

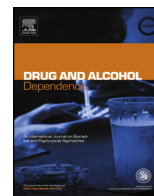


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Short communication

## Factors associated with smoking frequency among current waterpipe smokers in the United States: Findings from the National College Health Assessment II

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### ABSTRACT

**Background:** Some waterpipe smokers exhibit nicotine dependent behaviors such as increased use over time and inability to quit, placing them at high risk of adverse health outcomes. This study examines the determinants of dependence by measuring frequency of use among current waterpipe smokers using a large national U.S. sample.

**Methods:** Data were drawn from four waves (Spring/Fall 2009 and Spring/Fall 2010) of the American College Health Association-National College Health Assessment datasets. The sample was restricted to students who smoked a waterpipe at least once in the past 30 days ( $N=19,323$ ). Ordered logistic regression modeled the factors associated with higher frequency of waterpipe smoking.

**Results:** Among current waterpipe smokers, 6% used a waterpipe daily or almost daily (20–29 days). Daily cigarette smokers were at higher odds of smoking a waterpipe at higher frequencies compared with non-smokers of cigarettes (OR = 1.81; 95% CI = 1.61–2.04). There was a strong association between daily cigar smoking and higher frequency of waterpipe smoking (OR = 7.77; 95% CI = 5.49–11.02). Similarly, students who used marijuana had higher odds of smoking a waterpipe at higher frequencies (OR = 1.57; 95% CI = 1.37–1.81).

**Conclusions:** Daily consumers of other addictive substances are at a higher risk of intensive waterpipe smoking and thus higher risk of waterpipe dependence. Intervention programs must incorporate methods to reduce waterpipe dependence and subsequently prevent its deleterious health effects.

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### 1. Introduction

Waterpipe smoking (also known as hookah, shisha, and narghileh) is increasing in popularity in the United States, with the highest prevalence rates reported among college students (Maziak et al., 2015; Salloum et al., 2014). Waterpipe smoke contains many of the same toxicants as cigarette smoke (Shihadeh et al., 2015), and waterpipe smoking has been associated with respiratory and cardiovascular illnesses, periodontal disease, and obstetric and perinatal complications (Akl et al., 2010; El-Zaatari et al., 2015). Similar to cigarette smokers, waterpipe smokers exhibit nicotine

dependent behaviors such as increased use over time, drug-seeking behaviors, withdrawal symptoms following abstinence, and inability to quit even after repeated attempts (Kassim et al., 2014; Maziak et al., 2005).

To assess the magnitude and implication of this addictive behavior, there is a need to understand dependence patterns of waterpipe smokers and identify those at high risk of becoming addicted. Waterpipe smoking delivers the same or higher doses of nicotine compared with cigarette smoking (Cobb et al., 2011; Eissenberg and Shihadeh, 2009), with daily users exposed to considerably higher levels (Maziak et al., 2011). While waterpipe smoking is mainly an intermittent tobacco use method, smoking frequency increases with prolonged use (Asfar et al., 2005). Higher frequency of waterpipe use is associated with younger age at initiation, perception of being hooked, and smoking a waterpipe in groups (Ward et al.,

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2007). Higher waterpipe smoking frequency is also correlated with physiological dependence, psychological craving, positive reinforcement, and higher scores on a waterpipe-specific dependence measure (Salameh et al., 2008). These results suggest that smoking frequency may be an acceptable proxy for waterpipe dependence.

Recent studies have examined waterpipe smoking patterns in the U.S., in particular, the correlates of current waterpipe smoking. However, most have been limited to specific geographic regions. For example, Eissenberg et al. (2008) conducted a study among college students in Virginia, revealing that 20% were current waterpipe smokers and more likely to be male, younger than 20 years, and white. A study using the 2008–2009 National College Health Assessment (NCHA) showed that 8.4% are current waterpipe smokers and that current waterpipe smoking was strongly associated with younger age, male gender, white race, and fraternity/sorority membership (Primack et al., 2013). Other studies using local/regional samples have also reported that gender, ethnicity, and cigarette use are associated with current waterpipe smoking (Smith-Simone et al., 2008; Sutfin et al., 2011). Overall, these studies have concluded that college students have some of the highest prevalence rates for waterpipe smoking (Akl et al., 2011; Maziak et al., 2015).

While we are beginning to understand waterpipe smoking patterns in the U.S. and worldwide, there is limited knowledge about dependence among waterpipe smokers. Using frequency of use as a proxy to waterpipe dependence, a study in Syria found that daily smokers – compared to weekly/monthly – were more likely to be male, smoke alone at home and less likely to share their waterpipe with others (Maziak et al., 2004). However, the extent and correlates of waterpipe dependence among the adult population in the U.S. has not been investigated. A better understanding of waterpipe smoking dependence is critically needed to inform intervention and prevention strategies among youth. Using NCHA data, this study provides national estimates of the prevalence and correlates of frequent waterpipe smoking as a proxy to dependence among U.S. college students.

