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Predictors of Initiation of Hookah Tobacco Smoking: A One-Year Prospective Study of First-Year College Women

Robyn L. Fielder, Kate B. Carey, and Michael P. Carey

Center for Health and Behavior and Department of Psychology, Syracuse University

Abstract

Hookah tobacco smoking has become increasingly prevalent among American college students over the past decade. Hookah smoking is associated with poor health outcomes and exposes users to high levels of nicotine, carbon monoxide, and smoke. Research on the correlates of hookah use has begun to emerge, but all studies thus far have been cross-sectional. Little is known about hookah use during the transition to college, psychosocial factors related to hookah smoking, or prospective predictors of hookah initiation and frequency of use. This longitudinal cohort study examined risk and protective factors predicting initiation of hookah tobacco smoking during the first year of college. First-year female college students ($N = 483$; 64% White) provided data on demographic, behavioral, and psychosocial variables and pre-college hookah use at baseline; they then completed 12 monthly online surveys about their hookah use from September 2009 to August 2010. Among the 343 participants who did not report pre-college use, 79 (23%) initiated hookah tobacco smoking during the year after college entry. Zero-inflated negative binomial regression showed that alcohol use predicted the likelihood of initiating hookah use; impulsivity, social comparison orientation, and marijuana use predicted the frequency of hookah use. These findings suggest that hookah prevention and intervention efforts may need to address other forms of substance use as well as hookah use.

Keywords

hookah; waterpipe; tobacco; college students; predictors

Hookah, or waterpipe, tobacco smoking involves the passage of smoke through water (in the body of the hookah) prior to inhalation (Maziak, 2008). Hookah use is associated with reduced lung function (Raad et al., 2011) and increased odds of lung cancer, respiratory illness, and periodontal disease (Akl et al., 2010). Compared to smoking one cigarette, a typical session (45–60 minutes) of hookah tobacco smoking confers a higher nicotine dose, greater carbon monoxide exposure, and almost 50 times the smoke volume (Eissenberg & Shihadeh, 2009).

The prevalence of hookah use has increased among youth worldwide over the past two decades (Akl et al., 2011). In the United States, lifetime hookah tobacco smoking is now almost as common among college students as cigarette smoking (Sutfin et al., 2011). One-third to one-half of students report lifetime hookah use, and 10–20% report use during the

Correspondence concerning this article should be addressed to Robyn L. Fielder, Department of Psychology, 430 Huntington Hall, Syracuse University, Syracuse, NY 13244. rffielde@syr.edu.

Kate B. Carey is now at the Department of Behavioral and Social Sciences, Program in Public Health, and the Center for Alcohol and Addiction Studies, Brown University. Michael P. Carey is now at the Centers for Behavioral and Preventive Medicine at The Miriam Hospital, the Department of Psychiatry and Human Behavior, and the Department of Behavioral and Social Sciences, Brown University.

past 30 days (Eissenberg, Ward, Smith-Simone, & Maziak, 2008; Primack et al., 2008; Sutfin et al. 2011). The increasing prevalence of hookah use and its adverse health effects suggests the need for education and prevention, ideally targeted toward those most likely to take up this practice.

Studies of the correlates of hookah use have focused on demographic factors and substance use behaviors. Hookah smoking is common among Arab-Americans (Grekin & Ayna, 2008), but it is less popular among other ethnic minority groups, such as African-Americans (Barnett, Curbow, Weitz, Johnson, & Smith-Simone, 2009). Adolescents and college students who smoke cigarettes, use other tobacco products (e.g., cigars), smoke marijuana, and drink alcohol are all more likely to report hookah tobacco use (Eissenberg et al., 2008; Jordan & Delnevo, 2010; Sutfin et al., 2011). Less is known about psychosocial determinants of hookah use, such as personality characteristics. Given the correlation between hookah use and other forms of substance use, one might expect that psychosocial correlates of cigarette smoking and alcohol use might also be associated with hookah use, including some personality traits (e.g., impulsivity), stress, religiosity, and depression (Kashdan, Vetter, & Collins, 2005; Patterson, Lerman, Kaufmann, Neuner, & Audrain-McGovern, 2004; Rigotti, Lee, & Wechsler, 2000).

