Review

Hookah Use Among US Youth: A Systematic Review of the Literature From 2009 to 2017

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Abstract

Introduction: Given the US Food and Drug Administration (FDA)'s authority to regulate hookah, more research is needed to inform regulations intended to prevent youth from using hookah. This systematic review summarizes and assesses the literature related to hookah use among adolescents (11 to ≤18 years of age) in the United States from 2009 to 2017.

Methods: Database searches yielded 867 peer-reviewed articles. After duplicates were removed, authors reviewed 461 articles for inclusion. Included articles ($n = 55$) were coded for study themes, study quality, and their relevance to FDA's research priorities. A qualitative synthesis is presented.

Results: The following themes were identified: (1) prevalence of hookah use ($n = 42$), (2) tobacco use transitions ($n = 7$), (3) sociodemographic correlates ($n = 35$), (4) psychosocial risk factors ($n = 21$), (5) concurrent use of other tobacco products ($n = 31$), (6) concurrent use of other substances ($n = 9$), and (7) other ($n = 15$)—which includes low prevalence themes. The qualitative synthesis showed increasing rates of hookah use. Older age, male gender, positive social normative beliefs, higher peer use, as well as lower perceived risk were associated with hookah use. Longitudinal studies of youth hookah use showed bidirectional relationships between use of hookah and other tobacco products. All articles fell within FDA's research priority related to "behavior," and three priorities ("impact analysis," "health effects," and "toxicity") have not been explored for hookah use among US youth since 2009.

Conclusions: The prevalence of hookah use among youth in the United States is increasing, thus more research is needed to inform policies targeted to protect this vulnerable population.

Implications: This study represents a novel contribution to our understanding of hookah use among youth in the United States from 2009—the year that the Family Smoking Prevention and Tobacco Control Act was passed—to 2017. In recent years, hookah has become a more popular tobacco product among US youth; however, to date, no systematic reviews of hookah use among this population exist. Results highlight implications for future US FDA regulatory policy and identify gaps in research to be addressed in future studies.

Introduction

Hookah (also known as water pipe) is a long-standing form of tobacco use that historically has been part of the cultures of various world regions—including Eastern Mediterranean, Middle Eastern, and some Asian countries—for centuries. In the United States, however, hookah is considered a novel form of tobacco use, becoming common among youth only in the last two decades.¹ Researchers describe a changing landscape of youth tobacco use in the United States in which use of conventional cigarettes has been declining over the past 30 years, and use of alternative tobacco products, including electronic cigarettes (e-cigarettes) and hookah, is on the rise.² Although research on e-cigarette use is rapidly proliferating,³ hookah use remains understudied.

In 2009, the Family Smoking Prevention and Tobacco Control Act gave the US Food and Drug Administration (FDA) authority to regulate the manufacturing, distribution, and marketing of tobacco products, including cigarettes and smokeless tobacco.⁴ In August 2016, the FDA expanded its regulatory authority to include all tobacco products, including e-cigarettes, hookah, and cigars, although many of these new regulations have not yet taken effect.⁵

Given that the FDA now has authority to regulate hookah products, more research is needed to inform potential regulations. The FDA has identified priority research areas to build evidence for the regulation of tobacco products, including (1) toxicity (ie, understanding how tobacco product characteristics cause morbidity and mortality), (2) addiction (ie, understanding how tobacco product characteristics affect addiction and abuse liability), (3) health effects (ie, understanding the short- and long-term health effects of tobacco products), (4) behavior (ie, understanding the knowledge, attitudes, and behavior related to tobacco product use), (5) communications (ie, understanding how to effectively communicate the health effects of tobacco products to the public), (6) marketing influences (ie, understanding why people become susceptible to tobacco products), and (7) impact analysis (ie, understanding the potential impact of FDA regulation through policy evaluation, behavioral economics, or population modeling).⁶ Currently, it is unclear how these priorities are addressed in the literature in relation to hookah use and youth. To date, no systematic reviews of hookah use among US youth exist. Although another review of noncigarette tobacco product use among youth exists, it is not systematic and focuses solely on tobacco product use prevalence.² Other reviews of hookah use focus on college students^{7,8} or a wide range of ages.^{9,10} As such, this is the first systematic review of hookah use focusing on US youth.

The aim of this systematic review was to summarize and assess the quality of extant literature related to hookah use among youth (aged 11 to ≤18 years) in the United States from 2009 (the year that the Family Smoking Prevention and Tobacco Control Act was passed) to 2017. Results are intended to inform both policy and research by highlighting implications for future FDA regulatory policy and identifying gaps in research to be addressed in future studies.

Methods

Article Search

One author (MC) searched two databases (Ovid MEDLINE and PubMed) for published, peer-reviewed articles. Searches were limited to English language studies conducted in the United States between January 1, 2009, and June 23, 2017 (the date that the searches were

conducted). The search strategy used a combination of subject keywords and Medical Subject Heading (MeSH) terms, such as “hookah,” “water pipe,” “shisha,” “youth,” “teen,” and “adolescent.” The complete search syntax is presented in [Supplementary Appendix A](#) and was developed with guidance from the University of Texas Health Science Center at Houston’s librarian with experience conducting systematic review searches. Database searches yielded 867 articles.

