference data included the coder's typewritten description of any
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19 image references or verbatim text from profiles usually found in the form of status updates or in
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21 info section. If present, identifiable information was removed from text references. One year of
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23 profile data was assessed for each participant, starting from the date of evaluation and going back
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25 to the same date, one year prior.
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32 Profiles were categorized into one of two groups. Profiles with one or more references to
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34 hookah use were classified as hookah "Displayers". Example references included personal
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36 photographs in which the profile owner was smoking a hookah, or text references describing
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38 smoking hookah. Only photographs that contained the profile owner with a clearly identifiable
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40 hookah and text references that explicitly mentioned the word hookah or a synonym of hookah,
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42 such as shisha or narghile, were coded. Profiles without any hookah references were considered
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44 "Non-Displayers".
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48 Because of infrequent references to hookah on Facebook, interater agreement was uses to
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50 assess coder reliability. A 20% random subsample of profiles was evaluated by all three coders
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52 and 96% interrater reliability was achieved.
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55 **Analysis**

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Demographic characteristics, frequency and prevalence of hookah use, and Facebook displays of hookah were summarized using descriptive statistics. Bivariate logistic regression was used to examine covariates of lifetime hookah use (outcome); odds ratios and their 95% confidence intervals were obtained for independent variables including age, gender, race/ethnicity, university, and substance use. A multivariate model of lifetime hookah use was also fit, including the covariates of age, gender, race/ethnicity, university, and substance use. Bivariate comparisons between demographic characteristics and hookah Displayer/Non-Displayer groups were conducted using Fisher's exact tests and Chi squared tests. All statistical analyses were conducted using STATA version 11.0 (Statacorp, College Station, TX). A two-sided p-value $p < 0.05$ was considered statistically significant.

RESULTS

Subjects

A total of 307 Facebook profiles were coded; 216 (70% response rate) of these individuals completed all survey questions with viable answers and were included in the analyses. Participants had an average age of 18.8 years (SD 0.7), were 54.2% female and 70.4% Caucasian. Approximately half of participants were from each university. See Table 1 for further details. (Table 1)

Table 1. Descriptive characteristics of survey respondents (n=216)

Variable	Percent (n)		
	Total	Hookah Non-Users (n=153)	Hookah Users (n=60)
Age (yr) ^a			
18	35.7% (77)	36.5% (57)	33.3% (20)
19	50.9% (110) (110)	48.1% (75)	58.3% (35)
20	13.4% (29)	15.4% (24)	8.33% (5)
Gender			
Male	47.2% (102)	45.5% (71)	51.7% (31)

Female	52.8% (114)	54.5% (85)	48.3% (29)
State			
Washington	46.8% (101)	47.4% (74)	45.0% (27)
Wisconsin	53.2% (115)	52.6% (82)	55.0% (33)
Race/Ethnicity ^b			
Caucasian	70.4% (150)	68.0% (104)	76.7% (46)
African American	0%	0%	0%
Asian/Pacific Islander	18.8% (40)	20.9% (32)	13.3% (8)
Hispanic	2.3% (5)	2.6% (4)	1.7% (1)
Other/Multiracial	8.5% (18)	8.5% (13)	8.3% (5)
^a Overall mean (SD), 18.8 (0.7) years			
^b 3 missing values			

Survey Results

Prevalence of hookah use

Lifetime hookah use was reported by 27.8% (N=60) of participants (Table 2).

Participants who reported ever using hookah were on average 18.8 (SD 0.6) years of age, and tended to be male (51.7%) and White (76.7%) (Table 1). There were no significant differences between age, gender, race, or university for hookah use. Of those who reported ever smoking hookah, 78.3% smoked hookah monthly or less and 21.6% were current users who reported smoking hookah more than once per month.

Table 2. Survey Results: Endorsement of Substance Use

Variable	Percent (n)		
	Total	Hookah Non-Users ^a	Hookah Users ^b
Hookah	27.8% (60)	0%	100% (60)
Cigarettes	16.2% (35)	7.1% (11)	40% (24)
Marijuana ^c	30.7% (66)	13.6% (21)	75% (45)
^a N=156			
^b N=60			
^c 3 missing values			

Substances smoked in the hookah

More than three-quarters (78%) of those who reported ever smoking hookah reported primarily smoking tobacco in their hookah. Only 12% reported smoking only hash in their hookah, while 10%

reported smoking both marijuana/hash and tobacco in their hookah. A total of 22% reported using a hookah to smoke marijuana.