Psychological theory can help to understand hookah initiation and use. From a substance use perspective, Jessor's (1991) problem behavior theory invokes the notion of risk factors, which might include role models for problem behavior, greater access and opportunity to engage in it (e.g., due to location of hookah lounges in college towns; Barnett, Curbow, Soule, Tomar, & Thombs, 2011), and personal and contextual vulnerability for its occurrence (e.g., peer pressure). Because hookah use often co-occurs with other forms of substance use, it may be part of a cluster of co-occurring substance use risk behaviors. Similarly, from a developmental perspective, Arnett's (2000) theory of emerging adulthood suggests that experimenting with hookah might be part of a normative process of seeking new experiences, as rates of other substance use peak during the 18–25 age range (Arnett, 2005). From both theoretical frameworks, the transition to college is a likely time for hookah initiation given the increased freedom enjoyed by residential students, the popularity of hookah lounges in college towns (Sutfin et al., 2011), the ability of students under age 21 to get into hookah lounges but not regular bars (Barnett et al., 2011), media portrayals of hookah smoking as exotic and trendy (Maziak, 2008), permissive social norms about substance use typical of the college environment (Perkins, Meilman, Leichliter, Cashin, & Presley, 1999), and the developmental task of identity exploration (Arnett, 2005).

Given the paucity of research on the predictors of hookah use, we sought to identify risk and protective factors for hookah initiation and subsequent use. Building on empirical precedent (e.g., Windle, Mun, & Windle, 2005) and theory, we investigated demographics, intrapersonal functioning, values, personality, and other substance use as possible predictors of hookah use among female college students. We expected Black and Asian race, academic achievement, religiosity, health value, and self-esteem to be protective factors for hookah initiation and use. We expected impulsivity, sensation-seeking, depression, anxiety, stress, social comparison, marijuana use, cigarette smoking, and alcohol use to be risk factors for hookah initiation and use.

We focused on females because tobacco use patterns, risk, and protective factors differ by gender (Rigotti et al., 2000). We focused on first-year college students because the transition to college is an important developmental period when risky behaviors, such as alcohol and marijuana use, often increase (Fromme, Corbin, & Kruse, 2008). Our research improves upon prior efforts by (a) using a prospective longitudinal design and (b) assessing frequency

(rather than just dichotomous indicators) of hookah use. This design allowed us to identify predictors of hookah initiation and of greater involvement with hookah over one year.

Method

Study Design and Procedures

All procedures were approved by the Institutional Review Board. Data were from a larger study, conducted from August 2009 to August 2010 at a private university in Upstate New York, on health behaviors, relationships, sexual behavior, and adjustment among first-year college women. Participants for the larger study ($N = 483$)¹ were recruited via a mass mailing sent to incoming female students who would be at least 18 years old by the start of the study and were not international students or scholarship athletes (excluded due to postal lags and policies of the National Collegiate Athletic Association, respectively). Campus fliers, word of mouth, and the psychology department participant pool were also used to bolster recruitment. Most participants (61%) were recruited from the mass mailing, 28% from the participant pool, and 11% from word of mouth or flyers. During their first three weeks on campus, interested students attended brief in-person orientation sessions, during which research staff explained study procedures and obtained written informed consent, and participants completed the baseline survey.

Participants were also invited to complete 12 monthly follow-up surveys. Invitations were sent by email on the last day of each month with an embedded link to a confidential survey website; the surveys required 10 to 20 minutes to complete, and participants had one week to complete them. Participants who missed surveys were allowed to resume participation with the next survey. Participants received \$20 (or credit for one hour of research if from the department participant pool) for the baseline survey, \$10 for each of the next 10 surveys, and \$15 and \$20 for the final two surveys; higher compensation was offered at baseline because that survey was the longest, and for the final two surveys to reduce attrition during the summer.

Measures

All predictors were assessed at baseline unless otherwise noted. Participants provided their age, sexual orientation (reduced to heterosexual or other), race (Asian, Black, White, or other/multiple), and ethnicity (Hispanic). Socioeconomic status (SES) was assessed at wave eight using a 10-point SES ladder (Adler, Epel, Castellazzo, & Ickovics, 2000).

