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What are Young Adults Smoking in their Hookahs? A Latent Class Analysis of Substances Smoked

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Abstract

Rationale—Hookah smoking continues to be a popular form of tobacco use, especially among college students. Although hookahs are commonly used to smoke tobacco, anecdotal evidence suggests other substances, including herbal shisha, marijuana and hashish may be used. However, little is known about the variety of substances smoked in hookahs, or correlates associated with different substances smoked.

Methods—In fall 2010, 3,447 students from 8 colleges in N.C. completed an online survey.

Results—44% of students reported ever smoking tobacco from a hookah. Of those ever users, 90% reported smoking flavored tobacco in a hookah, 45% marijuana, 37% herbal (non-tobacco) shisha, and 18% hashish. Latent class analysis revealed two distinct classes. The most prevalent class (77%) primarily smoked flavored tobacco, with minimal use of herbal shisha and marijuana and virtually no use of hashish. The second class (23%) primarily smoked marijuana, hashish and flavored tobacco with moderate use of herbal shisha. Logistic regression analysis adjusting for clustering within-schools revealed that males, illicit drug users, daily, nondaily and former cigarette smokers and those whose mothers had higher levels of education were significantly more likely to be in the second class compared to the first.

Conclusions—Rates of lifetime use of hookah were high in our sample of college students. While the majority of hookah users smoked tobacco in hookahs, they also smoked other

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Contributors

All authors were involved in the design of the study. Drs. Reboussin and Song conducted the statistical analysis and Dr. Sutfin wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

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substances, notably marijuana and herbal shisha. Prevention efforts should recognize that students are using hookahs to smoke a variety of substances.

Keywords

hookah; tobacco; college students

1. Introduction

Declines in cigarette smoking among adolescents and young adults may be offset, at least in part, by the spread of hookah tobacco in the U.S. Current cigarette smoking among young adults dropped from 24% in 2005 to 20% in 2010 (Centers for Disease Control and Prevention, 2011), and for adolescents it dropped from 36% in 1997 to 20% in 2009 (Centers for Disease Control and Prevention, 2010). However, hookah smoking may be increasing, especially among adolescents and young adults. For example, data from *Monitoring the Future* show that annual prevalence of hookah use among 12th graders increased from 17% in 2010 to 19% in 2011 (Johnston, O'Malley, Bachman, & Schulenberg, 2012). Data from the New Jersey Youth Tobacco Survey show an increase in both lifetime and current hookah use from 2008 (18% and 10% respectively) to 2010 (21% and 11% respectively) in a large sample of high school students (Bover Manderski, Hrywna, & Delnevo, 2012).

The existing evidence suggests that hookah smoking-associated health risks are at least comparable with, and perhaps greater than, those of cigarette smoking. A systematic review concluded that hookah use was significantly associated with lung cancer, respiratory illness, low birth-weight and periodontal disease (Akl et al., 2010). An analysis of mainstream waterpipe smoke (i.e., inhaled by the user) found large amounts of carcinogens, hydrocarbons, and heavy metals (Shihadeh, 2003). Additionally, the charcoal used to roast the tobacco results in high levels of carbon monoxide (Jawad, McEwen, McNeill, & Shahab, 2013).

Waterpipes are commonly used to smoke flavored tobacco (Maziak, Ward, Afifi Soweid, & Eissenberg, 2004). Known as *shisha* in the U.S., hookah tobacco contains shredded tobacco mixed with honey or molasses and dried fruit and flavorings (Primack, Aronson, & Agarwal, 2006). In addition to tobacco shisha, non-tobacco or herbal shisha, which is made from herbs and molasses, is also available. Herbal shisha is often labeled as having fewer toxicants, such as “0% tar”, which may increase perceptions that it is a safer product, leading in turn to increased use. Additionally, studies have shown associations between marijuana and hookah smoking (Dugas, Tremblay, Low, Cournoyer, & O'Loughlin, 2010; Sutfin et al., 2011), but few have assessed the use of a hookah waterpipe to smoke marijuana.

