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Prevalence and Harm Perceptions of Hookah Smoking among U.S. Adults, 2014–2015

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Abstract

This study aimed to determine the prevalence and factors associated with hookah smoking and perceptions of harm among U.S. adults. Data were pooled from the Tobacco Products and Risk Perceptions Surveys conducted separately in the summers of 2014 and 2015, among a probability sample selected from an online research panel. Descriptive, logistic regression, and multinomial logistic regression analyses were conducted. In 2014/2015, prevalence of ever and past 30-day hookah smoking among U.S. adults were 15.8% (95% C.I.: 15.0%, 16.7%) and 1.5% (95% C.I.: 1.2%, 1.8%), respectively. Adults who used other alternative tobacco products had a higher odds of hookah smoking than those who did not. Adults with some college education (AOR, 1.53) and with a college degree or more (AOR, 2.21), those identified as non-Hispanic other (AOR, 1.38) were more likely to be ever hookah smokers. Being a young adult (AOR, 2.7), college-educated (AOR, 2.3), never smoker (AOR, 2.1), and an ever hookah smoker (AOR, 2.8) were associated with lower perceptions of harm. Findings suggest that young college students are at higher risk of smoking hookah and that hookah smoking is more prevalent among individuals who use other tobacco products, such as little cigars and cigarillos, traditional cigars, and e-cigarettes, indicating a distinct group of users of alternative tobacco products. Regarding potential harm of hookah, the

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Contributors

All authors were involved in the design of the study. Majeed conducted the statistical analysis and wrote the first draft of the manuscript and 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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study highlights a knowledge gap and misperception especially among young, college-educated, and never smokers. Public health interventions should target these subpopulations to provide them with accurate information on hookah smoking.

1. Introduction

Hookah tobacco smoking, also known as waterpipe, narghile and shisha (Pepper & Eissenberg, 2014; Shihadeh, et al., 2015), is rising in popularity (Soule, Lipato, & Eissenberg, 2015), especially among youth and college students (Lauterstein, et al., 2014; Pepper & Eissenberg, 2014). Males, young adults aged 18–24 years, those who self-identify as non-Hispanic other (American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, and multiple race individuals), those who have college education, and current smokers are more likely to smoke hookah (Cavazos-Rehg, Krauss, Kim, & Emery, 2015; Haddad, El-Shahawy, Ghadban, Barnett, & Johnson, 2015; Villanti, Cobb, Cohn, Williams, & Rath, 2015). Hookah relies on charcoal combustion to heat a moist sweetened flavored tobacco to generate an aerosol that travels through the water-filled hookah body, then passes through a hose to be inhaled by the hookah smoker via a mouthpiece (Soule, et al., 2015). Hookah smoking is commonly considered as a “social ritual” (Carroll, et al., 2014), typically smoked with friends in sessions, lasting 45–60 minutes (Montazeri, Nyiraneza, El-Katerji, & Little, 2016), at hookah establishments that usually provide food, alcohol, and some sort of entertainment (Carroll, et al., 2014).

Similar to cigarettes, hookah generates smoke that contains nicotine and other toxicants, such as tar and carbon monoxide (CO), associated with smoking-related diseases (Ramo, Shihadeh, Salman, & Eissenberg, 2015). Yet, compared to cigarette smoking, hookah is commonly misperceived by users to be less harmful and less addictive and viewed as socially more acceptable (Akl, et al., 2013; Barnett, Shensa, et al., 2013). Relative to one cigarette, a single hookah smoking session exposes users to higher levels of smoke, nicotine, tar, and CO (Primack, et al., 2016). A recent meta-analysis documented that hookah smoking was associated with higher risk of cancer, particularly, lung and esophageal cancers (Montazeri, et al., 2016). However, consumers, especially young and college educated adults, tend to consider hookah as less risky than cigarettes (Lipkus, Eissenberg, Schwartz-Bloom, Prokhorov, & Levy, 2014; Wackowski & Delnevo, 2015). Correcting this misperception is important to combat the rise in hookah smoking.

In May 2016, after reviewing the evidence supporting the risk associated with hookah smoking, the Food and Drug Administration (FDA) deemed tobacco products (including tobacco smoking using hookah) to be subject to the agency’s regulatory authority as amended by the Family Smoking Prevention and Tobacco Control Act. This rule prohibits the sale of deemed tobacco products to minors (under age of 18 years) and mandates display of health warning statements on the products and in advertisements (“Deeming Tobacco Products To Be Subject to the Federal Food, Drug, and Cosmetic Act, as Amended by the Family Smoking Prevention and Tobacco Control Act; Restrictions on the Sale and Distribution of Tobacco Products and Required Warning Statements for Tobacco Products. Final rule,” 2016). The decision to regulate hookah tobacco smoking was rooted in the

concern pertaining to the use of hookah with other tobacco products, known as dual and polytobacco use; the rise in hookah smoking prevalence; the potential of nicotine dependence and smoking-related diseases; and the misperceptions regarding the actual toxicity and health risks associated with hookah smoking ("Deeming Tobacco Products To Be Subject to the Federal Food, Drug, and Cosmetic Act, as Amended by the Family Smoking Prevention and Tobacco Control Act; Restrictions on the Sale and Distribution of Tobacco Products and Required Warning Statements for Tobacco Products. Final rule," 2016). To inform the policy and public health programs, continuous monitoring of hookah smoking uptake and perception is warranted.

