Drug and Alcohol Dependence 170 (2017) 152–155

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Short communication

Association between breath alcohol concentration and waterpipe lounge patrons' carbon monoxide exposure: A field investigation

Eleanor L. Leavens[a,b], Emma I. Brett[b], Summer Frank[a], Raees A. Shaikh[a], Thad R. Leffingwell[b], Julie M. Croff[c], Theodore L. Wagener[a,*]

[a] Oklahoma Tobacco Research Center, Oklahoma City, OK, United States
[b] Department of Psychology, Oklahoma State University, Stillwater, OK, United States
[c] School of Applied Health and Educational Psychology, Oklahoma State University, Stillwater, OK, United States

ARTICLE INFO

Article history:
Received 14 September 2016
Received in revised form 9 November 2016
Accepted 12 November 2016
Available online 16 November 2016

Keywords:
Waterpipe
Tobacco
Smoking
Alcohol
Drinking
Toxicant exposure
Co-use

ABSTRACT

Background and aims: Concurrent alcohol use and waterpipe (WP) smoking is common among young adults. WP smokers are more than twice as likely to use alcohol as non-users and frequently consume alcohol immediately before and during a WP smoking session. It is unclear what impact alcohol has on WP smoking patterns and resultant exposure to tobacco-related toxicants. The current research aimed to understand the association between alcohol consumption and WP smoke exposure among WP lounge patrons.

Methods: Seventy-one lounge patrons (66.2% male; M_{age} = 27.03, SD = 5.32) completed pre- and post-WP session self-report measures and biomarkers of smoking (expired carbon monoxide; eCO) and alcohol consumption (breath alcohol concentration; BrAC) upon entering and exiting the WP lounge.

Results: After controlling for number of bowls and charcoals smoked, greater consumption of alcohol was associated with greater smoke exposure among WP lounge patrons ($p < 0.05$), such that a 0.1 unit increase in BrAC was associated with an eCO increase of 19.44 ppm. This relationship was mediated by time spent in the WP lounge.

Conclusions: Concurrent alcohol use resulted in greater eCO, likley due to participants spending a greater amount of time in the WP lounge and experiencing longer sustained exposure to secondhand smoke. These findings illustrate a need for further research on the impact of alcohol consumption on WP smoking to assess the potential need for regulation of these products in WP lounges.

1. Introduction

Waterpipe (WP; a.k.a. "hookah") tobacco smoking is rapidly increasing in the U.S., particularly among young adults (Arrazola et al., 2015). WP smoke contains many of the same toxicants present in cigarette smoke (Al Rashidi et al., 2008; Daher et al., 2010; Sepetdjian et al., 2008) and is associated with many of the same negative health outcomes as cigarette smoking (Akl et al., 2010). Alcohol is often consumed in conjunction with WP smoking (Goodwin et al., 2014; Haider et al., 2015; Jarrett et al., 2012; Sutfin et al., 2011; Villanti et al., 2015). Notably, WP smokers are about twice as likely to use alcohol compared to their nonsmoking counterparts (Sutfin et al., 2011). More than two-thirds of WP lounge patrons over the minimum legal drinking age report consuming alcohol before, during, and/or after WP smoking (Soule et al., 2012). WP smokers in qualitative research report alcohol and WP are complementary behaviors and concurrent alcohol consumption increases the positive effects of WP smoking (Soule et al., 2015).

Systematic research with objective measurements of smoking and drinking patterns is needed to understand the interaction of WP smoking and alcohol consumption. To date, no studies have been conducted in a controlled laboratory setting or with biochemical verification of WP smoking and alcohol consumption. However, inferences regarding the influence of alcohol on WP smoking can be drawn from the existing cigarette smoking literature. Research indicates that individuals not only initiate smoking earlier and have more difficulty abstaining from smoking after consuming alcohol; they also smoke a greater number of cigarettes (Kahler et al., 2014; McKee et al., 2006). If alcohol's effects on WP smoking are similar,

* Corresponding author at: Oklahoma Tobacco Research Center, University of Oklahoma Health Sciences Center, 655 Research Parkway, Oklahoma City, OK 73104, United States.
E-mail address: Theodore-wagener@ouhsc.edu (T.L. Wagener).

http://dx.doi.org/10.1016/j.drugalcdep.2016.11.010
0376-8716/

we would expect increased exposure to harmful tobacco-related toxicants.

The current study investigates the association between alcohol consumption and WP smoking using both self-report measures and biochemical markers of smoking (expired carbon monoxide; eCO) and alcohol (breath alcohol concentration; BrAC) for WP smokers visiting a WP lounge. We hypothesized that greater alcohol consumption would be associated with increased smoke exposure.

