



Published in final edited form as:

N C Med J. 2017 ; 78(3): 149–155. doi:10.18043/ncm.78.3.149.

Trends and Correlates of Hookah Use among High School Students in North Carolina

Li-Ling Huang, PhD^a, Erin L Sutfin, PhD^b, Sarah Kowitt, MPH^c, Tanha Patel, MPH^d, Leah Ranney, PhD^{a,e}, and Adam O Goldstein, MPH, MD^{a,e}

^aCenter for Regulatory Research on Tobacco Communication, Lineberger Comprehensive Cancer Center, University of North Carolina, Chapel Hill, North Carolina

^bDepartment of Social Sciences and Health Policy, Wake Forest School of Medicine, Winston-Salem, North Carolina

^cGillings School of Global Public Health, University of North Carolina, Chapel Hill, North Carolina

^dTobacco Prevention and Control Branch, North Carolina Department of Health and Human Services, Raleigh, North Carolina

^eTobacco Prevention and Evaluation Program, Department of Family Medicine, School of Medicine, University of North Carolina, Chapel Hill, North Carolina

Abstract

Objectives—Although youth cigarette smoking has declined in the United States, use of alternative tobacco products, such as hookah, has increased. This study aims to assess changes in prevalence from 2011 to 2013 and examine factors associated with current hookah use among North Carolina high school students in 2013.

Methods—Data came from the NC Youth Tobacco Survey (NCYTS) in 2011 (n=4,791) and 2013 (n=4,092). STATA logistic regression survey procedures account for the complex survey design and sampling weights.

Results—Prevalence of reported current hookah use significantly increased from 3.6% (95% CI: 2.8–4.5) in 2011 to 6.1% (95% CI: 4.9–7.5) in 2013 while reported lifetime hookah use increased from 9.8% (95% CI: 8.0–12.0) in 2011 to 12.6% (95% CI: 11.0–14.4) in 2013. Correlates of current hookah use included having a weekly disposable income over \$50 (adjusted odds ratio (AOR)=2.05, 95% CI:1.25–3.35), currently smoking cigarettes (AOR=4.57, 95% CI:1.80–11.62), and living with hookah users (AOR=6.45, 95% CI:3.21–12.93). Self-reported positively commenting about or “Liking” tobacco in social media (AOR=1.83, 95% CI:1.84–4.52) and frequent exposure to online tobacco advertisements (AOR=1.61, 95% CI:1.13–2.28) were also associated with current hookah use.

Conclusions—Comprehensive product-specific communication and policy interventions are needed to educate youth about the dangers of hookah use and reduce social acceptability among youth. To decrease hookah use in NC, policymakers should consider restoring funding for

comprehensive tobacco prevention and control programs and equalizing tobacco tax rates for all tobacco product types.

INTRODUCTION

Hookah (also known as water pipe, nargileh, and shisha) smoking has become a global epidemic, spreading from its origins in the Middle East to most parts of the world. Hookah smoking has gained popularity in western countries including the U.S., United Kingdom and Canada.[1–3] According to the most recent Global Youth Tobacco Survey, hookah use has already replaced cigarettes as the most common form of tobacco products used by adolescents aged 13–15 years in 17 Eastern Mediterranean countries with a prevalence of hookah smoking ranging from 9% to 15%. [3] Hookah use is widespread and rising among U.S. adolescents and young adults, despite declines in youth cigarette use over time.[4, 5] The Centers for Disease Control and Prevention (CDC) suggests that this decline in cigarette smoking may be offset by the rapidly increasing use of other forms of smoked tobacco,[6] including hookah. The prevalence of past 30-day (current) hookah use among U.S. high school students significantly increased from 4.1% in 2011 to 7.2% in 2015.[7–9] Evidence suggests that health risks associated with hookah use are similar to those with cigarette smoking, including nicotine addiction, lung cancer, respiratory illness, low birth-weight and periodontal disease.[10] Hookah users may smoke over a longer period of time compared to cigarette users and absorb higher concentrations of the same toxins found in cigarette smoke due to the method of smoking.[11]

