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Young adult waterpipe smokers: Smoking behaviors and associated subjective and physiological effects

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HIGHLIGHTS

- Waterpipe smokers compensate behaviorally through puffing.
- Occasional waterpipe smoking is associated with headrush.
- Waterpipe smoking is associated with an increased heart rate.
- Non-nicotine waterpipe smoking is associated with high levels of carbon monoxide.

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ABSTRACT

Introduction: The purpose of this pilot study was to investigate smoking behaviors and subjective and physiological effects of nicotine on young adult occasional waterpipe smokers.
Methods: This study utilized a repeated-measures design that included one repeated factor for condition (nicotine and non-nicotine). For each participant, the sequencing of the repeated factor was assigned using random allocation. The two nicotine conditions were nicotine (0.75 g) and non-nicotine (0 g placebo) tobacco. Over the course of two weeks, twenty-two participants completed subjective (Acute Subjective Effects of Nicotine) and physiological (blood pressure, heart rate, and CO level) measures. Additional measures (QSU and MNWS-R) were used to assess for withdrawal symptoms.
Sample: The participants (n = 22) were young adults (23 ± 3.1 years); 71% smoked waterpipe once a month in the past year and 29% smoked waterpipe 1–2 times per week. In addition, 60% reported sharing their waterpipe with friends while smoking. None of the participants reported using any other forms of tobacco products.
Results: Under the nicotine condition, participants tended to smoke longer (i.e. smoking duration, $p = 0.004$), take more puffs ($p = 0.03$), take shorter puffs ($p = 0.03$), and inhale less volume with each puff ($p = 0.02$). The repeated measures analysis of the factor *headrush* revealed an effect of the nicotine condition ($F = 9.69$, $p < 0.001$, partial $\eta^2 = 0.31$) and time ($F = 8.17$, $p = 0.02$, partial $\eta^2 = 0.30$). Heart rate increased significantly across the nicotine condition ($F = 7.92$, $p = 0.01$, partial $\eta^2 = 0.31$) and over time ($F = 12.64$, $p = 0.01$, partial $\eta^2 = 0.41$).
Conclusions: This study demonstrates how differences between nicotine and non-nicotine waterpipe smoking are associated with changes in smoking behaviors, experiencing a *headrush* and an increase in heart rate.

1. Introduction

Nearly all adults who smoke cigarettes started smoking before the age of 26 (U.S. Department of Health and Human Services, 2012). One in every four senior high school students uses tobacco (Arrazola, Dube, & Engstrom, 2012). As youth transition to adulthood, tobacco use becomes more prevalent (U.S. Department of Health and Human Services, 2012). In fact, young adults (18–25 years old) currently have the highest prevalence of cigarette smoking of all age groups (Substance Abuse and Mental Health Services Administration [SAMHSA], 2011).

In recent years, waterpipe smoking has become increasingly popular. Waterpipe smoking is becoming the most common type of tobacco smoking after cigarettes among U.S. young adults (Cobb, Khader, Nasim, & Eissenberg, 2012; Primack et al., 2008, 2013). Reports have shown a 40% increase from 2005 to 2008 (Smith et al., 2011). This rise is a major concern in the U.S. and globally (Maziak, 2011; The First International Conference on Waterpipe Tobacco Research Declaration, 2013; U.S. Department of Health and Human Services, 2012; World Health Organization, 2005).

Typically, waterpipe smoking in the young adult population is non-daily, with the majority smoking only on weekends (Ahmed, Jacob,

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Allen, & Benowitz, 2011). Additionally, substantial proportions (6–41%) of current waterpipe smokers do not report the use of other tobacco products (Cobb et al., 2012; Primack et al., 2013). As such, waterpipe smoking is affecting a population of otherwise nicotine-naïve individuals who might not have initiated tobacco use without waterpipes. This raises the concern that waterpipe smoking may serve as a portal to nicotine dependence (Maziak et al., 2009; Ward et al., 2007). Thus, understanding waterpipe smoking behaviors and the consequences of waterpipe smoking in young adult occasional smokers who do not smoke cigarettes or use other tobacco products is imperative.

Exposure to waterpipe tobacco smoke poses a serious health risk (Akl et al., 2010; Al Mutairi, Shihab-Eldeen, Mojiminiyi, & Anwar, 2006; Al-Kubati, Al-Kubati, al'Absi, & Fiser, 2006; Aydin et al., 2004; Boskabady, Farhang, Mahmodinia, Boskabady, & Heydari, 2012; El-Nachef & Hammond, 2008; El-Setouhy et al., 2008; Sajid, Chaouachi, & Mahmood, 2008; Sepetdjian, Shihadeh, & Saliba, 2008). Waterpipe smoke delivers the same or larger quantities of harmful gases and cancer-causing toxins as cigarettes (Al Rashidi, Shihadeh, & Saliba, 2008; Jacob et al., 2011, 2013; Saleh & Shihadeh, 2008; Sepetdjian et al., 2008; Shihadeh et al., 2012). The American Cancer Society warns that waterpipe tobacco smoking is linked to heart disease and cancers in a manner similar to cigarette smoking (American Cancer Society, 2012). However, current knowledge of waterpipe tobacco smoking is based largely on samples of dual users of both waterpipes and cigarettes (Blank et al., 2011; Eissenberg & Shihadeh, 2009; Rastam et al., 2011).

