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A multi-year survey of waterpipe and cigarette smoking on a U.S. university campus

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Abstract

Objectives—To examine the prevalence and characteristics of dual users of cigarettes and waterpipes by comparing them to individuals who use either product exclusively.

Participants—Cross-sections of undergraduate students at a public university recruited each spring semester from 2006–2011 (total N=2998).

Methods—Participants completed an internet survey that assessed demographics, tobacco use, perceptions, and norms concerning various tobacco products. Individuals who reported exclusive cigarette, exclusive waterpipe, and dual (waterpipe+cigarette) use were examined.

Results—Across years, 22% reported exclusive cigarette, 6.1% exclusive waterpipe, and 9.3% dual cigarette and waterpipe use. Dual users differed in demographics and social influences from their exclusive counterparts.

Conclusions—Findings suggest dual waterpipe and cigarette use was more prevalent than exclusive waterpipe use, and dual users may differ from individuals who use either product alone. These results warrant the inclusion of waterpipe specific content in state and national surveys as well as tobacco prevention and intervention efforts.

Introduction

Waterpipe tobacco smoking (WTS) is an alternative form of tobacco use that involves passing tobacco smoke through water before inhalation.¹ WTS has increased in popularity globally, including the United States (U.S.).^{2–4} There is some evidence that waterpipe users believe that this form of tobacco use is less harmful and less addictive than others.^{5–7} This belief may be influencing the initiation and maintenance of WTS.

While little is known about the dependence potential of WTS compared to other tobacco use methods, results from a controlled clinical laboratory examination demonstrated that, relative to smoking a single cigarette, a single WTS episode produces equivalent peak nicotine plasma levels and significantly higher carbon monoxide levels.⁸ In another clinical

study, significant increases in the metabolites of known carcinogens (NNK; polycyclic aromatic hydrocarbon) were observed following a single WTS episode.⁹ These and other studies^{10–11} support the notion that WTS may lead to significant adverse health effects including tobacco dependence and cancer.

With global increased WTS prevalence and evidence of toxicant exposure and dependence potential, there has been growing interest in assessing WTS patterns alone and in combination with other modes of tobacco use. Concomitant use of multiple tobacco products is of particular concern, due to a potential increased risk of nicotine dependence that makes quitting difficult. For example, relative to cigarette use alone, dual users of cigarettes and smokeless tobacco may be exposed to more nicotine, have an increased risk for dependence symptoms, and/or greater difficulty quitting tobacco use.^{12–13} Interestingly, cigarette use has been implicated as a predictor of current WTS.^{6,14–15} The prevalence estimates of combined waterpipe and cigarette use in U.S. adolescent (4.6%;¹⁴) and university samples (9.6%;¹⁶) indicate that dual use of these two tobacco products is increasingly important. In addition, while many studies note differences between current waterpipe smokers and non-smokers,^{16–18} none have examined differences between dual users of waterpipe and cigarettes and smokers who use cigarettes exclusively. Concurrent use of cigarettes and other tobacco products (bidis, kreteks, smokeless tobacco, and/or cigars) is more prevalent in males^{19–20} and among those who affiliate with peers holding favorable attitudes and beliefs about smoking.²⁰ Whether these associations are evidenced among dual users of waterpipes and cigarettes is uncertain. Considering the potential health risks associated with dual tobacco use, an investigation of the patterns and predictors of WTS in combination with cigarettes is warranted.

To our knowledge this study represents the first multi-year cross-sectional survey of WTS and cigarette use among a U.S. university population. Our goals were to report the prevalence and characteristics of dual smoking of waterpipe and cigarettes compared to WTS alone and cigarette smoking alone.