Hookah users engagement with other substances

Of those who reported ever using hookah, 40% reported ever smoking cigarettes, of whom 42.7% reported smoking cigarettes more than once a month. Most (75%) hookah users reported ever using marijuana, of whom 51% reported using marijuana more than once per month. No hookah users endorsed cigarette use only; all hookah smokers who smoked cigarettes also smoked marijuana. (Table 3)

Table 3. Survey Results: Endorsement of Substance Use by Hookah Use

Variable	Percent (n)			
	Cigarettes only	Marijuana only	Cigarettes & Marijuana	None
Hookah Users (N=60)	0	35% (21)	40% (24)	25% (15)
Hookah Non Users (N=155) ^a	4.5% (7)	11% (17)	2.5% (4)	82% (127)

^a 1 missing value

Multivariate modeling of lifetime hookah use indicated that those who endorsed hookah use were more likely to report other substance use. Hookah users were more likely to use cigarettes (OR=3.41, $p<0.05$) and marijuana (OR=15.01, $p<0.001$) compared to non-hookah smokers. (Table 4)

Table 4. Multivariate logistic regression modeling of lifetime hookah use (n=216)

Variable	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
Age	0.92 (0.58-1.44)	0.86 (0.47-1.57)
Gender	0.78 (0.43-1.42)	1.22 (0.55-2.70)
Race		
Caucasian	Reference group	Reference group
Asian/Pacific Islander	0.57 (0.24-1.32)	0.59 (0.18-1.99)
Hispanic	0.57 (0.60-5.20)	0.19 (.02-2.45)
Other/Multiracial	0.87 (0.29-2.58)	2.25 (0.58-8.75)

University	1.1 (0.61-2.00)	0.95 (0.40-2.26)
Cigarettes	8.79 (3.94-19.59)	3.41 (1.20-9.64)**
Marijuana	19.14 (9.10-40.27)	15.01 (6.50-34.65)**
* Odds ratios were adjusted for all other variables in the table		
** $p < 0.05$		

Facebook results

Hookah references were present on 5.3% of Facebook profiles. There were no significant differences in hookah display between gender, race, or university. Examples of hookah references included personal images of profile owners smoking a hookah, downloaded images of icons saying “ I ♥ HOOKAH”, or status updates such as “Tonight is a hookah type of night, I love nights like these” and “Skippin’ class all day, goin’ hookah shopping, fun!”

DISCUSSION

This study explored characteristics of college student hookah smokers and evaluated the presence of hookah references displayed on university students’ public Facebook pages. More than one quarter of college students reported smoking hookah and this prevalence estimate is consistent with the national estimate of hookah use among young adults enrolled in college.[25] To the author’s knowledge, this is the first study to survey college students about what substances they smoke in their hookah. The majority of hookah smokers reported smoking tobacco in their hookah, yet more than 20% reported experience with using marijuana or hash in their hookah. These findings support the rising popularity and diversity of hookah use among young adults in the US.

The finding that so many college students are smoking hookah, and specifically smoking tobacco in their hookah, is cause for clinical and public health concern. Although the health effects of hookah have not been studied nearly as extensively as cigarettes, smoking tobacco in a

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3 waterpipe is associated with negative health outcomes similar to those associated with cigarette
4 use. Studies compare hookah to cigarettes and illustrate that both forms of tobacco use expose
5 smokers to toxicants associated with cardiovascular and lung disease, including carbon
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waterpipe is associated with negative health outcomes similar to those associated with cigarette use. Studies compare hookah to cigarettes and illustrate that both forms of tobacco use expose smokers to toxicants associated with cardiovascular and lung disease, including carbon monoxide and polycyclic aromatic hydrocarbons.[3 26] Further, hookah use significantly increases one's risk for lung cancer, respiratory illness, low birthweight and periodontal disease.[27] Lastly, preliminary research shows hookah use may be associated with nicotine dependence and could be a gateway drug to cigarette smoking.[3 28]

These negative health consequences of hookah use are compounded by the many misperceptions and incorrect beliefs and attitudes held by hookah users. Many hookah smokers underestimate the health risks and addictive properties of hookah use. Contrary to the published harms of hookah use, college students and young adults believe smoking tobacco in a waterpipe is less harmful and less addictive than cigarettes and believe they can quit anytime.[29 30]

Similar to other studies, the results of this study suggest that hookah users were more likely than non-hookah users to engage in substance use (separate from their hookah smoking) such as marijuana, cigarettes and other psychoactive drugs.[10 31 32] Due to the cross-sectional nature of this study, it is impossible to determine the temporal sequence of hookah smoking and the use of other substances. However, it may not be surprising that hookah smokers also engage in other substance use behaviors. Previous research supports that engagement in one risk behavior is often associated with an increased likelihood of engaging in other risk behaviors.[33] This may be especially true for hookah, cigarettes, and marijuana, all different means of smoking. It may be that once a college student decides to engage in a smoking behavior, they may be open to a variety of smoking behaviors. These results suggest hookah prevention efforts may be paired with other substance use and general smoking prevention strategies.

