Original Investigation

Examining Hookah Smoking Among a Cohort of Adolescent Ever Smokers

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Abstract

Introduction: Evidence suggests that hookah smoking is growing among adolescents, particularly among those with a history of cigarette smoking, and is an emerging public health concern. We examined hookah use and its correlates among a sample of adolescents who have ever smoked and may be considered high risk for hookah use.

Methods: We examined differences between hookah users and nonusers among a cohort of 951 adolescents (75.3% of the baseline sample, mean age 17.6 years at 24 months), consisting exclusively of youth who reported ever smoking cigarettes who were participating in a longitudinal study of adolescent smoking predictors and patterns. Ever and 30-day hookah use were assessed at 24 months.

Results: Of the 951 participants, 58.5% reported ever use and 30.2% reported smoking hookah at least 1 day in the past 30 days. Multivariate logistic regression analyses found that 30-day hookah use was associated with sex ($p < .05$); race ($p < .001$); current cigarette ($p < .0001$), cigar ($p < .01$), kretek ($p < .05$), and alcohol use ($p < .01$); and attending a hookah bar, lounge, or restaurant ($p < .001$). Participants who were male, White, and were concurrent users of multiple tobacco products and other substances had increased odds of 30-day hookah use.

Conclusions: Prevalence of hookah use is high among youth who have already tried cigarette smoking and is associated with a variety of tobacco and other substance use behaviors. Evidence-based programs may be needed to prevent initiation of or reduce Hookah smoking, as well as address cooccurring problem behaviors, to lessen the health risks associated with use among adolescents.

Introduction

While cigarette use has decreased among youth in the United States in the past decade, the use of other tobacco products has increased. Hookah smoking (also known as water pipe, shisha, or narghile smoking), an older form of tobacco use that originated

in the Middle East, has rapidly become popular in the United States (Eissenberg, Ward, Smith-Simone, & Maziak, 2008; Maziak, 2011; Primack et al., 2008; Ward et al., 2007). The American Lung Association (2007) reported that hookah tobacco use "... has become as fashionable [in the U.S.] as cigars were in the 1990s". Hookah tobacco use poses a new challenge for tobacco control researchers (American Lung Association, 2007; Maziak, 2008; World Health Organization, 2005). Though often perceived by youth and young adults as healthier than cigarette smoking (Sutfin et al., 2011), hookah tobacco smoke contains many of the same toxicants as cigarette smoke (Shihadeh & Saleh, 2005) and contains more nicotine than cigarettes (Shafagoj, Mohammed, & Hadidi, 2002). Similar to cigarette use, hookah use has also been associated with several health risks (Bedwani, Renganathan, & El-Kwhsky, 1997; Boffetta, Pershagen, Jockel, & Forastiere, 1999; Maziak, 2011). A recent meta-analysis that systematically reviewed 24 studies for the effects of water pipe tobacco smoking on health outcomes found that, in addition to lung cancer (odds ratio [OR] = 2.1; 95% CI = 1.3–3.4), hookah smoking was significantly associated with respiratory illness (OR = 2.3; 95% CI = 1.1–5.1), low birth weight (OR = 2.1; 95% CI = 1.1–4.2), and periodontal disease (OR = 3.0–5.0; Akl et al., 2010). Taken together, these data suggest that continued use of hookah could lead to nicotine dependence, difficulty quitting smoking, and increased risk of tobacco-related diseases.

A growing number of published studies indicate that hookah smoking is popular among youth and young adults, particularly among college students, with ever use rates ranging between 10% and 40%, depending on sample characteristics (Eissenberg et al., 2008; Grekin & Ayna, 2008; Primack et al., 2008; Smith-Simone, Curbow, & Stillman, 2008; Sutfin et al., 2011). Sociodemographic factors associated with hookah use and the perceptions and risks of hookah smoking have been examined among young adults. Compared with nonusers, studies have found that hookah smokers were more likely to be male (Barnett, Curbow, Weitz, Johnson, & Smith-Simone, 2009; Primack, Walsh, Bryce, & Eissenberg, 2009; Sutfin et al., 2011), White (Aljarrah, Ababneh, & Al-Delaimy, 2009), or of Arab ethnicity (Grekin & Ayna, 2008) and to have higher levels of education (i.e., enrolled in or attended college; Ward, Vander Weg, Relya, Debon, & Klesges, 2006). Hookah smokers were also more likely to have used cigarettes or