Methods

Study design

A cross-sectional internet survey was conducted among students enrolled in Virginia Commonwealth University (VCU) Introduction to Psychology courses every spring semester for six years from 2006–2011. This survey was deemed exempt by the VCU's institutional review board due to method of data collection that never linked survey responses to participant names. Survey data were collected from March 8th (2006–2009, 2011) or 10th (2010) through May 4th during each year. Participants were eligible to complete the survey if they were at least 18 years of age and currently enrolled at VCU. Each participant earned 1 research credit for participating; all students enrolled in these courses had the option to complete this study (among many others) or complete an alternative assignment for research credit. The survey (hosted by Survey Monkey.com®) included items that assessed sociodemographics, general nicotine/tobacco use (cigarette, cigar/cigarillo, nicotine inhaler, and waterpipe), risk perceptions, and social norms. Use of other tobacco products including bidis, kreteks, pipes, and smokeless tobacco was not

assessed. Items were virtually identical to those used in a similar survey administered to students at Johns Hopkins University except for university specific items (see ^{5,21}). For the complete record of the survey see ²². Collapsed across the six years of data collection, 3309 survey responses were recorded. Individuals with missing demographic or duplicate data were removed (N=311), thus, 2998 respondents were included in the final dataset. Data from the 2006 survey wave were reported previously (see ¹⁷).

Smoking status definitions

The analysis focused on four groups: (1) non-current (not past 30-day) users of any tobacco or nicotine product, (2) exclusive cigarette users, (3) exclusive waterpipe users, and (4) dual users of cigarette and waterpipe. Exclusive users were defined as participants reporting past 30-day use of cigarette or waterpipe and non-current use of other tobacco or nicotine products (cigarette, cigar/cigarillo, nicotine inhaler, or waterpipe). Dual users were defined as participants reporting past 30-day use of waterpipe and cigarette and non-current use of cigar/cigarillo and nicotine inhaler.

Survey measures

Sociodemographic variables included age, sex, ethnicity/race, and average weekly disposable income. Risk perceptions were assessed via multiple scales that included one item: "SELECT FROM THE FOLLOWING ADJECTIVES TO DESCRIBE THE LIKELIHOOD OF GETTING ADDICTED WHEN USING THIS PRODUCT SOCIALLY." Participants used a rating scale from "None" (0), "Low" (1), "Medium" (2), to "High" (3). Item responses for waterpipes and cigarettes for the above item were chosen for relevancy. Social norms were assessed using three items: "WHAT IS THE LIKELIHOOD THAT YOU ARE INFLUENCED BY YOUR FRIENDS TO TRY OR USE THIS PRODUCT IN THE NEXT YEAR?" (peer influence), "WHAT IS THE SOCIAL ACCEPTABILITY OF USING THIS PRODUCT AMONG YOUR PEERS?" (social acceptability), and "HOW COOL DO YOUR PEERS LOOK WHEN THEY USE THE FOLLOWING PRODUCTS?" (peers look cool). For the peer influence and social acceptability items, participants used a rating scale from "None" (0), "Low" (1), "Medium" (2), to "High" (3), and for the peers look cool item the scale was from "Not Cool" (0), "Cool" (1), to "Very Cool" (2). Item responses for waterpipes and cigarettes were chosen for relevancy. Lastly, the year of survey participation (2006–2011) was also examined.

Statistical analyses

Data were analyzed using the Statistical Package for Social Sciences (IBM SPSS, version 19). Sociodemographic characteristics, year of survey participation, and selected risk perception/social norm items were described and compared across groups (non-current, exclusive cigarette, exclusive waterpipe, and dual [waterpipe and cigarette]) using the Chi-square test. Multinomial logistic regression was used to evaluate the odds of exclusive cigarette use and exclusive waterpipe use, with dual users as the reference group for sociodemographic characteristics, year of survey participation and selected risk perceptions/social norms. The final regression model was reached by the backward elimination method and included variables that had a statistically significant contribution to the model. The odds

ratios (ORs) and 95% confidence intervals (CIs) were reversed and interpreted to determine factors associated with dual smoking compared to exclusive cigarette and exclusive waterpipe smoking in a single model. Variables were evaluated as main effects in the regression models, and the odds ratios for each variable were adjusted for all other variables in the model. The requirement for a minimum ratio of cases to independent variables was satisfied. The criterion for classification accuracy was satisfied. Multicollinearity was checked by examining the standard errors for the b coefficients. There was no evidence for the multicollinearity problem because none of the independent variables in the analysis had a standard error larger than 2.0. The goodness-of-fit was assessed using Deviance Chi-square test. A *P*-value of <0.05 was considered statistically significant for all analyses.