Brockman and colleagues (Brockman, Pumper, Christakis, & Moreno, 2012) conducted an online survey of 216 college students recruited via Facebook to assess hookah smoking practices, and to measure references to hookah smoking on Facebook profile pages. Results revealed that 27.8% reported lifetime hookah use. Of those who used a hookah, 78% reported mostly smoking tobacco, 22% smoked marijuana, 12% smoked only hashish, and

10% smoked both marijuana and hashish. These findings suggest that hookahs are used to smoke substances other than tobacco. However, the study was limited to participants from only two colleges and those that had a publically available Facebook page. Therefore, generalizability is limited.

The goals of this study were to: (1) describe the variety of substances that young adults smoke from hookahs; (2) determine whether subtypes or classes of hookah users exist based on the types of substances smoked and (3) describe the correlates associated with these classes. Research on tobacco use among college students has shown associations with several contextual and behavioral factors. For example, affiliation with Greek organizations is associated with tobacco use among college students, particularly social smoking (Morrell, Cohen, Bacchi, & West, 2005; Sutfin et al., 2012; Sutfin, Reboussin, McCoy, & Wolfson, 2009). Residence location is also associated with cigarette smoking. Students who report smoking only a few puffs in the past month are more likely to live on-campus than heavy, moderate or social smokers (Sutfin et al., 2009). Finally, a large body of research has documented the association of tobacco use and other substance use, including alcohol and illicit drugs (Morrell et al., 2005; Ridner, 2005; Sutfin et al., 2012). In this paper, we aim to describe classes of hookah users based on demographic and behavioral correlates. To our knowledge, this is the first study to explore classes of users based on substances smoked.

2. Methods

2.1 Sample

In fall 2010, a stratified random sample of undergraduate students attending eight universities in North Carolina was invited to complete a web-based survey as part of a randomized group trial of an intervention to reduce high-risk drinking behaviors and their consequences, the Study to Prevent Alcohol-Related Consequences (SPARC) (Wolfson et al., 2012). Participating schools included public and private universities (seven public and one private), ranging from 5,000 to over 40,000 students. Students from each campus were selected randomly within class year strata from undergraduate enrollment lists provided by each school. Our target sample at each university was 450 respondents, equally divided by class year, for a total of approximately 3,600 students. The number of students selected to participate was based both on power considerations for the overall SPARC trial, and the expectation from previous studies and previous waves of the survey that approximately 30–35% of the students would complete the survey within the allotted time period (Reed, Wang, Shillington, Clapp, & Lange, 2007). Shortly after the target number from the eight schools was met, the website was closed.

2.2 Procedures

All randomly selected students were sent an email inviting them to participate in a web-based survey. The message included a link to a secured website where the survey could be completed. Students were sent up to four emails over approximately four weeks. All who completed the survey were provided \$15.00 in PayPal dollars. From the list of completions, one student at each school was randomly selected to receive \$100. The study protocol was approved by the Wake Forest School of Medicine (WFSM) Institutional Review Board

(IRB). Participating schools' institutional review boards individually approved the study protocol or deferred to the WFSM IRB.

2.3 Measures

The web-based College Drinking Survey, from which data in the present report were taken, focused on alcohol use and measured demographics, alcohol consumption behaviors, and consequences of alcohol use. The survey also assessed other health-risk behaviors, including use of tobacco, marijuana, and other drugs.

2.3.1 Hookah Smoking—In the section of the survey focused on tobacco use, students were asked several questions about waterpipe use, adapted from Maziak and colleagues, (Maziak, Eissenberg, & Ward, 2005) and Ward and colleagues (Ward et al., 2007), including: *Have you ever smoked tobacco from a waterpipe (also known as hookah, shisha, narghile), even one or two puffs (yes/no)*. Follow-up questions then assessed whether the participant had used a hookah to smoke any of the following substances: flavored tobacco, non-tobacco or herbal shisha, marijuana and hashish. These items were not mutually exclusive.

2.3.2 Demographic Characteristics—Demographics included year in school (freshmen vs. other), gender, race/ethnicity, residence location (on vs. off-campus) and mother's and father's educational level (some college education or less vs. college degree or higher). Participants were asked about membership in Greek organizations (fraternities or sororities), as a member or a pledge, because membership in Greek organizations is associated with tobacco use among college students, particularly social smoking (Morrell et al., 2005; Sutfin et al., 2012, 2009).