Study Selection

After duplicate results were removed, three authors (MG, MC, GK) independently reviewed 461 unique articles for eligibility using a screening checklist. If eligibility was unclear, the authors discussed the article to reach a consensus about exclusion. Eligibility criteria were the following: quantitative and qualitative original research articles examining hookah use among US youth aged 11 to ≤18 years published between January 1, 2009, and June 23, 2017. After screening titles and abstracts, 378 articles were excluded. Articles were excluded based on a hierarchy of reasons: (1) were not published within the years of interest, (2) were not conducted in the United States, (3) were literature/policy reviews or commentaries where no original data were presented, (4) included a population that was not human adolescents ≤18 years of age, (5) did not address hookah use or hookah use was not part of the study hypothesis or results, or (6) were an erratum to a peer-reviewed article. After initial exclusions, 83 articles remained. After screening the full text of the 83 articles, 28 were excluded based on the initial hierarchy. See [Figure 1](#) for tabulations of excluded articles by reason. Studies may have been excluded for more than one reason, but exclusions were tabulated in the order presented.

Data Extraction

Study authors developed a standardized data extraction form that included three components: study themes, study quality, and FDA research priorities. Study themes were developed by one author (MC) after reviewing the included articles, and were edited and finalized after feedback from a second author (GK). Included manuscripts ($n = 55$) were independently coded by three study authors (MC, LP, MG), and consensus was reached when two or more of the three authors coded articles identically. If no consensus was reached during the first round of coding, authors resolved the disagreement by discussion.

First, included articles were coded under one or more of the following, most salient themes: (1) prevalence of hookah use, (2) tobacco use transitions, (3) sociodemographic correlates, (4) psychosocial risk factors, (5) concurrent use of other tobacco products, (6) concurrent use of other substances, and (7) other—which includes low-prevalence themes identified such as flavors ($n = 4$), social activity ($n = 4$), cessation ($n = 3$), access ($n = 2$), and marketing ($n = 2$).

Second, authors rated the quality of each article. The Quality Assessment Tool for Quantitative Studies^{11,12} (see [Supplementary Appendix B](#)) was used to assess the quality (strong, moderate, or weak) of included articles across the following domains: (1) selection bias (how likely individuals selected to participate were to be representative of the target population), (2) study design (rated on strength of the design), (3) confounders (percentage of relevant confounders that were controlled), (4) data collection (documented reliability and validity of tools), and (5) withdrawal and dropouts (the

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. A hierarchy of reasons for exclusion was developed. Studies may have been excluded for more than one reason, but exclusions were tabulated in order presented (Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 2009;6(7):e1000097. doi:10.1371/journal.pmed1000097).

percentage of participants completing the study). A global rating for each study was derived based on quality scores across each domain.

Third, authors coded articles in terms of their relevance to the FDA Center for Tobacco Products' stated research priorities: (1) toxicity, (2) addiction, (3) health effects, (4) behavior, (5) communications, (6) marketing influences, and (7) impact analysis.

A qualitative synthesis of the evidence is presented. Statistics such as effect estimates, confidence intervals, and *p* values are presented consistent with the original article. Study characteristics, themes, and prevalence estimates are presented in [Supplementary Table 1](#).

Results

Prevalence of Hookah Use

Forty-two articles reported the prevalence of hookah use in youth (2009–2017).^{13–54}

Ever Use^{13,14,16–20,23,25–28,30,31,35,37–39,43,44,46,48,49,51,53,54}

Nationally representative estimates show increasing rates of ever use of hookah in recent years. According to the 2011 National Youth

Tobacco Survey (NYTS), 7.3% of all middle school and high school youth reported ever using hookah,¹³ which rose to 8.9% in 2012.⁵⁴ In 2013, ever use of hookah was 3.0% for middle school students and 14.3% for high school students according to the NYTS.¹⁴

Representative statewide estimates also show increasing prevalence of ever use of hookah. For example, in 2007, the Florida Youth Tobacco Survey (FYTS) found that 4.0% of middle school students and 11.0% of high school students had ever used hookah.¹⁶ In Florida, hookah use increased to 22.5% by 2014 in high school students,¹⁹ but remained low in middle school students between 2007 and 2013.^{17,18} The New Jersey Youth Tobacco Survey showed that ever use of hookah also increased among high school students (from 17.9% in 2008 to 20.9% in 2010).²⁰

Nonprobability-based samples also document ever use of hookah, though trends regarding increased use are less clear. In a nonprobability-based sample of Somali high school youth in Minnesota in 2008, 3.8% reported ever use of hookah.²⁶ In nonprobability-based samples of Southern California high school students in 2010 and 2013–2014, ever use of hookah was 26.1% and 15.2%, respectively.^{37,46}

Current Use^{13–15,17–27,29–47,49–52,54}

Current use (defined as past-30-day use unless otherwise stated) of hookah has also risen among US youth in recent years. According to NYTS estimates, between 2011 and 2016 a nonlinear increase in current use of hookah occurred among high school students (4.1% to 4.8%)—although a decrease was observed between 2015 and 2016 (7.2% to 4.8%); and a linear increase occurred for middle school students (1.0% and 2.0%).^{13–15,21,33,45,54} One study noted potential measurement bias in hookah estimates from NYTS due to the differing order in which hookah was presented on the check-all-that-apply list across years.²³ Monitoring the Future data from 2010 to 2013 showed that approximately 18.0% of high school seniors had used hookah within the past year,^{41,42} while during that time period 7.2% reported sustained use (ie, using hookah on at least six occasions within the past 12 months).⁴²