Representative data from many countries indicate that hookah use is more prevalent among those who are younger, male, have a high socioeconomic status, live in an urban area, and occasionally and socially use tobacco.[3] Factors that drive this hookah phenomenon include the introduction of flavored hookah tobacco (i.e., Maassel), reduced risk misperceptions, popular lounge or café culture, growing social appeal, the rise of internet and social media, and the lack of regulation.[2, 3, 12–14] The epicenter of the hookah use epidemic includes young adults, with peak use among 19–21 year olds.[3, 7, 15] The majority of hookah research has been conducted on college populations and shows hookah use is associated with being younger,[15, 16] male,[15–17] White,[15] cigarette use,[16–19] other drug use, [16, 19] and having a belief that hookah smoking is less harmful than cigarette smoking.[17, 19, 20] Research on adolescent hookah use indicates that factors associated with use include being male, current cigarette use, reduced perception of harm, and higher perceived social acceptability.[21–28]

The Internet has been widely exploited to sell tobacco products. Tobacco sale websites serve as a direct form of tobacco promotion and advertising where users or potential buyers can post comments on tobacco products.[29, 30] Hookah retail and lounge websites purposely target young people with their marketing messages and promote social aspects of hookah smoking by inviting young people to post hookah smoking images and blog about hookah with peers on social media such as Facebook.[31] Emerging evidence shows that exposure to marketing of the unhealthy products through social media platforms may impact adolescent health behaviors.[32] Given that 92% U.S. adolescents report going online daily, with 71% using Facebook,[33] the current study expands on previously identified correlates by

examining social media engagement and exposure to online tobacco advertising and their associations with hookah use in a representative sample of high school students in North Carolina. We also examined associations between hookah use and youth exposure to anti-tobacco messages, along with school and community tobacco prevention activities. Identification of these correlates of hookah use among adolescents may help to identify risk factors and facilitate the development of evidence-based campaigns and interventions to prevent and decrease hookah use. Given the social nature of hookah use and online advertising of growing hookah venue businesses, we hypothesize that social influence from family, friends, and others and exposure to and engagement with pro-tobacco messages on the Internet and social media will be associated with increased odds of current hookah use among youth.

METHODS

The data were from the 2011 and 2013 North Carolina Youth Tobacco Survey (NCYTS), a voluntary, anonymous school-based survey of middle and high school students that has been administered biannually since 1999. The NCYTS survey uses a 2-stage cluster probability sampling design to produce a representative sample of students in grades 6–12. The first-stage sampling frame for this study consisted of all public high schools (grades 9–12). Schools were selected with probability proportional to school enrollment size. Within each selected school, systematic equal probability sampling was used to randomly select classes and students in the selected classes were invited to participate in the survey. Passive parental consent forms were utilized, unless an active consent form was required according to a specific school district policy. The NCYTS is a CDC funded and approved survey conducted to evaluate state tobacco control efforts. This study was reviewed by the Office of Human Research Ethics at the University of North Carolina, Chapel Hill, which has determined that this study did not constitute human subjects research as defined under federal regulations and did not require an institutional review board approval.

Measures

Hookah and cigarette use—Two dichotomous variables assessed students' self-reported hookah use. Ever use was measured by one item: "Which of the following tobacco products have you ever tried, even just one time?" Current use was measured by one item: "In the past 30 days, which of the following tobacco products have you used on at least one day?" We created three variables: current use (use in the past month), ever use (use more than a month ago) and lifetime use (includes current and ever).

Current cigarette smoking was defined as any cigarette use in the past 30-day. One dichotomous variable was created from three items to measure susceptibility to cigarette smoking:[34] "Do you think you will smoke a cigarette in the next year?" ('definitely yes', 'probably yes', 'probably not', 'definitely not'), "Do you think that you will try a cigarette soon?" ('I have already tried smoking cigarettes', 'yes', 'no'), and "If one of your best friends were to offer you a cigarette, would you smoke it?" ('definitely yes', 'probably yes', 'probably not', 'definitely not'). Students were classified as not susceptible if they answered 'definitely not' or 'no' to all three items, otherwise as susceptible.

Sociodemographics—Students were asked to indicate their sex (male, female), grade (9th–12th), race/ethnicity (White, Black, Hispanic, and Other), and how much money they have each week to spend any way they want (< \$10, \$11 to \$50, > \$50).

Tobacco use among family, friends and teachers—One question asked about cigarette use among close friends: “How many of your four closest friends smoke cigarettes?”(0, 1–2, 3–4). Students were also asked if anyone who lived with them currently used any tobacco products (from a list) and responses were classified into no one using any tobacco products, someone using hookah, and someone using other tobacco products. Another question asked students to indicate whether they had seen a teacher or anyone else who worked or volunteered at their school use any tobacco product at any time including during school hours, after-school but still on campus, while riding a bus, or at an after-school event (‘yes’, ‘no’).