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other tobacco products (Aljarrah et al., 2009; Sutfin et al., 2011; Ward et al., 2006). Eissenberg et al. (2008) found that among 744 young adult participants, 30-day hookah use was associated with a greater likelihood of having smoked cigarettes ($OR = 10.44$, $95\% CI = 5.1-21.5$) and cigars or cigarillos ($OR = 6.31$, $95\% CI = 2.9-13.6$) in the past thirty days. Approximately 20% of the participants in the sample of Eissenberg et al. reported 30-day water pipe use. Of those, 58.7% were current cigarette smokers and 67.0% were current cigar/cigarillo smokers. An association among hookah tobacco use and other substance use behaviors has also been documented (Smith-Simone et al., 2008; Sutfin et al., 2011; Swift, Hall, & Copeland, 1998). Sutfin et al. (2011) examined the association among water pipe tobacco smoking and other health-risk behaviors, including alcohol and marijuana use, among 3,770 college students. Among this sample, 17% reported current water pipe use; of those, 66% were current marijuana smokers and 92% were current alcohol users. Both alcohol (adjusted odds ratio [AOR] = 2.20, $CI = 1.52-3.17$) and marijuana (AOR = 4.43, $CI = 3.46-5.66$) use were significantly associated with water pipe use among these college students.

For the first time in 2010, the Monitoring the Future survey assessed hookah use among 12th graders. An annual prevalence rate of 17% for hookah smoking was found, with 6.5% of the 12th graders reportedly smoking hookah more than five times during the year. Male 12th graders had higher prevalence rates (19%) than females (15.2%; Johnston, O'Malley, Bachman, & Schulenberg, 2011). These national-level data, along with an increasing number 2011 of published studies examining hookah use among high school students (Barnett et al., 2009; Jordan & Delnevo, 2010; Primack et al., 2009), suggest that hookah smoking is an emerging public health concern among adolescents. Correlates of hookah smoking have been identified for adolescents. Compared with nonusers, adolescent hookah smokers were more likely to be in high school instead of middle school (Barnett et al., 2009; Jordan & Delnevo, 2010; Primack et al., 2009) and were more likely to be White (Barnett et al., 2009; Primack et al., 2009), Asian-American (Jordan & Delnevo, 2010; Primack et al., 2009), or Pacific Islander (Primack et al., 2009). Similar to young adult hookah use, adolescent hookah use was associated with a history of tobacco use (Barnett et al., 2009; Jordan & Delnevo, 2010; Primack et al., 2009). For instance, Barnett et al. reported that among the 11% of high-school students in their sample who had ever tried water pipe tobacco, 41% had a history of cigarette use.

The purpose of the present study was to examine hookah use and its correlates among a sample of adolescents comprised exclusively of youth who have ever smoked cigarettes in their lifetime and as such may be considered at high risk for hookah use. Understanding who may be most vulnerable to hookah use among a sample already at risk may be informative for developing interventions that address multiple tobacco use among youth. We examined demographics, smoking history variables, and other substance use among these adolescents. We examined other substance use, particularly alcohol and marijuana use, as other studies have found these to be associated with hookah use (Smith-Simone et al., 2008; Sutfin et al., 2011; Swift et al., 1998). We hypothesized that hookah users, compared with nonusers, would show a more problematic profile among the smoking and substance use variables.

Methods

Overview of Study Design, Participant Recruitment, and Procedures

Data from this study come from the 24-month assessment of a large longitudinal study that investigated the social and emotional contexts of adolescent smoking patterns. The parent study established a cohort of adolescents comprising primarily youth who had ever smoked cigarettes.