Results

Of the 2998 participants, 641 were excluded due to reported past 30-day use of cigar/cigarillo or nicotine inhaler leaving 2357 (35.3% males and 64.7% females) responses to be included in the analysis. More than one third (38.7%) of students were older than 19 years. Of all respondents, 55.9% were White, 23.8% were Black or African American, 14.5% were Asian, and the remaining (5.8%) were of other ethnicities.

About two thirds of students (62.4%) were non-current users(no tobacco/nicotine product use during the past 30 days). Approximately 22% (20.9% of males and 23.0% of females) reported exclusive cigarette use, 6.1% (6.4% of males and 5.9% of females) reported exclusive waterpipe use, and 9.3% (9.5% of males and 9.2% of females) reported cigarette and waterpipe use (dual use). Figure 1 displays the distribution of the three groups(cigarette, waterpipe, and dual waterpipe and cigarette) by year of survey participation. When the proportions of exclusive cigarette, exclusive waterpipe, and dual users were averaged for the first three and last three years of data collection, values indicated exclusive cigarette use decreased (24.1 to 21.1%), exclusive waterpipe use increased slightly (5.4 to 6.9 %) and dual use decreased slightly (9.8 to 9.3%). Collapsed across year, the distributions of sociodemographics (except sex; *P* =0.594)and social norms were significantly different according to smoking status (*P*<0.05; see Table 1).

Table 2 displays the multinomial regression analysis of dual waterpipe and cigarette use versus exclusive cigarette use and versus exclusive waterpipe use. The value of the Deviance Chi-square test for the final multinomial logistic regression analysis was 1133.9 (*P*=0.996) indicating that the model adequately fit the data and the data were consistent with the model assumptions.

Results from the multinomial logistic regression analysis indicated that compared to exclusive cigarette users dual users were less likely to be >19 years old (OR=0.49). Dual users also were more likely to perceive peers who smoked waterpipe as “Cool” (OR=1.69) or “Very Cool” (OR=2.77)compared to exclusive cigarette users. Students who reported a likelihood of being influenced by their friends to smoke cigarettes were less likely to be dual users (e.g. “High”, OR=0.30)compared to exclusive cigarette users. On the other hand compared to exclusive cigarette users, dual users were more likely to report being influenced by friends to smoke waterpipe (e.g., “High”, OR=9.18).

Compared to exclusive waterpipe users, dual users did not differ in age distribution, but both groups had a high percentage of users aged 19 years (66–72%). Dual users were less likely to be of other ethnicities (other than Black/African American and Asian; OR=0.38) compared to exclusive cigarette users. In addition, the odds of dual use compared to exclusive waterpipe use were greater for all years of survey participation compared to 2011 data. Dual users were also less likely to report a “High” likelihood of being influenced by their friends to smoke waterpipe (OR=0.29) compared to exclusive waterpipe users. Dual users were more likely to perceive peers who smoked cigarettes as “Cool” (OR=2.81) or “Very Cool” (OR=5.88) compared to exclusive waterpipe users. Concomitantly, dual users were almost 30-times more likely than their exclusive waterpipe user counterparts to report being influenced by friends to smoke cigarettes. Dual use was also associated with a decreased odds of reporting the perception of “High” addiction likelihood when smoking waterpipe socially (OR=0.45) compared to exclusive waterpipe use.

Comment

Across six yearly cross-sectional surveys of VCU undergraduates, 22% were exclusive cigarette users, 6.1% were exclusive waterpipe users, and 9.3% smoked waterpipes and cigarettes (dual users). These levels of dual use are strikingly similar to another U.S. university sample (9.6%;¹⁶). Considering the known toxicant exposures^{8,9,23} and burgeoning empirical evidence that supports WTS associated harm,^{10,11} these levels of dual waterpipe and cigarette and exclusive waterpipe use among young adults in the U.S. call for the attention of the public health community. For example, legislation that gives the U.S. Food and Drug Administration authority to regulate tobacco bans non-menthol flavored cigarettes, but flavored waterpipe tobacco is allowed, almost certainly contributing to the continued growth of WTS among youth in this country. We already know that dual users of smokeless tobacco and cigarettes may be subject to additional risks that include heightened exposure to nicotine, greater difficulty quitting tobacco,^{12,13} and an increased likelihood for adverse tobacco-related health effects (e.g., acute myocardial infarction;²⁴). These results suggest that dual users of tobacco products may be in need of specialized cessation programs and increased awareness of potential tobacco-related health problems.

