



Waterpipe smoking patterns and symptoms of nicotine dependence: The Waterpipe Dependence in Lebanese Youth Study

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HIGHLIGHTS

- Waterpipe (WP) is characterized by intermittent use pattern over long smoking sessions.
- Increasing use of WP was associated with shorter time to attaining nicotine dependence (ND) symptoms.
- Longer smoking session was associated with shorter time to attaining ND symptoms.
- Length of smoking session emerged as a novel, single indicator of ND among WP smokers.

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ABSTRACT

Introduction: Waterpipe typically is smoked intermittently over long smoking sessions. Waterpipe is addictive and its users show symptoms of nicotine dependence (ND). This study examined the risk of developing ND symptoms across waterpipe use patterns among Lebanese youth.

Methods: Waterpipe use patterns (length of smoking session, smoking a whole waterpipe without sharing, past-30 day use frequency, number of waterpipes smoked) were assessed. Symptoms of ND were assessed using the 10-item Hooked on Nicotine Checklist (HONC; endorsement of ≥ 1 symptom) and the 6 criteria of the International Classification of Diseases-10th revision (ICD-10 ND; presence of ≥ 3 criteria during 12 months).

Results: Both the proportion of participants endorsing ND symptoms and the average number of endorsed ND symptoms increased with increasing waterpipe use frequency, number of waterpipes smoked, and length of smoking session. The risk of endorsing ≥ 1 HONC symptom increased with increasing number of waterpipes smoked in the past 30-days (≥ 10 vs. < 4 waterpipes; Hazard ratio (HR) = 2.05, 95% CI: 1.52–2.58, $p = 0.007$), and session length (> 60 min vs. < 30 min; HR = 2.87, 95% CI: 2.83–2.91, $p = 0.001$). The risk of attaining ICD-10 ND increased with increasing number of waterpipes used in the past 30-days (≥ 10 vs. < 4 waterpipes; HR = 2.56, 95% CI: 1.89–3.22, $p = 0.006$), and smoking every day/almost every day vs. less than once weekly (HR = 2.86, 95% CI: 2.12–3.60, $p = 0.007$).

Conclusions: Increasing use frequency, number of waterpipes smoked, and longer smoking sessions were associated with higher risk of ND. The length of smoking session emerged as a novel indicator of ND among waterpipe smokers.

1. Introduction

Waterpipe use has emerged as a new strain of the global tobacco

epidemic, mainly affecting youth (WHO, 2015). In many Eastern Mediterranean countries, waterpipe has exceeded cigarettes as the most common tobacco used among youth (WHO, 2015). Waterpipe users are

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exposed to the same toxic chemicals found in cigarettes, such as polycyclic aromatic hydrocarbons, carbon monoxide, and nicotine (Eissenberg & Shihadeh, 2009). Many waterpipe users are at risk of smoking-related health problems such as lung cancer, cardio-respiratory illnesses (El-Zaatari, Chami, & Zaatari, 2015), and nicotine dependence (ND) (Aboaziza & Eissenberg, 2015). In contrast to cigarettes, waterpipe consists of different components (head, body, water bowl, hose), is less accessible (Maziak, Taleb, Bahelah, et al., 2015), and usually is smoked intermittently over smoking sessions that can last ≥ 60 min (Sidani, Shensa, & Shiffman, 2016). During these long smoking sessions, waterpipe smokers inhale approximately 50–80 L of tobacco smoke compared with 0.5–0.8 L from smoking a single cigarette (Eissenberg, 2013). So, while less accessibility and intermittent smoking might reduce the exposure to nicotine, the length of a smoking session can play an important role in exposure to higher doses of nicotine and emergence of ND symptoms among waterpipe smokers. Moreover, the time spent during a single smoking session and a total volume of inhaled nicotine-containing tobacco smoke correlate positively with plasma nicotine levels (Maziak, Rastam, & Shihadeh, 2011). As nicotine is easily absorbed through the mouth and lungs into the blood circulation (Benowitz, Hukkanen, & Jacob, 2009), levels of plasma nicotine accumulate gradually over long smoking sessions which may explain why waterpipe smokers take more time, compared with cigarette smokers, to experience abstinence-induced withdrawal/craving symptoms (Cobb, Shihadeh, Weaver, & Eissenberg, 2011; Rastam, Eissenberg, & Ibrahim, 2011).

Waterpipe smoking patterns may influence ND symptoms differently than cigarettes (Aboaziza & Eissenberg, 2015). Few studies have examined the association between use patterns and ND symptoms among waterpipe smokers and these studies have limitations. For example, some studies failed to control for important factors related to ND (e.g., use of cigarettes/other tobacco) (Kassim et al., 2014; Primack, Khabour, Alzoubi, et al., 2014), while others applied cigarette-based measures of ND that may not be applicable to waterpipe-specific use patterns (Auf, Radwan, & Loffredo, 2012; Sidani et al., 2016).