Tobacco attitudes and beliefs—Students were asked “have you ever ‘Liked’ or commented positively about any tobacco product on a website such as Facebook, My Space, or Twitter?” (1=yes, 0=no or not using any social media). Two questions asked students how harmful they thought breathing smoke from other people’s cigarettes or other tobacco products was and to what extent they agreed that all tobacco products are dangerous on a 4-point Likert scale and responses were then dichotomized (harmful vs. not harmful; agree vs. disagree).

Exposure to Tobacco advertising—Students were asked how often they saw advertisements or promotions for tobacco products when using the Internet (0=do not use the Internet, never, or rarely, 1=sometimes, 2=most of the time or always), or when going to a convenience store, supermarket or gas station (0=never go to these places, never, or rarely, 1=sometimes, 2=most of the time or always).

Exposure to Anti-tobacco information and activities—One question assessed whether students saw or heard commercials on TV, the Internet, or on the radio about the dangers of cigarette smoking during the past month (‘yes’, ‘no’). Students were also asked to indicate whether they were taught in class about why not to use tobacco products and whether they participated in any school or community activities to prevent youth from using tobacco products (‘yes’, ‘no’).

Statistical analyses

NCYTS data were statistically weighted to reflect the likelihood of sampling each student and to reduce bias by compensating for differing patterns of nonresponse. Data were analyzed by using STATA version 13.1 survey procedures to account for the complex survey design and sampling weights unless stated otherwise. Chi-square tests were used to compare sample characteristics and examine descriptive statistics for each covariate of current hookah use in 2013. Bivariate and multivariable logistic regression analyses were conducted to examine the correlates of current hookah use in 2013. Only covariates that showed significant associations ($P<.05$) with use in the bivariate models were entered into multivariable models, including sex, grade, race/ethnicity, weekly disposable income,

smoking susceptibility, current cigarette use, closest friends who smoke cigarettes, family members who use tobacco products, seeing a teacher or anyone else who works/volunteers at school use any tobacco products, tobacco beliefs, positive commenting about tobacco products in social media, and seeing online ads for tobacco products.

RESULTS

4,791 students from 90 participating high schools in 2011 and 4,092 students from 83 participating high schools in 2013 completed the survey. The overall response rates were 78.2% in 2011 and 67.8% in 2013. Similar to the 2011 NCYTS, over half of high school students in 2013 were male and White, but a higher proportion of high school students in 2013 was Hispanic/Latino and non-Hispanic others (Table 1). The prevalence of current hookah use among North Carolina high school students in 2013 was 6.1% (95% CI: 4.9%–7.5%), nearly a 69% increase from 3.6% (95% CI: 2.8%–4.5%) in 2011 (unweighted mean difference: 2.2%, 95% CI: 1.4%–3.0%). Lifetime hookah use increased from 9.8% (95% CI: 8.0%–12.0%) in 2011 to 12.6% (95% CI: 11.0%–14.4%) in 2013 (unweighted mean difference: 3.1%, 95% CI: 1.9%–4.4%). Current cigarette use decreased from 15.1% (95% CI: 13.7%–16.7%) in 2011 to 13.1% (95% CI: 11.6%–14.7%) in 2013. It is worth noting that current hookah use among girls increased more than boys over the two years from 2.9% to 6.4% versus from 4.6% to 6.5%) although interaction between sex and year was not significant (unweighted OR=0.73, 95% CI: 0.48–1.12).

Current hookah use among high school students in 2013 differed according to socio-demographic characteristics, tobacco use and attitudes, and contextual factors associated with tobacco use (see Chi-square tests in Table 2). Bivariate and multivariate logistic regression results in Table 2 showed that White and Hispanic/Latino students had significantly higher odds of current hookah use than Black students in the bivariate model only. Having more than \$50 to spend each week increased odds for current hookah use (adjusted odds ratio (AOR) =2.05, 95% CI: 1.25–3.35). But sex was not associated with current hookah use.

Current cigarette smoking was a strong correlate of current hookah use. Those who smoked a cigarette in the past 30 days were about 5 times more likely to use hookah in the past 30 days than cigarette nonsmokers (AOR=4.57, 95% CI: 1.80–11.62). Students who were considered susceptible to cigarette smoking were also more likely to be a current hookah user (AOR=4.34, 95% CI: 2.07–9.10). Social influence from family and friends was significantly associated with current hookah use. For example, living with hookah users was strongly associated with current hookah use (AOR=6.45, 95% CI: 3.21–12.93). However, seeing school teachers or anyone else who worked or volunteered at school use any tobacco products at any time was associated with youth hookah use in bivariate models only (OR=1.83, 95% CI: 1.27–2.64).