Various statewide representative estimates show increasing rates of current hookah use. For example, the FYTS estimated that current use of hookah in high school students was 7.7% in 2009, which remained stable through 2012.¹⁷ In 2013, FYTS data showed current hookah smoking rose to 8.2% for high school students,¹⁸ and in 2014, rose again to 11.6%.¹⁹ New Jersey Youth Tobacco Survey estimates showed current hookah use among high school students increased from 9.7% in 2008 to 11.4% in 2010.^{20,34} In a representative sample of North Carolina high school students, current hookah use nearly doubled from 3.6% in 2011 to 6.1% in 2013.³¹

Other nonnationally or statewide representative samples also reported current hookah use. For example, in a nonrepresentative sample of Minnesota Somali high school youth in 2008, 2.3% reported current hookah use.²⁶ In a 2010 nonprobability-based sample of Southern California high school students, 18.2% had used hookah in the past 6 months, and 10.9% reported they used hookah in the past month.⁴⁶ In a 2013 nonprobability-based sample of Connecticut high school students, 7.7% reported current hookah use.⁴⁰ In a 2014 nonprobability-based sample of Southern California youth, hookah was the most prevalent tobacco product currently used among 11th and 12th grade students (10.7%).²⁵

Tobacco Use Transitions

Seven articles were longitudinal studies examining adolescent hookah use over time.^{27,28,32,37,48,55,56} Two were long-term cohort studies following children from elementary school through early adulthood.^{28,56} The remaining five cohort studies had relatively shorter follow-up periods, which ranged from 6 to 24 months.^{27,32,37,48,55} Two of these longitudinal studies of high school students found that baseline e-cigarette use was associated with subsequent hookah initiation,^{37,55} and one tested the relationship in both directions, finding that, in addition, baseline hookah use predicted e-cigarette initiation at 6- and 12-month follow-up periods.³⁷ Similar bidirectional relationships have been found for hookah and conventional cigarettes in three studies that included a combination of youth and young adults: one study found baseline hookah smoking was associated with conventional cigarette initiation, current use, and higher intensity of cigarette smoking at follow-up,⁴⁸ whereas two studies found baseline cigarette smoking, along with other risk factors such as higher sensation seeking²⁸ and parental education,²⁷ predicted hookah use over time. Similarly, two additional studies highlighted the potential of hookah use as an intermediary step between no tobacco use and starting to smoke cigarettes or use multiple products.^{32,56}

Sociodemographic Correlates

Thirty-five articles reported the sociodemographic correlates of adolescent hookah use.^{13,14,16,17,19,20,23–25,27–29,31,33–37,39–49,52–54,56–58}

Age^{13,14,16,19,20,23,24,27,29,31,33–37,39–41,43,46–49,52,53,58}

In general, the prevalence of hookah use was found to increase with age and school grade level,^{14,16,35,43,46,53} though in one study, increasing age was associated with ever use of hookah, but not current use.¹³ In one sample, the odds of current and ever hookah use were substantially higher for young adults (18–22 years) relative to youth (15–17 years; odds ratio [OR] = 42.95, $p < .001$).²⁷

Gender^{13,16,19,25,27,31,36,40–43,46,47,49,54,57}

The studies reporting significant associations between gender and hookah use were mixed. Results from several city, state, and national surveys found that gender was not associated with hookah use,^{13,31,46} but other studies, also from a wide range of data sources, showed that male youth were more likely than female youth to ever and currently use hookah.^{16,41–43,49,54} Between 2011 and 2014, among Florida high school students, current hookah use increased over time in females, but remained stable in males.¹⁹

Race and/or Ethnicity^{13,14,16,17,19,20,24,29,31,33,34,36,39–41,43–45,49,54,57}

Findings on race and/or ethnicity and hookah use varied. In 2013, 2015, and 2016, the NYTS showed that Hispanic youth had the highest prevalence of ever and current hookah use compared to other race and/or ethnicity groups,^{14,29,33,45} which is consistent with state-level data from FYTS in 2012 and 2014.^{24,39} Similarly, in 2013 in North Carolina, both Hispanic youth and non-Hispanic white youth had higher odds of current hookah use compared to black youth (OR = 1.89; 95% CI = 1.21 to 2.95 and OR = 1.94; 95% CI = 1.84 to 3.66, respectively).³¹ However, in a study of Chicago-area youth, Hispanic ethnicity (compared to white, Non-Hispanic youth) was a protective factor for both ever and current hookah use (OR = 0.30, 95% CI = 0.18 to 0.50 and OR = 0.49, 95% CI = 0.29 to 0.82, respectively).⁴⁹

On the basis of two studies using national and state-wide estimates, youth of an Asian race were more likely to have tried hookah,¹³ and currently use hookah³⁴ compared to non-Hispanic black youth. Further, Arizona middle and high school students who identified as of an Asian race or of white race had higher odds of ever use compared to American Indian youth (OR = 2.6; 95% CI = 1.1 to 6.2 and OR = 2.8; 95% CI = 1.5 to 5.1, respectively).⁴³