2.3.3 Cigarette Smoking—Using standard items from Youth Risk Behavior Surveillance System, age of smoking initiation (used to gauge if students had ever smoked a whole cigarette) and the number of days smoked in the past month were assessed. Responses to age of initiation were: I have never smoked a whole cigarette, age 8 or younger, each individual age between 9 and 21, and 22 or older. Responses to the number of days smoked were: 0 days, 1–2 days, 3–5 days, 6–9 days, 10–19 days, 20–29 days, and all 30 days. Using these two items, four categories were created to represent cigarette smoking behavior: never smoker (never smoked a whole cigarette), former or experimenter (smoked a whole cigarette in lifetime, but not in the past 30 days), current nondaily (smoked on between 1 and 29 of the past 30 days), and current daily (smoked on all of the past 30 days).

2.3.4 Alcohol and Drug Use—Students were asked about past month binge drinking, defined as having 4 or more drinks in a row for females and 5 or more drinks in a row for males (yes/no) and lifetime illegal drug use, including any form of cocaine, methamphetamines, hallucinogens, flunitrazepam (Rohypnol), 3–4-methylenedioxymethamphetamine (Ecstasy), or prescription drugs without a prescription (yes/no; any yes response was coded as lifetime illegal drug use).

2.4 Statistical Analyses

Latent class analysis was used to derive subtypes of hookah users based on their patterns of use of different types of substances smoked from a hookah using LatentGOLD 4.0. To our knowledge, this is the first study to use latent class analysis to assess hookah smoking. We started with the most parsimonious model (“all hookah users the same”) and fit successive models with an increasing number of classes to identify the smallest number of classes that adequately described the patterns of different products smoked in hookahs. Conventional global fit indices like the AIC and substantive interpretation of the latent classes guided model selection. Hookah users were then assigned to the mostly likely latent class based on their estimated probabilities of class membership given their observed pattern of item responses. Based on this class assignment, models were then fit to relate covariates to subtypes of hookah users using logistic regression analysis adjusting for clustering within-schools in SAS Version 9.2 PROC GLIMMIX.

3. Results

The survey was completed by 3,447 students (62% female, 83% White) for a 34% response rate. Forty-four percent (N=1,509) of students reported ever smoking tobacco from a hookah; these participants make up the analysis sample for this paper.

Among lifetime hookah users, 54% of participants were female, and 86% Non-Hispanic White. Participants were fairly equally distributed by class year, including 21% freshmen, 24% sophomore, 27% juniors, and 29% seniors or 5th year students. Just over half (53%) lived off-campus. The majority (82%) were not members or pledges of Greek letter organizations. Just over half reported having mothers (57%) and fathers (61%) with a college degree or higher. Forty-one percent reported past month cigarette smoking, either daily (8%) or nondaily (33%). Just over a quarter (26%) reported lifetime use of illegal drugs (not including marijuana) and 70% reported past month binge drinking. See Table 1 for demographic and behavioral characteristics of the sample.

The majority of participants (90%) reported smoking flavored tobacco in a hookah, 45% marijuana, 37% herbal (non-tobacco) shisha, and 18% hashish. We conducted latent class analysis in order to assess patterns of use of different substances. The AIC favored two classes of hookah users (see Figure 1). Students in Class 1 (“Mainly Tobacco Users”), which was the most prevalent class (77%), primarily smoked flavored tobacco, with minimal use of herbal shisha and marijuana and virtually no use of hashish. Students in Class 2 (23%, “Poly-Substance Users”) also smoked flavored tobacco, but were as likely to smoke marijuana and hashish, with moderate use of herbal shisha (see Figure 1).

Multivariable logistic regression analysis adjusting for clustering within-schools revealed that males (AOR=1.59, $p<.01$); illicit drug users (AOR=3.41, $p<.001$); former (AOR=2.01, $p<.05$), current nondaily (AOR=1.84, $p<.05$), and current daily (AOR=2.01, $p<.05$) cigarette smokers; and those whose mothers had higher levels of education (AOR=1.64, $p<.05$) were significantly more likely to be Poly-Substance Users (Class 2) compared to Mainly Tobacco Users (Class 1) (see Table 2).