With respect to tobacco-related attitudes and beliefs, higher odds of current hookah use (AOR=1.83, 95% CI: 1.20–2.80) were found among students who reported positively commenting on or “liking” tobacco products on social media. Having the belief that secondhand smoke is not harmful was associated with increased odds (AOR=2.89, 95% CI:

1.84–4.52) of current hookah use, while disagreeing that all tobacco products are dangerous was associated with increased odds of current hookah use in a bivariate model only (OR=2.83, 95% CI: 1.70–4.71).

Frequent exposure to tobacco advertisements on the Internet was associated with increased odds of using hookah in the past 30 days (AOR=1.61, 95% CI: 1.13–2.28). But seeing tobacco advertisements in stores, supermarkets, or gas stations, participation in antismoking classes or community activities, and exposure to any antismoking advertisements in the past 30 days were not significantly associated with current hookah use.

DISCUSSION

The prevalence of hookah use increased among North Carolina high school students from 2011 to 2013, even though youth cigarette smoking declined. Current hookah use increased 69% in just two years. The prevalence of current hookah use in North Carolina in 2013 was higher and rising at a greater rate than national data during 2011–2013 (NC: 3.6% to 6.1% vs. National: 4.1% to 5.2%).^[7, 9] Given that national current hookah use doubled from 2011 to 2014, the prevalence of hookah use may remain high without interventions.

This research is consistent with some demographic correlates of hookah use found in others studies among youth, such as being a senior in high school.^[7, 23–25, 27, 28] Unlike most previous studies,^[3, 21–25] sex was not found to be an independent correlate of hookah use in the 2013 NCYTS. This is likely because there was a greater increase in current hookah use among girls from 2011 to 2013 than among boys. Similar trends have occurred in Florida where the prevalence of hookah use among girls increased at a faster rate than boys from 2007 to 2012.^[23, 35] If this trend continues and spreads to other states, girls may soon have similar rates of hookah use nationally as do boys.^[9] Wealthier students appeared to have a higher rate of hookah use. Similar findings were found among adults globally^[3] and U.S. adolescents nationally.^[21, 25] The cost of frequenting commercial hookah establishments may explain this changing profile of tobacco users. Other underlying reasons for why wealthier adolescents tend to use hookah warrant further investigation.

Consistent with previous studies,^[22, 23, 25–28] current cigarette smoking and cigarette smoking susceptibility were strongly associated with hookah use. Longitudinal studies of representative samples are needed to tease out temporality of hookah and cigarette smoking and determine causal relationship between hookah and cigarette use.

Results from our study show that social influences from peers and family are significantly associated with adolescents' hookah use. Family hookah use was a particularly strong correlate of youth hookah use. However, the relationship of the hookah users in the household to the participants was unknown (i.e., father, mother, siblings, etc.), but should be included in future research. For instance, findings from Arab American adults show that fathers have the greatest impact on hookah use, followed by mothers and siblings.^[36] These family members might own a hookah for at-home use^[31] and hold social gatherings at home to smoke hookah.^[36] In order to reduce hookah prevalence, public health

interventions need to not only target adolescents but also their family members' risk perceptions, attitudes, and behaviors for hookah use.

The results from this study show that adolescents giving positive comments to tobacco products on social media and those frequently exposed to online tobacco advertisements were more likely to be current hookah users. Commercial hookah establishments may be important sources of exposure to hookah smoking information for young people and these establishments often use websites to promote hookah use and products.[22, 31] Pro-hookah messages on the Internet are often promoted and mobilized by interest groups such as hookah retailers and marketers.[13] Future research should investigate youth exposure to hookah marketing including promotion and advertising of hookah commercial establishments on websites and social media sites.

Current anti-tobacco messages and activities through counter-advertising, classroom and communities were not associated with reduced odds for hookah use. Although believing in the harmfulness of secondhand tobacco smoke was a significant protective factor for hookah use, such an association was not observed for believing that all tobacco products were dangerous. These findings suggest that product-specific interventions, such as health warnings on hookah products and commercial establishments including website and social media advertising as well as risk communication campaigns, are needed to educate the public including youth and parents about the dangers of hookah use. The Food and Drug Administration (FDA) extended its authority to regulate hookah as tobacco products on May 10, 2016 and will mandate a single warning on hookah packaging and advertisements, including websites, two years after the implementation of the law. We support FDA's regulatory action and urge state and local governments to implement bold, timely evidence-based tobacco policies to protect the public health in rapidly evolving tobacco marketplace given the limits on FDA authority and the slow pace of the federal regulatory process. Policymakers should consider restoring funding for North Carolina's comprehensive tobacco prevention and control programs and equalize tobacco tax rates for all tobacco product types including hookah as best practices to decrease hookah use among adolescents.