Across city, state, and nationwide samples, black youth were less likely to use hookah than other race and/or ethnicity groups;^{16,24,41,49,54,57} however, multiple tobacco product use (which included hookah) has been found to be higher among black youth compared to white youth.^{36,40} Statewide estimates have shown hookah use to increase over time among certain race and/or ethnicity groups. Specifically, between 2008 and 2010 in New Jersey and between 2011 and 2014 in Florida, increases in hookah use were seen in Hispanic and black youth.^{19,20}

Socioeconomic Status and Education^{27,31,41–43,58}

Socioeconomic status and education was measured differently across studies. Family financial situation (ie, a subjective measure of ability to meet basic expenses) was not associated with hookah in a prospective study of youth and young adults,²⁷ but higher parental education has been associated with greater odds of youth hookah use in multiple studies.^{27,41,42} A higher weekly disposable income (a proxy

variable for high socioeconomic status) also predicted current hookah use in North Carolina high school students ($> \$50/\text{week}$ adjusted odds ratio [aOR] = 2.05; 95% CI = 1.25 to 3.35)³¹ and recent hookah use in US high school seniors ($> \$50/\text{week}$ aOR = 1.26, $p < .05$ and $\$11\text{--}50/\text{week}$ aOR = 1.35, $p < .01$).⁴¹ Among Arizona youth, students who lacked definitive college plans (a proxy variable for low socioeconomic status) had higher odds of ever and current hookah use (OR = 1.7; 95% CI = 1.3 to 2.2 and OR = 1.9; 95% CI = 1.5 to 2.4, respectively).⁴³ In another sample of California seventh grade students, receiving free or reduced lunch (a proxy variable for low socioeconomic status) was positively associated with ever hookah use ($b = 0.07$, $p < .01$).⁵⁸

Psychosocial Risk Factors

Twenty-one articles documented psychosocial risk factors associated with youth hookah use.^{13,16,24,26–28,31,34,36,37,39,46,47,52,56,59–64}

Harm Perceptions^{26,27,31,34,36,39,46,59–64}

Harm perceptions were measured in various ways, including on an absolute scale (ie, not compared to other tobacco products). For example, one cross-sectional study of Texas youth observed that adjusting for other sociodemographic factors, dual users of e-cigarettes/cigarettes had lower harm perceptions related to hookah than nonusers.⁵⁹ Similarly, another cross-sectional study of Texas youth observed that significantly higher proportion of dual/multiple tobacco product users (42.4%) reported that hookah was “not at all harmful to health” than both single product users (21.7%, $p < .05$) and nonusers (10.4%, $p < .05$), and a significantly larger proportion of single product users (72.8%) reported that hookah was “not at all addictive” than nonusers (54.3%, $p < .05$).⁶⁰ In a cross-sectional California-based study, youth who ever used tobacco reported lower perceived risks—including short-term risks such as a bad cough and long-term risks such as lung cancer—related to hookah than youth who had never used tobacco.⁶³

Harm perceptions related to hookah were also evaluated relative to the harm perceptions of conventional cigarettes. For example, in a cross-sectional survey of Somali refugee youth in Minnesota, those who endorsed the belief that hookah was “less risky” than smoking cigarettes were more likely to be ever (vs. never) users of tobacco products (33.9% vs. 24.1%, $p < .01$) or report future intentions (vs. no intentions) to use tobacco (43.2% vs. 22.6%, $p < .01$).²⁶ and in a US-representative longitudinal cohort, youth and young adults who perceived hookah as “less harmful” than cigarettes had higher odds of current and ever hookah use compared to those who perceived harmfulness as “about the same” as cigarettes (OR = 15.02, $p < .001$).²⁷ Youth with this perception were also found to be disproportionately represented among students with lifetime asthma (16.1%) versus students who had never had asthma (14.4%), according to findings from the FYTS.³⁹ A cross-sectional study in California showed a statistically significantly greater proportion of youth who had ever used hookah (78.2%) reported they thought hookah was “safer or less addictive than cigarettes” as compared to youth who had not used hookah (31.6%, $p < .001$).⁴⁶ In the same study, out of four tobacco products (cigarettes, cigars, smokeless tobacco, and hookah), youth ranked hookah as being the least harmful.⁴⁶ Focus group results conducted in North Carolina described youth who perceived hookah as less dangerous than cigarettes because it was more “pure” and did not have “as many additives.”⁶¹ Other focus groups among African-born youth in Minnesota revealed misperceptions around shisha tobacco being less harmful than other types

of tobacco because of the flavor, smell, and presence of water.⁶² Qualitative research conducted in North Carolina has shown that, in general, youth and young adults were unaware of constituents present in novel tobacco products, such as hookah. However, when informed of constituents in such products (eg, benzene and formaldehyde), the majority had negative beliefs about them or worried about their health effects.⁶⁴

Hookah use is also associated with beliefs about the harm of tobacco products in general. Cross-sectional studies conducted in North Carolina and New Jersey showed that youth who disagreed with the statement “all tobacco products are dangerous,”³¹ as well as youth who reported that cigars were safer than cigarettes,³⁴ had greater odds (aOR = 1.29; 95% CI = 0.69 to 2.42 and aOR = 1.73; 95% CI = 1.12 to 2.70, respectively) of current hookah use. Findings from the 2012 NYTS showed that youth who endorsed the belief that breathing smoke from tobacco products causes harm were less likely (adjusted relative risk ratio, aRRR = 0.58, $p < .01$) to be poly-tobacco product users (ie, use cigarettes and two or more products, including hookah).³⁶