Participants were recruited from 16 Chicago area high schools. The sample was derived in a multistage process. All 9th and 10th graders at the schools ($N = 12,970$) completed a brief screening survey of smoking behavior. Invitations were mailed to eligible students and their parents. Students were eligible to participate in the longitudinal study if they fell into one of the four levels of smoking experience: (a) never-smokers, (b) former experimenters (smoked at least one cigarette in the past, have not smoked in the last ninety days, and have smoked fewer than 100 cigarettes in their lifetime), (c) current experimenters (smoked in the past ninety days but smoked less than 100 cigarettes in lifetime), and (d) regular smokers (smoked in the past thirty days and have smoked more than 100 cigarettes in their lifetime).

Recruitment packets were mailed to 3,654 eligible students and their parents. Eligible students included all youth classified as "current experimenters" and "regular smokers," in addition to random samples from the "never-smoker" and "former experimenter" categories. Participants were enrolled into the longitudinal study after written parental consent and student assent were obtained. All student participants had to agree to potentially participate in all components of the main program project, including multiple longitudinal questionnaire assessments, an ecological momentary assessment study, a family observation study, and a psychophysiological laboratory assessment study. Of the 3,654 invited participants, 1,344 (36.8%) agreed to participate in the study. Ninety-four percent ($N = 1,263$) completed the baseline measurement wave. The baseline sample of 1,263 adolescents included 213 never-smokers, 304 former experimenters, 594 current experimenters, and 152 regular smokers. The mean age of the sample at baseline was 15.6 years (range: 13.9–17.5 years), and 56.5% were female. The sample's racial/ethnic distribution was 56.5% White, 17.2% Hispanic, 16.9% Black, 4.0% Asian, and 5.4% "other." The study was approved by the Institutional Review Board of the University of Illinois at Chicago.

Study Sample Description

Data for the current investigation come from participants who completed the 24-month assessment who reported ever trying a cigarette in their lifetime ($N = 951$, 75.3% of the baseline sample). The majority of these adolescents were females (57.2%). The mean age of this sample at 24 months was 17.6 years ($SD = 0.61$). The racial/ethnic distribution was 57.8% White, 18.1% Hispanic, 14.3% Black, 4.0% Asian, and 5.8% other. Of the 951 adolescents who had ever smoked cigarettes, 51.3% reported smoking cigarettes one or more days in the past month at the 24-month assessment. The mean number of cigarettes smoked per day in the past thirty days for this sample was 1.93 ($SD = 3.57$).

Measures

Participants completed a questionnaire assessing sociodemographic characteristics, psychosocial variables, and health behaviors at baseline and at 6, 15, and 24 months. Demographic data used in this study included age, sex, and self-reported race/ethnicity. Hookah use was assessed at 24 months by two items: (a) Have you ever tried a hookah? (or water pipe; responses: yes or no) and (b) During the past days, on how many days did you smoke a hookah? (responses: 0, 1–2, 3–5, 6–9, 10–19, 20–29, and all 30 days). Participants were also asked if they had ever been to a hookah bar, lounge, or restaurant (responses: yes/no) at the 24-month assessment. Smoking-related variables used in this study included current cigarette, smokeless tobacco, cigar (including cigarillos and little cigars), bidi (defined as sweet-flavored cigarettes from India), and kretek use (defined as clove-flavored cigarettes). Though these smoking-related variables were assessed at each wave, data from the 24-month assessment were used in this study. Cigarette smoking was assessed by items that asked about participants' number of days smoked in the past thirty days (responses: 0, 1–2, 3–5, 6–9, 10–19, 20–29, and all 30 days) and the number of cigarettes smoked each day during the past thirty days. Smokeless tobacco, cigar, bidi, and kretek use were each assessed by an item that asked about the number of days participants' smoked the product in the past thirty days. Response categories for each of these items were 0, 1–2, 3–5, 6–9, 10–19, 20–29, and all 30 days. School performance was assessed by asking participants, "Which of the following best describes your average grade in school this year?" (responses: A+, A–, B+, B, B–, C+, C, C–, and D). Substance use behaviors were assessed by asking participants the following: "During the past three months how often did you drink alcohol (beer wine, or wine coolers, liquor such as rum, gin, vodka or whiskey)?" and "During the past three months, how often did you smoke marijuana (grass, pot, weed, sins, buds, or hash)?" Responses for each item were zero times, once a month or less, more than once a month but less than once a week, one or more times a week but not every day, and every day.