Most available studies on hookah smoking in the United States have been conducted among subgroups such as college students (Barnett, Smith, et al., 2013; Enofe, Berg, & Nehl, 2014; Gathuru, Tarter, & Klein-Fedyshin, 2015; Shepardson & Hustad, 2015), youth (Lauterstein, et al., 2014; Wang, King, Corey, Arrazola, & Johnson, 2014), and young adults (Rezk-Hanna, Macabasco-O'Connell, & Woo, 2014; Sutfin, Song, Reboussin, & Wolfson, 2014). Few recent studies have documented the prevalence of hookah smoking and examined the factors associated with it among a nationally representative sample of U.S. adults (Agaku, et al., 2014; McMillen, Maduka, & Winickoff, 2012). The proportion of U.S. adults who have ever smoked hookah in 2009–2010 ranged from 8.8% to 9.8% (Salloum, Thrasher, Kates, & Maziak, 2015). In 2010, prevalence of current use of hookah among U.S. adults, defined as smoking tobacco in a hookah on at least one day within the past 30 days, was 1.5% (Salloum, et al., 2015). Data from the 2012–2013 National Adult Tobacco Survey estimated that 0.5% were "every day" or "some day" and 3.9% were "every day," "some day," or "rarely" hookah smokers (Agaku, et al., 2014).

To our knowledge, no recent study has examined the risk perceptions of hookah among a representative sample of adults. To fill this research gap, we sought to examine the prevalence and the perceived harm of hookah smoking in a national probability sample of adults. The current study's objectives were to estimate the prevalence of ever and current hookah smoking among U.S. adults, aged 18 years and older, examine factors associated with being ever and current hookah smokers, and determine the prevalence and factors associated with perceptions of risk of hookah smoking.

2. Method

2.1. Sample

Data were from the cross-sectional 2014 (June–November) and 2015 (August–September) Tobacco Products and Risk Perceptions Surveys. These were online surveys among a probability sample from an online research panel designed to represent the English and Spanish speaking, non-institutionalized U.S. adults, known as *KnowledgePanel*. Panel members are recruited using address-based sampling method (ABS). Households at the randomly selected addresses are invited to join *KnowledgePanel* by mail. Recruited households that are without internet service are provided with a web-enabled device and free internet. Upon joining the panel, members who are eligible to participate in surveys receive invitation by email with a link to survey questionnaire. In 2014, 5,717 adults and in 2015, 6,051 adults completed the surveys, yielding final stage completion rates of 74.1% in 2014

and 76.0% in 2015. Details about the study methods have been published elsewhere (Weaver, et al., 2016). The GSU Institutional Review Board approved the data collection for both 2014 and 2015 surveys. Data from the two surveys were pooled to improve the accuracy of the estimates.

2.2. Measures

Demographic and other characteristics included in this study were sex, age, race/ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic other: multiple race individual, Asian, American Indian, Alaskan Native, and Hawaiian), educational attainment, annual household income, U.S. census region, perceived physical health status, and sexual orientation (heterosexual and non-heterosexual). Data on respondent characteristics were obtained from the profile survey among all members of the online research panel,

KnowledgePanel—Respondents who indicated that they have heard of hookah prior to the survey were defined as being aware of hookah. Survey participants who have ever smoked hookah, even one or two puffs, were considered ever hookah smokers. Current hookah smoking was defined as having used hookah in the past 30 days. Survey respondents were also asked whether they have ever tried or used little cigars and cigarillos (LCCs), traditional cigars (TC), and electronic vapor products (e-cigarettes) in the past 30 days. In this paper, the term “other tobacco products” is used to refer to LCCs, TCs, and e-cigarettes. Perceived harm of hookah relative to cigarette smoking was assessed using this question: “Is smoking hookah less harmful, about the same, or more harmful than smoking regular cigarettes?” Respondents could select one of these three response options or “I don’t know.”

Adults who reported smoking at least 100 cigarettes in their lifetime and were currently smoking every day or some days were categorized as current smokers. Adults who have smoked 100 cigarettes in their lifetime and responded *not at all* to the “smoke now” question were classified as former smokers. Never smokers were adults who reported not having smoked at least 100 cigarettes in their lifetime.

2.3 Statistical Analysis—Data were analyzed during March-April, 2016, using Stata 13.0 (StataCorp, College Station, TX). All analyses were weighted to account for the complex survey design and survey non-response. Survey sample weights were computed in several stages. The entire *KnowledgePanel* is weighted to the benchmarks from the latest March supplement of the Current Population Survey (CPS) along multiple dimensions: age, race/ethnicity, education, census region, household income, home ownership status, metropolitan area, and internet access. These weights are used to measure the size for each panel member in a probability proportional to size sampling procedure to select the study specific sample. After conducting the study, a post-stratification weights are computed to adjust for non-response and oversampling of smokers. Demographic characteristics of U.S. adults aged 18 and older from the most recent CPS were used as benchmarks.

Overall and by adult characteristics, we computed the point estimates and 95% confidence interval (CI) of the proportions of ever and current hookah smoking. Crude odds ratios (OR) and 95% CI were computed for bivariate associations with ever and current hookah smoking. To identify factors associated with ever and current hookah smoking, two

multivariable logistic regression models were constructed. Model 1 included demographic characteristics and smoking status as independent variables. The independent variables in model 2 were demographic characteristics, smoking status, and (ever or current) use of other tobacco products: LCCs, TCs, and e-cigarettes. For these models, adjusted odds ratios (AOR) and 95% CIs were estimated.

The response category ‘more harmful’ was grouped with ‘about the same level of harm’ to create a new category representing the perception that hookah smoking was equally or more harmful than cigarette smoking. Multivariable multinomial logistic regression was used to examine factors associated with perceptions of harm pertaining to hookah smoking. For this analysis, the category aligned with reality, ‘equally or more harmful’ was used as the reference group of the dependent variable, and demographic characteristics, smoking status, and ever hookah smoking were the independent variables. Significance level was set at $p < 0.05$.

To examine whether current use of any other tobacco products (traditional cigars, little cigars or cigarillos, or e-cigarettes) was associated with current hookah smoking, and whether this relationship varied between current cigarette smokers and non-cigarette smokers, an interaction effect was tested using a multiple logistic regression analysis. In this model, the dependent variable was current hookah smoking, the independent variables were current use of any other tobacco products (binary variable 1 yes, 0 no), current cigarette smoking (1 current smoker, 0 non-smoker), and an interaction effect (product of the two variables). Demographic characteristics were covariates.