Peer Use, Social Norms, and Other Tobacco

Attitudes^{16,24,31,34,36,37,46,52,63}

In repeated cross-sectional surveys of North Carolina youth, those who reported that three to four (vs. zero) of their closest friends smoked cigarettes had increased odds (aOR = 2.70; 95% CI = 1.72 to 4.25) of current hookah use.³¹ In a longitudinal study of California high school-aged youth, peer smoking at baseline increased the odds of hookah initiation at 6- and 12-month follow-up time points (aOR = 1.16; 95% CI = 1.01 to 1.34).³⁷ Findings from the 2012 NYTS showed that youth who reported one or more of their peers at school used tobacco products had increased odds of poly-tobacco use (ie, using cigarettes and two or more other products, including hookah) compared to those who reported that none of their school peers used tobacco products (1–4 peers, aOR = 3.61, $p < .05$; 5–10 peers, aOR = 5.73, $p < .05$).³⁶

In a cross-sectional survey conducted in California, a statistically significantly larger proportion of high school youth who had ever used hookah (87.6%) reported that they thought hookah was “more socially acceptable than cigarettes” as compared to youth who had not used hookah (46.7%, $p < .001$).⁴⁶ In a cross-sectional survey of Florida middle and high school students, youth who reported that cigarettes helped to relieve stress and helped make social situations more comfortable had increased odds of ever hookah use (aOR = 1.8; 95% CI = 1.4 to 2.3 and aOR = 2.1; 95% CI = 1.5 to 2.7, respectively).¹⁶ In a cross-sectional survey of New Jersey high school students, those who reported that smoking looks cool or helps them to fit in had higher odds of current hookah use (aOR = 1.74; 95% CI = 1.12 to 2.70).³⁴ In a cross-sectional California-based study comparing perceptions of various tobacco products, youth perceived hookah as more likely to help them “look cool” or “fit in” compared to other products.⁶³

Household Use^{13,26,28,31}

In nationally representative US and North Carolina samples, youth who reported someone at home smokes hookah had between six³¹ and ten¹³ times the odds of current hookah use, and in another study in Minnesota, higher likelihood of ever tobacco use.²⁶ In a longitudinal study conducted in Oregon, history of mother’s cigarette smoking in early adolescence was predictive of novel tobacco product use—including hookah—in early adulthood ($\beta = .045$, $p = .001$).²⁸

Intrapersonal Factors^{28,37,47,56}

In a prospective study conducted in Oregon, higher sensation seeking in early adolescence was associated with ever use of hookah in early adulthood ($\beta = .036$, $p < .001$).²⁸ Another prospective study in Oregon identified four smoking trajectory classes in high school youth, finding that membership in any cigarette smoking class (vs. nonsmokers) was predicted by level of sensation seeking ($\beta = 3.09$, $p < .001$) and that in early adulthood, cigarette smoking and hookah use were associated among the high school youth classified as “experimenters” ($\chi^2(1) = 13.38$, $p < .001$).⁵⁶ In a prospective study of California students, higher levels of impulsivity and delinquent behaviors increased the odds of hookah use onset at 6 and 12 months (aOR = 1.28; 95% CI = 1.11 to 1.46 and aOR = 1.38; 95% CI = 1.14 to 1.66, respectively).³⁷ In a US sample of youth and young adults, higher levels of sensation seeking was associated with multiple tobacco product use (ie, current use of three or more products, including hookah; third quartile: aOR = 2.2; 95% CI = 1.15 to 4.21 and fourth quartile: aOR = 2.02; 95% CI = 1.1 to 3.72).⁴⁷

Concurrent Use of Other Tobacco Products

Thirty-one articles documented youth use of hookah concurrent with use of one or more other tobacco products (s).^{13,14,16,18,20,25,29,31–37,40–42,45–47,49,50,52,54,57–60,65–67}

Nationally representative estimates from the Population Assessment of Tobacco and Health study showed that, among youth who currently use any tobacco product—including hookah—in 2013–2014, 43% used two or more products.³⁵ The NYTS showed that, among youth tobacco users, dual and poly-tobacco product use—including hookah—patterns have increased from 1999 to 2014: from 7% to 14% for poly-use and from 2% to 13% for noncigarette combustible and non-combustible dual use.⁶⁶ NYTS estimates showed that in 2012, among current youth tobacco users, the prevalence of current hookah use was similar among single (41.3%) and multiple product (41.6%) users.⁵² The 2012 NYTS also documented that ever and current use of hookah was higher for youth who were current users of other nonconventional tobacco products (eg, e-cigarettes, snus, dissolvables) than for youth who were current users of other conventional tobacco products (cigarettes, cigars/cigarillos/little cigars, smokeless tobacco)—51.5% versus 28.9% and 29.8% versus 8.3%, respectively.⁵⁴

