HHS Public Access

Author manuscript

Addict Behav. Author manuscript; available in PMC 2018 May 01.

Published in final edited form as:

Addict Behav. 2017 May ; 68: 1–5. doi:10.1016/j.addbeh.2016.12.012.

Hookah tobacco smoking in a large urban sample of adult cigarette smokers: Links with alcohol and poly-tobacco use

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Abstract

Hookah tobacco smoking (HTS) has been increasing, particularly among young adults and has similar health effects compared to cigarette smoking. The link between HTS and poly-tobacco use is well documented, but fewer show an association between HTS and alcohol use. It is essential to identify factors that increase the risk for or addictiveness and consequences of HTS, given its growing prevalence. This study examined whether the association between HTS and poly-tobacco use differed as a function of age and alcohol consumption within in a sample of 1,223 adult cigarette smokers. Approximately 20% of participants reported HTS. Compared to non-users, hookah users were more likely to be male, highly educated, and to report drug and alcohol use, binge drinking, and poly-tobacco use but were less likely to be heavy smokers (>10 cigarettes per day). Regression analyses predicting number of tobacco products used (excluding cigarettes and HTS) indicated a three-way interaction of HTS, frequency of alcohol use, and age such that the association between HTS and number of tobacco products used was strongest for younger respondents who consumed alcohol more frequently. As observed in previous studies, alcohol is an important risk factor in the relationship between HTS and poly-tobacco use, particularly among younger cigarette smokers. The links between alcohol, HTS, and poly-tobacco use should be considered when developing HTS education and prevention materials directed toward younger

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Contributors

Amy Cohn and Sarah Ehlke designed the study and wrote the protocol, and conducted analyses. Amy Cohn, Sarah Ehlke, Eric Soule, and Caroline Cobb conducted literature searches, provided summaries of previous research studies, and assisted with conceptualization and writing of the current study findings. Author Cohn wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript

Conflict of Interest

Authors have no conflicts of interest to disclose.

cigarette smokers. Findings provide information relevant to FDA's interest in the addiction potential of HTS and its link to poly-tobacco use.

Keywords

hookah; shisha; alcohol; poly-tobacco use; young adults; binge drinking

Hookah tobacco smoking has been on the rise among men and women over the age of 18 over the last five years,[1–3] and has become particularly popular among young adults.[4] The increasing prevalence of HTS is concerning. HTS places users at risk for many of the same cancer-causing diseases as cigarette smokers, such as lung cancer and pulmonary and chronic obstructive pulmonary disorder[5–11] and may be a catalyst to nicotine dependence, progression to regular tobacco and other health-risk behaviors correlated with increased cancer risk, including alcohol and marijuana use.[12–22] HTS is associated with unique acute health effects such as carbon monoxide poisoning,[23–26] and the spread of communicable diseases like herpes and tuberculosis.[27] Failure to respond to the increasing HTS trend could contribute to morbidity and mortality in the U.S.

HTS has been consistently linked to the use of other tobacco products, including poly-tobacco use (≥ 2 tobacco products). For instance, cigarette smoking is commonly reported among hookah users.[21,28–30] Among individuals 18 years and older, non-daily and daily smokers show a higher prevalence of lifetime HTS compared to the use of any other type of alternative tobacco product.[31] A number of studies also document an association between alcohol use and HTS[16,22,32,33] and between alcohol use and poly-tobacco use.[34–36] The association between HTS and alcohol is concerning for several reasons: alcohol use has been shown to increase the likelihood of HTS initiation above and beyond other tobacco-related risk factors [18,37–40] and has been implicated in the use of a variety of other new and alternative tobacco products.[22,34] Alcohol use is also robustly correlated with more severe nicotine dependence,[41,42] lower desire to quit smoking,[43] and poor tobacco cessation outcomes.[44–46] Existing studies have found that many hookah users drink alcohol while engaging in HTS[39,47] and concurrent alcohol use and HTS may enhance the subjective effects of HTS.[39] However, not all studies have reported an association between HTS and alcohol use,[48,49] suggesting further research is needed to tease apart "for whom" and "under what circumstances" alcohol is linked to HTS behavior. Understanding links between HTS and alcohol use is also important, given that the short- and long-term effects of new and alternative tobacco products, like HTS. are not well understood.