2. Method

2.1. Participants and procedure

WP lounge patrons were recruited from lounges in a Midwestern city from July to October 2015. The city had three WP lounges, one which served alcohol. To increase the likelihood of recruiting individuals with elevated BrACs, we selected the lounge that served alcohol and randomly selected a lounge from the other two. Both lounges allowed WP smoking indoors while one also allowed outdoor smoking. Participants planning to smoke outdoors were not eligible for the current study. All WP lounge patrons were invited to participate. Potential participants were approached outside WP lounges and invited to take part in a study "examining hookah smoking and associated behaviors." Participants were informed of the general nature of the research (e.g., WP smoking and impact of associated behaviors) but information about specific behaviors, hypotheses, and post-session assessment measures was not shared. Interested individuals were assessed for eligibility (≥18, English-speaking, and planning to smoke WP indoors that evening). Eligible participants provided informed consent and completed measures of demographic information and WP and alcohol use history upon entrance into the WP lounge. Upon exit, participants reported WP and alcohol use on the night of data collection. Participants provided two breath samples at entrance and exit to assess BrAC and eCO. Participants received a $5 gift card as compensation. Procedures were approved by the university's Institutional Review Board.

2.2. Measures

2.2.1. Demographics. Participants completed a demographics form assessing participant sex, age, ethnicity, and employment status.

2.2.2. WP dependence. The Lebanon Waterpipe Dependence Scale-11 (LWDS-11; Salameh et al., 2008) is an 11-item self-report scale assessing WP dependence. A total score greater than 10 is indicative of WP dependence.

2.2.3. Alcohol use history and problems. Two items assessed current alcohol use and heavy episodic drinking (HED). First, participants reported past month alcohol use (yes/no). If participants responded "yes," they reported on frequency of past month HED (4/5+ drinks for women/men). The Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993) assessed severity of alcohol-related problems.

2.2.4. WP smoking patterns (in lounge). Upon exiting the WP lounge, participants self-reported the number of WP bowls smoked, charcoals used, and number of individuals in their smoking group

2.2.5. eCO change. Participants provided two eCO samples, one before entering and immediately upon exiting the lounge. eCO is a validated measure of smoke exposure (Middleton and Morice, 2000) and was measured using the Micro Smokerlyzer carbon monoxide (CO) monitor (Bedfont Scientific Ltd). eCO change was calculated by subtracting entrance eCO from exit eCO.

2.2.6. Mean BrAC. Participants also provided breath samples to measure BrAC before entering and upon exiting the lounge. A mean BrAC measure was derived. BrAC is a validated measure of alcohol consumption and non-invasive proxy for blood alcohol concentration (Gibb et al., 1984). BrAC was measured using the Intoxilyzer 400PA (CMI Inc.).

2.2.7. Time elapsed in the WP lounge. The amount of time spent in the WP lounge on the evening of data collection was calculated by subtracting the recorded exit and entrance times.

2.3. Data analytic plan

Hierarchical regression was used to examine associations between mean BrAC and eCO change after controlling for number of bowls and charcoals smoked. Independent samples *t*-tests were used to compare smoke exposure, number of bowls smoked, charcoals used, number of people in the smoking group, and time spent in the WP lounge between those with elevated (>0) versus non-elevated BrACs (=0). A Bonferroni correction (.05/5 = 0.01) was used to account for possible inflation of Type I error. Two mediation analyses using the bias-corrected bootstrap with 5000 samples (Hayes, 2013) were conducted to evaluate whether the relationship between mean BrAC and eCO change score was mediated by time spent in the WP lounge and number of people in group.

3. Results

3.1. Participant demographics

Participants ($N = 71$) were 66.2% ($n = 47$) male with a mean age of 27.03 ($SD = 5.32$) years and low WP dependence ($M = 6.19$, $SD = 4.87$). Participants self-reported smoking with an average of 3.33 ($SD = 2.20$) other people, smoking 1.43 ($SD = 2.03$) bowls of tobacco, using 3.04 ($SD = 1.31$) charcoals, consuming 1.36 ($SD = 1.20$) standard drinks, and spent an average of 115.07 ($SD = 44.98$) min in the WP lounge (Table 1).

3.2. Alcohol consumption and smoke exposure

Bowls and number of charcoals smoked significantly predicted eCO ($R^2 = 0.10$, $p = 0.029$). However, when entered into the model in step two, mean BrAC was significantly associated with eCO change over and above bowls smoked and charcoals used ($\Delta R^2 = 0.07$, $p = 0.027$) such that higher mean BrAC was associated with greater eCO. Together, the three predictors accounted for 17% of the variation in eCO change scores. Additionally, for every 0.1 unit increase in BrAC a corresponding increase of 19.44 ppm was observed for eCO.

3.3. Between group differences

Participants with elevated BrACs ($M = 27.09$ ppm, $SD = 15.58$) had greater eCO change measures compared to participants with non-elevated BrACs ($M = 14.50$ ppm, $SD = 16.38$), $t(69) = -3.315.40$, $p = 0.002$. Compared to participants with non-elevated BrACs, those with elevated BrACs were in a larger smoking group, more likely to be from the WP lounge with alcohol sales, and spent a greater amount of time in the WP lounge ($ps < 0.0125$) (Table 1).

3.4. Mediating role of elapsed time and number of people in the smoking group

Time spent in the lounge mediated the relationship between mean BrAC and eCO change. The indirect effect was significant, as the confidence interval did not contain zero (Fig. 1). A similar model