3. Results

3.1. Prevalence of hookah smoking

Overall awareness of hookah among U.S. adults was 80.9% (95% CI, 80.0 – 81.7). Table 1 shows prevalence of hookah smoking (ever and current), overall, and by participant characteristics. The percentages of ever and current hookah smoking were higher among males (18.8% and 1.7%, respectively) than among females (13.0% and 1.3%, respectively). Higher percentages of adults aged 18–24 years (25.0% and 3.6%) and 25–34 years (32.4% and 3.8%) were ever and current hookah smokers than adults aged 65 years and older. By race/ethnicity, prevalence of ever hookah smoking was highest among adults categorized as “other, non-Hispanic” (22.8%), and prevalence of current hookah smoking was highest among Hispanic adults (3.5%). Prevalence of ever hookah smoking by education was highest among adults with some college or a college degree (18.5 and 19.8%, respectively); however, no differences by education status were observed for current hookah smoking. By sexual orientation, non-heterosexual adults (29.0%) had nearly twice the prevalence of ever hookah smoking than heterosexual adults (15.1%). Prevalence of ever and current hookah smoking was highest among current smokers (25.1% and 3.5%, respectively). Adults who reported ever use of LCCs, TCs, and e-cigarettes were more likely to report ever hookah smoking. Prevalence of current hookah smoking was highest among current smokers of LCCs (12.2%), current smokers of TCs (9.1%), and current users of e-cigarettes (11.4%).

3.2. Factors associated with ever hookah smoking

Table 2 shows the crude and adjusted OR for ever hookah smoking. In model 1, adjusting for demographic characteristics and cigarette smoking status, the odds ratio of ever hookah smoking for males compared to females was 1.41. Compared to older adults (65 years and older), adults aged 64 years and younger had higher odds of being ever hookah smokers. For example, adults aged 18–24 had a 12.26 increase in the odds to be ever hookah smokers compared to older adults.

Adults with some college education or bachelor's degree had higher odds of ever smoking hookah than did adults with less than high school. The odds of ever hookah smoking among current smokers and former smokers were 3.66 and 3.28 times, respectively, as large as the odds among never smokers. Model 2 demonstrates that adults with some college (AOR, 1.53) and with college degree or more (AOR, 2.21), those identified as non-Hispanic other (AOR, 1.38) were more likely to be ever hookah smokers. Adults who used alternative tobacco products, little cigars and cigarillos (AOR, 2.79); traditional cigars (AOR, 2.61); e-cigarettes (AOR, 3.72), have higher odds of ever hookah smoking than those who have not used these alternative tobacco products. Given model 2, there was a 95% chance that an individual, who aged 18–24 years; who self-identified as other, non-Hispanic; had at least some college education; who self-identified as non-heterosexual; who was a former cigarette smoker (rather than never smoker); and who had ever tried traditional cigars; little cigars or cigarillos; or e-cigarettes, to ever smoke hookah.

3.3. actors associated with current hookah smoking

In keeping with their higher prevalence of current hookah use, younger adults had substantially higher odds of being current hookah smokers, controlling for other demographic characteristics, smoking status, and current use of other tobacco products (Table 3). Compared to White, Non-Hispanic adults, identifying as Hispanic was associated with higher odds of current hookah smoking (AOR, 2.08), however this relationship was not statistically significant after controlling for current use of other tobacco products. Similarly, compared to never smokers, current smokers had 3.18 times greater odds of current hookah smoking, as shown in model 1. After including current use of other tobacco products, smoking status showed no independent effect on current hookah smoking (Model 2). Adults who were current smokers of little cigars and cigarillos (AOR, 4.15), traditional cigars (AOR, 2.98); and e-cigarettes (AOR, 6.68) had greater odds of being current hookah smokers, controlling for demographic characteristics and smoking status. Given Model 2 a young adult, aged 18–24, who was a current user of traditional cigars, little cigars or cigarillos, or e-cigarettes had a 63% chance to be a current hookah smoker.

The multiple logistic regression analysis revealed that a current user of any other tobacco products had 8.27 (95% CI, 4.41 – 15.52) higher odds to be a current hookah smoker, adjusting for demographic characteristics. There was no evidence that this effect varies by cigarette smoking status, after examining the interaction of current use of other tobacco products and current cigarette smoking (AOR, 0.98; 95% CI, 0.38 – 2.55) (data not shown).

3.4. Perceived harm of hookah smoking relative to cigarette smoking

As shown in Table 4, overall, 13.0% of respondents who were aware of hookah thought that it was less harmful than smoking cigarettes; 43.1% thought that hookah use was as harmful as or more harmful than smoking cigarettes, and 43.9% were uncertain. Compared to older adults (65 years and older), younger adults (18–24 and 25–34) had double the odds of holding the perception that hookah smoking was less harmful than cigarettes (versus the perception that hookah was equally or more harmful), after adjusting for other demographic characteristics, smoking status, and ever hookah smoking. Having a college degree, being a never cigarette smoker (compared to a current smoker), and an ever hookah smoker were more likely to perceive hookah as less harmful than cigarettes. Adults who perceived hookah smoking to be less harmful than cigarettes had 2.8 times greater odds of ever smoking hookah (Table 4). Compared to adults who perceived hookah as equally or more harmful than cigarettes, adults who perceived hookah as less harmful than cigarettes had 5.18 (95% CI, 2.70–9.91) times the odds to be current hookah smokers (data not shown).

4. Discussion

This study provides current national prevalence of use and perceptions of risk among U.S. adults. Our findings indicate that in 2014–2015, 4 in 5 adults in the U.S. were aware of hookah, nearly 1 in 6 adults have ever smoked hookah and 1.5% were current hookah smokers (used in past 30 days). This study demonstrates that ever hookah smoking was more common among young adults aged, 18–24 years; who self-identify as other, non-Hispanic; have at least some college education; who self-identify as non-heterosexual; who are former cigarette smokers; and who have ever tried LCCs, traditional cigars, or e-cigarettes. Given the multiple logistic regression model, there is a 95% chance that an individual with these characteristics would ever smoke hookah. We also found that young adults, aged 18–24 years, and current user of LCCs, TCs, or e-cigarettes were the most likely to be current hookah smokers. A young adult, aged 18–24, who currently uses LCCs, TCs, and e-cigarettes has a 63% chance of being a current hookah smoker. Furthermore, the study revealed that the majority of adults were uncertain about the harmfulness of hookah relative to combustible cigarettes. Perceiving hookah as less harmful than cigarettes was positively associated with use. This misperception was prevalent among young adults, college-educated, and never smokers.