Protective factors—Participants indicated their high school grade point average (GPA) on a 4.0 scale. Religiosity was measured with the global religiosity self-ranking item from the Brief Multidimensional Measure of Religiousness/Spirituality (Fetzer Institute, 1999). Health value was measured with the 4-item Health Value Scale (Lau, Hartman, & Ware, 1986). Self-esteem was measured with the 10-item Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965).

Risk factors—Impulsivity and sensation-seeking were each measured using six items (Magid, MacLean, & Colder, 2007) from the impulsiveness and monotony avoidance subscales, respectively, of the Impulsiveness Monotony Avoidance Scale (Schalling, 1978). Depression was measured with the Patient Health Questionnaire-9 (Spitzer, Kroenke, & Williams, 1999), anxiety with the Generalized Anxiety Disorder-7 (Spitzer, Kroenke, Williams, & Löwe, 2006), and perceived stress with the 4-item Perceived Stress Scale

¹Per university data, the sample represented 26% of all incoming female students at the university, with an equivalent ethnic breakdown.

(Cohen, Kamarck, & Mermelstein, 1983). Social comparison orientation, or the extent to which individuals compare themselves with others (e.g., peers), was measured with the six items that constitute the ability factor of the Iowa-Netherlands Comparison Orientation Measure (Gibbons & Buunk, 1999).

Substance use during the month prior to college entry was assessed, and specific anchor dates (i.e., August 1–31) were provided to facilitate recall. Participants indicated the number of days on which they used marijuana, the number of cigarettes they smoked each day in a typical week (summed for a measure of cigarettes per week), and the number of standard drinks they consumed each day in a typical week (summed for a measure of drinks per week).

Hookah use—Pre-college hookah use was assessed at baseline; participants indicated how many times they “ever smoked hookah before starting college (before August 26, 2009).” At each follow-up, participants indicated on how many days in the last month they “used hookah to smoke tobacco.” All last-month intervals were specified with anchor dates to facilitate recall.

Because the study spanned a year and involved 13 assessments, 2–18% of participants had missing data on hookah use at each follow-up.² To maintain the entire sample, we used multiple imputation, which is preferred over traditional approaches such as listwise deletion (Schafer, 1999). We imputed binary indicators of monthly hookah use (based on all observed data used in the analyses) because it was not feasible to impute count data for the number of days of hookah use. We then created a summary variable by summing the total number of months in which participants reported hookah tobacco smoking during the year-long follow-up (i.e., between waves 2–13); this count data outcome served as a measure of sustained hookah use over time. We imputed five complete datasets (Schafer, 1999) with the R package *mi* (Su, Gelman, Hill, & Yajima, 2011). Analyses were conducted with all five datasets, and parameter estimates were pooled using the imputation algorithms in Mplus 6 (Múthen & Múthen, 2010).

Analytic Approach

Count data tend to violate the assumptions needed for unbiased ordinary least squares regression (Atkins & Gallop, 2007). However, count regression accommodates non-negative integer outcomes with high positive skew. We first tested each variable as a univariate predictor of hookah initiation using zero-inflated negative binomial (ZINB) regression. Negative binomial regression was more appropriate than Poisson regression due to overdispersion, and ZINB regression was used instead of negative binomial regression due to the proportion (77%) of zeroes as well as a theoretical rationale that two processes likely lead to zeroes (i.e., some participants will never use hookah, whereas some will but simply did not do so during the period we observed). ZINB regression includes a logistic portion predicting non-occurrence of the outcome and a count portion predicting the frequency of the outcome when it occurs (Atkins & Gallop, 2007). Following recommendations for exploratory multivariate models, univariate predictors with $p < .25$ were candidates for the multivariate model (Hosmer & Lemeshow, 2000). We entered these candidates into a multivariate ZINB regression, with simultaneous entry of all predictors for both the logistic and count portions of the model. In the interest of parsimony, we removed variables with $p > .10$ in this model and then calculated the final multivariate model.

