ORIGINAL INVESTIGATION

Knowledge, Attitudes, and Normative Beliefs as Predictors of Hookah Smoking Initiation: A Longitudinal Study of University Students

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ABSTRACT

Introduction: While cross-sectional studies have shown that hookah tobacco smoking (HTS) is an increasingly popular behavior among university students, little is known about factors associated with initiation. This study sought to determine associations between knowledge, attitudes, and normative beliefs and initiation of HTS among university students.

Methods: Data were from a prospective longitudinal cohort study of 569 randomly selected first- and second-year university students. Online questionnaires that were developed in accordance with our composite theoretical model were completed in September 2010 and April 2011.

Results: About one-seventh (13%) of participants initiated HTS by follow-up. Positive attitudes and favorable normative beliefs were associated with increased adjusted odds of initiation (*AOR* = 4.12, 95% CI = 2.56, 6.59; and *AOR* = 2.01, 95% CI = 1.35, 2.99, respectively), while negative attitudes were associated with decreased adjusted odds (*AOR* = 0.62, 95% CI = 0.48, 0.80). Correct knowledge regarding toxicants associated with HTS was not significantly associated with initiation.

Conclusions: While positive attitudes and favorable normative beliefs are associated with initiation of HTS in a cohort of never-users, increased knowledge about toxins is not associated with lower initiation. It may be particularly valuable for educational interventions to attempt to alter positive attitudes and normative beliefs related to HTS.

INTRODUCTION

Smoking tobacco from a hookah (also known as waterpipe, shisha pipe, or arghileh) is an emerging trend among U.S. university students. Approximately one in five university students report hookah tobacco smoking (HTS) within the past year (Grekin & Ayna, 2012) and 30%–40% report lifetime HTS (Primack et al., 2008, 2013; Sutfin et al., 2011). A growing body of evidence suggests that HTS may expose the user to substantial amounts of smoke volume, carbon monoxide, nicotine, carcinogens, and tar (Barnett, Curbow, Soule, Tomar, & Thombs, 2011; Cobb, Ward, Maziak, Shihadeh, & Eissenberg, 2010; Eissenberg & Shihadeh, 2009; Schubert et al., 2011). Additionally, HTS has been linked to health conditions such as lung cancer and other respiratory illnesses (Akl et al., 2010; Cobb et al., 2010). Despite this evidence, it does not appear that university students are knowledgeable about the composition or potential harmful effects of HTS. In fact, a study of university students showed that more than half of them answered 100% of items incorrectly when asked about harmful components of HTS versus cigarettes (Nuzzo et al., 2013). Research also indicates that university students view HTS to be less addictive than cigarettes (Primack et al., 2008) and also believe it to be a highly socially acceptable form of tobacco use (Smith-Simone, Curbow, & Stillman, 2008). Studies of high school students and younger adolescents show that they also have poor knowledge and positive normative beliefs regarding HTS, suggesting that these views may be carried with them as they enter the university population (Jordan & Delnevo, 2010; Smith et al., 2011).

Compared with their nonsmoking peers, university users of hookah tobacco tend to be male, White, live in a fraternity/sorority, and have lower grades (Braun, Glassman, Wohlwend, Whewell, & Reindl, 2012; Jarrett, Blosnich, Tworek, & Horn, 2012; Primack et al., 2008, 2013; Sidani, Shensa, & Primack,