Similar to findings from 2013 (Cavazos-Rehg, et al., 2015), we estimated that about 16% of U.S. adults have tried hookah, even once in their life in 2014–2015. The prevalence of ever hookah smoking in the current study was higher than that rates in reported in NATS in 2012–2013 (12.3%) (Agaku, et al., 2014) in 2009–2010 (9.8%) (Salloum, et al., 2015) and that estimated using the Social Climate Survey of Tobacco Control in 2010 (8.8%) (McMillen, et al., 2012). On the other hand, the rate of current hookah use in this study was similar to that documented in a national survey in 2009–2010 (Salloum, et al., 2015), but lower than that estimated during 2012–2013 (Agaku, et al., 2014). This difference could be explained by varying survey methods and definitions of current hookah smoking. A previous study defined current hookah smoking as current “every day,” “someday,” or “rarely” and resulted in higher rate of current hookah smoking (3.9%) (Agaku, et al., 2014). Data from

the Tobacco Use Supplement of the Current Population Survey (2010/2011) revealed that the prevalence of lifetime hookah smoking among adults aged 18–40 was 3.9% in 2010/2011 (Grinberg & Goodwin, 2016). Taken together, our findings confirm the increasing trend in experimentation of hookah smoking (Maziak, 2015).

Consistent with the literature (Barnett, Smith, et al., 2013; Cavazos-Rehg, et al., 2015; Salloum, et al., 2015), the results of the current study show that ever hookah smoking is more common among young, educated, non-heterosexual, and other, non-Hispanic, adults. The popularity of hookah smoking among young and college-educated adults is emphasized by the strategic placement of hookah establishments in close proximity to college campuses (Kates, et al., 2016), exposure to online and social media advertisement (Krauss, et al., 2015; Primack, et al., 2012), and the use of flavors attractive to young people (Akl, et al., 2015). Concurrent with past research (Blosnich, Jarrett, & Horn, 2011; Johnson, et al., 2016; Salloum, et al., 2015), our findings suggest that non-heterosexual adults are at higher risk of smoking hookah. Non-heterosexual adults are known to have higher risk of smoking cigarettes and trying alternative tobacco products, such as e-cigarettes (Weaver, et al., 2016). The result that non-Hispanic, other, and Hispanic adults were more likely to smoke hookah than non-Hispanic White adults was expected (Agaku, et al., 2014; Barnett, Smith, et al., 2013; Cavazos-Rehg, et al., 2015). These findings highlight the profiles of individuals who are at risk of hookah smoking, and therefore, for whom it would be useful to target tailored interventions.

Consistent with previous studies (Grekin & Ayna, 2012; Weaver, et al., 2016), we detected a positive relationship between being a current smoker and hookah smoking. However, after adjusting for use of other tobacco products, being a current smoker exerted no independent effect on hookah smoking. Our findings confirm that hookah is commonly used in combination with other alternative tobacco products (Gilreath, et al., 2016; Lee, Hebert, Nonnemaker, & Kim, 2014).

This study indicates that, irrespective of cigarette smoking status, those who use alternate tobacco products may constitute a distinct group (Erickson, Lenk, & Forster, 2014). This study confirms a knowledge gap regarding the harmfulness of hookah smoking, especially among young people, the college-educated, and hookah smokers (Lipkus, et al., 2014). The finding that never smokers were more likely to underestimate the harm of hookah smoking is alarming, given the role of lower risk perception on smoking initiation. Although individuals may be a current user of alternative tobacco products, such as LCCs, they are defined as never smokers if they report having not smoked at least 100 cigarettes in their lifetime. This may explain why never cigarette smokers misperceive the relative harm of hookah smoking. Future research needs to examine the reasons underlying this misperception.

Unlike other studies (Akl, et al., 2015; Dugas, O'Loughlin, Low, Wellman, & O'Loughlin, 2014), in the current study we allowed participants to choose “I don't know” in response to the perception of relative harm measure. Despite these differences, consistent with previous studies (Grekin & Ayna, 2012; Sutfin, et al., 2011; Villanti, et al., 2015), we detected a positive relationship between hookah smoking and perceiving hookah as less harmful than cigarettes. The perception of lower relative harm, especially among hookah smokers, has

been attributed to pleasant flavors, water filtered smoke, fewer chemicals, and social acceptability (Akl, et al., 2013).

Although the KnowledgePanel is maintained to represent the U.S. general population, its use of an online research may potentially limit generalizability. This study is based on cross-sectional data, therefore limiting our ability to determine whether the use of other tobacco products and the perception that hookah was less harmful than cigarettes preceded or followed initiation of hookah smoking. Self-reported use of alternative tobacco products (e.g. hookah) has not been well-validated yet. Relying on self-report to gather hookah use data may raise concerns related to recall and response bias. Finally, similar to previous research on hookah smoking (Doran, Godfrey, & Myers, 2015; Jones & Cunningham-Williams, 2016), we defined current use as any use in past 30 days, which may limit the comparability of the study findings with other studies (Agaku, et al., 2014) that define current use differently.

The findings of the current study indicate that public health interventions are urgently needed to address the misperception that hookah could be less harmful than cigarettes to curb the rise of hookah smoking, especially among young adults aged 18–24 years. In addition, the positive association of use of tobacco products with hookah smoking highlights the need to assess patterns of use of alternative tobacco products and not be limited to cigarettes. Examination of the health consequences related to exclusive and dual use of hookah is also needed. The findings consistent with previous research on the role of perceived relative harm of hookah on use behavior (Lipkus, Eissenberg, Schwartz-Bloom, Prokhorov, & Levy, 2011), have implications for both intervention and future research. Tailored health messages communicating the real level of risk associated with hookah smoking are needed to provide the public with the necessary information to make informed decision regarding hookah smoking by influencing their perception of risk (Slovic, 2010).