In samples of youth in Illinois and Florida, current youth hookah users also reported current use of cigarettes (74.7%)⁴⁹; cigars, cigarillos, and little cigars (48.1%)⁴⁹; e-cigarettes (37.0%)¹⁸; and smokeless tobacco (13.2%).⁴⁹ Among high school students in California who had ever used hookah, 75.6% had smoked cigarettes and 30.6% reported current use of cigarettes.⁴⁶ National estimates from the Monitoring the Future survey showed that, among past-year hookah users, 61.9% reported past-year use of little cigars and 46.2% reported current use of cigarettes.⁴² North Carolina youth who were current smokers were nearly five times more likely to currently use hookah (aOR = 4.57; 95% CI = 1.80 to 11.62).³¹ Another study utilizing Monitoring the Future data showed that increasing risk of hookah use has been found for higher amounts of cigarette smoking among high school seniors; specifically, among youth who reported regular cigarette use, 52.8% reported past-year hookah use; however, among those who reported smoking once or twice, 25.2% reported past-year hookah use.⁴¹

In two California-based studies, concurrent use of hookah and e-cigarettes was high: among ever users of e-cigarettes, 46.5% had ever used hookah³⁷ and a latent class (8.2%) emerged of youth who reported high probabilities of using both products.²⁵ In

samples of youth in Florida, Texas, New Jersey, New York, Ohio, and Connecticut, of the current e-cigarette users, 60.0% were lifetime hookah users⁵⁹ and 42.1%⁶⁵ to 64.4%⁶⁰ were current hookah users; of the current cigarette smokers, 32.3%⁵⁹ to 45.6%^{16,20} were lifetime hookah users and 18.9%⁶⁵ to 36.0%^{20,34} were current hookah users; of the current smokeless tobacco/cigar users, 48.7% to 55.2%²⁰ were lifetime hookah users and 26.5%⁶⁰ to 49.2%^{20,50} were current hookah users; and of the current e-cigarette/cigarette dual users, 59.9% were lifetime hookah users.⁵⁹

Concurrent Use of Other Substances

Nine articles reported youth use of hookah concurrent with use of one or more other substance(s).^{28,32,40,41,49,50,53,57,61} Co-use of alcohol and hookah was reported qualitatively whereby authors described “social use” of both products together in a North Carolina-based focus group sample,⁶¹ and in a content analysis of hookah-related images on social media, marijuana-related references appeared in 11% of posts and alcohol in 6%.⁵⁷ In a nationally representative survey of high school seniors, past-year hookah users had higher odds of lifetime alcohol use (aOR = 3.34; 95% CI = 2.12 to 5.25), lifetime marijuana use (aOR = 4.48; 95% CI = 3.38 to 5.94), and lifetime use of other illicit substances (aOR = 1.53; 95% CI = 1.22 to 1.92).⁴¹ Other nationally representative estimates showed that youth who were current users of any tobacco (a variable including hookah or other tobacco products) were more likely to report current alcohol use (adjusted prevalence ratio, aPR = 1.37; 95% CI = 1.22 to 1.52) and current marijuana use (adjusted prevalence ratio, aPR = 1.64; 95% CI = 1.49 to 1.80).⁵³ In a cross-sectional study of ever smoking youth in Chicago area, Illinois, ever hookah use was associated with higher odds of recent alcohol use (aOR = 1.34; 95% CI = 1.09 to 1.65) and recent marijuana use (aOR = 1.75; 95% CI = 1.46 to 2.10), while past-30-day hookah use was associated with higher odds of recent alcohol use (aOR = 1.39; 95% CI = 1.14 to 1.69).⁴⁹ In a cross-sectional study of Ohio high school students, 32.8% of current users of cigars for smoking marijuana (ie, “blunters”) also reported current hookah use.⁵⁰

Findings from an Oregon-based longitudinal study showed early trying of substances—both alcohol and marijuana by grade 8—was found to influence hookah uptake in emerging adulthood.²⁸ In a latent transition analysis that included high school youth in California, authors reported an increasing prevalence of poly-product use (ie, hookah, blunts, cigarettes, e-cigarettes, and cigars) over time (from 4% to 9%) and a typical transition pattern of moving to more diverse product use over time.³² Similarly, in a latent class analysis including Connecticut high school students, hookah use was included in a class of youth who reported high probability of using all products (ie, other tobacco products, alcohol, and marijuana), comprising 6.9% of youth surveyed.⁴⁰

Other Themes

Other low prevalence themes were identified. Four studies discussed use of flavored hookah tobacco.^{22,36,53,61} The 2014 NYTS showed that the proportion of current youth hookah users who reported current flavored hookah use was 60.6%.²² During qualitative interviews that took place in North Carolina, youth and young adults also stated they like the availability of different flavorings for hookah.⁶¹ Use of a flavored tobacco product was associated with dual use and poly-tobacco use (including hookah) according to data from the 2012 NYTS.³⁶ In 2013–2014 estimates from Population Assessment of Tobacco and Health, among youth who had ever used hookah, 89% reported that their first product was flavored and the greatest trial

of flavored tobacco before 15 years of age was for hookah (87% of youth ever users).⁵³

Four studies described social activity.^{31,53,57,61} In a qualitative study, youth and young adults in North Carolina reported enjoying doing smoke tricks with hookah and posting videos of smoke tricks to social media. Participants discussed going to hookah bars as a fun social activity, especially for those who were too young for traditional bars.⁶¹ In another North Carolina cross-sectional study, youth who reported “liking” or positively commenting on tobacco products on social media had greater odds of current hookah use (aOR = 1.83; 95% CI = 1.84 to 4.52).³¹ In a study of social media postings related to hookah smoking, the most prominent themes included postings on socializing and tricks performed with hookah smoke.⁵⁷ Among a US sample of youth and young adult current hookah users, the top-ranked reason for use was “I like socializing while using them.”⁵³