4. Discussion

The purpose of this study was to identify the substances young adults smoke in hookahs and to determine whether certain patterns of use exist, as represented by latent classes of users. Results indicated that within a large, random sample of college students from eight colleges in North Carolina, 44% of students reported lifetime hookah smoking. Among hookah users, the majority smoke flavored tobacco. Hookah tobacco is available in a wide variety of fruit, candy, and cocktail flavors (Morris, Fiala, & Pawlak, 2012). The flavoring produces a mild, sweet-smelling smoke that is not as harsh as cigarette smoke. In fact, Maziak and colleagues (Maziak et al., 2004) hypothesize that the introduction of sweetened, flavored tobacco in the 1990s is responsible for the widespread increase in popularity of hookah smoking. It is well documented that adolescents and young adults use flavored tobacco products at a higher rate than adults (Klein et al., 2008). Additionally, there is evidence that the availability of flavored tobacco products is associated with beliefs of less harm and lower addictive potential (Centers for Disease Control and Prevention, 1999; Primack et al., 2008). Therefore, it is not surprising that the vast majority of hookah users smoke flavored tobacco.

Just under half of students also reported smoking marijuana from a hookah. Several studies have reported on the association between hookah and marijuana smoking (Dugas et al., 2010; Primack et al., 2012; Sutfin et al., 2011). In a previous study, we found that among college students, 66% of current hookah users also reported smoking marijuana (Sutfin et al., 2011). While that study did not assess smoking marijuana directly from a hookah, it does demonstrate the substantial overlap between use of the two substances. In addition to marijuana use, just under a fifth of participants reported smoking hashish from a hookah.

Just over a third of students reported smoking herbal (non-tobacco) shisha. This is concerning because, although the marketing often suggests otherwise (Shihadeh et al., 2012), the health risks of use of herbal and tobacco shisha are likely to be similar. Shihadeh and colleagues compared toxicant yields from tobacco-based and non-tobacco shisha in a laboratory study (Shihadeh et al., 2012). While nicotine was only present in the smoke from the tobacco-based product, both substances produced smoke containing nearly identical levels of toxicants, including carbon monoxide, nitric oxide, volatile aldehydes, tar, and polycyclic aromatic hydrocarbons (PAH). These toxicants are associated with cancer, lung disease, and cardiovascular disease (Al Rashidi, Shihadeh, & Saliba, 2008; Sepetdjian, Shihadeh, & Saliba, 2008; A Shihadeh, 2003). The finding that these two products did not differ in toxicant yield may be due to the fact that both are heated with charcoal which is the primary contributor of carbon monoxide and PAH in hookah smoke (Monzer, Sepetdjian, Saliba, & Shihadeh, 2008).

Results from the latent class analysis indicated a two-class fit. The first class, which was the most prevalent class (77%), smoked mostly flavored tobacco with only minimal use of herbal shisha and marijuana and virtually no use of hashish. Students in the second class (23%) primarily smoked marijuana, hashish and flavored tobacco, with moderate use of herbal shisha. Demographic and behavioral correlated differed by class. Those in Class 2 (Poly-Substance Users) were more likely to be males, which is consistent with the literature on substance use by college students. Interestingly, those in Class 2 were more likely to have

mothers with a college degree or higher (versus some college or less), compared with those in Class 1 (Mainly Tobacco Users). Parental education, as a marker of socioeconomic status, has been linked to increased substance use among young adults (Patrick, Wightman, Schoeni, & Schulenberg, 2012). Several hypotheses for this finding have been proposed. Some suggest that youth from more affluent families may have intense pressures to succeed and use substances to cope with these increased pressures (Luthar, 2003). Others suggest that affluent parents may be more tolerant of substance use, creating a more normative culture for those youth (Luthar & Goldstein, 2008). Another possibility is that those from more affluent families have more resources to use for substances. Our finding suggests those with mothers with higher levels of education experiment with smoking a variety of substances from waterpipes.

Poly-Substance Users (Class 2) also reported higher levels of cigarette smoking and lifetime use of other illicit drugs. This finding is consistent with the literature which highlights co-occurring substance use behaviors among college students (Ahijevych & Garrett, 2004; Egan, Reboussin, Blocker, Wolfson, & Sutfin, 2012; O'Brien, McCoy, Rhodes, Wagoner, & Wolfson, 2008; O'Grady, Arria, Fitzelle, & Wish, 2008; Snipes & Benotsch, 2013).