Statistical Analysis

Participant demographics, smoking-related and substance use behaviors, and school performance variables were explored using descriptive statistics. To assess the prevalence of hookah use among adolescents in our sample, we conducted descriptive analyses, comparing questionnaire responses from those participants who reported ever and current hookah use (or 30-day users, defined as using a hookah at least once in the past thirty days prior to the survey) at 24 months and those that did not report use. The prevalence of multiple tobacco product use among hookah smokers and nonusers was also assessed. To account for clustering within schools, models with school as cluster were run using the SAS Proc GLIMMIX procedure. Bivariate and multivariate logistic regression analyses were conducted to assess the associations between ever and current hookah smokers and the demographic, school performance, smoking-related, and substance use variables.

Results

Hookah Smoking and Demographic Characteristics

Overall, 58.5% of the 951 adolescents in our restricted sample reported ever trying hookah and 30.2% reported using hookah

in the past thirty days (30-day use) at the 24-month assessment. Table 1 shows the prevalence of ever hookah use by demographic, smoking-related, and substance use variables. Compared with those adolescents who did not report use, 30-day hookah users were mostly male (52.6%, $p < .0001$), White (73.5%, $p < .0001$), and had an average grade point average (GPA) of 3.73 ($SD = 0.77$, $p < .01$) at 24 months.

Concurrent Tobacco Use and Substance Use Among Past Thirty-Day Hookah Users

Other tobacco use was found among our sample of past thirty-day hookah users (Table 2). Past thirty-day hookah users reported concurrently using multiple tobacco products, such as cigarettes ($p < .001$), cigars ($p < .001$), smokeless tobacco ($p < .001$), bidis ($p < .001$), and kreteks ($p < .001$), more often than non-hookah users at the 24-month assessment. Other substance use, such as alcohol and marijuana use in the past three months, was also common among past thirty-day hookah users in the sample. Almost all (93.0%) of those who reported using hookah in the past thirty days reported using alcohol at least once in the past thirty months compared with 76.3% of hookah nonusers ($p < .0001$). With regard to marijuana use, 71.7% of past thirty-day hookah users, compared with 47.8% of nonusers, also smoked marijuana at least once in the past three months ($p < .0001$).

Hookah Bars, Lounges, and Restaurants

At the 24-month assessment, participants were asked to report if they had ever been to a hookah bar, lounge, or restaurant. As expected, past thirty-day hookah users were more likely to report ever going to a hookah bar, lounge, or restaurant than non-hookah users (79.1% vs. 29.8%, $p < .001$). Of those past thirty-day hookah users who attended a hookah bar, lounge, or restaurant ($N = 424$), the majority were White (70.1%, $p < .0001$), over half were female (55.0%, $p > .05$), and had a mean age of 17.7 years ($SD = 0.60$, $p < .001$).

Predicting Ever and Past Thirty-Day Hookah Use

Bivariate and multivariate logistic regression analyses were conducted to assess whether demographic, school performance, smoking-related, and substance use variables predicted ever and past thirty-day hookah use at the 24-month assessment. Bivariate analyses found that age; sex; race; current (defined as use at least once during the past thirty days) cigarette, smokeless, cigar, and kretek use; alcohol and marijuana use in the past three months; and attending a hookah bar, lounge, or restaurant were all significant predictors of ever hookah use at 24 months. Predictors of past thirty-day hookah use included these variables, school performance, and current bidi use; age was not significantly associated with past thirty-day hookah use. These variables were significant at $p < .05$ and were included in the multivariate analyses.

Multivariate predictors of ever and past thirty-day hookah use are presented in Table 3. Ever hookah use was associated with sex, race, current alcohol and marijuana use in the past three months, and attending a hookah bar, lounge, or restaurant. ORs for ever hookah use were lower for females compared

Table 1. Demographic, Smoking-Related, and Substance Use Characteristics of Adolescents Reporting Ever Hookah Use