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2013; Sutfin et al., 2011). Although HTS is associated with cigarette use (Braun et al., 2012; Eissenberg, Ward, Smith-Simone, & Maziak, 2008; Sterling & Mermelstein, 2011), approximately 30%–50% of hookah tobacco users do not also smoke cigarettes, suggesting that HTS affects a population that may otherwise have been nicotine-naive (Primack et al., 2008). Cross-sectional research suggests that positive attitudes toward HTS among university students are associated with increased odds of hookah use, while negative attitudes are associated with decreased odds (Barnett et al., 2013; Eissenberg et al., 2008; Noonan & Kulbok, 2012; Noonan, Kulbok, & Yan, 2011; Primack et al., 2008; Smith-Simone, Curbow, et al., 2008). Positive normative beliefs, such as the belief that HTS is socially acceptable among peers, have also been shown in cross-sectional studies of university students to be associated with increased odds of hookah use (Eissenberg et al., 2008; Primack et al., 2008; Smith-Simone, Curbow, et al., 2008) and intention to initiate HTS (Barnett et al., 2013; Noonan & Kulbok, 2012; Noonan et al., 2011). Although thus far knowledge of hookah tobacco toxicants does not seem to be strongly associated with HTS behavior or intention to use hookah in the university population (Nuzzo et al., 2013), conceptually it would be expected that knowing more about potential harm might be associated with lower likelihood of use.

The vast majority of HTS research has been cross-sectional. While these studies have answered valuable questions about the factors associated with the use of hookah, they leave unanswered questions of temporality, or chronological sequence, which will have important implications for future intervention programming. For example, while it has been shown that positive attitudes are associated with greater odds of HTS, it is not known if those who participate in HTS develop positive attitudes or whether positive attitudes lead to experimentation with HTS. Determining the temporality of these associations will assist educators in deciding whether to focus on attitudes during primary prevention (i.e., preventing smoking initiation) or secondary prevention (i.e., encouraging smokers to quit) efforts. Similarly, considering knowledge has not been associated with HTS in cross-sectional analyses, the question remains whether or not educating about the knowledge of the harmful components of hookah tobacco smoke will be effective in preventing the initiation of HTS. Answers to these questions will allow for the development of more effective interventions, using both primary and secondary prevention efforts.

One important longitudinal study examining initiation of HTS has been conducted with university students (Fielder, Carey, & Carey, 2012a, 2012b). This study, which followed first-year university women recruited through mass mailings, flyers, and word of mouth, has been valuable in understanding initiation rates and investigating factors associated with HTS initiation. Specifically, it was found that one-third of these students participated in HTS before entering college, that approximately one in five students initiated HTS during the first year of college, and that the highest rates of initiation were during the first 2 months after arriving on campus. Additionally, the authors determined that one important behavioral factor, alcohol use, was associated with initiation of HTS in this population.

In order to continue this vein of research, findings such as these should be confirmed in more general populations, such as those of mixed gender and random samples. Additionally, it will be valuable to assess a more comprehensive set of prediction variables according to selected theoretical constructs. Thus, we designed a composite theoretical model for this study, which integrated the attitudes and subjective norms constructs of the Theory of Reasoned Action with the perceived severity construct of the Health Belief Model (Glanz, Rimer, & Viswanath, 2008). The Theory of Reasoned Action, often cited related to health risk behaviors among adolescents (Noonan et al., 2011), posits that attitudes toward performing the behavior and normative beliefs associated with the behavior are particularly relevant. Additionally, the Health Belief Model suggests links between knowledge and behavior and is often used to examine why individuals do or do not follow healthy living recommendations such as avoidance of substance use (Janz & Becker, 1984; Kauffman, Silver, & Poulin, 1997; Werch, Moore, DiClemente, Bledsoe, & Jobli, 2005). By combining the key constructs of attitudes, normative beliefs, and knowledge (perceived severity) from these health behavior theories into a composite theoretical model, we sought to determine which constructs may be most relevant with regard to HTS, which will assist researchers and health professionals in designing particularly targeted and valuable interventions.

Thus, the purpose of this study was to longitudinally follow a cohort of university students, in order to determine temporal associations between initiation of HTS and several theory-based predictors of uptake, including knowledge, attitudes, and normative beliefs. Based on prior empiric results as well as theory, it was hypothesized that prospective initiation of HTS would be positively associated with higher initial positive attitudes toward HTS (Hypothesis 1), lower negative attitudes toward HTS (Hypothesis 2), higher positive normative beliefs about HTS (Hypothesis 3), and lower levels of knowledge about the dangers of HTS (Hypothesis 4).