Using puff topography (puff numbers, volume, duration, and intermittent puff intervals [IPI]) measures, studies demonstrated that waterpipe smokers adjusted puffing during each smoking session by controlling the number of puffs and the volume of inhaled tobacco smoke in each puff (Eissenberg & Shihadeh, 2009; Maziak et al., 2009). Self-regulation is well demonstrated in cigarette smokers where the dose of nicotine obtained from tobacco products is regulated by the number of puffs, the duration of individual puffs, and the volume of inhaled tobacco smoke (Husten, 2009). This is further evidenced by waterpipe smoking studies. A study of dependent dual users found that plasma nicotine levels increased with an increase in total inhaled tobacco smoke volume, while puff number and total smoke volume decreased over the course of a waterpipe smoking session (Maziak et al., 2011). Similarly, a study of occasional dual users of waterpipe and cigarettes, ages 18–50, found that puff number and total smoke volume decreased over time (Blank et al., 2011). Smoking behaviors among younger naïve waterpipe smokers have not been studied. Therefore, a comparison of the nicotine and non-nicotine conditions will help in better understanding the effects of nicotine on waterpipe smoking behaviors in the young adult population.

Evidence suggests that non-daily cigarette smokers seek immediate positive reinforcement from cigarette smoking (Glautier, 2004), while daily smokers seek drug maintenance to avoid withdrawal symptoms when smoking—negative reinforcement (Shiffman, Dunbar, Scholl, & Tindle, 2012). A survey of occasional waterpipe smokers indicated that the most commonly reported subjective effect was lightheadedness (Ahmed et al., 2011). In a laboratory-based study examining the effectiveness of waterpipe and cigarette smoking in reducing tobacco abstinence symptoms experienced by dependent dual users of waterpipe and cigarettes, participants experienced lightheadedness, nausea, and dizziness (Maziak et al., 2009; Rastam et al., 2011). However, in a laboratory-based study comparing the subjective effects of waterpipe tobacco by occasional dual users of waterpipe and cigarettes compared to a placebo, subjective effects observed were not related to the nicotine condition (Blank et al., 2011). The subjective effects of nicotine on occasional waterpipe smokers who do not use other tobacco products need to be examined.

The purpose of this study was to inform our limited knowledge of the effects of waterpipe smoking on young adults in the U.S. who do not smoke cigarettes or use tobacco products other than occasional waterpipe smoking. The primary aim of this study was to examine smoking behaviors (puff topography) and the associated subjective and physiological effects of nicotine throughout waterpipe smoking session by comparing these parameters during a nicotine and a non-nicotine condition. The research hypotheses tested whether smoking behaviors differ by nicotine condition and can be associated with the direct effect of nicotine.

2. Materials and methods

2.1. Participants

Twenty-two participants were recruited. Inclusion criteria were: (a) 18–30 years of age, (b) smoked a waterpipe at least 10 times in the past year, and (c) had not smoked a waterpipe more than two times per week in the past 3 months. Exclusion criteria were: (a) smoked cigarettes or used any other tobacco product, (b) the use of illicit drugs, including marijuana and prescribed opioids, in the past 14 days, and (c) pregnancy. Participants were recruited from the community through postings on craigslist and flyers. Participants were compensated financially for their time. This study was approved by the Institutional Review Board at Washington State University.

2.2. Study procedures

This study as reported here utilized a repeated-measures design that included one repeated factor for condition (nicotine and non-nicotine). For each participant, the sequencing of the repeated factor was assigned using random allocation. The two nicotine conditions were nicotine (0.75 g) and non-nicotine (0 g placebo) tobacco. Initially, the study was designed to include a second repeated factor focusing on two target smoke volumes: low volume (40 liters) and high volume (80 liters) such that there were four conditions (high-volume nicotine, high-volume non-nicotine, low-volume nicotine, and low-volume non-nicotine). However, initial analyses showed that the low-volume conditions did not produce a meaningful amount of variance in the primary outcomes. Participants smoking low volumes of nicotine and non-nicotine tobacco reached the total volume of smoke inhaled in approximately 24 min and 14 min respectively. This was a truncated timeframe, and thus produced a period of outcome observation that was qualitatively different from the high-volume visits, which made a comparison between high and low conditions difficult to interpret. Based on the puff topography data, the low-volume conditions were met early due to the number of puffs and tobacco smoke volume inhaled early in the visit. Consequently, the study design and analyses reported here only include the two conditions of nicotine and non-nicotine tobacco at the high volume (80 liters).

Each participant attended three visits during a week, one smoking visit and two follow-up visits, on consecutive days, for a total of 2 weeks (one week for each smoking condition). Follow-up visits were conducted at 24 and 48 h after completion of the smoking visit to assess for withdrawal symptoms. Upon completion of all visits, participants were given monetary compensation of $25 for each smoking visit and $20 for each follow-up visit. A bonus of $40 was given for completion of all study visits.

Once consent was obtained, the Lebanon Waterpipe Dependence Scale (LWDS) was administered to assess for nicotine dependence (Salameh, Waked, & Aoun, 2008). Participants were asked to abstain from nicotine for at least 24 h before the smoking visit and through both follow-up visits each week; abstinence from nicotine was verified by saliva cotinine using the NicAlert test (<10 ng/ml) and a CO measurement (<7 ppm). Participants were blinded to study condition assignments.

All smoking visits took place in a private, fenced, outdoor location. Measures were taken to provide a natural smoking environment (e.g., participants were provided with magazines to read).