	Ever hookah users (<i>N</i> = 556, %)	Non-hookah users (<i>N</i> = 395, %)	Total sample (<i>N</i> = 951, %)	<i>p</i> Value
Age (<i>M</i> , <i>SD</i>)	17.6 (0.61)	17.6 (0.60)	17.6 (0.61)	
Sex (% female)	52.5	63.8	57.2	***
Race				***
Asian/Pacific Islander	5.0	2.5	4.0	
Black	5.0	27.3	14.3	
Hispanic	13.7	24.3	18.1	
White	72.1	37.7	57.8	
Other	4.1	8.1	5.8	
School performance (<i>M</i> GPA, <i>SD</i>)	3.82 (0.77)	3.74 (0.72)	3.85 (0.75)	
30-day cigarette smoking (days)				***
0	36.8	65.6	48.7	
1	6.2	4.3	5.4	
2–3	8.3	6.9	7.7	
4–5	4.9	3.6	4.3	
6–7	3.3	3.1	3.2	
8–10	4.5	2.6	3.7	
11–20	7.3	3.6	5.7	
21–29	11.4	4.1	8.4	
All 30	17.4	6.4	12.8	
30-day cigarette smoking (cigarettes/day)				***
0	37.3	65.9	49.2	
≤1	20.7	15.3	18.4	
2–5	27.3	15.5	22.4	
6–10	9.4	2.5	6.6	
≥11	5.3	0.8	3.4	
Used alcohol past three months				***
Zero times	10.6	30.0	18.7	
Once a month or less	18.9	30.7	23.8	
More than once a month but less than once a week	37.3	26.1	32.7	
One or more times a week but not every day	33.2	13.0	24.8	
Every day	0.0	0.3	0.1	
Used marijuana past three months				***
Zero times	32.8	62.2	45.0	
Once a month or less	19.1	17.3	18.3	
More than once a month but less than once a week	14.8	8.9	12.3	
One or more times a week but not every day	18.2	9.1	14.4	
Every day	15.1	2.5	9.9	
Attended hookah bar, restaurant, lounge?				***
Yes	70.1	8.7	44.7	
No	29.9	91.4	55.3	

Note. **p* < .05. ***p* < .01. ****p* < .001.

with males and for Black, Hispanic, and participants reporting “all other” races/ethnicities compared with Whites. Being Asian was not a significant predictor of ever hookah use in our sample. Participants who had used alcohol and marijuana in the past three months and had ever attended a hookah bar, lounge, or restaurant had increased odds of ever smoking hookah at 24 months.

Past thirty-day hookah use was associated with sex; race; current cigarette, cigar, and kreteks use; alcohol use in the past three months; and attending a hookah bar, lounge, or restaurant. Similar to ever hookah use, females and Blacks and Hispanics had lower odds of past thirty-day hookah use. Asian and

“all other” racial/ethnic groups were not significantly associated with past thirty-day hookah smoking. Participants who were current cigarette, cigar, and kretek smokers and who had used alcohol in the past three months had increased odds of 30-day hookah use. Similar to ever hookah use, those who attended a hookah bar, lounge, or restaurant were six times more likely to report 30-day hookah smoking.

Discussion

Consistent with findings from national-level data and a growing number of studies, our results suggest that hookah smoking is

Table 2. Concurrent Use of Multiple Tobacco Products Reported by Past Thirty-Day Hookah Users at 24 Months

	Past thirty-day hookah users (N = 284) %	Non-hookah users (N = 660) %	Total sample (N = 944) ^a	p Value
Also currently uses ^b cigarettes	74.7	41.2	51.3	***
Also currently uses smokeless tobacco	13.2	3.6	6.5	***
Also currently uses cigars, cigarillos, and/or little cigars	48.1	19.9	28.4	***
Also currently uses bidis	7.8	1.2	3.2	***
Also currently uses kreteks	10.2	2.3	4.6	***

Note. ^aOf 951 participants, 7 did not provide responses.

^bCurrent use is defined as smoking the tobacco product at least once during the past thirty days at 24-month assessment.

* $p < .05$. ** $p < .01$. *** $p < .001$.

an emerging public health concern for adolescents, particularly for those with a history of tobacco use. Among our restricted sample of participants who reported ever smoking a cigarette, more than half (58.5%) reported ever smoking hookah and about one-third (30.2%) reported smoking hookah at least once in the past thirty days at the 24-month assessment. National prevalence data suggest that 17% of 12th grade students had used hookah annually (Johnston et al., 2011). Compared with these data, our findings suggest that adolescents who have reported ever smoking cigarettes have a much higher prevalence of hookah use.