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3 The findings that one in five hookah smokers smoke marijuana in their hookah and that
4 hookah smokers are more likely to smoke marijuana separately compared to non-hookah
5 smokers, are important for two reasons. First, given that many college students maintain that
6 hookah smoking is a safe alternative to cigarette smoking and that hookah smoking doesn't
7 constitute "smoking",^[11] it is possible that these young adults differentiate between methods of
8 tobacco use. Similarly, college students may have altered perceptions of the safety of smoking
9 marijuana in a hookah. Second, given the integration of hookah smoking into the social scene on
10 college campuses^[11], it is possible that marijuana may also experience a sort of social
11 promotion when associated with hookah. This may have implications for intervention strategies
12 and further work is needed to explore these ideas.
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27 To the best of the authors' knowledge, this is also the first study to investigate hookah
28 use using Facebook. These findings show more than 5% of college student profiles display
29 references to hookah on Facebook. While this percentage does not compare with the prevalence
30 of smoking hookah, hookah references on SNSs have not yet been extensively studied. Other
31 work illustrates that adolescents display references to other risk behaviors such as alcohol and
32 substance use on their SNS profile.^[21] These displays of various risk behaviors may represent
33 engagement in that behavior, consideration of engagement in the behavior, boastful claims, or
34 nonsense.^[21] College students who display references to intoxication or problem drinking on
35 their Facebook profile were more likely to meet clinical criteria for problem drinking compared
36 to those who do not display such references.^[34] Additionally, adolescents interpret alcohol
37 displays on SNSs to be influential and valid representations of alcohol use.^[35] Thus, these
38 displays are meaningful. Given the social nature of hookah smoking, the social dimension of
39 Facebook may be a salient factor in popularizing hookah use. Since students mainly initiate and
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3 practice hookah use with friends, Facebook may allow them to find such friends. Further
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5 research exploring the presence and meaning of specifically hookah displays on Facebook
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7 profiles is necessary.
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11 There are several potential limitations to this study. First, participants were recruited from
12
13 only two universities and the study sample included very few minority and no African American
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15 participants. While the study sample is demographically representative of the student population
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17 at the two selected universities, it is possible that these two universities do not provide a
18
19 representative sample of the US college population. The literature suggests that after students of
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21 Arab descent, Caucasian students, followed by Asian students have the highest reported
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23 prevalence rates of smoking hookah.[11] Therefore, given that the participants were selected
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25 from large geographically distinct state universities and that these prevalence estimates are
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27 consistent with other studies' estimates, this suggests the results may be generalizable to the US
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29 college population. Second, only profiles from one SNS were evaluated and participants were
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31 limited to those who maintained a public Facebook profile and allowed their phone numbers to
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33 be listed in either the university directory or on Facebook. The extent to which findings could be
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35 generalized to profiles that have their security set to private, to profiles on other SNSs, or to
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37 younger adolescent populations is not known. It is important to note that SNS profile privacy
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39 settings are not permanent; profile owners may change their privacy settings at any time or to
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41 reflect what security upgrades are offered by Facebook. It is unclear whether profile owners who
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43 maintained a private profile at the time of this study would be more likely, or less likely, to
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45 display hookah references. Lastly, the cross-sectional design of this study precluded determining
46
47 the temporal sequence of smoking hookah and engagement in other substance use. Future
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ARTICLE SUMMARY

Article Focus:

- To confirm the prevalence of hookah use among US college students
- To identify characteristics of US college student smokers, including substances typically smoked in a hookah
- To determine the prevalence of hookah references on Facebook profiles belonging to US college students

Key Messages:

- Hookah smoking is becoming increasingly popular and more than 25% of college students smoke hookah.
- Hookah smoking is significantly associated with cigarette and marijuana use, and some college students smoke marijuana in their hookah.
- Some college students reference hookah on their Facebook profiles.

Strengths and Limitations of this study:

- This is the first study to examine what substances college hookah smokers use in their hookah, and the presence of hookah references on Facebook.
- The validity of hookah references on Facebook remains unknown.

ACKNOWLEDGEMENTS

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COMPETING INTERESTS

The authors have no competing interests.

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CONTRIBUTORSHIP STATEMENT

As the first author, I, Libby Brockman, contributed to this paper by designing the project, and by acquiring, analyzing and interpreting the data for this study. I also provided statistical expertise and drafted the manuscript. My co-authors contributed as follows: Megan A Pumper actively participated in data collection, and provided technical support as well as a critical revision of the manuscript for important intellectual content. Dimitri A Christakis provided statistical expertise, administrative/technical/material support, and critical revisions of the manuscript for important intellectual content. Megan A Moreno contributed to this paper by providing conception and design efforts, funding, administrative/technical/material support, supervision, and a critical revision of the manuscript for important intellectual content.

DATA SHARING STATEMENT

There is no additional unpublished data from this study.

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest
Outcome data	15*	Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Hookah's New Popularity Among US College Students: A **Pilot** Study of The Characteristics of Hookah Smokers and Their Facebook Displays

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Keywords: Hookah, tobacco, smoking, college students, social networking website

Word Count: 3,502

ABSTRACT

Objectives: (1) To [confirm](#) the prevalence of hookah use among US college students. (2) To identify substances commonly smoked in hookahs and other substance use characteristics of hookah smokers. (3) Given the powerful influence of Facebook and its potential role in promoting behaviors, to assess the prevalence of hookah references on Facebook profiles.

Design: Cross sectional study.

Setting: Two large US universities; www.Facebook.com.