METHODS

Participants and Procedures

A random sample of 2,400 E-mail addresses of first- and second-year male and female undergraduate and graduate students for the 2010–2011 academic school year was supplied by the University of Florida Registrar. Both undergraduate and graduate students in their first 2 years were included because these years can be transitional for both groups.

In September 2010, E-mails were sent to the sample of 2,400 students inviting them to participate in an online survey. Those who completed the baseline survey received a $10 Amazon.com gift card. Of the 2,339 subjects who received the invitation (61 E-mails were returned as undeliverable), 852 (36%) completed the baseline survey. In April 2011, those 852 students who completed the baseline survey were sent an E-mail inviting them to participate in a follow-up online survey. Of baseline respondents, 569 (67%) completed the follow-up assessment and had complete data for analysis. Those who completed the follow-up survey received a $15 Amazon.com gift card. The process and surveys were approved by Institutional Review Boards at both the University of Pittsburgh and the University of Florida.

Measures

Survey items, which were the same at both baseline and follow-up, assessed demographic information, HTS behavior, and key possible predictors developed according to our composite theoretical model integrating constructs from the Theory

of Reasoned Action and the Health Belief Model, including knowledge, attitudes, and normative beliefs related to HTS.

Demographics

Subjects were asked to complete 15 demographic items. The items used for this study assessed age, sex, race/ethnicity, enrollment status (undergraduate vs. graduate), fraternity/sorority membership, and residence type (on-campus vs. off-campus), which are the demographics most often associated with HTS in prior research (Primack et al., 2008, 2013; Sutfin et al., 2011).

Initiation of HTS

In both baseline and follow-up surveys, subjects were asked the following, "Have you *ever* smoked tobacco from a hookah, even a puff?" with a yes/no response. Boldface instructions prior to this item informed the subjects that the hookah-related questions referred to using a hookah to smoke tobacco, not marijuana. The outcome measure, *initiation of HTS*, was defined as answering "no" to the ever use item at baseline and "yes" at follow-up.

Attitudes Toward HTS

To measure the attitudes construct of the Theory of Reasoned Action, subjects were asked to rate their attitudes toward HTS in the following terms: attractive, romantic, fun, relaxing, harmful, and addictive. For each term, Likert-type responses included definitely no, probably no, don't know, probably yes, and definitely yes. These terms were assessed individually and collapsed into two summary scales, with attractive, romantic, fun, and relaxing forming "positive attitudes" and harmful and addictive forming "negative attitudes." Two different scales were created representing positive and negative attitudes instead of combining the items into a single attitude scale because these scales are commonly found to have differential associations with outcomes in other research (Dalton, Sargent, Beach, Bernhardt, & Stevens, 1999).

Knowledge About HTS

To measure the perceived severity construct of the Health Belief Model and assess knowledge about HTS, subjects were presented with the item, "Please answer the following questions to the best of your knowledge. We'd like you to compare smoking a single cigarette with a single hookah tobacco smoking session." Although the time it takes to smoke a single cigarette is typically much shorter than a single HTS session, this stem was used to be consistent with available literature and current practice in this area (Cobb et al., 2010; Daher et al., 2010; Eissenberg & Shihadeh, 2009). The subsequent items asked participants to indicate which form of tobacco (cigarette or hookah) had more nicotine, tar, carcinogens, carbon monoxide, and heavy metals. For each question, Likert-type responses included definitely cigarette, probably cigarette, don't know, probably hookah, and definitely hookah. Based on established research (Cobb et al., 2010; Eissenberg & Shihadeh, 2009; Saleh & Shihadeh, 2008; Shihadeh, 2003; Shihadeh & Saleh, 2005), a participant's response was considered correct if s/he answered "probably hookah" or "definitely hookah" and incorrect if s/he answered "probably cigarette" or "definitely cigarette," while "don't know" was categorized and analyzed separately. Additionally, a summary knowledge score was developed to measure how many of the five items the subject answered correctly.