Subgroups at higher risk of smoking hookah include young, self-identified as non-Hispanic other or Hispanic, non-heterosexual, and college-educated adults. Hookah smoking appear to be prevalent among individuals who use other alternative tobacco products, suggesting a distinct group of users. Young adults, college-educated, and never smokers are likely to misperceive hookah as less harmful than cigarettes. These findings can inform future research, policy, and interventions aiming to curb the hookah smoking epidemic in the U.S.

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Highlights

- Hookah smoking is prevalent among users of other alternative tobacco products.
- A knowledge gap regarding the harmfulness of hookah smoking was identified.
- Young, college-educated, and never smokers perceive hookah as less harmful.

Table 1

Ever and current hookah smoking among U.S. adults, 2014–2015

	Ever hookah smoking	Current hookah smoking
Characteristics	% (95% CI)	% (95% CI)
Overall	15.8 (15.0–16.7)	1.5 (1.2–1.8)
Sex		
Male	18.8 (17.6–20.1)	1.7 (1.3–2.2)
Female	13.0 (12.0–14.1)	1.3 (1.0–1.8)
Age (year)		
18–24	25.0 (21.8–28.5)	3.6 (2.3–5.5)
25–34	32.4 (29.9–34.9)	3.8 (2.8–5.1)
35–44	14.7 (13.0–16.6)	0.7 (0.4–1.2)
45–54	11.0 (9.4–12.8)	1.0 (0.5–1.8)
55–64	10.4 (9.1–11.9)	0.4 (0.2–0.8)
65+	5.3 (4.4–6.4)	0.2 (0.1–0.9)
Race/Ethnicity		
White, NH	14.9 (14.0, 15.8)	1.1 (0.8–1.4)
Black, NH	12.8 (10.6–15.4)	1.0 (0.5–2.2)
Other, NH	22.8 (19.1–27.0)	2.1 (1.2–3.9)
Hispanic	18.9 (16.6–21.6)	3.5 (2.4–4.9)
Education		
Less than high school	12.8 (10.3–15.8)	2.0 (1.1–3.7)
High school	10.6 (9.4–11.9)	1.3 (0.9–2.0)
Some college	18.5 (16.9–20.1)	1.9 (1.4–2.6)
Bachelor's degree +	19.8 (18.3–21.3)	1.0 (0.7–1.5)
Annual household income		
<\$15,000	14.8 (12.5–17.4)	2.6 (1.7–4.1)
\$15,000–\$24,999	13.2 (10.7–16.3)	1.2 (0.6–2.6)
\$25,000–\$39,999	13.4 (11.6–15.5)	1.2 (0.7–2.0)
\$40,000–\$59,999	15.1 (13.2–17.2)	1.5 (0.9–2.6)
\$60,000–\$84,999	16.9 (15.1–19.0)	1.6 (1.0–2.5)
\$85,000–\$99,999	16.6 (13.6–20.0)	1.6 (0.8–3.2)
\$100,000 +	17.8 (16.2–19.6)	1.1 (0.7–1.8)
U.S. census region		
Northeast	17.8 (15.9–20.0)	1.4 (0.9–2.3)
Midwest	13.3 (11.9–14.9)	0.8 (0.5–1.3)
South	14.8 (13.5–16.1)	1.7 (1.2–2.3)
West	18.4 (16.6–20.2)	1.9 (1.3–2.8)
Perceived health status		
Excellent	15.8 (13.4–18.4)	1.8 (1.0–3.1)
Very good	16.9 (15.6–18.3)	1.8 (1.3–2.5)
Good	15.4 (14.1–16.7)	1.0 (0.7–1.4)

	Ever hookah smoking	Current hookah smoking
Fair	14.6 (12.5–17.1)	1.4 (0.7–2.6)
Poor	18.4 (13.6–24.4)	3.1 (1.3–7.4)
Sexual orientation		
Non-Heterosexual	29.0 (24.8–33.5)	1.9 (0.9–3.6)
Heterosexual	15.1 (14.3–15.9)	1.5 (1.2–1.8)
Cigarette smoking status		
Current smoker	25.1 (22.8–27.4)	3.5 (2.6–4.7)
Former smoker	18.4 (16.8–20.0)	0.9 (0.6–1.5)
Never smoker	11.9 (11.0–13.0)	1.2 (0.9–1.7)
Ever LCC smoking		
No	8.1 (7.4–8.9)	
Yes	32.8 (31.0–34.6)	
Ever TC smoking		
No	9.5 (8.7–10.3)	
Yes	31.3 (29.6–33.1)	
Ever e-cigarette use		
No	10.8 (10.1–11.5)	
Yes	43.6 (40.9–46.3)	
Current LCC smoking		
No		1.1 (0.9–1.4)
Yes		12.2 (8.4–17.4)
Current TC smoking		
No		1.3 (1.0–1.6)
Yes		9.1 (5.8–14.2)
Current e-cigarette use		
No		0.9 (0.7–1.2)
Yes		11.4 (8.3–15.5)

NH: Non-Hispanic; LCC: Little cigars, Cigarillos, or Filtered cigars; TC: Traditional Cigars