Some limitations of our study should be noted. First, our current hookah use measure was assessed as "at least one-day use in the past 30 day." This measure did not differentiate the frequency and intensity of hookah use. Future research should use standardized measures to capture meaningful gradients in hookah use pattern for population surveillance.[3] We used students' weekly spending money as a proximal measure to socio-economic status but it did not reflect the source of income (e.g., from a job or parents), so the source of income as well as parental education and household income should be included in future research. Our findings may not generalize to youth in other populations other than North Carolina high school students; however, our results are similar to global and national results for youth hookah use. Finally, NCYTS is cross-sectional, which limits our ability to make causal conclusions about the associations between correlates and hookah use, but many associations are consistent with known causal factors for cigarette use and provide an important direction for longitudinal research.

CONCLUSION

Results from this study showed that current hookah use among North Carolina adolescents significantly increased from 2011 to 2013. Contrary to typical cigarette smokers, adolescent hookah smokers tend to hold higher socioeconomic status. However, like cigarette smoking behaviors, perceived risks, social influence, and perceived social norms still play an important role in hookah use behaviors. New correlates of hookah use among adolescents, such as pro-tobacco engagement on social media and exposure to online tobacco advertising, also emerged. The U.S. Food and Drug Administration should develop risk communication campaigns aimed at adolescent hookah use[37] and conduct research to understand promotion and advertising of hookah through commercial establishment websites and social media sites, which target youth. Comprehensive product-specific communication and policy interventions are critical and require collective efforts among educators, health practitioners, researchers, and policy makers to thwart the youth hookah use by educating youth the dangers of hookah use and reducing social acceptability of hookah use.

Acknowledgments

This work was supported by the National Cancer Institute at the National Institutes of Health and Center for Tobacco Products at the Food and Drug Administration (P50CA180907); and the Centers for Disease Control and Prevention (DP 14-1415). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health, the Food and Drug Administration, or the Centers for Disease Control and Prevention. The authors declare no conflicts of interest.

References

1. Akl EA, Gunukula SK, Aleem S, et al. The prevalence of waterpipe tobacco smoking among the general and specific populations: a systematic review. *BMC public health*. 2011; 11:244. [PubMed: 21504559]
2. Martinasek MP, McDermott RJ, Martini L. Waterpipe (Hookah) Tobacco Smoking Among Youth. *Curr Prob Pediatr Ad*. 2011; 41(2):34–57.
3. Maziak W, Taleb ZB, Bahelah R, et al. The global epidemiology of waterpipe smoking. *Tobacco control*. 2015; 24(Suppl 1):i3–i12. [PubMed: 25298368]
4. US Department of Health and Human Services U. Preventing tobacco use among youth and young adults, 2012: a report of the Surgeon General. 2012.
5. Arrazola RA, Kuiper NM, Dube SR. Patterns of current use of tobacco products among U.S. high school students for 2000–2012—findings from the National Youth Tobacco Survey. *Journal of adolescent health*. 2014; 54(1):54–60.e59. [PubMed: 24074604]
6. Centers for Disease Control and Prevention C. Drop in cigarette consumption offset by increases in other forms of smoked tobacco. 2012.
7. Arrazola RA, Dube SR, King BA. Tobacco Product Use Among Middle and High School Students – United States, 2011 and 2012. *MMWR Morb Mortal Wkly Rep*. 2013; 62(45):893–897. [PubMed: 24226625]
8. Arrazola RA, Singh T, Corey CG, et al. Tobacco use among middle and high school students – United States, 2011–2014. *MMWR Morb Mortal Wkly Rep*. 2015; 64(14):381–385. [PubMed: 25879896]
9. Singh T, Arrazola RA, Corey CG, Husten CG, Neff LJ, Homa DM, King BA. Tobacco Use Among Middle and High School Students—United States, 2011–2015. *MMWR Morb Mortal Wkly Rep*. 2016; 65(14):361–367. [PubMed: 27077789]
10. Akl EA, Gaddam S, Gunukula SK, Honeine R, Jaoude PA, Irani J. The effects of waterpipe tobacco smoking on health outcomes: a systematic review. *Int J Epidemiol*. 2010; 39(3):834–57. [PubMed: 20207606]