Normative Beliefs

To measure the normative beliefs construct of the Theory of Reasoned Action, subjects were presented with a single item: "Among people your age, how socially acceptable is it to smoke tobacco from a hookah?" The response scale included "not socially acceptable," "somewhat socially acceptable," "moderately socially acceptable," and "very socially acceptable."

Analysis

Data were analyzed in 2012 using Stata 12 (StataCorp, 2011). Comparisons of demographic information were conducted to determine if there were significant differences between those who completed the baseline survey and those who did not as well as differences between those who completed the follow-up survey and those who did not. Frequencies and percentages were used to describe the demographic information according to the outcome measure, initiation of HTS. Cronbach α was computed to assess the internal consistency reliability of each of the attitude scales and the knowledge scales. Chi-square tests were used to assess bivariable associations between demographics and the outcome variable. Multivariable logistic regression models were used to assess temporal associations between the attitude, knowledge, and normative beliefs measures and the outcome measure of HTS initiation, while controlling for all measured covariates, which were determined a priori due to their associations with HTS in the cross-sectional literature. Two-tailed p values of <.05 were considered to be significant.

RESULTS

Comparisons of Responders and Nonresponders

For the baseline survey, compared to the entire population to whom surveys were sent, respondents (n = 852) were younger (20.6 vs. 21.1, p = .04), more commonly female than male (46.8% vs. 40.0%, p < .01), and more commonly White than non-White (71.0% vs. 58.7%, p < .001). The final sample was limited to students who completed surveys at both baseline and follow-up. Of baseline respondents, 569 (67%) completed the follow-up assessment and had complete data for analysis. Study retention was not significantly related to age or race/ethnicity. However, compared with participants who did not complete the follow-up assessment, those who did were slightly more commonly male than female (55% vs. 47%, p = .04).

Demographic Information

The final sample was roughly one-third 18 years old, one-third 19 years old, and one-third 20+ years old. The sample was 55% male. Most respondents in the final sample self-identified as White (71%), followed by Asian (13%), Black (9%), and other race (6%). The majority (76%) of the final sample was undergraduate, did not belong to a fraternity/sorority (89%), and lived off-campus (63%).

Initiation of HTS: Bivariable and Multivariable Analyses

Initiation of HTS

Ever HTS was reported by 204 (36%) of subjects at baseline. Among the 365 (64%) who reported never having smoked tobacco from a hookah at baseline, 46 (13%) had initiated this

behavior by follow-up. In bivariable analyses, demographic factors were not significantly associated with initiation of HTS during the study period (Table 1).

Attitudes and Normative Beliefs

Both positive and negative attitudes scales were determined to be internally consistent (α = .82 and .70, respectively). In the multivariable model, significant associations were found between initiation of HTS and individual positive and negative attitudes, with adjusted odds ratios ranging from 1.93 to 3.12 and 0.55 to 0.77, respectively (Table 2). Overall positive attitudes were associated with increased odds of initiation of HTS (adjusted odds ratio [*AOR*] = 4.12, 95% CI = 2.56, 6.59), and overall negative attitudes were associated with a decreased odds of initiation of HTS (*AOR* = 0.62, 95% CI = 0.48, 0.80). The normative beliefs measure was associated with an increased odds of initiation of HTS (*AOR* = 2.01, 95% CI = 1.35–2.99).

Knowledge of HTS

Cronbach α for knowledge items was .81. The multivariable models found no significant associations between correct or incorrect answers and initiation of HTS. However, a "don't know" response for tar, nicotine, and carcinogens was associated with a decreased risk for initiation of HTS (*AOR* = 0.35, 95% CI = 0.14–0.90; *AOR* = 0.12, 95% CI = 0.03–0.50; and *AOR* = 0.28, 95% CI = 0.11–0.70, respectively). The summary knowledge score was not associated with initiation of HTS.

DISCUSSION

This study found that 13% of a random sample of first- and second-year undergraduate and graduate students initiated HTS during a 7-month period. Although a previous longitudinal study found initiation rates of 22% (Fielder et al., 2012a, 2012b), it examined first-year students only.