Three studies discussed hookah cessation.^{44,46,52} In one cross-sectional sample of California youth, 93.1% of ever users of hookah reported they were “very confident” they could quit hookah smoking anytime; however, 29.3% reported they did not plan to quit smoking hookah.⁴⁶ Data from the 2013 NYTS showed that current hookah users had the lowest prevalence of quit intentions (41.5%) and past-year quit attempts (43.7%) than current users of other tobacco products.⁵² Further, a school-based intervention focused on cigarette smoking cessation was effective in reducing cigarette use, but not hookah use.⁴⁴

Two studies discussed access to hookah.^{46,49} Among samples of youth in Southern California and Chicago, ever use⁴⁶ and current use⁴⁹ of hookah were associated with having attended a hookah bar, lounge, or restaurant. Southern California youth who had ever used hookah were more likely to know about the presence of a hookah lounge in the community.⁴⁶ Among the ever hookah users, 81.1%

reported they usually smoked hookah at a friend’s house; 25.7% reported they usually smoked hookah at a hookah lounge (multiple responses were allowed).⁴⁶

Two studies discussed marketing.^{31,36} Findings from repeated cross-sectional surveys from North Carolina showed that frequent exposure to tobacco ads on the Internet—but not tobacco ads in stores, supermarkets, or gas stations—was associated with increased odds (aOR = 1.61; 95% CI = 1.13 to 2.28) of current hookah use.³¹ According to NYTS estimates, tobacco marketing receptivity was associated with poly-tobacco use, including hookah, (aRRR = 2.52, $p < .001$) among youth smokers.³⁶

FDA Research Priorities

Studies selected fell within FDA’s research priority “behavior,” which aims to understand knowledge, attitudes, and behaviors related to diverse tobacco product use. All major themes (ie, prevalence, tobacco use transitions, sociodemographic correlates, psychosocial risk factors, and concomitant tobacco and other substance use) fell within this research priority. Two studies fell within the “communications” research priority^{61,64} and two fell within the “marketing influence” research priority.^{31,36} One study fell within the “addiction” research priority documenting with latent class analysis that youth poly-tobacco product users, which included hookah, were more likely to report symptoms of nicotine dependence.²⁹ Three research priorities—those related to “toxicity,” “health effects,” and “impact analysis”—were not identified in this search that spanned 8 years.

Study Quality

In terms of study quality, the majority of included studies were rated “moderate” in the selection bias domain ($n = 31$), meaning that study

Table 1. Quality Rating of Included Articles ($n = 55$)

	Number	%
Selection bias		
Weak: Selected individuals are not likely to be representative of the target population	13	23.64
Moderate: Selected individuals are at least somewhat likely to be representative of the target population	31	56.36
Strong: Selected individuals are very likely to be representative of the target population	11	20.00
Study design		
Weak: Studies that used any other method or did not state the method used	47	85.45
Moderate: Cohort analytic study, a case control study, a cohort design, or an interrupted time-series	8	14.55
Strong: Articles that described randomized controlled trials and controlled clinical trials	0	0
Confounders		
Weak: Less than 60% of relevant confounders were controlled	17	30.91
Moderate: Studies that controlled for 60%–79% of relevant confounders	20	36.36
Strong: Articles that controlled for at least 80% of relevant confounders	18	32.72
Data collection methods		
Weak: Data collection tools have not been shown to be valid or both reliability and validity are not described	45	81.82
Moderate: Data collection tools have been shown to be valid and have not been shown to be reliable or reliability is not described	7	12.73
Strong: Data collection tools have been shown to be valid and reliable	3	5.45
Withdrawals and dropouts		
Weak: Follow-up rate is less than 60% or withdrawals and dropouts not described	1	1.82
Moderate: Follow-up rate is 60%–79%	3	5.45
Strong: Follow-up rate is 80% or greater	4	7.27
Not applicable: One-time surveys or interviews	47	85.45
Global rating		
Weak: Two or more weak ratings	46	83.64
Moderate: One weak rating	7	12.73
Strong: No weak ratings	2	3.64

participants were at least somewhat likely to be representative of the study population (see Table 1). Eighteen articles used data from US nationally representative, population-based surveys, 13 articles used data from state-representative surveys, and 3 articles used representative data from other localities such as cities or counties. Twenty-one articles used nonrepresentative data or convenience samples. Thirty-four articles were cross-sectional studies, nine were repeated cross-sectional studies, eight were cohort studies, and four were mixed methods or qualitative studies (see Supplementary Table 1). As such, with the exception of the eight cohort studies, the majority of studies ($n = 47$) were rated “weak” in the study design domain. In the domain assessing confounders, most studies were rated “moderate” ($n = 20$) as the coders judged them to control for 60%–79% of relevant confounders. In the data collection methods domain, most studies ($n = 45$) were rated as “weak” because data collection tools were not shown to be valid or both reliability and validity was not described. The majority of studies were coded as “not applicable” ($n = 47$) in the withdrawals and dropouts domain because they were one-time interviews or cross-sectional surveys. The majority of studies ($n = 46$) fell within the global rating category of “weak,” which included studies with two or more weak ratings in each domain.