²Also, two participants had missing data for sexual orientation, one for high school GPA, one for health value, one for social comparison orientation, and 35 for SES; these missing data were also imputed.

Results

Pre-college hookah use was reported by 29% of participants ($n = 140$), for whom the mean number of days of use was 7.0 ($SD = 11.7$, median = 3, range: 1–100). These 140 participants were excluded from the present study of hookah initiation.

Participants were 343 first-year female college students who reported no pre-college hookah use. The average age at baseline was 18.1 years ($SD = 0.3$, range: 18–21), and 96% identified as heterosexual. The racial/ethnic distribution was 64% White, 14% Asian, 11% Black, and 12% other/multiple; 7% identified as Hispanic. Participants completed an average of 10.9 out of 12 ($SD = 2.3$, median = 12) follow-up surveys; response rates ranged from 86–98% during the academic year and 83–90% during the summer afterward. Descriptive statistics for all other predictors are presented in Table 1, along with Cronbach's α for all scales.

Seventy-nine participants (23%) initiated hookah use during the year-long follow-up. The average total number of months of hookah use for those who initiated was 2.0 ($SD = 1.3$, median = 2, range: 1–7). Results from the univariate ZINB regressions appear in Table 2. Based on the univariate results, we entered age, sexual orientation, high school GPA, religiosity, self-esteem, impulsivity, social comparison orientation, marijuana use, and alcohol use as predictors in both portions of a preliminary ZINB multivariate model; next, we removed predictors that were not statistically significant at $p < .10$ in either portion of the model and re-ran a more parsimonious final model. In the final multivariate model (see Table 3), alcohol use was the only significant predictor in the zero-inflation portion of the model. As alcohol use increased, the likelihood of being a zero (i.e., non-occurrence of the outcome) decreased; that is, the more alcohol use participants reported at baseline, the more likely they were to initiate hookah tobacco use. Impulsivity, social comparison orientation, and marijuana use were significant predictors in the negative binomial, or count, portion of the model; the higher these variables, the greater the predicted number of months of hookah tobacco use during the year-long follow-up.

Discussion

Hookah tobacco smoking, which has become increasingly common among college students (Sutfin et al., 2011), is an emerging public health concern (Akl et al., 2010). In this study, almost one-third of incoming first-year female college students had smoked hookah prior to college entry, consistent with the results of a study conducted in 2010 (Smith et al., 2011b) but higher than the 10% prevalence found in three previous studies (Barnett et al., 2009; Jordan & Delnevo, 2010; Primack, Walsh, Bryce, & Eissenberg, 2009). The higher rates found by Smith et al. (2011b) and in the current study are likely the result of sampling (i.e., our sample comprised first-year college students, who would have had more time and opportunities to use hookah than 9th–12th grade students sampled in earlier studies) and an ongoing cultural trend; that is, prevalence rates from these two recent studies (data collected in 2010) are higher than rates obtained in studies with data collection in 2005, 2007, and 2008. These and other studies suggest that the popularity of hookah has increased over the past few years; indeed, rates of hookah use among adults in California increased by 40% from 2005 to 2008 (Smith et al., 2011a).

We found that 23% initiated hookah tobacco smoking during their first year of college. Among women who initiated hookah smoking during the study, 45% reported use in only one month, suggesting that many young women who try hookah will experiment with it but not become frequent or regular users. The low-level involvement of many hookah users is consistent with the assertion that substance use is experimental for most emerging adults

(Arnett, 2005). More concerning from a health perspective are women who report frequent use. Because hookah smokers ingest nicotine, report increased pleasant subjective effects, and exhibit decreased tobacco abstinence symptoms (Maziak et al., 2009), abuse and dependence are possible.