Some of the findings from the current study differed from what is known from cross-sectional studies of current hookah tobacco smokers. For example, while cross-sectional studies demonstrate that being a member of a fraternity or sorority increases the odds of being a hookah tobacco smoker (Jarrett et al., 2012; Primack et al., 2013; Sidani et al., 2013), the current study found no independent association between fraternity/sorority membership and HTS initiation during the study period. A possible explanation for this may be that a substantial portion of fraternity/sorority participants had already experimented with HTS, and therefore would not be classified as initiators, although this should be evaluated further in future research studies.

The results showed that positive attitudes toward HTS are strongly associated with increased odds for HTS initiation and that negative attitudes toward HTS are strongly associated with decreased odds, consistent with the Theory of Reasoned Action and supporting Hypothesis 1 and Hypothesis 2. These findings are similar to those found in cross-sectional studies (Barnett et al., 2013; Eissenberg et al., 2008; Primack et al., 2008; Smith-Simone, Maziak, Ward, & Eissenberg, 2008). Although

Table 1. Sample Characteristics by Baseline Hookah Nonsmokers and Hookah Tobacco Smoking

	Baseline hookah nonsmokers (n = 365)[a]	Hookah tobacco smoking initiation[b]		
		Yes[c] (n = 46)	No[c] (n = 319)	p value[d]
Characteristic	n (%)	%	%	
Age, years				
18	146 (41)	48	40	.41
19	108 (30)	34	30	
20	17 (5)	2	5	
21 and above	86 (24)	16	25	
Sex				
Female	168 (46)	48	46	.81
Male	196 (54)	52	54	
Race				
White	245 (68)	73	68	.90
Black	41 (11)	11	11	
Asian/Pacific Islander	51 (14)	11	15	
Other	21 (6)	5	6	
Enrollment status				
Undergraduate	276 (77)	84	76	.23
Graduate	83 (23)	16	24	
Fraternity/sorority				
Nonmember	340 (93)	89	94	.27
Member	25 (7)	11	6	
Residence				
Off-campus housing	220 (61)	64	61	.71
On-campus housing	140 (39)	36	39	

Note. [a]This number includes only subjects who had data for baseline and follow-up.
[b]Defined as never having smoked tobacco from a hookah at baseline and having taken at least one puff at follow-up.
[c]Cells represent column percentages. Data do not always sum to total sample sizes because of missing data. Percentages are based on the total for each category and may not total 100 due to rounding.
[d]For chi-square analyses.

Table 2. Bivariable and Mutivariable Associations Between Attitudes, Normative Beliefs, Knowledge, and Initiation of Hookah Tobacco Smoking