Participants: 307 Facebook profiles were coded and 216 of these profile owners completed an online survey. On average, participants were 18.8 years old (SD=0.7), female (54%), Caucasian (70.4%), and approximately half were from each university.

Outcome measures: Lifetime and frequency of hookah use, substance smoked in hookah, cigarette and marijuana use, hookah references displayed on Facebook.

Results: 27.8% of participants endorsed hookah use; there were no significant differences between age, gender, race, or university for hookah use. Hookah users reported smoking tobacco (78%), hash (12%) and both tobacco and marijuana/hash (10%) in their hookah. Compared to non-hookah smokers, hookah smokers were more likely to report using cigarettes (OR=3.41,95%CI=1.2-9.64) and marijuana (OR=15.01,95%CI= 6.5-34.65). Hookah references were present on 5% of Facebook profiles.

Conclusions: More than one quarter of college students smoke hookah. Most smoke tobacco in their hookah, and hookah smoking is associated with polysubstance use. Some hookah users reference this this behavior on Facebook. Hookah may present new risks for nicotine addiction in this population.

INTRODUCTION

Tobacco use is the leading preventable cause of morbidity and mortality worldwide. Encouragingly, public health efforts have successfully decreased the prevalence of cigarette smoking in the US by half over the past 45 years.[1] This achievement is attributed to the first Surgeon General's report on smoking and health in 1964, taxation, indoor smoking bans, media advertising restrictions and counter-advertising campaigns, and increased public awareness of the harms associated with cigarette smoking.[2]

Despite this laudable public health accomplishment, the use of alternative forms of tobacco is currently rising, threatening these successful efforts. Of particular concern is the increasing popularity of hookah.[3] Hookah use, also known as shisha, narghile and waterpipe, is defined as the smoking of substances through a waterpipe such that the smoke passes through water and is cooled prior to inhalation. Smoking a waterpipe is a tradition dating back at least four centuries to origins in northern Africa and southwest Asia.[4] Until recently, smoking in this fashion remained primarily a tradition observed in Middle Eastern countries, most popular among adult men.[5]

Presently, hookah smoking is becoming an increasingly popular form of tobacco use worldwide. Spreading from the Eastern Mediterranean region, hookah use is now common in Western countries including Australia, the United Kingdom, Canada and the United States.[3] Further, hookah is becoming increasingly popular among youth. A recent global surveillance study examining time trends (1999-2008) of tobacco use in youth found an increase in hookah smoking amongst teens as young as 13-15 year olds.[3 6] In the United States, adolescents and young adults are at the forefront of this resurgence.

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3 The understanding of hookah smoking patterns among youth remains incomplete.
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5 Current estimates suggest 15-41% of undergraduate college students smoke hookah.[7-11]
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7 However, while hashish or opium were once smoked in hookahs in the Middle East and India,[5
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10 12] smoking tobacco in hookahs was popularized in the 1990s with the introduction of *maasel*, a
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12 sweetened and flavored tobacco product.[3] Some reports suggest marijuana, hashish or other
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14 drugs are sometimes added to hookah tobacco.[13] However, the predominate substances
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16 smoked in hookahs and other substance use practices of hookah users among US teens remain
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18 unknown.
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22 Therefore, the primary purpose of this pilot study was to confirm the lifetime prevalence
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24 of hookah smoking amongst undergraduate students at two large public universities in different
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26 regions of the US. The second aim of this study was to identify the specific substance use
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28 practices of hookah smokers, including the predominant substance that young adults smoke in
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30 their hookah, and other substance use characteristics of hookah smokers. Identifying these
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32 characteristics of hookah smokers has numerous public health and clinical implications, and is a
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34 necessary step in developing targeted prevention and intervention strategies.
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39 Finally, how and why hookah smoking is gaining popularity among young adults also
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41 remains unclear. Many attribute hookah's popularity to its social nature; hookah use is a shared,
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43 communal experience and two or more people often share a single waterpipe.[4 6] It is also
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45 possible that new forms of media are playing a role in promoting hookah smoking among young
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47 adults. Recent work suggests hookah-related videos on YouTube, compared to cigarette-related
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49 videos, are less likely to reference the harmful consequences of smoking nor provide anti-
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51 smoking messages.[14] As the cultivation theory suggests, online videos may influence viewers'
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3 opinions and perceptions; videos that fail to portray the negative consequences of hookah
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5 smoking may serve to promote this behavior among young adults.[15]
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8 The authors hypothesize that social networking websites (SNSs) may also popularize
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10 hookah smoking by serving as a venue in which young adults learn about and promote hookah
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12 use among their social groups. In recent years, SNSs such as Facebook, have become a
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14 tremendously popular source of social media among adolescents and young adults; Facebook is
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16 now used by over 90% of college students and is the most popular SNS among university
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18 students.[16] While previous studies have found associations between consuming media, such as
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20 television and movies, depicting tobacco and the initiation of tobacco use, it has been argued that
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22 Facebook may have greater influence than traditional media because Facebook combines the
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24 power of interpersonal persuasion with the reach of mass media. [17 18] Specifically for
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26 adolescents and young adults, for whom peers are the most important source of influence, the
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28 power of interpersonal persuasion cannot be underestimated.[19] Some suggest these websites
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30 may serve as a media “super-peer” by promoting norms of behavior among adolescents.[20]
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32 Additionally, social learning theory predicts that adolescents observe, imitate, and model
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34 behaviors they see in their peers.
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41 Thus, the third objective of this study was to conduct a pilot investigation of the presence
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43 of hookah references on Facebook. As a social networking site, Facebook may provide a venue
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45 for peer interaction and social networking, both of which are recognized as contributors to risk
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47 behaviors.[21] Risk behaviors such as alcohol and drug use have been found to be displayed on
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49 SNS profiles.[21] It is therefore possible that hookah is also displayed online within social
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51 networks, but the extent to which this is so remains unknown.
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METHODS