Another observation in this study was that younger individuals were at higher risk for dual use of waterpipes and cigarettes. Exclusive waterpipe use was also prevalent among younger individuals in this study; a finding corroborated by a previous report among university students.¹⁶ These younger individuals may be using alternative tobacco use methods that are cheaper due to increases in cigarette excise taxes²⁵ and easier to engage in due to indoor smoking restrictions for cigarettes.²⁶ In addition, waterpipe cafés or restaurants that allow WTS on the premises present unique social contexts that may encourage use among younger patrons. Some state indoor smoking legislation includes exemptions that allow venues such as waterpipe cafés to continue to operate (e.g., Virginia, Colorado, New York;²⁷), and many waterpipe cafés are alcohol-free and operate at late hours. These contexts may attract younger individuals (<21 years old) who wish to socialize and/or smoke but may be unable enter restaurants/bars that serve alcohol. For instance, when a group of waterpipe users in the Richmond community were surveyed in 2005, over a third reported that they almost

always smoked in a café.²⁸ Together, these findings support future study of exclusive and dual waterpipe use especially in relation to tobacco control policies.

The current study also demonstrates that dual users of waterpipe and cigarettes appear to be influenced by their peers to smoke both tobacco products but to a different extent than exclusive users. Importantly, dual users also may differ in other ways not assessed in this study including tobacco dependence symptomology, tobacco use frequency, quit attempts, and patterns of drug/alcohol use.^{12,13,29} One large-scale survey among U.S. undergraduate students has confirmed an association between current waterpipe use and alcohol/ illicit drug use.¹⁶ Future studies of concurrent tobacco use among waterpipe users should include items that assess these vulnerabilities.

The change in proportion of exclusive cigarette, waterpipe, and dual users by year was not reliable in this sample, but data suggest exclusive waterpipe use may be increasing while exclusive cigarette and dual use of waterpipe and cigarette is decreasing. Multinomial regression analyses indicated that dual use levels were higher in previous years compared to exclusive waterpipe use in 2011. While state-level survey data among adults concerning exclusive waterpipe use and dual use of waterpipe and cigarettes are unavailable, current Virginia cigarette smoking rates have been declining, especially during the years of 2002 through 2008.³⁰ In addition, a recent survey among Virginia youth (grades 6–12) reported an increase in current waterpipe (“hookah”) use in 2009 (7%) relative to 2007 (5%;³¹). Nationwide increases in prevalence among sub-groups of adolescents have been observed for smokeless tobacco³² and cigar/cigarillo use.³³ Potentially, decreases in cigarette smoking and increases in other tobacco use methods may reflect “trading” or switching tobacco use types among these individuals and not reduced tobacco use initiation.^{34–35} Continued surveillance or a longitudinal study is needed to examine whether these patterns of WTS and cigarette smoking prevalence persist among this population and others.

Limitations

Some limitations of the current study included convenience sampling and the cross-sectional nature of each yearly dataset. An ongoing campaign at VCU about the health effects of WTS may have influenced risk perceptions and social norms of participants.³⁶ In addition, study definitions of exclusive waterpipe/cigarette use and dual use are limited due to the lack of assessment of other tobacco products (e.g., smokeless tobacco, bidis/kreteks, electronic cigarettes, pipes) by this survey. While this limitation is important, controlling for all methods of tobacco use is difficult within a single study, and at least this analysis controlled for cigar/cigarillo use, a tobacco use behavior with higher prevalence among Virginia youth compared to smokeless tobacco (9% vs. 5%;³¹).

Conclusions

This multi-year survey represents the first report of concurrent waterpipe and cigarette smoking compared to exclusive use of either product in a university population. Among those sampled, dual use of waterpipe and cigarettes was more common than exclusive waterpipe use, and individuals 19 years old were more likely to identify as exclusive waterpipe and dual users.