Attitude, subjective norm, and knowledge item	Hookah tobacco smoking initiation[a] (n = 365)[b]	
	OR (95% CI)[c]	*AOR* (95% CI)[c]
Positive attitudes		
Hookah seems attractive	**2.45 (1.74–3.44)**	**3.12 (2.08–4.65)**
Hookah seems romantic	**2.17 (1.48–3.20)**	**2.65 (1.69–4.15)**
Hookah seems fun	**2.22 (1.70–2.90)**	**2.27 (1.71–3.00)**
Hookah seems relaxing	**1.88 (1.37–2.59)**	**1.93 (1.38–2.71)**
Overall positive attitude	***3.60 (2.35–5.51)***	***4.12 (2.56–6.59)***
Negative attitudes		
Hookah seems harmful	0.81 (0.66–1.01)	**0.77 (0.61–0.97)**
Hookah seems addicting	**0.57 (0.45–0.73)**	**0.55 (0.42–0.71)**
Overall negative attitude	***0.65 (0.52–0.83)***	***0.62 (0.48–0.80)***
Normative beliefs[d]	**2.04 (1.42–2.95)**	**2.01 (1.35–2.99)**
Knowledge[e]		
Which has more tar?		
Incorrect	1.0 (reference)	1.0 (reference)
Correct	0.69 (0.29–1.66)	0.62 (0.25–1.52)
Don't know	0.46 (0.20–1.04)	**0.35 (0.14–0.90)**
Which has more nicotine?		
Incorrect	1.0 (reference)	1.0 (reference)
Correct	0.73 (0.29–1.84)	0.68 (0.26–1.78)
Don't know	**0.22 (0.07–0.63)**	**0.12 (0.03–0.50)**
Which has more carcinogens?		
Incorrect	1.0 (reference)	1.0 (reference)
Correct	0.63 (0.25–1.59)	0.48 (0.18–1.34)
Don't know	**0.31 (0.13–0.73)**	**0.28 (0.11–0.70)**
Which has more carbon monoxide?		
Incorrect	1.0 (reference)	1.0 (reference)
Correct	0.84 (0.38–1.84)	0.77 (0.34–1.74)
Don't know	0.73 (0.36–1.50)	0.74 (0.35–1.56)
Which has more heavy metals?		
Incorrect	1.0 (reference)	1.0 (reference)
Correct	0.79 (0.36–1.73)	0.76 (0.34–1.69)
Don't know	0.66 (0.32–1.35)	0.58 (0.27–1.27)
Final score[f]	*0.97 (0.78–1.22)*	*0.94 (0.75–1.20)*

Note. [a]Defined as never having smoked tobacco from a hookah at baseline and having taken at least one puff at follow-up.
[b]Only baseline hookah nonsmokers and those who had complete and consistent responses to survey item assessing ever hookah tobacco smoking were included in these analyses.
[c]*AOR* = adjusted odds ratio, adjusted for age, gender, race/ethnicity, graduate student status, fraternity/sorority membership, and housing; CI = confidence interval; *OR* = odds ratio.
[d]Normative beliefs measured with item, "How socially acceptable is it?"
[e]Correct answer is "hookah" for all items; incorrect answer (reference group) is "cigarettes."
[f]The final score was the number of items scored correct summed. Associated odds ratios represent the odds for each 1-point increase in the 5-point scale. Numbers in bold are statistically significant, whereas numbers in italics represent a summary scale.

this may seem obvious, it is not necessarily the case for cigarette smoking, for which positive attitudes are associated with increased use, while negative attitudes are inconsistently associated with lower use (Dalton et al., 1999). Because in the current study positive attitudes had stronger associations with initiation compared with lower negative attitudes, it may be particularly valuable for interventions to rebut positive associations with HTS in order to prevent young adults from experimenting with it. This may prove to be particularly challenging, however, because HTS is frequently promoted as relaxing, pleasurable, fun, and sexual (Carroll, Shensa, & Primack, 2013; Griffiths, Harmon, & Gilly, 2011; Primack, Rice, et al., 2012).

It is also consistent with the Theory of Reasoned Action that positive normative beliefs about HTS were associated with HTS initiation, supporting Hypothesis 3. This is also consistent with current research demonstrating that hookah tobacco users report having been introduced to HTS by a friend and that they frequently participate in HTS in the company of others (Braun et al., 2012). Similarly, HTS does not seem to be hampered by the negative social stigmas of cigarette smoking (Eissenberg et al., 2008; Smith-Simone, Curbow, et al., 2008). Thus, altering normative beliefs regarding HTS may be another avenue for intervention for prevention of initiation among young adults.

There are substantial misperceptions among users about the safety and potential of addiction related to HTS (Griffiths et al., 2011). However, no associations were found between knowledge of hookah tobacco toxicants and initiation of HTS, which led to the rejection of Hypothesis 4. Although there

may still be some value in correcting misperceptions (Lipkus, Eissenberg, Schwartz-Bloom, Prokhorov, & Levy, 2011), these findings suggest that only focusing on the harms might not be the most important elements of interventions aimed at preventing initiation of HTS. Interestingly, an answer of "don't know" for certain toxicants was associated with decreased odds for initiation of HTS. Although this possible explanation was not tested during this study, it is possible that answering "don't know" to these questions simply served as a marker for having little interest in, or limited social exposure to, the behavior. This possibility should be explored through future research, including qualitative studies.