This study was conducted between September 2009 and December 2011 and received IRB approval from both the University of Wisconsin and the University of Washington.

Setting

Participants for this study attended one of two large, public universities, in the Midwest and on the West Coast. Participants were recruited via the social networking website Facebook (www.Facebook.com). This SNS was selected because it is the most popular SNS among the target population of college students.[22]

Subject selection

The Facebook search engine was used to identify random public profiles registered within either university network that listed a graduation year indicating the profile owner was a freshman, sophomore or junior student. Inclusion criteria required profile owners to report an age on their profile between 18 and 20 years and to show evidence of profile activity within the last 30 days.

In order to reach a target survey sample size of 200 participants, a total of 307 eligible Facebook profiles were identified in 2009 and 2010 and invited to participate in the study. All profiles returned in the search results were assessed sequentially for eligibility until the target sample size was reached. Profiles were excluded if they did not meet search criteria (ie, incorrectly listed), including those who were not undergraduates (N=448), did not meet the age criteria (N=313) or did not display their age (N=49). Profiles were also excluded if their profiles were completely private, had any one of the following sections set to private: information section, wall or photographs (N=1630), or if the profile owner was not reachable for recruitment

(ie, no phone number or email listed on Facebook profile or in the university directory) (N=303).

Demographic data was recorded from eligible profiles.

Recruitment

The 307 profile owners with profiles that met inclusion criteria were called on the phone. The phone call served two purposes. First, profile owners identity and age were verified. Second, eligible students were then recruited to participate in the online survey. Survey invites were only sent to profile owners whose identity could be confirmed over the phone. The study was explained to the profile owner and permission was requested to send an email that contained further information about the study. If the participant consented to receive the email, an email was sent that provided detailed information about the study as well as a link to an online survey. The survey was administered online via a Catalyst WebQ online survey engine. Survey respondents were provided a \$15 iTunes gift card as compensation.

Survey

The online survey evaluated hookah use. Participants were asked about their lifetime experience using hookah. Those who reported ever using hookah were also questioned about their frequency of use; answer options included never, monthly or less, 2-4 times a month, 2-3 times a week, 4 or more times a week. Participants were also asked what substances they typically smoked in their hookah; answer options included tobacco, marijuana, hash, a mix of marijuana/hash and tobacco. All participants were also questioned about their lifetime experience and frequency of use of marijuana and cigarettes, with similar answer options for frequency as described above.

Facebook Profile Coding

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3 To investigate the presence of hookah references on college student's Facebook profiles, all
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5 307 profiles were evaluated once by one of three trained coders using a research codebook. This
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7 codebook has been previously used to evaluating the display of other health risk behavior
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9 references on SNS profiles such as alcohol and violence.^[23 24] The codebook was adapted for
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11 this to code for references to hookah. In order to determine whether hookah references were
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13 present, coders viewed all publicly accessible elements of the Facebook profile including profile
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15 owners' tagged pictures, profile pictures, information sections, and their Wall. Both images and
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17 text were coded and hookah reference data included the coder's typewritten description of any
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19 image references or verbatim text from profiles usually found in the form of status updates or in
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21 info section. If present, identifiable information was removed from text references. One year of
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23 profile data was assessed for each participant, starting from the date of evaluation and going back
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25 to the same date, one year prior.
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32 Profiles were categorized into one of two groups. Profiles with one or more references to
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34 hookah use were classified as hookah "Displayers". Example references included personal
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36 photographs in which the profile owner was smoking a hookah, or text references describing
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38 smoking hookah. Only photographs that contained the profile owner with a clearly identifiable
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40 hookah and text references that explicitly mentioned the word hookah or a synonym of hookah,
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42 such as shisha or narghile, were coded. Profiles without any hookah references were considered
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44 "Non-Displayers".
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48 Because of infrequent references to hookah on Facebook, interrater agreement was used to
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50 assess coder reliability. A 20% random subsample of profiles was evaluated by all three coders
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52 and 96% interrater reliability was achieved.
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55 **Analysis**

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Demographic characteristics, frequency and prevalence of hookah use, and Facebook displays of hookah were summarized using descriptive statistics. Bivariate logistic regression was used to examine covariates of lifetime hookah use (outcome); odds ratios and their 95% confidence intervals were obtained for independent variables including age, gender, race/ethnicity, university, and substance use. A multivariate model of lifetime hookah use was also fit, including the covariates of age, gender, race/ethnicity, university, and substance use. Bivariate comparisons between demographic characteristics and hookah Displayer/Non-Displayer groups were conducted using Fisher's exact tests and Chi squared tests. All statistical analyses were conducted using STATA version 11.0 (Statacorp, College Station, TX). A two-sided p-value $p < 0.05$ was considered statistically significant.