Table 2

Factors associated with ever hookah smoking among U.S. adults, 2014–2015

Characteristics	Crude OR	<u>Model 1</u> Adjusted OR ^a	<u>Model 2</u> Adjusted OR ^b
Sex			
Male	1.55 (1.37–1.75) **	1.41 (1.23–1.61) **	0.90 (0.77–1.06)
Female	Ref	Ref	Ref
Age (year)			
18–24	5.93 (4.54–7.73) **	12.26 (9.05–16.63) **	10.32 (7.50–14.21) **
25–34	8.51 (6.78–10.68) **	11.31 (8.83–14.49) **	8.38 (6.43–10.91) **
35–44	3.06 (2.40–3.90) **	3.23 (2.49–4.19) **	2.69 (2.04–3.53) **
45–54	2.19 (1.69–2.85) **	2.28 (1.73–3.00) **	1.94 (1.45–2.60) **
55–64	2.07 (1.62–2.65) **	2.33 (1.80–3.01) **	2.15 (1.64–2.81) **
65+	Ref	Ref	Ref
Race/Ethnicity			
White, NH	Ref	Ref	Ref
Black, NH	0.84 (0.67–1.05)	0.86 (0.67–1.10)	1.12 (0.88–1.44)
Other, NH	1.69 (1.34–2.14) **	1.17 (0.89–1.53)	1.38 (1.02–1.87) *
Hispanic	1.34 (1.12–1.60) **	1.15 (0.94–1.40)	1.24 (1.00–1.53)
Education			
Less than high school	Ref	Ref	Ref
High school	0.81 (0.61–1.07)	1.10 (0.80–1.50)	1.08 (0.78–1.51)
Some college	1.55 (1.18–2.02) **	1.85 (1.37–2.50) **	1.53 (1.12–2.11) **
Bachelor's degree +	1.68 (1.29–2.19) **	2.51 (1.83–3.44) **	2.21 (1.58–3.10) **
Annual household income			
<\$15,000	Ref	Ref	Ref
\$15,000–\$24,999	0.88 (0.64–1.20)	0.98 (0.69–1.38)	0.95 (0.66–1.37)
\$25,000–\$39,999	0.89 (0.69–1.15)	1.00 (0.75–1.35)	0.97 (0.71–1.33)
\$40,000–\$59,999	1.02 (0.80–1.31)	1.10 (0.82–1.47)	1.06 (0.77–1.44)
\$60,000–\$84,999	1.17 (0.92–1.49)	1.22 (0.92–1.63)	1.02 (0.75–1.39)
\$85,000–\$99,999	1.14 (0.85–1.54)	1.26 (0.89–1.78)	1.10 (0.75–1.59)
\$100,000 +	1.25 (1.00–1.56)	1.39 (1.05–1.84) *	1.23 (0.91–1.67)
U.S. census region			
Northeast	Ref	Ref	Ref
Midwest	0.71 (0.59–0.86) **	0.71 (0.57–0.87) **	0.70 (0.56–0.89) **
South	0.80 (0.67–0.95) *	0.84 (0.69–1.01)	0.81 (0.66–1.00)
West	1.04 (0.86–1.25)	0.93 (0.76–1.15)	0.91 (0.73–1.14)
Perceived health status			
Excellent	Ref	Ref	Ref
Very good	1.09 (0.88–1.34)	1.28 (1.01–1.63) *	1.18 (0.92–1.52)

Characteristics	Crude OR	Model 1	Model 2
		Adjusted OR ^a	Adjusted OR ^b
Good	0.97 (0.78–1.20)	1.26 (1.00–1.60)	1.08 (0.84–1.40)
Fair	0.92 (0.70–1.19)	1.41 (1.04–1.91) *	1.18 (0.86–1.63)
Poor	1.20 (0.80–1.81)	2.15 (1.37–3.38) **	1.79 (1.08–2.96) *
Sexual orientation			
Non-Heterosexual	2.29 (1.84–2.86) **	1.65 (1.29–2.12) **	1.64 (1.23–2.18) **
Heterosexual	Ref	Ref	Ref
Cigarette smoking status			
Current smoker	2.47 (2.11–2.88) **	3.66 (3.04–4.41) **	1.09 (0.85–1.38)
Former smoker	1.66 (1.44–1.91) **	3.28 (2.77–3.88) **	1.51 (1.25–1.83) **
Never smoker	Ref	Ref	Ref
Ever LCC smoking			
No	Ref	--	Ref
Yes	5.50 (4.84–6.27) **		2.79 (2.32–3.36) **
Ever TC smoking			
No	Ref		Ref
Yes	4.35 (3.83–4.94) **	--	2.61 (2.15–3.17) **
Ever e-cigarette use			
No	Ref		Ref
Yes	6.39 (5.59–7.31) **	--	3.72 (3.05–4.54) **

Model 1: independent variables were demographic characteristics and cigarette smoking status.

Model 2: Independent variables were demographic characteristics, cigarette smoking status, and ever use of other tobacco products traditional cigars, little cigars or cigarillos, and electronic vapor products.

NH: Non-Hispanic; LCC: Little cigars-Cigarillos-or Filtered cigars; TC: traditional cigar