The prospective design of this study allowed us to examine a variety of demographic, behavioral, and psychosocial predictors of hookah initiation. The strongest risk factors were alcohol and marijuana use; alcohol use predicted initiation, and marijuana use predicted frequency of use. These results corroborate prior research showing strong correlations between hookah and other substance use (e.g., Sutfin et al., 2011) and support the hypothesis of a cluster of substance use behaviors put forth in problem behavior theory (Jessor, 1991). Explanations for the connections among these forms of substance use may include the social aspect, predisposing personality traits, and the (“deviant”) act of smoking. Moreover, youth may have “socially organized opportunities to learn risk behaviors together and normative expectations that they be performed together” (Jessor, 1991, p. 600). Different forms of substance use may also co-occur because they have similar functions (e.g., coping, social affiliation, hedonistic benefits). Prevention and intervention efforts targeting hookah use will need to take into account the probable co-occurrence of multiple forms of substance use (Jessor, 1991).

Relatively few psychosocial risk or protective factors predicted hookah use. Impulsivity and social comparison orientation were positively associated with frequency of hookah use. When presented with the opportunity to use hookah, impulsive students may acquiesce to social influences more easily. Students who compare their behavior to others’ may be affected by perceived social norms (Perkins et al. 1999), especially in settings where hookah use is more prevalent and hookah lounges provide more access. College students overestimate the degree to which their peers use substances; only 9% of students used hookah in the last month, but 68% perceived that the typical student had (American College Health Association [ACHA], 2011).

Limitations of the Research

Recruitment from one university may limit the generalizability of our findings; however, the racial/ethnic distribution of our sample is equivalent to that of national samples of female students (e.g., ACHA, 2011). Future research should include men and study gender differences. Our sample had low rates and frequencies of cigarette smoking. Research should be conducted with a sample in which there is higher rates of, and more frequent, cigarette smoking. Although we improve on past research by using continuous rather than dichotomous indicators of hookah use, our outcome was number of months of use rather than a more sensitive daily measure. We assessed only a subset of possible predictor variables and followed participants for only their first year of college. Finally, given the state of the field, our analyses were necessarily exploratory.

Strengths of the Research

To our knowledge, this is the first prospective study of the predictors of hookah initiation. We surveyed almost 500 women about their hookah use during a key developmental period, the transition to college. Patterns of use of other tobacco products differ by gender (Rigotti et al., 2000), so it is useful and novel to investigate hookah use among women. We addressed a gap in the literature by investigating psychosocial predictors of hookah use, and our data clarify the ratio of experimenters to more frequent users. By using ZINB regression to accommodate the count outcome, we determined predictors of any use and of more frequent use.

Implications and Future Research

Because many youth only experiment with hookah a few times and because the strongest predictors of hookah tobacco smoking were other forms of substance use, prevention and intervention efforts should (a) focus on regular users and (b) jointly target hookah, marijuana, and alcohol use to optimize the public health impact. Future research should include males and non-college attending emerging adults, explore social norms related to hookah use, and investigate why some youth only experiment and others proceed to regular use.

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Table 1

Descriptive Statistics for Predictors (N = 343)

Predictor	M	SD	Median	Observed range	Cronbach's α
Socioeconomic status ^a	6.09	1.72	6	1–10	–
High school GPA	3.66	0.28	3.7	2.8–4.0	–
Religiosity	2.29	0.95	2	1–4	–
Health value	18.80	4.78	19	4–28	.69
Self-esteem	33.20	5.47	34	12–40	.90
Impulsivity	12.43	3.73	12	6–24	.81
Sensation-seeking	17.11	3.77	17	8–24	.82
Depression	5.34	4.24	4	0–24	.81
Anxiety	6.22	4.48	5	0–21	.86
Perceived stress	6.14	2.72	6	0–14	.73
Social comparison orientation	20.92	4.85	22	6–30	.83
Marijuana use (days/month)	0.70	2.84	0	0–31	–
Marijuana users ($n = 60$)	4.00	5.78	2	1–31	–
Cigarette use (cigarettes/week)	0.17	1.24	0	0–16	–
Cigarette smokers ($n = 16$)	3.75	4.58	2	1–16	–
Alcohol use (drinks/week)	3.80	6.54	0	0–55	–
Alcohol drinkers ($n = 163$)	8.01	7.50	6	1–55	–

Note. GPA = grade point average on a 4.0 scale.