The majority of studies to date on HTS have focused on youth and young adult users, particularly college students,[21,33,50,51] but not the full spectrum of tobacco users who may also be engaging in HTS. As a result, little is known about the HTS risk profiles in older age groups. While hookah use, and to some extent poly-tobacco use,[34] are concentrated among youth and young adults, alcohol is robustly associated with tobacco use across the age spectrum.[41,45,52,53] Taken together, these studies argue for inclusion of alcohol use as an important risk factor linking HTS to poly-tobacco use, but suggest there may also be different important age differences. This study examined the moderating effects of both age

and alcohol use on the association between HTS and poly-tobacco use in a large sample of adult cigarette smokers.

Method

Participants and Procedure

This is a secondary analysis of data that were combined from the screening measures of two NIH-funded studies (data collected from January 2014 to December 2015). The first study was a naturalistic assessment of the longitudinal smoking change outcomes of risky drinking adult smokers. The second was an administrative supplement to this project, designed to examine motivations for alcohol use and cigarette smoking in adult smokers with and without a history of risky drinking. Both studies included the same battery of questionnaires at baseline (described below). Eligibility for both studies was nearly identical and included: 1) 18–65 years old; 2) smoke > 10 cigarettes per day; and 3) desire to quit smoking in the next 6-months. Exclusion criteria were 1) suicidal, homicidal, or severe psychiatric disturbance; 2) substance dependence (excluding nicotine and caffeine); 3) current use of psychotropic medication; and 4) potential for severe alcohol withdrawal. Additionally, individuals eligible for the parent grant drank at risky levels [< 2 drinks a day for men; >1 for women and > 14 drinks per week for men; 7 for women, according to the guidelines of the National Institute on Alcoholism and Alcohol Abuse] and were excluded if they were pregnant or planning to become pregnant in the next 6 months. For the administrative supplement, a sampling method was employed to recruit 50% risky drinkers and 50% non-risky drinkers (consume at least 1 drink/week in the last 30 days but less than risky drinking levels). Participants included in the current analysis completed the screening for these studies but did not have to meet eligibility criteria, therefore not all participants who took the screening measure were risky drinkers. Participants in the parent grant were eligible to receive up to $178 for their participation over 6 months, and participants in the administrative supplement were eligible to receive up to $50 for completing two experimental sessions.

Participants were recruited from a large Northeastern US city via web or print advertisements, or through word-of-mouth. Advertisements asked for “smokers who are regular drinkers”. Participants were directed to complete an initial online screening survey or call a telephone number to determine eligibility; final eligibility was determined over the phone by a trained research assistant. A total of 1,405 individuals completed the screening questionnaires; 171 had missing other tobacco use data and 11 indicated smoking 0 cigarettes, so they were excluded from analyses. A final sample size of 1,223 adult (18+) cigarette smokers were included. [a]

[a]It is possible that some participants may have completed the screening questionnaire for both studies. We were unable to detect duplicates.

Measures

Participants provided demographic information on age, race (White, African American, other), gender, education (<high school, high school graduate or GED, some college education or higher), and employment status (employed, unemployed, other).

Data were collected on number of drinks consumed per drinking episode (quantity) and number of days in a typical week alcohol was consumed (frequency). A binge drinking variable (yes/no) was computed from quantity/frequency measurements based on established measures (4+ drinks for women/5+ drinks for men).[54,55] Participants were also queried "Have you used any drugs in the past 90 days?" (yes/no).