*
p<0.05,

**
p<0.01

Table 3

Factors associated with current hookah smoking among U.S. adults, 2014–2015

Characteristics	Crude OR	Model 1 Adjusted OR	Model 2 Adjusted OR
Sex			
Male	1.29 (0.85–1.97)	1.25 (0.81–1.94)	1.04 (0.64–1.70)
Female	Ref	Ref	Ref
Age (year)			
18–24	15.67 (3.74–65.69) **	40.65 (8.95–184.64) **	34.22 (7.05–166.13) **
25–34	16.49 (4.07–66.72) **	39.77 (9.14–172.97) **	31.18 (6.93–140.33) **
35–44	3.09 (0.72–13.30)	7.32 (1.58–33.94) *	6.00 (1.24–29.04) *
45–54	4.21 (0.95–18.67)	10.11 (2.08–49.20) **	10.85 (2.13–55.34) **
55–64	1.82 (0.41–8.11)	4.72 (0.98–22.66)	4.59 (0.92–22.89)
65+	Ref	Ref	Ref
Race/Ethnicity			
White, NH	Ref	Ref	Ref
Black, NH	0.95 (0.42–2.15)	0.71 (0.31–1.63)	0.71 (0.32–1.58)
Other, NH	2.05 (1.04–4.03) *	1.33 (0.61–2.87)	1.06 (0.42–2.65)
Hispanic	3.35 (2.11–5.34) **	2.08 (1.22–3.54) **	1.79 (0.99–3.25)
Education			
Less than high school	Ref	Ref	Ref
High school	0.64 (0.31–1.35)	1.02 (0.45–2.33)	1.12 (0.40–3.11)
Some college	0.95 (0.48–1.91)	1.43 (0.64–3.20)	1.71 (0.64–4.58)
Bachelor's degree +	0.49 (0.23–1.03)	0.94 (0.35–2.51)	1.01 (0.33–3.12)
Annual household income			
<\$15,000	Ref	Ref	Ref
\$15,000–\$24,999	0.44 (0.18–1.10)	0.45 (0.17–1.18)	0.61 (0.22–1.70)
\$25,000–\$39,999	0.44 (0.22–0.90) *	0.58 (0.28–1.20)	0.68 (0.29–1.58)
\$40,000–\$59,999	0.57 (0.28–1.17)	0.77 (0.37–1.61)	0.93 (0.42–2.05)
\$60,000–\$84,999	0.59 (0.31–1.13)	0.80 (0.41–1.58)	0.88 (0.42–1.88)
\$85,000–\$99,999	0.61 (0.26–1.41)	0.96 (0.40–2.30)	0.77 (0.27–2.16)
\$100,000 +	0.40 (0.20–0.79) **	0.69 (0.31–1.53)	0.78 (0.33–1.85)
U.S. census region			
Northeast	Ref	Ref	Ref
Midwest	0.55 (0.27–1.12)	0.59 (0.29–1.21)	0.48 (0.22–1.09)
South	1.18 (0.66–2.12)	1.15 (0.62–2.14)	0.98 (0.49–1.94)
West	1.35 (0.73–2.52)	0.98 (0.49–1.95)	0.92 (0.44–1.92)
Perceived health status			
Excellent	Ref	Ref	Ref
Very good	1.03 (0.54–1.97)	1.24 (0.64–2.39)	1.37 (0.65–2.88)
Good	0.54 (0.28–1.06)	0.65 (0.32–1.31)	0.78 (0.36–1.69)

Characteristics	Crude OR	Model 1	Model 2
		Adjusted OR	Adjusted OR
Fair	0.76 (0.32–1.81)	0.96 (0.39–2.37)	0.87 (0.32–2.31)
Poor	1.78 (0.61–5.18)	2.44 (0.74–7.98)	3.64 (1.05–12.59) *
Sexual orientation			
Non-Heterosexual	1.26 (0.61–2.60)	0.61 (0.32–1.15)	0.63 (0.34–1.18)
Heterosexual	Ref	Ref	Ref
Cigarette smoking status			
Current smoker	3.01 (1.91–4.74) **	3.18 (1.97–5.13) **	0.91 (0.46–1.80)
Former smoker	0.80 (0.45–1.41)	1.54 (0.85–2.80)	1.05 (0.53–2.11)
Never smoker	Ref	Ref	Ref
Current LCC smoking			
No	Ref	Ref	Ref
Yes	12.31 (7.63–19.85) **		4.15 (2.01–8.56) **
Current TC smoking			
No	Ref	Ref	Ref
Yes	7.83 (4.53–13.55) **		2.98 (1.53–5.81) **
Current e-cigarette use			
No	Ref	Ref	Ref
Yes	13.68 (8.80–21.27) **		6.68 (3.45–12.94) **

Current hookah smoking was defined as have smoked hookah in the past 30 days.

Model 1: Independent variables were demographic characteristics and cigarette smoking status.

Model 2: Independent variables were demographic characteristics, cigarette smoking status, and ever use of other tobacco products traditional cigars, little cigars or cigarillos, and electronic vapor products.

NH: Non-Hispanic; LCC: Little cigars, Cigarillos, or Filtered cigars; TC: Traditional Cigars

* p<0.05,

** p<0.01.

Table 4

Perceived harm of hookah smoking relative to combustible cigarette smoking among U.S. adults who were aware of hookah, 2015.

Characteristics	Less harmful % (95% CI)	Equally or more harmful % (95% CI)	"I don't know" % (95% CI)	Less harmful vs. Equally or more harmful AOR (95% CI)	"I don't know" vs. Equally or more harmful AOR (95% CI)
Overall	13.0 (11.8, 14.3)	43.1 (41.4–44.9)	43.9 (42.1–45.7)	--	--
Sex**					
Male	15.0 (13.2–17.0)	43.3 (40.8–45.8)	41.7 (39.3–44.1)	1.3 (1.0–1.7)	1.0 (0.8–1.2)
Female	10.9 (9.4–12.5)	43.0 (40.4–45.6)	46.1 (43.6–48.7)	Ref	Ref
Age (year)**					
18–24	25.8 (20.2–32.3)	50.0 (43.2–56.8)	24.2 (19.1–30.1)	2.7** (1.6–4.5)	0.3** (0.2–0.4)
25–34	22.9 (19.8–26.3)	47.0 (43.1–50.9)	30.2 (26.7–33.8)	1.8** (1.2–2.8)	0.4** (0.3–0.5)
35–44	11.2 (9.0–13.7)	49.6 (45.3–53.8)	39.3 (35.2–43.5)	1.1 (0.7–1.7)	0.4** (0.3–0.5)
45–54	9.5 (7.4–12.1)	41.4 (37.1–45.9)	49.1 (44.7–53.6)	1.2 (0.8–2.0)	0.5** (0.4–0.7)
55–64	5.3 (3.8–07.3)	42.8 (38.9–46.8)	51.9 (47.9–55.9)	0.7 (0.4–1.1)	0.5** (0.4–0.7)
65–74	5.3 (3.8–07.3)	28.8 (25.4–32.5)	65.9 (62.1–69.6)	Ref	Ref
Race/Ethnicity**					
White, NH	11.7 (10.4–13.0)	42.3 (40.2–44.3)	46.1 (44.0–48.1)	Ref	Ref
Black, NH	11.9 (8.7–16.1)	40.0 (34.1–46.2)	48.1 (42.0–54.2)	1.0 (0.6–1.5)	1.2 (0.9–1.7)
Other, NH	22.1 (15.6–30.2)	45.6 (37.9–53.6)	32.3 (25.5–39.9)	1.1 (0.7–1.8)	0.9 (0.6–1.3)
Hispanic	15.0 (11.9–18.8)	47.9 (43.0–52.8)	37.1 (32.6–41.9)	0.8 (0.6–1.2)	0.9 (0.7–1.1)
Education**					
Less than high school	10.4 (6.3–16.7)	47.2 (39.8–54.8)	42.4 (35.4–49.7)	Ref	Ref
High school	09.2 (7.4–11.3)	37.8 (34.7–41.0)	53.1 (49.8–56.3)	1.9 (1.0–3.7)	1.2 (0.9–1.8)
Some college	11.7 (9.8–14.0)	46.0 (42.6–49.5)	42.2 (38.9–45.7)	1.6 (0.9–3.0)	1.0 (0.7–1.4)
Bachelor's degree+	18.1 (16.0–20.5)	43.7 (41.0–46.5)	38.2 (35.5–40.9)	2.3* (1.2–4.4)	1.0 (0.7–1.4)
Annual household income					
<\$15,000	12.3 (9.0–16.6)	46.3 (40.2–52.5)	41.4 (35.7–47.3)	Ref	ref
\$15,000–\$24,999	08.3 (5.6–12.1)	39.1 (32.2–46.4)	52.6 (45.3–59.8)	0.8 (0.5–1.5)	1.4 (0.9–2.1)
\$25,000–\$39,999	12.0 (9.3–15.3)	42.6 (37.8–47.4)	45.5 (40.7–50.3)	1.1 (0.6–1.7)	1.2 (0.8–1.7)