Discussion

Across studies, this systematic review shows increasing rates of ever and current hookah use in US youth, especially for older (ie, high school) youth, as the prevalence has remained relatively stable and low in middle school youth. Generally, youth hookah use in the United States is associated with older age, male gender, and higher among some race and/or ethnicity groups, such as Hispanic, Asian, and non-Hispanic white. However, differences by race and/or ethnicity should be interpreted with caution as national surveys may be limited by the way they categorize race and/or ethnicity groups; state surveys may have different racial/ethnic compositions; and across surveys and analyses, different reference categories were used. Studies reporting socioeconomic correlates also had mixed findings. Some proxy variables for high socioeconomic status (eg, parental education and weekly disposable income) were associated with hookah use and some proxy variables for low socioeconomic status (eg, lacking firm college plans and receiving free or reduced lunch) were also associated with hookah use.

Similar to research on other tobacco products such as cigarettes and smokeless tobacco,^{68–71} higher social normative beliefs and peer use were associated with hookah use, along with household use, sensation seeking, impulsivity, and delinquent behaviors. Also consistent with previous research on other tobacco products,^{72,73} across the included studies, lower perceptions about the harm related to hookah and tobacco in general were associated with higher odds of hookah use. Measures of harm perceptions varied across studies, including absolute and relative harm as well as the harm of tobacco products in general.

Longitudinal studies of youth hookah use showed bidirectional relationships between use of hookah and other tobacco products. Some longitudinal studies suggest hookah use may act as intermediary step to poly-tobacco use or conventional cigarette use. Among youth who used hookah, dual use and poly-tobacco use—including use of conventional cigarettes and more novel products—was common. In addition, concurrent use of alcohol and marijuana was found to be high for youth who used hookah.

Our review identified several notable research gaps related to hookah use in US youth. Only two studies reported on youth

exposure or engagement with tobacco marketing (consistent with the FDA priority, “marketing influences”), documenting that exposure to tobacco advertisements generally was associated with hookah use. However, any exposure to hookah-related marketing or advertising and its effect on youth susceptibility to use hookah are currently unknown. Only two studies, with samples from California and Chicago, investigated youth access to hookah, documenting hookah lounges or using hookah at a friend’s house as common points of access for youth. More research is needed in other geographic areas or with nationally representative estimates to better understand how youth access hookah. One study fell within the research priority of “addiction” and documented that youth who were poly-tobacco users were more likely to report symptoms of nicotine dependence. However, characteristics specific to hookah and their effects on addiction and abuse liability in US youth remain unknown. The two studies that fell within the research priority of “communications” made recommendations on messaging to include in future hookah communications campaigns, based on focus group findings. However, to date, research has not explored either health message development or message testing related to hookah in a youth population in the United States.

Three FDA research priorities (ie, “impact analysis,” “health effects,” and “toxicity”) have not been explored for hookah use among US youth since the Family Smoking Prevention and Tobacco Control Act was passed in 2009. No studies focused on implementing regulations on hookah, which is the stated priority of the FDA (ie, “impact analysis”). According to the Tobacco Control Legal Consortium, some states and cities have implemented policies related to youth and hookah, such as restricting youth access, restrictions on free samples, and flavor restrictions;⁷⁴ however, no studies have documented the effects of such regulations, and as such, little is known about the potential successes of these policies. Future research could use statewide data on hookah policies to provide an impact analysis per state. In addition, the degree or amount of exposure to hookah secondhand smoke among youth in the United States remains unknown as well as the potential “health effects” of hookah use—another research priority stated by the FDA—including cardiovascular and respiratory effects in US youth. Studies of “toxicity” of hookah, such as those addressing potential design characteristics that impact constituent exposure or studies on biomarkers to assess exposure, have not been conducted among US youth.

The majority of included studies fell within the global rating category of “weak.” We concluded that the quality of the literature on hookah use would be strengthened in future studies by ensuring selection bias is minimized with probability-based sampling techniques; using more rigorous study designs such as cohort studies; controlling for all or almost all relevant confounders (including correlates such as socioeconomic status, impulsivity, and sensation seeking, which were not regularly included as control variables); ensuring that measurement tools used are reliable and valid; and ensuring a high follow-up rate in prospective cohort studies. However, we should note that as hookah is a recently emerging tobacco product in the United States, reliable and valid measures were not always available.

One potential limitation of this systematic review is that we did not include unpublished data or manuscripts. This may have resulted in publication bias, that is, studies with null findings may not have been published, and therefore not included. However, including unpublished studies can also introduce bias, especially if they are of lower methodological quality.⁷⁵ As such, we determined the inclusion of unpublished studies would not necessarily enhance the quality of the review.

Conclusion

We identified 55 articles between 2009 and 2017 that addressed hookah use in US youth. The majority were cross-sectional studies reporting hookah prevalence, sociodemographic correlates, and prevalence of concomitant tobacco use at one point in time. A few prospective cohort studies provide evidence for bidirectional associations between hookah use and other tobacco product use. Given the increasing prevalence of hookah use in the United States among youth, more research, especially in FDA research priority areas that remain unaddressed, is warranted.

Supplementary Material

Supplementary data are available at *Nicotine & Tobacco Research* online.

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Declaration of Interests

None declared.

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