11. World Health Organization. Waterpipe tobacco smoking: health effects, research needs and recommended actions by regulators. Geneva, Switzerland: World Health Organization; 2015. Retrieved from http://www.who.int/tobacco/global_interaction/tobreg/Waterpipe%20recommendation_Final.pdf
12. Primack BA, Hopkins M, Hallett C, et al. US health policy related to hookah tobacco smoking. *Am J Public Health*. 2012; 102(9):e47–51. [PubMed: 22827447]
13. Primack BA, Rice KR, Shensa A, et al. U.S. Hookah Tobacco Smoking Establishments Advertised on the Internet. *Am J Prev Med*. 2012; 42(2):150–156. [PubMed: 22261211]
14. Akl EA, Jawad M, Lam WY, Co CN, Obeid R, Irani J. Motives, beliefs and attitudes towards waterpipe tobacco smoking: a systematic review. *Harm reduction journal*. 2013; 10:12. [PubMed: 23816366]
15. Primack BA, Shensa A, Kim KH, et al. Waterpipe smoking among U.S. university students. *Nicotine & tobacco research*. 2013; 15(1):29–35. [PubMed: 22641433]
16. Sutfin EL, McCoy TP, Reboussin BA, Wagoner KG, Spangler J, Wolfson M. Prevalence and correlates of waterpipe tobacco smoking by college students in North Carolina. *Drug and alcohol dependence*. 2011; 115(1–2):131–136. [PubMed: 21353750]
17. Grekin ER, Ayna D. Waterpipe smoking among college students in the United States: a review of the literature. *Journal of American college health*. 2012; 60(3):244–249. [PubMed: 22420702]
18. Doran N, Godfrey KM, Myers MG. Hookah Use Predicts Cigarette Smoking Progression Among College Smokers. *Nicotine & tobacco research*. 2015
19. Heinz AJ, Giedgowd GE, Crane NA, et al. A comprehensive examination of hookah smoking in college students: use patterns and contexts, social norms and attitudes, harm perception, psychological correlates and co-occurring substance use. *Addictive behaviors*. 2013; 38(11):2751–2760. [PubMed: 23934006]
20. Goodwin RD, Grinberg A, Shapiro J, et al. Hookah use among college students: prevalence, drug use, and mental health. *Drug and alcohol dependence*. 2014; 141:16–20. [PubMed: 24882367]
21. Palamar JJ, Zhou S, Sherman S, Weitzman M. Hookah use among U.S. high school seniors. *Pediatrics*. 2014; 134(2):227–234. [PubMed: 25002664]
22. Sterling KL, Mermelstein R. Examining hookah smoking among a cohort of adolescent ever smokers. *Nicotine & tobacco research*. 2011; 13(12):1202–1209. [PubMed: 21896886]
23. Barnett TE, Curbow BA, Weitz JR, Johnson TM, Smith-Simone SY. Water Pipe Tobacco Smoking Among Middle and High School Students. *Am J Public Health*. 2009; 99(11):2014–2019. [PubMed: 19762667]
24. Primack BA, Walsh M, Bryce C, Eissenberg T. Water-Pipe Tobacco Smoking Among Middle and High School Students in Arizona. *Pediatrics*. 2009; 123(2):E282–E288. [PubMed: 19171581]
25. Amrock SM, Gordon T, Zelikoff JT, Weitzman M. Hookah use among adolescents in the United States: results of a national survey. *Nicotine & tobacco research*. 2014; 16(2):231–237. [PubMed: 24154512]
26. Jordan HM, Delnevo CD. Emerging tobacco products: hookah use among New Jersey youth. *Prev Med*. 2010; 51(5):394–396. [PubMed: 20817023]
27. Smith JR, Novotny TE, Edland SD, Hofstetter CR, Lindsay SP, Al-Delaimy WK. Determinants of Hookah Use among High School Students. *Nicotine & Tobacco Research*. 2011; 13(7):565–572. [PubMed: 21454909]
28. Manderski MTB, Hrywna M, Delnevo CD. Hookah Use Among New Jersey Youth: Associations and Changes Over Time. *American journal of health behavior*. 2012; 36(5):693–699. [PubMed: 22584096]
29. Ribisl KM, Kim AE, Williams RS. Web sites selling cigarettes: how many are there in the USA and what are their sales practices? *Tobacco control*. 2001; 10(4):352–359. [PubMed: 11740027]
30. Freeman B. New media and tobacco control. *Tobacco control*. 2012; 21(2):139–144. [PubMed: 22345236]
31. Griffiths MA, Harmon TR, Gilly MC. Hubble Bubble Trouble: The Need for Education About and Regulation of Hookah Smoking. *J Public Policy Mark*. 2011; 30(1):119–132.