Use of other tobacco products, exclusive of cigarettes, was assessed by asking participants "Do you use any other tobacco products other than cigarettes?" with response options for e-cigarettes, cigars, little cigar/cigarillos, hookah, chew, and "other." A variable capturing the total number of tobacco products was created by summing the number of 'yes' responses for each product (excluding hookah). For the parent grant, participants were asked if they smoked > 10 cigarettes per day (yes/no). However, for the administrative supplement study participants were asked how many cigarettes they smoke per day. Thus, to be consistent and examine cigarette smoking across both studies, participants were categorized into light smokers (≤10 cigarettes per day) versus heavy smokers (>10 cigarettes per day), consistent with the literature.[56]

Analyses

The prevalence and distributions of study variables were examined across hookah users and non-users. Following recommendations of Aiken and West,[57] the moderating effects of age and alcohol use (separately for quantity, frequency, and binge drinking) on the association between HTS and number of non-cigarette tobacco products used were then examined. Continuous variables (alcohol quantity, alcohol frequency, and age) were z-transformed to reduce multi-collinearity and to account for scale invariance.[57] Using HTS (0 = no) as the independent variable, and alcohol use (quantity, frequency, or binge drinking) and age as the moderators, regression equations were computed with relevant covariates entered in the first step, main effects in the second step, two-way interactions in the third step, and the three-way interaction (HTS x alcohol use x age) in the final step. For equations with significant interactions, regression coefficients for simple effects (one standard deviation above and below the mean of each moderator; e.g., low vs. high frequency drinking) were examined to determine whether they were significantly different than zero.[57] Unstandardized betas are reported. Analyses were conducted using SPSS 22 [58].

Results

Differences between smokers reporting HTS and no HTS

Bivariate differences between adult smokers who were hookah users and non-users are shown in Table 1. Nearly 20% reported HTS. Those who reported HTS were predominantly male [$\chi^2(1) = 4.50$], highly educated [$\chi^2(3) = 25.52$], younger [$F(1, 1220) = 185.03$], used a greater number of other tobacco products (excluding cigarettes and hookah) [$F(1, 1221) =$

644.38], and were more likely to binge drink [$\chi^2(1) = 5.10$] and use drugs [$\chi^2(1) = 39.05$] (all p's < .05). Compared to non-users, smokers reporting HTS were less likely to smoke heavily [$\chi^2(1) = 22.00$] and to be African American [$\chi^2(2) = 7.72$] (all p's < .05). HTS was unrelated to alcohol quantity and frequency at the bivariate level.

Moderating effects of alcohol use and age on the association between HTS and number of other tobacco products

There was a significant HTS x alcohol use frequency x age interaction [$F(12, 1181) = 61.17$, $p < 0.001$, $R^2 = 0.38$], after controlling for gender, race, heavy smoking, education, and drug use. Explication of the simple slopes revealed a positive association between HTS and other tobacco use, although the strength of the association between HTS and number of tobacco products used was strongest for those who were younger and who drank alcohol more frequently ($b = 1.78$, $p < 0.001$; see Figure 1). The weakest association between HTS and poly-tobacco use was found among older respondents who drank more frequently ($b = 0.94$, $p < 0.001$). That is, HTS was also positively associated with other tobacco use among older respondents who consumed alcohol more often, but the slope was not as steep.

There were no significant three-way interactions when alcohol quantity or binge drinking were examined as moderators in the model. There was a significant alcohol quantity x HTS interaction [$F(8,1181) = 86.52$, $p < 0.001$, $R^2 = 0.37$], showing that the association between HTS and number of tobacco products used was stronger for those who drank greater quantities of alcohol ($b = 1.61$, $p < 0.001$), relative to those who drank less ($b = 1.32$, $p < 0.001$). No other two-way interactions or main effects emerged.

Discussion

Findings showed that HTS's association to dual and poly-tobacco use were strongest among younger respondents who drank more often and more frequently. This is the first study examining alcohol use frequency and age as moderators of the relationship between HTS and poly-tobacco use among adult hookah users, rather than looking at main effect relationships of alcohol use or HTS to poly-tobacco use separately, as has been done in all prior research.[49,59,60] Findings provide information relevant to the Food and Drug Administration's (FDA) effort to understand the abuse liability of HTS and associations with other tobacco product use. Such information has the potential to inform FDA regulations of HTS products, including enhanced warning labels of the potential harms associated with HTS or age restrictions on HTS purchases (among others).