Characteristics	Less harmful	Equally or more harmful	"I don't know"	Less harmful vs. Equally or more harmful	"I don't know" vs. Equally or more harmful
	% (95% CI)	% (95% CI)	% (95% CI)	AOR (95% CI)	AOR (95% CI)
\$40,000–\$59,999	14.2 (11.0–18.0)	39.2 (35.0–43.5)	46.6 (42.3–51.0)	1.2 (0.7–1.9)	1.4 (1.0–1.9)
\$60,000–\$84,999	13.1 (10.6–16.0)	45.7 (41.7–49.8)	41.2 (37.3–45.3)	0.9 (0.5–1.4)	1.1 (0.7–1.5)
\$85,000–\$99,999	9.9 (7.1–13.8)	48.1 (41.9–54.3)	42.0 (36.1–48.0)	0.7 (0.4–1.3)	1.0 (0.7–1.5)
\$100,000 +	15.3 (12.8–18.2)	41.6 (38.3–45.0)	43.1 (39.7–46.5)	1.1 (0.7–1.8)	1.3 (0.9–1.9)
U.S. census region [*]					
Northeast	15.4 (12.5–18.9)	42.3 (38.2–46.6)	42.2 (38.1–46.5)	Ref	Ref
Midwest	09.6 (7.7–11.9)	42.3 (38.7–45.9)	48.1 (44.5–51.7)	0.7 (0.5–1.0)	1.1 (0.8–1.4)
South	12.6 (10.8–14.8)	43.4 (40.3–46.5)	44.0 (41.0–47.0)	0.9 (0.7–1.3)	1.0 (0.8–1.2)
West	14.5 (12.0–17.4)	44.1 (40.6–47.7)	41.4 (37.9–45.0)	0.9 (0.6–1.4)	1.0 (0.8–1.3)
Perceived health status ^{**}					
Excellent	16.9 (13.1–21.4)	48.6 (43.0–54.3)	34.5 (29.6–39.7)	0.8 (0.3–1.8)	0.5 [*] (0.3–0.9)
Very good	14.6 (12.6–16.9)	43.7 (40.8–46.6)	41.7 (38.8–44.6)	1.0 (0.4–2.1)	0.6 (0.4–1.0)
Good	11.3 (9.5–13.2)	42.5 (39.6–45.5)	46.2 (43.3–49.2)	0.8 (0.4–1.8)	0.7 (0.4–1.1)
Fair	10.3 (7.4–14.0)	40.3 (35.5–45.4)	49.4 (44.4–54.4)	0.9 (0.4–2.0)	0.7 (0.4–1.2)
Poor	9.3 (4.8–17.0)	33.0 (23.7–43.7)	57.8 (46.8–68.1)	Ref	Ref
Sexual orientation					
Non-Heterosexual	16.9 (12.2–22.8)	43.6 (36.4–51.2)	39.5 (32.4–47.0)	1.1 (0.7–1.7)	1.1 (0.8–1.6)
Heterosexual	12.6 (11.4–13.9)	43.3 (41.5–45.2)	44.1 (42.2–45.9)	Ref	Ref
Cigarette smoking status ^{**}					
Current smoker	9.4 (7.1–12.4)	44.5 (40.2–48.8)	46.1 (41.8–50.4)	Ref	Ref
Former smoker	7.6 (6.1–09.6)	40.7 (37.5–44.0)	51.6 (48.3–54.9)	1.1 (0.7–1.7)	0.9 (0.7–1.2)
Never smoker	16.6 (14.9–18.6)	44.0 (41.6–46.5)	39.3 (37.0–41.7)	2.1 ^{**} (1.4–3.1)	0.8 (0.6–1.0)
Ever hookah smoking ^{**}					
No	8.6 (7.5–09.8)	41.9 (39.9–43.9)	49.5 (47.5–51.6)	Ref	Ref
Yes	27.4 (24.2–30.9)	47.2 (43.5–51.0)	25.3 (22.3–28.6)	2.8 ^{**} (2.1–3.6)	0.5 ^{**} (0.4–0.6)

AOR: Adjusted Odds Ratio; NH: Non-Hispanic.

^{*} p<0.05,^{**} p<0.01

On the names of the variables signify p values based on bivariate test of associations.

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