32. Dunlop S, Freeman B, Jones SC. Marketing to Youth in the Digital Age: The Promotion of Unhealthy Products and Health Promoting Behaviours on Social Media. *Media and Communication*. 2016; 4(3):1–14. 2016.
33. Lenhart, A., Duggan, M., Perrin, A., Stepler, R., Rainie, H., Parker, K. Teens, social media & technology overview 2015. 2015. Retrieved from http://www.pewinternet.org/files/2015/04/PI_TeensandTech_Update2015_0409151.pdf
34. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Merritt RK. Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. *Health Psychol*. 1996; 15(5):355–361. [PubMed: 8891714]
35. Barnett TE, Forrest JR, Porter L, Curbow BA. A multiyear assessment of hookah use prevalence among Florida high school students. *Nicotine & tobacco research*. 2014; 16(3):373–377. [PubMed: 24346322]
36. Jamil H, Janisse J, Elsouhag D, Fakhouri M, Arnetz JE, Arnetz BB. Do household smoking behaviors constitute a risk factor for hookah use? *Nicotine & tobacco research*. 2011; 13(5):384–388. [PubMed: 21330269]
37. Food and Drug Administration. The Real Cost Campaign. 2015. Retrieved from <http://www.fda.gov/TobaccoProducts/PublicHealthEducation/PublicEducationCampaigns/TheRealCostCampaign/default.htm>

Table 1
 Sample characteristics of high school students in the 2011 and 2013 NCYTS by current and lifetime use of hookah

Sample Characteristics	2011 (n=4,791)				2013 (n=4,092)					
	All	Hookah Use (%; 95% CI)		All	Hookah Use (%; 95% CI)		All	Hookah Use (%; 95% CI)		
		Current	Lifetime		Current	Lifetime		Current	Lifetime	
Sex										
Female	49.3%	2.9%	(2.2–4.0)	8.5%	(6.6–11.0)	48.9%	6.4%	(4.7–8.8)	11.9%	(10.0–14.0)
Male	50.7%	4.6%	(3.4–6.3)	11.0%	(8.9–13.5)	51.1%	6.5%	(5.2–8.2)	13.3%	(11.3–15.6)
Grade										
9th	29.9%	2.0%	(1.4–2.9)	4.4%	(3.2–6.1)	28.8%	4.2%	(3.1–5.7)	7.0%	(5.5–9.0)
10th	26.0%	3.2%	(2.2–4.5)	7.3%	(5.5–9.7)	25.9%	6.1%	(3.3–11.3)	10.2%	(7.7–13.5)
11th	23.3%	4.4%	(3.2–6.1)	12.1%	(9.2–15.8)	23.4%	6.8%	(4.8–9.5)	15.3%	(10.0–14.0)
12th	20.8%	6.8%	(4.3–10.7)	18.1%	(14.4–22.4)	21.9%	10.0%	(7.0–14.1)	19.9%	(11.3–15.6)
Race/Ethnicity										
Non-Hispanic White	55.9%	5.1%	(4.0–6.4)	13.0%	(10.9–15.5)	54.0%	7.7%	(5.9–9.9)	14.7%	(12.3–17.5)
Non-Hispanic Black	32.2%	1.3%	(0.7–2.3)	4.1%	(2.7–6.1)	27.3%	4.1%	(2.9–5.8)	8.6%	(6.9–10.7)
Hispanic/Latino	8.0%	5.2%	(3.0–8.8)	9.7%	(6.6–14.1)	11.2%	7.5%	(5.6–9.9)	13.4%	(11.1–16.0)
Non-Hispanic other	3.9%	4.4%	(2.2–8.8)	10.9%	(6.1–18.6)	7.5%	5.3%	(2.5–10.9)	10.8%	(7.9–14.6)

Abbreviations: CI – confidence interval; NCYTS – North Carolina Youth Tobacco Survey

Table 2
Factors associated with current hookah use among North Carolina high school students in 2013