Compared to non-users, hookah users were more likely to be male, highly educated, to report drug and alcohol use, including binge drinking, and to consume a greater number of non-cigarette tobacco products. At the bivariate level, drinking frequency and quantity were unrelated to HTS. This is not consistent with other research showing an association between alcohol use and HTS [22,33,61], although the majority of these studies utilized college student samples or focused exclusively on young adults. Respondents in our study spanned the age continuum (20% 18–24; 32% 25–34; 18% 35–45; 31% 46+). Hookah users in our study were also less likely to endorse heavy smoking. This observation may be attributed to the fact that HTS is perceived to be less harmful than cigarette smoking. [33,62] Therefore,

individuals may be more inclined to use hookah instead of cigarettes because they believe it is a less risky alternative. Additionally, there may have been a selection bias for those who completed the screening survey for this study because advertisements asked for regular drinkers.

Regression analyses showed that age and alcohol frequency significantly moderated the relationship between HTS and number of other tobacco products used, beyond the influence of several covariates. That is, dual users of cigarettes and hookah reported using a greater number of other tobacco products compared to cigarette smokers who did not use HTS, and this relationship was strongest among younger adults who reported drinking alcohol more often. Because alcohol has been shown to enhance the subjective effects of HTS (Soule et al., 2015), it is possible that hookah users who drink alcohol on a more frequent basis try other tobacco products to obtain similar subjective experiences. It may also be that, because alcohol reduces one's inhibitions and restraint, those who are willing to try hookah may also use other products when they are intoxicated. The association between "real-time" drinking and number or types of tobacco products used should be examined in future research. These results suggest that the both age and how often one drinks alcohol are contributing factors to HTS and other tobacco use, rather than each factor alone.

This study had several limitations. The sample included self-reported regular cigarette smokers who responded to an advertisement asking for "regular drinkers", rather than a general population of hookah users. While these sample characteristics may limit generalizability, cigarette and alcohol use are common among hookah users and thus findings nonetheless have public health implications. Furthermore, respondents in the sample were not drinking heavily or even daily. Second, due to data collection methods, cigarette smoking frequency was assessed dichotomously, not as a continuous factor. Although hookah users were lighter smokers, consistent with the research, it is unknown if this finding would be different if smoking was measured continuously. Further, because data were assessed via a brief screener, specific types of drug classes used were not assessed. Lastly, alternative tobacco use was also analyzed dichotomously, so the current analyses do not account for differences in frequency of alternative tobacco use.

This study fills an important gap in the literature by examining the influence of both age and alcohol use on the relationship between HTS and poly-tobacco use in a diverse adult sample of smokers across a broad age continuum. Most prior studies of HTS and alcohol use have included college students only or small convenience samples[21,33,48,50,60,63]; few have explored these associations in larger urban samples with a wide age range. As HTS increases in popularity in the US and outpaces cigarette smoking among younger users, it is essential to continue to investigate potential factors that increase the risks associated with HTS. HTS exposes individuals to many of the same toxicants found in cigarette smoke in higher concentrations[64,65] and places users at risk for many of the same diseases as cigarette smokers[66–69] including nicotine dependence, lung cancer, and respiratory illness.[67–69] The results of this study identify a need to use rigorous prospective designs to investigate the short- and long-term harms of the combination of alcohol, HTS, and poly-tobacco use public health interventions focused on enhanced awareness of HTS health effects that target young adults and youth who may be at risk for HTS and poly-tobacco use. Without knowledge of

the factors associated with HTS, which could be targeted in health interventions, HTS will continue to pose health risks and increase in prevalence in the foreseeable future.

Acknowledgments

FUNDING: This work was supported by grants R03CA 175870-01A1 and R03CA 175870-01A1S.

Role of Funding Sources

This work was supported by grants R03CA 175870-01A1 and R03CA 175870-01A1S.

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Highlights

- To examine effects of alcohol use and age on the association between hookah and poly-tobacco use in adult cigarette smokers
- Poly-tobacco use is common among adult smokers who use hookah
- The link between hookah and poly-tobacco use was strongest in younger respondents who drank more often