^aThe socioeconomic status ladder asked participants to indicate the perceived socioeconomic standing of their family relative to other families in the U. S. The mean of 6.09 corresponds to middle to upper-middle class.

Table 2

Univariate Predictors of Hookah Initiation (N = 343)

Predictor	Zero-inflation Model				Count Model			
	B	SE	Z	Ratio	B	SE	Z	Ratio
Age	-4.958	12.803	-0.387	0.01	-2.395	1.459	-1.641	0.09 [†]
Asian ^a	0.499	0.575	0.868	1.65	-0.089	0.429	-0.207	0.91
Black ^a	0.465	0.784	0.594	1.59	-0.566	0.641	-0.882	0.57
Hispanic ^a	-0.660	1.069	-0.617	0.52	-0.256	0.657	-0.389	0.77
Other/multiple race/ethnicity ^a	0.143	0.776	0.184	1.15	-0.131	0.534	-0.246	0.88
Sexual orientation ^b	-8.693	296.825	-0.029	0.00	-2.904	1.040	-2.793	0.05 ^{**}
Socioeconomic status	0.049	0.109	0.450	1.05	0.062	0.081	0.769	1.06
High school GPA	1.076	0.680	1.582	2.93 [†]	0.188	0.436	0.430	1.21
Religiosity	0.327	0.207	1.580	1.39 [†]	-0.146	0.151	-0.966	0.86
Health value	0.002	0.038	0.051	1.00	0.013	0.029	0.447	1.01
Self-esteem	-0.018	0.033	-0.538	0.98	-0.034	0.026	-1.321	0.97 [†]
Impulsivity	-0.102	0.057	-1.782	0.90 [*]	0.051	0.039	1.305	1.05 [†]
Sensation-seeking	-0.052	0.050	-1.031	0.95	0.022	0.036	0.630	1.02
Depression	-0.053	0.063	-0.838	0.95	-0.003	0.039	-0.066	1.00
Anxiety	-0.025	0.044	-0.580	0.98	0.029	0.028	1.039	1.03
Perceived stress	-0.150	0.293	-0.511	0.86	0.020	0.082	0.239	1.02
Social comparison orientation	0.055	0.038	1.445	1.06 [†]	0.072	0.026	2.811	1.07 ^{**}
Marijuana (days/month)	-1.516	0.511	-2.969	0.22 ^{**}	0.011	0.021	0.492	1.01
Cigarettes (cigarettes/week)	-2.425	4.650	-0.521	0.09	0.037	0.050	0.738	1.04
Alcohol (drinks/week)	-0.349	0.116	-3.010	0.71 ^{**}	-0.004	0.017	-0.231	1.00

Note. B = regression estimate; SE = standard error; GPA = grade point average on a 4.0 scale. Ratios are odds ratios (predicting zeroes, or non-occurrence of hookah initiation) for the zero-inflation (logistic) portion of the model and incidence rate ratios for the negative binomial (count) portion of the model.

^aCoded 0 = no, 1 = yes.

^bCoded 0 = heterosexual, 1 = other.

[†] $p < .25$.
^{*} $p < .10$.
^{**} $p < .01$.

Table 3

Multivariate Predictors of Hookah Initiation (N = 343)

Predictor	Zero-Inflation Model				Count Model			
	B	SE	Z	Ratio	B	SE	Z	Ratio
Age	-1.566	2.612	-0.600	0.21	-1.918	1.250	-1.535	0.15
Impulsivity	-0.035	0.073	-0.485	0.97	0.083	0.037	2.261	1.09 *
Social comparison orientation	0.046	0.044	1.060	1.05	0.051	0.024	2.080	1.05 *
Marijuana (days/month)	-0.040	0.058	-0.692	0.96	0.069	0.025	2.800	1.07 **
Alcohol (drinks/week)	-0.293	0.102	-2.859	0.75 **	-0.022	0.015	-1.425	0.98

Note. B = regression estimate; SE = standard error. Ratios are odds ratios (predicting zeroes, or non-occurrence of hookah initiation) for the zero-inflation (logistic) portion of the model and incidence rate ratios for the negative binomial (count) portion of the model.

* $p < .05$.

** $p < .01$.