RESULTS

Subjects

A total of 307 Facebook profiles were coded; 216 (70% response rate) of these individuals completed all survey questions with viable answers and were included in the analyses. Participants had an average age of 18.8 years (SD 0.7), were 54.2% female and 70.4% Caucasian. Approximately half of participants were from each university. See Table 1 for further details. (Table 1)

Table 1. Descriptive characteristics of survey respondents (n=216)

Variable	Percent (n)		
	Total	Hookah Non-Users (n=153)	Hookah Users (n=60)
Age (yr) ^a			
18	35.7% (77)	36.5% (57)	33.3% (20)
19	50.9% (110) (110)	48.1% (75)	58.3% (35)
20	13.4% (29)	15.4% (24)	8.33% (5)
Gender			
Male	47.2% (102)	45.5% (71)	51.7% (31)

Female	52.8% (114)	54.5% (85)	48.3% (29)
State			
Washington	46.8% (101)	47.4% (74)	45.0% (27)
Wisconsin	53.2% (115)	52.6% (82)	55.0% (33)
Race/Ethnicity ^b			
Caucasian	70.4% (150)	68.0% (104)	76.7% (46)
African American	0%	0%	0%
Asian/Pacific Islander	18.8% (40)	20.9% (32)	13.3% (8)
Hispanic	2.3% (5)	2.6% (4)	1.7% (1)
Other/Multiracial	8.5% (18)	8.5% (13)	8.3% (5)
^a Overall mean (SD), 18.8 (0.7) years			
^b 3 missing values			

Survey Results

Prevalence of hookah use

Lifetime hookah use was reported by 27.8% (N=60) of participants (Table 2).

Participants who reported ever using hookah were on average 18.8 (SD 0.6) years of age, and tended to be male (51.7%) and White (76.7%) (Table 1). There were no significant differences between age, gender, race, or university for hookah use. Of those who **reported** ever smoking hookah, 78.3% smoked hookah monthly or less and 21.6% were current users who reported smoking hookah more than once per month.

Table 2. Survey Results: Endorsement of Substance Use

Variable	Percent (n)		
	Total	Hookah Non-Users ^a	Hookah Users ^b
Hookah	27.8% (60)	0%	100% (60)
Cigarettes	16.2% (35)	7.1% (11)	40% (24)
Marijuana ^c	30.7% (66)	13.6% (21)	75% (45)

^a N=156

^b N=60

^c 3 missing values

Substances smoked in the hookah

More than three-quarters (78%) of those who reported ever smoking hookah reported primarily smoking tobacco in their hookah. Only 12% reported smoking only hash in their hookah, while 10%

[reported smoking both marijuana/hash and tobacco in their hookah. A total of 22% reported using a hookah to smoke marijuana.](#)

Hookah users engagement with other substances

Of those who reported ever using hookah, 40% reported ever smoking cigarettes, of whom 42.7% [reported](#) smoking cigarettes more than once a month. Most (75%) hookah users reported ever using marijuana, of whom 51% reported using marijuana more than once per month. No hookah users endorsed cigarette use only; [all hookah smokers who smoked cigarettes also smoked marijuana.](#) (Table 3)

Table 3. Survey Results: Endorsement of Substance Use by Hookah Use

Variable	Percent (n)			
	Cigarettes only	Marijuana only	Cigarettes & Marijuana	None
Hookah Users (N=60)	0	35% (21)	40% (24)	25% (15)
Hookah Non Users (N=155) ^a	4.5% (7)	11% (17)	2.5% (4)	82% (127)

^a 1 missing value

Multivariate modeling of lifetime hookah use indicated that those who endorsed hookah use were more likely to report other substance use. Hookah users were more likely to use cigarettes (OR=3.41, $p<0.05$) and marijuana (OR=15.01, $p<0.001$) compared to non-hookah smokers. (Table 4)

Table 4. Multivariate logistic regression modeling of lifetime hookah use (n=216)

Variable	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
Age	0.92 (0.58-1.44)	0.86 (0.47-1.57)
Gender	0.78 (0.43-1.42)	1.22 (0.55-2.70)
Race		
Caucasian	Reference group	Reference group
Asian/Pacific Islander	0.57 (0.24-1.32)	0.59 (0.18-1.99)
Hispanic	0.57 (0.60-5.20)	0.19 (.02-2.45)
Other/Multiracial	0.87 (0.29-2.58)	2.25 (0.58-8.75)

University	1.1 (0.61-2.00)	0.95 (0.40-2.26)
Cigarettes	8.79 (3.94-19.59)	3.41 (1.20-9.64)**
Marijuana	19.14 (9.10-40.27)	15.01 (6.50-34.65)**
* Odds ratios were adjusted for all other variables in the table		
** $p < 0.05$		

Facebook results

Hookah references were present on 5.3% of Facebook profiles. There were no significant differences in hookah display between gender, race, or university. Examples of hookah references included personal images of profile owners smoking a hookah, downloaded images of icons saying “I ♥ HOOKAH”, or status updates such as “Tonight is a hookah type of night, I love nights like these” and “Skippin’ class all day, goin’ hookah shopping, fun!”