With regard to demographic variables, though more than half of the females (52.5%) in our sample reported ever hookah use at 24 months, our findings suggest that males had increased odds of ever and 30-day hookah use. This is consistent with findings presented in national-level data and in previous studies (Barnett et al., 2009; Johnston et al., 2010; Martinasek, McDermott, &

Martini, 2011; Primack et al., 2009; Sutfin et al., 2011). Though males are more likely to report using hookah than females, studies that seek to understand gender differences in hookah use may be warranted. In a recent qualitative study that examined water pipe usage among Lebanese participants (both sexes, ages 18 years and older), Nakkash, Khalil, and Affi (2011) found notable differences among males and females with regard to beliefs about water pipes. The women participants in this study frequently endorsed several qualities about water pipes, including their affordability of use (i.e., saying that you can share the cost with friends), their attractiveness (i.e., noting they are delicate, ornate, and have attractive designs), and the availability of the varieties of tobacco flavors that can be smoked in the water pipe. Women participants also noted the use of women in media to attract and motivate other women to initiate water pipe use. Findings from the Nakkash et al. study perhaps suggest that aspects of hookah smoking are appealing, or are even targeted, to women

Table 3. Multivariate Logistic Regression Analyses Predicting Hookah Use at 24-Month Assessment

Predictor	OR (95% CI) for ever hookah use	p Value	OR (95% CI) for past thirty-day hookah use	p Value
Age	0.95 (0.69–1.31)		–	
Sex		*		*
Male	1.0		1.0	
Female	0.65 (0.43–0.98)		0.67 (0.46–0.97)	
School performance	–		0.84 (0.65–1.08)	
Race				
White	1.0		1.0	
Asian	1.54 (0.55–4.28)		1.55 (0.65–3.67)	
Black	0.06 (0.03–0.13)	***	0.29 (0.14–0.63)	**
Hispanic	0.30 (0.18–0.50)	***	0.49 (0.29–0.82)	**
All other	0.32 (0.15–0.73)	**	0.57 (0.24–1.35)	
Current cigarette use	1.09 (0.99–1.20)		1.16 (1.08–1.26)	***
Current cigar use	1.05 (0.86–1.30)		1.29 (1.09–1.53)	**
Current smokeless tobacco use	0.98 (0.73–1.32)		0.99 (0.79–1.25)	
Current bidi use	–		1.64 (0.97–2.78)	
Current kretek use	0.99 (0.62–1.57)		1.70 (1.05–2.77)	*
Alcohol use in the past three months	1.34 (1.09–1.65)	**	1.39 (1.14–1.69)	**
Marijuana use in the past three months	1.75 (1.46–2.10)	***	1.12 (0.97–1.29)	
Attending a hookah bar, lounge, or restaurant	22.9 (14.27–36.89)	***	6.25 (4.24–9.23)	***

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

smokers. Coupled with those from Nakkash et al., our findings suggest that additional studies may be needed to examine hookah smoking prevalence and beliefs related to use by sex.

Consistent with other studies (Aljarrah et al., 2009; Ward et al., 2006), past thirty-day hookah users in our sample reported higher rates of concurrent tobacco use, including cigarette, cigar, and kretek use, than non-hookah users. An issue that has received considerable attention in the field is the temporal relationship between hookah use and use of other tobacco products among adolescents and young adults. Several have questioned whether hookah smoking leads to cigarette and other tobacco use or is a substitute behavior for those who have quit smoking cigarettes (Asfar, Ward, Eissenberg, & Maziak, 2005; Hammal, Mock, Ward, Eissenberg, & Maziak, 2008; Maziak, 2011). Recently, Jensen, Cortes, Engholm, Kremers, and Gislum (2010) found that hookah smoking frequency predicted regular cigarette smoking among boys in a sample of 762 Danish youth (ages 14–16 years). A limitation of our study was the inability to examine the temporal relationship among hookah smoking and use of other tobacco products as hookah use was assessed cross-sectionally. The temporality between hookah smoking and use of other tobacco products, particularly cigarette smoking, is important and requires further study among other samples of adolescents. Our data do suggest the importance of assessing multiple forms of tobacco use, including hookah, among adolescents.