## 2. Methods

### 2.1. Data source

The NCHA has been administered by the American College Health Association (ACHA) to assess the health and well-being of university students since 2000. The survey collects data from random samples of students at voluntarily participating universities on physical health, mental health, use and dependence on alcohol, tobacco or drugs, sex behavior and contraception practices, weight, nutrition and exercise along with student demographic information (American College Health Association, 2008). Further details on survey methodology are reported elsewhere (Jarrett et al., 2012). Our study sample was pooled from four waves (semesters) of ACHA-NCHA II datasets (Spring/Fall, 2009 and Spring/Fall, 2010) and included 247,118 respondents. For the dependence related analysis (frequency of use as a proxy), our sample was restricted to 19,323 students who smoked a waterpipe at least once in the past 30 days [Within the last 30 days, on how many days did you use tobacco from a waterpipe (hookah)?]. Approval for the study protocol was obtained from the Institutional Review Board of the University of South Carolina.

### 2.2. Dependent variable

Students who smoked a waterpipe in the past 30 days were asked to report frequency of smoking by category: (1) 1–2 days, (2) 3–5 days, and (3) 6–9 days, (4) 10–19 days, (5) 20–29 days, and (6) daily. Thus, the dependent variable for the correlates of frequent waterpipe smoking was treated as an ordinal variable with six levels.

### 2.3. Independent variables

The main predictor of interest was frequency of cigarette smoking, for which students were categorized as non-smokers, non-daily smokers, or daily smokers. We also included frequency of use for the following tobacco and drug products: cigar smokers (non-smokers, non-daily, or daily), smokeless tobacco use (never, non-daily, or daily), marijuana use (never, non-daily, or daily), cocaine use (never, non-daily, or daily), and alcohol use (never, non-daily, or daily). We defined

participants as *non-smokers/never users* if they never used the product; *non-daily users* if they ever used the product but were not daily users; and *daily users* if they used the product every day for the past 30 days. Other covariates in our analysis include age (in years), gender (male or female), race/ethnicity (white, African American, Hispanic/Latino, Asian/Pacific Islanders, or other), sexual orientation (heterosexual/straight or lesbian/gay/bisexual/transgender [LGBT]), marital status (married/partnered or not married), educational status (undergraduate or graduate/professional/other), residence (on-campus or off-campus), fraternity/sorority membership, and geographic region (Northeast, Midwest, South, or West).

### 2.4. Data analyses

For descriptive statistics, we measured frequency and percentage of sample characteristics for current waterpipe smokers and less than current waterpipe smokers. Multilevel ordered logistic regression was used to model the factors associated with increased frequency of smoking among current waterpipe smokers. College ID was used as the random effect in this model to account for possible confounding among students within the same institution. We tested the proportionality odds assumption (i.e., whether the distances among categories are equal) after fitting the model. Our modeling assumption was appropriate given the large sample size (Long and Freese, 2006). We also obtained similar results using an alternative ordinary least squares model (results not shown). The multilevel ordered logistic model was selected over ordinary least squares due to ease of interpretation. All analyses were performed with STATA version 13.1.

## 3. Results

### 3.1. Characteristics of current waterpipe smokers versus not current smokers

Among current waterpipe smokers ( $N = 19,323$ ), 536 (2.8%) were daily users, and another 612 (3.2%) reported smoking on 20–29 days (almost daily) in the past month (Table 1). In terms of concurrent tobacco use, the majority of current waterpipe smokers were non-daily cigarette smokers (56.6%), and non-daily cigar smokers (62.6%). Meanwhile, 30.8% of current waterpipe smokers never smoked a cigarette. The majority of students who were not current waterpipe smokers did not smoke cigarettes (70.3%), did not smoke cigars (76.1%), never used smokeless tobacco (90.7%), never smoked marijuana (68.2%), and never used cocaine (94.7%). Almost 25% of students who did not currently smoke a waterpipe never consumed alcohol while only 3.6% of current waterpipe smokers never consumed alcohol. The majority of current waterpipe smokers in this sample were female (52.9%), white (71.5%), heterosexual (91.9%), unmarried (97.1%), at the undergraduate level (95.0%), and not members in a fraternity/sorority (85.8%). Approximately half of current waterpipe smokers (50.1%) resided on-campus whereas the majority (57.7%) of non-current waterpipe smokers resided off-campus.

### 3.2. Predictors of waterpipe smoking frequency

Multilevel ordered logistic regression results (Table 2) showed that daily (OR = 1.81; 95% CI = 1.61–2.04) and non-daily (OR = 1.24; 95% CI = 1.14–1.35) cigarette smokers were at higher odds of smoking a waterpipe at higher frequencies compared with non-smokers of cigarettes. Strong correlates of high waterpipe smoking frequency included daily (OR = 7.77; 95% CI = 5.49–11.02) and non-daily (OR = 1.11; 95% CI = 1.03–1.21) cigar smoking, daily (OR = 1.57; 95% CI = 1.37–1.81) and non-daily (OR = 1.12; 95% CI = 1.03–1.21) marijuana smoking, and daily use of cocaine (OR = 18.49; 95% CI = 8.24–41.50). Whereas daily alcohol consumption was correlated with high waterpipe smoking frequency (OR = 1.84; 95% CI = 1.39–2.43), non-daily use of alcohol was significantly associated with lower waterpipe smoking frequency (OR = 0.71; 95% CI = 0.59–0.85). Compared to white waterpipe smokers, African Americans (OR = 1.26; 95% CI = 1.00–1.58), Asians (OR = 1.18; 95% CI = 1.05–1.33) and students from other races/ethnic groups (OR = 1.19; 95% CI = 1.06–1.34) were at higher odds of smoking a

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