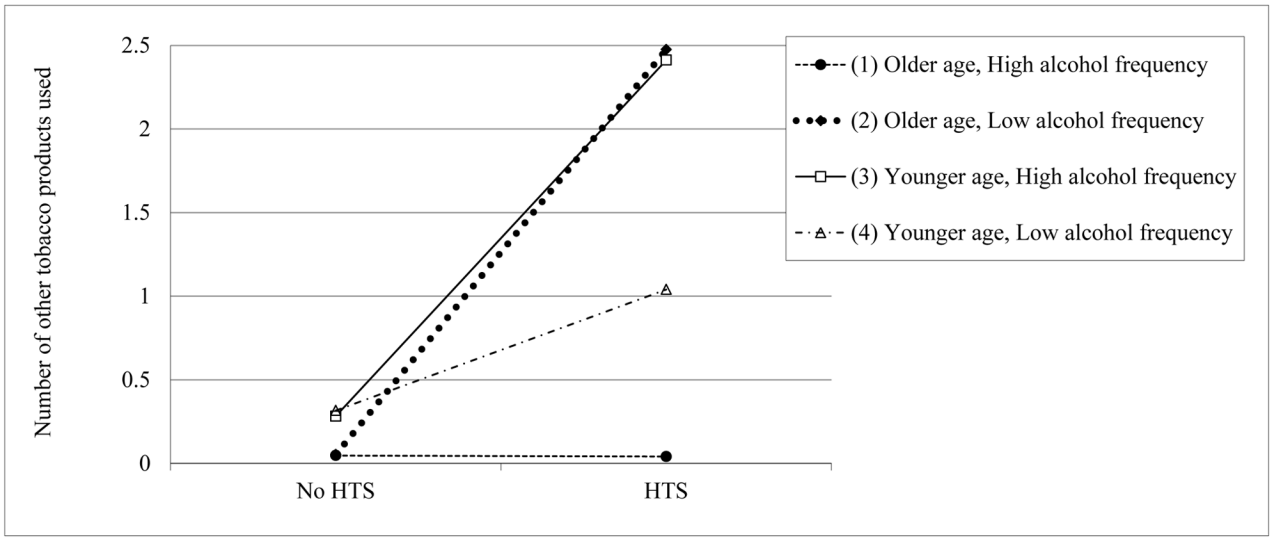

Figure 1.

Moderating effects of alcohol use frequency and age on the association between HTS and number of other tobacco products used in adult cigarette smokers.

Note. Other non-hookah tobacco product use included e-cigarettes, cigars, little cigar/cigarillos, chew, and "other."

Addict Behav. Author manuscript; available in PMC 2018 May 01.

Table 1

Descriptive statistics and differences between adult cigarette smokers with and without HTS use on demographic, tobacco, and alcohol and drug use.

	HTS Use n = 231; 18.9%		**Non-HTS Use n = 992; 81.1%**		
	n	**%**	**n**	**%**	***p***
Gender					0.03
Male	141	61.0	529	53.3	
Female	90	39.0	463	46.7	
Race					0.02
African American	132	57.4	624	63.1	
White	58	25.1	258	26.1	
Other	40	17.4	107	10.8	
Education					0.001
< HS diploma	8	3.5	80	8.1	
HS graduate/GED	43	18.6	310	31.3	
Some college	118	51.1	373	37.6	
College graduate or higher	62	26.8	228	23.0	
Employment status					0.08
Employed	122	52.8	450	45.4	
Unemployed	65	28.1	349	35.2	
Other	44	19.0	192	19.4	
Heavy smoker (≥10 cigs/day)	152	65.8	787	80.1	0.001
Drug use (yes)	95	42.0	216	21.8	0.001
Binge drinking (yes)	135	58.4	498	50.2	0.02
Other non-hookah tobacco product use					0.001
0 products	30	13.0	720	72.6	
1 product	67	29.0	194	19.6	
2 products	55	23.8	58	5.8	
3+ products	79	34.2	20	2.0	
	Mean	**SD**	**Mean**	**SD**	

	HTS Use n = 231; 18.9%		Non-HTS Use n = 992; 81.1%		
	n	**%**	**n**	**%**	***p***
Age	27.16	7.26	39.38	13.19	0.001
Alcohol frequency	4.11	1.66	4.29	2.09	0.22
Alcohol quantity	5.31	3.88	5.54	5.12	0.52

Note. Data represent column percents. Totals may not equal 1,223 due to missing data. Other non-hookah tobacco use included e-cigarettes, cigars, little cigar/cigarillos, chew, and “other.”