DISCUSSION

This study explored characteristics of college student hookah smokers and evaluated the presence of hookah references displayed on university students’ [public](#) Facebook pages. More than one quarter of college students reported smoking hookah and this prevalence estimate is consistent with the [national estimate of hookah use among young adults enrolled in college](#).^[25] To [the author’s](#) knowledge, this is the first study to survey college students about what substances they smoke in their hookah. The majority of hookah smokers reported smoking tobacco in their hookah, yet more than 20% reported experience with using marijuana or hash in their hookah. These findings support the rising popularity and diversity of hookah use among young adults in the US.

The finding that so many [college](#) students are smoking hookah, and specifically smoking tobacco in their hookah, is cause for clinical and public health concern. Although the health effects of hookah have not been studied nearly as extensively as cigarettes, smoking tobacco in a

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3 waterpipe is associated with negative health outcomes similar to those associated with cigarette
4 use. Studies compare hookah to cigarettes and illustrate that both forms of tobacco use expose
5 smokers to toxicants associated with cardiovascular and lung disease, including carbon
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waterpipe is associated with negative health outcomes similar to those associated with cigarette use. Studies compare hookah to cigarettes and illustrate that both forms of tobacco use expose smokers to toxicants associated with cardiovascular and lung disease, including carbon monoxide and polycyclic aromatic hydrocarbons.[3 26] Further, hookah use significantly increases one's risk for lung cancer, respiratory illness, low birthweight and periodontal disease.[27] Lastly, preliminary research shows hookah use may be associated with nicotine dependence and could be a gateway drug to cigarette smoking.[3 28]

These negative health consequences of hookah use are compounded by the many misperceptions and incorrect beliefs and attitudes held by hookah users. Many hookah smokers underestimate the health risks and addictive properties of hookah use. Contrary to the published harms of hookah use, college students and young adults believe smoking tobacco in a waterpipe is less harmful and less addictive than cigarettes and believe they can quit anytime.[29 30]

Similar to other studies, [the results of this study suggest](#) that hookah users were more likely than non-hookah users to engage in substance use (separate from their hookah smoking) such as marijuana, cigarettes and other psychoactive drugs.[10 31 32] Due to the cross-sectional nature of this study, [it is impossible](#) to determine the temporal sequence of hookah smoking and the use of other substances. However, it may not be surprising that hookah smokers also engage in other substance use behaviors. Previous research supports that engagement in one risk behavior is often associated with an increased likelihood of engaging in other risk behaviors.[33] This may be especially true for hookah, cigarettes, and marijuana, all different means of smoking. It may be that once a college student decides to engage in a smoking behavior, they may be open to a variety of smoking behaviors. [These results suggest hookah prevention efforts may be paired with other substance use and general smoking prevention strategies.](#)

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The findings that one in five hookah smokers smoke marijuana in their hookah and that hookah smokers are more likely to smoke marijuana separately compared to non-hookah smokers, are important for two reasons. First, given that many college students maintain that hookah smoking is a safe alternative to cigarette smoking and that hookah smoking doesn't constitute "smoking",^[11] it is possible that these young adults differentiate between methods of tobacco use. Similarly, college students may have altered perceptions of the safety of smoking marijuana in a hookah. Second, given the integration of hookah smoking into the social scene on college campuses^[11], it is possible that marijuana may also experience a sort of social promotion when associated with hookah. This may have implications for intervention strategies and further work is needed to explore these ideas.

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To the best of the authors' knowledge, this is also the first study to investigate hookah use using Facebook. These findings show more than 5% of college student profiles display references to hookah on Facebook. While this percentage does not compare with the prevalence of smoking hookah, hookah references on SNSs have not yet been extensively studied. Other work illustrates that adolescents display references to other risk behaviors such as alcohol and substance use on their SNS profile.^[21] These displays of various risk behaviors may represent engagement in that behavior, consideration of engagement in the behavior, boastful claims, or nonsense.^[21] College students who display references to intoxication or problem drinking on their Facebook profile were more likely to meet clinical criteria for problem drinking compared to those who do not display such references.^[34] Additionally, adolescents interpret alcohol displays on SNSs to be influential and valid representations of alcohol use.^[35] Thus, these displays are meaningful. Given the social nature of hookah smoking, the social dimension of Facebook may be a salient factor in popularizing hookah use. Since students mainly initiate and