Available evidence shows that cigarette smoking frequency (e.g. number of cigarettes or days of smoking) is correlated with ND symptoms among adolescents (Caraballo, Novak, & Asman, 2009; Lessov-Schlaggar, Hops, & Brigham, 2008; O'Loughlin, DiFranza, & Tyndale, 2003). As waterpipe has unique use patterns that differ from cigarettes, whereby exposure intensity can be related to both length of smoking session (averaging an hour compared to 5 min for cigarettes; Maziak et al., 2015) as well as frequency of smoking, it is important to include other aspects of waterpipe use such as the length of a smoking session in assessing determinants of ND among young waterpipe smokers.

Using baseline data from the *Waterpipe Dependence in Lebanese Youth* (WDLY) study, we showed that smoking a whole waterpipe without sharing and the length of a smoking session were among the factors strongly associated with ND (Bahelah, DiFranza, & Ward, 2016a). Using a survival analysis, the current study aims to examine the risk of attaining the first ND symptom (as measured by Hooked on Nicotine Checklist "HONC") and the full syndrome of ND (as measured by ICD-10 ND criteria) and how this risk differs by smoking patterns among adolescent waterpipe smokers. We hypothesize that the risk of attaining the first symptom and full syndrome of ND will be positively associated with the length of smoking session, higher smoking frequency and number of waterpipes smoked, and smoking a whole waterpipe without sharing, as all of these behaviors would result in more frequent or more intense nicotine dosing. Findings from this study will facilitate the understanding of the relationship between unique use patterns of waterpipe such as the length of a smoking session and experiencing ND symptoms among adolescent smokers.

2. Methods

2.1. Participants

The sample for this study consists of 160 current waterpipe smokers recruited at baseline from the WDLY study. WDLY is a cohort study of 498 adolescent smokers and never smokers (mean \pm SD age at baseline for the whole sample = 14.1 \pm 1.1 years) enrolled in 8th and 9th school grades from 4 regions in Lebanon (Beirut, Mount Lebanon, Nabatiye, South Lebanon). Inclusion criteria were evaluated using in-class, self-administered questionnaires. Never smokers who had the intention to initiate smoking and those who smoked either waterpipe or cigarettes, but not both, in the past 30 days were eligible to participate. Dual users were ineligible because it would not be possible to determine the unique contribution of waterpipe use to ND symptoms among dual users. We inquired about lifetime and past 30-day use of tobacco products (waterpipe, cigarettes, cigar/cigarillos, smokeless tobacco, electronic cigarettes) at the initial screening to determine eligibility. No student reported use of tobacco products other than cigarettes and waterpipe. We limited the sample of this study to those used waterpipe in the past 30-days as this is the standard measure of current use in adolescent smokers (U.S. Department of Health and Human Services, 2014), and that less frequent use is less likely to be associated with ND among adolescents (O'Loughlin et al., 2003). More details about the WDLY study can be found elsewhere (Bahelah et al., 2016a).

2.2. Procedures

Using interviewer-administered questionnaires, participants provided information about their tobacco use patterns and responded to measures of ND (Bahelah et al., 2016a; DiFranza et al., 2007). Interviewers met participants individually in private rooms on school premises and school personnel were not allowed during interviews to minimize social-desirability bias. During interviews, participants provided exact dates for first developing important milestones that include ever smoking a whole waterpipe without sharing, endorsement of ND symptoms from the Hooked on Nicotine Checklist (HONC), and the criteria of ND using the International Classification of Diseases-10th revision (ICD-10 ND). Recall of the dates of these milestones was facilitated by the use of 4 techniques proved to improve recall of past events: decomposition, bounded recall, personal landmarks, and the depiction of these landmarks visually to create a personal calendar for each student (Bahelah et al., 2016a; DiFranza et al., 2007). However, if the exact date could not be recalled, we recorded the 7th for events in the beginning of the month, the 14th for middle of the month, and the 21st for events toward the end of the month (Bahelah et al., 2016a). The study protocol was approved by the institutional review boards of Florida International University and the American University of Beirut.

2.3. Measures

Selection of smoking patterns and important covariates in this study was guided by a review of the factors associated with ND among adolescent smokers (Kleinjan, Vitaro, & Wanner, 2012; Racicot, McGrath, & Karp, 2013) and symptoms of ND among waterpipe smokers (Bahelah et al., 2016a; Maziak, Eissenberg, & Ward, 2005). Smoking patterns assessed in this study were: (a) *Past 30-day use frequency* (smoked waterpipe less than once a week, smoked at least once a week but not every day, smoked every day/almost every day), (b) *Past 30-day number of waterpipes smoked* (divided into 3 categories: < 4 , 4–9, and ≥ 10), (c) *Usual length of a waterpipe smoking session* (< 30 min, 30–60 min, > 60 min), and (d) *Ever smoking a whole waterpipe without sharing* (Yes, No). Smoking a whole waterpipe without sharing was asked as a lifetime measure rather than a past 30 day measure, as this was considered a milestone, similar to asking cigarette smokers if they have ever smoked a whole cigarette (e.g., Hu,

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