That hookah smoking increases one's risk of nicotine dependence (Maziak, 2011; Neergaard, Singh, Job, & Montgomery, 2007) and that some 30-day hookah smokers report concurrent tobacco use are a cause for concern. The concurrent use of these tobacco products may increase adolescents' risk for developing nicotine dependence (Jordan & Delnevo, 2010; Knishkowsky & Amitai, 2005), thus making it difficult to quit smoking and achieve long-term abstinence (Curry, Sporer, Pugach, Campbell, & Emery, 2007). A growing body of literature has examined the development and progression of nicotine dependence among adolescent cigarette smokers (DiFranza et al., 2007; O'Loughlin et al., 2002). While researchers have examined the features of nicotine dependence among adult hookah samples (see Maziak, 2011 for further discussion), additional studies are needed to understand the influence of hookah smoking on the development of nicotine dependence among adolescents. Furthermore, new treatment programs may need to be developed, or already existing adolescent-specific treatment programs may need to be modified to address the prevention and reduction of hookah use among adolescents, especially those who are concurrent tobacco users.

As was found in other studies, our results also highlight the co-occurrence of hookah use and other substance use, notably alcohol and marijuana use. Sutfin et al. (2011) found that current water pipe tobacco smokers were twice as likely to report using alcohol in the past thirty days. Though this association requires further study, perhaps the social context in which hookah use occurs (i.e., use with friends or at a party, see Sutfin et al. for further discussion) can shed light on the association between hookah and alcohol use. Prior evidence has also suggested that some adult smokers use hookah pipes to smoke marijuana (Smith-Simone et al., 2008; Swift et al., 1998). For instance in a study examining knowledge, attitudes, beliefs, and smoking patterns of 201 adults (ages 18 years and over) who were water

pipe smokers, Smith-Simone et al. (2008) found that 10% of their sample used their water pipe to smoke both tobacco and marijuana. Furthermore, 36% of their sample reported using marijuana within the past thirty days. Whether marijuana use is part of a constellation of problem behaviors for adolescent hookah smokers or adolescent hookah smokers are using the water pipe to smoke other substances requires further study. It is important to note that the item that assessed hookah use in our study did not specifically ask if participants were smoking tobacco in the hookah. Though this item has been used to assess hookah tobacco use in other studies (i.e., Sutfin et al., 2011), it may bias findings because the item may capture other substances, in addition to tobacco, that participants may smoke with the hookah. Thus, our findings may slightly overestimate the prevalence of adolescents who smoke tobacco from a hookah. As noted by Sutfin et al., it is important for future studies to use items that ask participants if they have smoked tobacco from a hookah pipe.

Attending a hookah bar, lounge, or restaurant was an important predictor of both ever and past thirty-day hookah smoking among participants in our sample. According to a report issued by the American Lung Association, between 300 and 1,000 hookah cafes, bars, and lounges opened from 1999 to 2007 (TheBACCHUSNetwork, 2007). As noted by Primack et al. (2009), hookah bars, lounges, and restaurants often do not sell alcohol, making them readily accessible to adolescents. Additionally, these venues may be quite alluring to adolescents because they are often the focal gathering point where one can socialize with friends in what is perceived as an enticing, cool, and hip activity. Our findings suggest that hookah bar, lounges, and restaurants may be an important source of exposure to hookah smoking for adolescents who are using hookah and those who are non-hookah smokers and should be further explored in future studies. Though additional evidence is needed, perhaps restricting adolescents' access to hookah bars and lounges should be considered (Maziak, 2011).

In conclusion, our findings suggest that adolescents with a history of ever smoking cigarettes are using hookah. Additionally, these hookah smokers are using multiple substances and forms of tobacco. Evidence-based programs may be needed to prevent initiation or reduce hookah smoking, as well as address cooccurring problem behaviors, to lessen the health risks associated with use among adolescents. To inform the development of interventions, additional studies may be needed to understand adolescents' attitudes toward hookah smoking, to understand their sources of exposure to hookah smoking, and to understand perceived messages received from those sources of exposure.

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Declaration of Interests

None declared.

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