The findings of this study should be interpreted in light of the limitations. This study was limited to college students from a particular state, which limits generalizability. In addition, the response rate for the web survey is a concern; however, it is similar to rates found by others using this approach with college students (McCabe, Diez, Boyd, Nelson, & Weitzman, 2006; Reed et al., 2007). Furthermore, prior research has demonstrated that, despite lower response rates, internet surveys yield similar statistics regarding health behaviors compared to mail and phone surveys (An et al., 2007). An additional limitation is that the classes were defined based on lifetime hookah use, rather than current hookah use. Our classes likely capture participants with a wide range of experiences with hookah, including those with minimal use. Future studies should assess classes of users among a sample of current hookah smokers.

Despite these limitations, this paper adds significantly to the literature on hookah smoking by exploring substances, beyond tobacco, that are smoked in hookah waterpipes. While flavored tobacco was the most commonly-used substance, just under half of the participants reported smoking marijuana and about a fifth reported smoking hashish from a hookah. Prevention efforts addressing hookah smoking also need to include cannabis as a target, given the substantial overlap in substances. For example, campus health centers that screen for tobacco use should consider asking hookah users about other substances they may smoke in hookah. Additionally, campus officials could consider classifying waterpipes as drug paraphernalia and ban them from campus as part of an overall ban on paraphernalia. Finally, over a third of the students reported smoking herbal or non-tobacco shisha in a hookah. This finding is alarming, because of the likely misperception that herbal shisha is safer than tobacco shisha. While it does not contain nicotine, herbal shisha still produces significant levels of toxicants. Prevention efforts, such as health communication campaigns, should communicate the health risks associated with use of herbal shisha, as well as tobacco shisha.

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Highlights

- We explore substance that college students smoke in hookahs.
- 44% of student had smoked tobacco from a hookah in their lifetime.
- Most (90%) hookah users smoked flavored tobacco, 45% smoked marijuana, 37% smoked herbal (non-tobacco) shisha, and 18% smoked hashish in a hookah.
- Latent class analysis revealed two distinct classes of hookah users, based on the substances they smoked in hookahs, with differing demographic and behavioral profiles.

Figure 1.
Latent Classes of Hookah Smoking

Table 1

Demographic Characteristics of the Sample (N=1509)

	Overall N (%) [*]
Demographic Characteristics	
Gender	
Male	684 (46)
Female	811 (54)
Race/Ethnicity	
African-American	56 (4)
Asian/Pacific Islander	35 (2)
Hispanic	56 (4)
Other	69 (5)
White	1,279 (86)
Class year	
Freshman	310 (21)
Sophomore	359 (24)
Junior	406 (27)
Senior/5 th year	433 (29)
Residence location	
On-campus	709 (47)
Off-campus	794 (53)
Greek member/pledge	
Yes	256 (18)
No	1,134 (82)
Mother's highest education	
4 year college degree or higher	843 (57)
Some college or less	641 (43)
Father's highest education	
4 year college degree or higher	887 (61)
Some college or less	756 (52)
Health-Risk Behaviors	
Cigarette smoker type	
Never smoker	447 (30)
Former/experimenter	436 (29)
Current nondaily	492 (33)
Current daily	119 (8)

	Overall N (%) [*]
Current binge drinker	
Yes	911 (70)
No	397 (30)
Lifetime Illegal drug use	
Yes	393 (26)
No	1,111 (74)

^{*} Categorical totals may differ from sample totals due to missing responses.

Table 2

Multivariable Logistic Regression by Hookah User Class

	Class 2 (Poly-Substance Users) vs. Class 1 (Mainly Tobacco Users)	
Correlates	AOR	95% Confidence Interval
Male (vs. female)	1.59	1.14, 2.23
Hispanic or Nonwhite (vs. Non-Hispanic White)	0.99	0.58, 1.68
Non-Freshmen (vs. Freshmen)	0.74	0.44, 1.23
On-campus (vs. off-campus)	0.68	0.44, 1.07
Greek member or pledge (vs. non-member or pledge)	0.83	0.53, 1.31
Mother College Degree or Higher (vs. Some College or Less)	1.64	1.11, 2.41
Father College Degree or Higher (vs. Some College or Less)	1.28	0.87, 1.90
Cigarette Smoker Type		
Never (referent)	-	-
Former/experimenter	2.01	1.19, 3.38
Current nondaily	1.84	1.10, 3.07
Current daily	2.01	1.02, 3.96
Current Binge Drinker	1.28	0.86, 1.91
Lifetime Other Illicit Drug Use	3.42	2.38, 4.91