Correlates	Current hookah user vs. never user (n=219 vs. 3590)			
	%	OR	95% CI	AOR 95% CI
Sex				
Female	6%	ref		ref
Male	7%	1.02	(0.71–1.45)	0.80 (0.53–1.22)
Grade^a				
9th	4%	ref		ref
10th	6%	1.50	(0.66–3.41)	1.17 (0.48–2.85)
11th	7%	1.67	(0.99–2.83)	1.14 (0.57–2.25)
12th	10%	2.55	(1.46–4.46)**	1.95 (0.98–3.86)
Race/Ethnicity^a				
Non-Hispanic Black	4%	ref		ref
Non-Hispanic other	5%	1.30	(0.51–3.33)	0.88 (0.24–3.18)
Hispanic/Latino	7%	1.89	(1.21–2.95)**	1.69 (0.82–3.49)
Non-Hispanic White	8%	1.94	(1.37–2.76)***	1.32 (0.79–2.21)
Weekly disposable income^a				
\$10	4%	ref		ref
\$11 to \$50	6%	1.45	(0.97–2.18)	1.56 (0.95–2.54)
> \$50	10%	2.59	(1.84–3.66)***	2.05 (1.25–3.35)**
Smoking susceptibility^a				
No	1%	ref		ref
Yes	13%	12.54	(6.32–24.90)***	4.34 (2.07–9.10)***
Current cigarette use^a				
No	3%	ref		ref
In the past 30 days	32%	14.02	(6.71–29.31)***	4.57 (1.80–11.62)***

Correlates	Current hookah user vs. never user (n=219 vs. 3590)			
	%	OR	95% CI	AOR 95% CI
Closest friends who smoke cigarettes ^a				
0	3%	ref		ref
1 to 2	9%	3.92	(2.43–6.30) ^{***}	1.44 (0.89–2.34)
3 to 4	26%	13.77	(8.54–22.22) ^{***}	2.70 (1.72–4.25) ^{***}
Family members who use tobacco products ^a				
None	7%	ref		ref
Other tobacco products	7%	1.69	(1.33–2.16) ^{***}	0.80 0.60–1.06
Hookah	48%	20.86	(12.74–34.16) ^{***}	6.45 (3.21–12.93) ^{***}
Seeing a teacher or anyone else who works/volunteers at school use any tobacco products ^a				
No	6%	ref		ref
Yes	10%	1.83	(1.27–2.64) ^{**}	0.69 (0.36–1.31)
All tobacco products are dangerous ^a				
Agree	5%	ref		ref
Disagree	14%	2.83	(1.70–4.71) ^{***}	1.29 (0.69–2.42)
Breathing smoke from other people's cigarettes or other tobacco products is ^a				
Harmful	5%	ref		ref
Not harmful	19%	4.48	(3.23–6.20) ^{***}	2.89 (1.84–4.52) ^{***}
Like/commenting positively about tobacco products in social media ^a				
No	5%	ref		ref
Yes	17%	3.84	(2.88–5.12) ^{***}	1.83 (1.20–2.80) ^{**}
Seeing tobacco product ads in the Internet ^a				
I do not use the Internet/Never/Rarely	7%	ref		ref
Sometimes	5%	0.67	(0.47–0.96) [*]	0.92 (0.56–1.51)
Most of time/Always	10%	1.59	(1.13–2.23) ^{**}	1.61 (1.13–2.28) ^{**}
Seeing tobacco product ads in a store/gas station				

Correlates	Current hookah user vs. never user (n=219 vs. 3590)			
	%	OR	95% CI	AOR 95% CI
I do not go to a store/Rarely	6%	ref		
Sometimes	6%	0.96	(0.59–1.58)	– –
Most of time/Always	7%	1.13	(0.69–1.86)	– –
Taught in any classes about why you should not use tobacco products				
Yes	7%	ref		
No	6%	0.87	(0.55–1.39)	– –
Participating in school or community activities to discourage tobacco use among youth				
Yes	8%	ref		
No	6%	0.73	(0.43–1.25)	– –
Have seen or heard any ads about dangers of smoking in the past 30 days				
Yes	6%	ref		
No	7%	1.05	(0.75–1.47)	– –

Note. Asterisks denote significance levels for logistic regression:

* $P < .05$,

** $P < .01$,

*** $P < .001$.

Superscript letter a denotes significance levels for Chi-square tests at $P < .05$.

Final logistic regression models adjust for sex, grade, race/ethnicity, weekly disposable income, smoking susceptibility, current cigarette use, closest friends who smoke cigarettes, family members who use tobacco products, seeing a teacher or anyone else who works/volunteers at school use any tobacco products, tobacco beliefs (“All tobacco products are dangerous”, “Breathing smoke from other people’s cigarettes or other tobacco products is harmful”), like/commenting positively about tobacco products in social media, and seeing tobacco product ads in the Internet.

Abbreviations: OR – odds ratio; AOR – adjusted odds ratio; CI – confidence interval; ref, reference