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3 practice hookah use with friends, Facebook may allow them to find such friends. Further
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5 research exploring [the presence and meaning of specifically hookah displays on Facebook](#)
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7 [profiles](#) is necessary.
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11 There are several potential limitations to this study. First, participants were recruited from
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13 [only two universities and the study sample included very few minority and no African American](#)
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15 [participants. While the study sample is demographically representative of the student population](#)
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17 [at the two selected universities, it is possible that these two universities do not provide a](#)
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19 [representative sample of the US college population. The literature suggests that after students of](#)
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21 [Arab descent, Caucasian students, followed by Asian students have the highest reported](#)
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23 [prevalence rates of smoking hookah.](#)[11] [Therefore,](#) given [that the](#) participants were selected
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25 from large geographically distinct state universities and that [these](#) prevalence estimates are
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27 consistent with other studies' estimates, this suggests [the results may be generalizable to the US](#)
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29 [college population.](#) Second, [only profiles from one SNS were evaluated](#) and participants were
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31 limited to those who maintained a public Facebook profile and allowed their phone numbers to
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33 be listed in [either](#) the university directory or on Facebook. The extent to which findings could be
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35 generalized to profiles that have their security set to private, to profiles on other SNSs, or to
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37 younger adolescent populations is not known. It is important to note that SNS profile privacy
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39 settings are not permanent; profile owners may change their privacy settings at any time or to
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41 reflect what security upgrades are offered by Facebook. It is unclear whether profile owners who
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43 maintained a private profile at the time of this study would be more likely, or less likely, to
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45 display hookah references. [Lastly, the cross-sectional design of this study precluded determining](#)
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47 [the temporal sequence of smoking hookah and engagement in other substance use. Future](#)
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3 [research including longitudinal studies are needed to explore these associations, especially the](#)
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6 [potential role of hookah as a gateway to cigarette smoking.](#)
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8 Despite these limitations, [the](#) findings have important implications. First, this is the first
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10 study to illustrate that hookah use goes beyond tobacco. [College students](#) also smoke marijuana
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12 and hash in their hookah. With this understanding, future prevention and intervention methods
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14 may pair existing tobacco and marijuana strategies when targeting college hookah smokers.
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17 Second, hookah use is also emerging on Facebook profiles, which may [help](#) promote the illusion
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19 that it is a socially acceptable behavior and safe alternative to cigarettes. [To determine if hookah](#)
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21 [references aid in the promotion of hookah smoking among college students, more work is](#) needed
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23 to [explore the presence and meaning of hookah displays on Facebook. Further, similar to studies](#)
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25 [which have found Facebook to be feasible for identifying college students at risk for problem](#)
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27 [drinking, more work is needed to determine if SNSs may also be](#) helpful for screening [and](#)
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29 [identifying college students at risk for or engaged in hookah smoking.](#)
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36 **WHAT THIS PAPER ADDS**

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38 Hookah smoking is a popular alternative form of tobacco use among US college students.
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40 However, patterns of use and characteristics of young hookah smokers remain unclear, as does
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42 why hookah is particularly attractive to this population. This paper adds to our understanding of
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44 hookah use by identifying the predominate substances college students smoke in a hookah, their
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46 [patterns of](#) use of other substances, and how hookah is displayed on their Facebook profiles.
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49 Hookah may present new risks for nicotine addiction in this population and our results have
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51 implications for the content and perhaps venue of future interventions.
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ARTICLE SUMMARY

Article Focus:

- To confirm the prevalence of hookah use among US college students
- To identify characteristics of US college student smokers, including substances typically smoked in a hookah
- To determine the prevalence of hookah references on Facebook profiles belonging to US college students

Key Messages:

- Hookah smoking is becoming increasingly popular and more than 25% of college students smoke hookah.
- Hookah smoking is significantly associated with cigarette and marijuana use, and some college students smoke marijuana in their hookah.
- Some college students reference hookah on their Facebook profiles.

Strengths and Limitations of this study:

- This is the first study to examine what substances college hookah smokers use in their hookah, and the presence of hookah references on Facebook.
- The validity of hookah references on Facebook remains unknown.

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1
2
3 The authors have no competing interests.
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14 Development.
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20 CONTRIBUTORSHIP STATEMENT

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22 As the first author, I, Libby Brockman, contributed to this paper by designing the project, and by
23
24 acquiring, analyzing and interpreting the data for this study. I also provided statistical expertise
25
26 and drafted the manuscript. My co-authors contributed as follows: Megan A Pumper actively
27
28 participated in data collection, and provided technical support as well as a critical revision of the
29
30 manuscript for important intellectual content. Dimitri A Christakis provided statistical expertise,
31
32 administrative/technical/material support, and critical revisions of the manuscript for important
33
34 intellectual content. Megan A Moreno contributed to this paper by providing conception and
35
36 design efforts, funding, administrative/technical/material support, supervision, and a critical
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38 revision of the manuscript for important intellectual content.
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46 DATA SHARING STATEMENT

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48 There is no additional unpublished data from this study.
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