Because cross-sectional studies have shown that *current* university hookah smokers are more likely to be male, White, younger, and living in a fraternity/sorority residence, it may be valuable for secondary prevention interventions to target these specific subgroups. However, the current longitudinal study did not demonstrate an association between these demographics and *initiation* of HTS, suggesting that primary preventive measures may be useful for a broader set of demographic groups instead of limited to specific subgroups. The results of this study suggest that interventions that seek to prevent HTS initiation may be more successful among university students if they are based upon the attitudes and normative beliefs constructs of the Theory of Reasoned Action, which may be more valuable than the perceived severity constructs of the Health Belief Model for this particular health behavior. For example, an educational campaign targeted at incoming college freshmen may be more effective if it targets the perception that HTS is attractive and romantic rather than educating students about the harmful components of hookah tobacco smoke. Additionally, it will be valuable for future studies to include other related constructs of these or other health behavior theories to determine if they could be effective components of HTS initiation interventions.

Interventions incorporating policy initiatives may be useful in addressing university students' attitudes and normative beliefs toward HTS. While regulation of tobacco products such as cigarettes is relatively comprehensive, the current regulation of HTS in the United States is confusing and inconsistent, possibly leading to the misperception that HTS is less harmful than cigarettes. Although the majority (73%) of the most populous U.S. cities have clean indoor air policies, it is unclear how these policies affect hookah bars and cafes, which are usually present in close proximity to university campuses (Primack, Hopkins, et al., 2012). Furthermore, hookah tobacco does not appear to be under the purview of the Family Smoking Prevention and Tobacco Control Act (U.S. Food and Drug Administration, 2012). Thus, manufacturers and distributers of hookah tobacco are not impeded by the regulations mandated for other tobacco products, such as banning the use of flavorings, requirement of health warnings, and banning the use of promotions and giveaways, all of which are effective marketing techniques for younger populations. Clear policy measures addressing the sale and marketing of hookah products and regulation of hookah bars and cafes may be valuable for raising awareness of the potentially harmful effects of HTS, which may counteract the positive attitudes and normative beliefs young adults hold toward it.

This study was limited in that it was conducted with a sample of students from one university in the Southeastern United States. Because we did not conduct specific analyses to compare the demographics of our sample student population to the entire U.S. student population, we cannot ensure the generalizability of our results to all university students. Future research projects examining the initiation of HTS in the university population should be nationally representative to test our results. Additionally, while the response rates could be considered low (36% for the baseline survey and 67% for the follow-up survey), these response rates are typical for Web-based surveys of university students (Reed, Wang, Shillington, Clapp, & Lange, 2007; Turrisi et al., 2009). While respondents' demographic characteristics did not match exactly the whole study population, previous research has shown that this response pattern is typical with university survey takers (McCabe & Boyd, 2005; Reed et al., 2007; Sheehan, 2001). Another limitation of this study is the fact that the results are based on self-report survey data without biochemical validation. However, because the surveys were confidential, there is little reason to believe that participants would have been dishonest. A final limitation is the use of the stem for the knowledge item asking students to compare harmful components in a single hookah smoking session to those in a single cigarette. Because a typical hookah smoking session lasts a longer time period than smoking a single cigarette, this item could have caused confusion in some respondents, leading to them incorrectly answering the question.

In summary, this study found that attitudes and normative beliefs were significantly associated with initiation of HTS among university students, while knowledge about toxicant content of HTS was not. Additionally, demographic factors that have been linked to current HTS in cross-sectional research were not associated with initiation of HTS in this study. These findings suggest that initiatives to prevent HTS initiation might be most valuable if they address attitudes and normative beliefs about HTS among a variety of sociodemographic populations.

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DECLARATION OF INTERESTS

None declared.

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