The risk and social norms profile of dual users of waterpipe and cigarettes differed compared to exclusive users of either product. Also, the results highlighted the frequency of WTS both with and without cigarettes among this population. The continued presence of WTS among U.S. populations^{37–38} and others^{39–40} merits the inclusion of WTS assessment measures in both state and national surveys as well as WTS specific content within tobacco prevention and cessation efforts.

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Figure 1.
Percentage of cigarette, waterpipe, and dual waterpipe and cigarette users by year of survey participation.

Table 1

Sociodemographic characteristics, risk perceptions, and social norms by smoking status.

Variable	Smoking status			P
	Exclusive cigarette use n (%)	Exclusive waterpipe use n (%)	Dual waterpipe and cigarette n (%)	
Age (years)				<0.005
19	272 (51.9)	95 (66.4)	157 (71.7)	
>19	252 (48.1)	48 (33.6)	62 (28.3)	
Sex				0.594
Male	174 (33.2)	53 (37.1)	79 (36.1)	
Female	350 (66.8)	90 (62.9)	140 (63.9)	
Ethnicity / Race				<0.005
White	395 (75.4)	79 (55.2)	161 (73.5)	
Black or African American	57 (10.9)	18 (12.6)	14 (6.4)	
Asian	50 (9.5)	35 (24.5)	26 (11.9)	
Others	22 (4.2)	11 (7.7)	18 (8.2)	
Average weekly disposable income				0.031
<30	248 (47.3)	83 (58.0)	120 (54.8)	
30	276 (52.7)	60 (42.0)	99 (45.2)	
Peers look cool-cigarette				<0.005
Not cool	290 (55.3)	114 (80.3)	98 (44.7)	
Cool	200 (38.2)	26 (18.3)	96 (43.8)	
Very cool	34 (6.5)	2 (1.4)	25 (11.4)	
Peers look cool-waterpipe				<0.005
Not cool	276 (52.7)	46 (32.4)	57 (26.0)	
Cool	197 (37.6)	69 (48.6)	109 (49.8)	
Very cool	51 (9.7)	27 (19.0)	53 (24.2)	
Peer influence-cigarette				<0.005
None	93 (17.7)	83 (58.5)	31 (14.2)	
Low	123 (23.5)	26 (18.3)	45 (20.5)	
Medium	128 (24.4)	24 (16.9)	64 (29.2)	
High	180 (34.4)	9 (6.3)	79 (36.1)	
Peer influence-waterpipe				<0.005
None	146 (27.9)	22 (15.5)	19 (8.7)	
Low	159 (30.3)	24 (16.9)	38 (17.4)	
Medium	130 (24.8)	39 (27.5)	73 (33.3)	
High	89 (17.0)	57 (40.1)	89 (40.6)	
Social acceptability-cigarette				<0.005
None	26 (5.0)	15 (10.6)	7 (3.2)	
Low	64 (12.2)	33 (23.2)	23 (10.5)	
Medium	187 (35.7)	51 (35.9)	84 (38.4)	
High	247 (47.1)	43 (30.3)	105 (47.9)	
Social acceptability-waterpipe				<0.005

Variable	Smoking status			<i>P</i>
	Exclusive cigarette use n (%)	Exclusive waterpipe use n (%)	Dual waterpipe and cigarette n (%)	
None	48 (9.2)	3 (2.1)	5 (2.3)	0.487
Low	101 (19.3)	8 (5.6)	7 (3.2)	
Medium	174 (33.2)	39 (27.5)	64 (29.2)	
High	201 (38.4)	92 (64.8)	143 (65.3)	
Addiction from social use-cigarette				0.122
None	12 (2.3)	6 (4.2)	4 (1.8)	
Low	60 (11.5)	13 (9.2)	26 (11.9)	
Medium	185 (35.3)	42 (29.6)	68 (31.1)	
High	267 (51.0)	81 (57.0)	121 (55.3)	
Addiction from social use-waterpipe				0.122
None	68 (13.0)	20 (14.0)	35 (16.0)	
Medium	144 (27.5)	35 (24.6)	61 (27.9)	
Low	209 (39.9)	48 (33.8)	91 (41.6)	
High	103 (19.7)	39 (27.5)	32 (14.6)	

Table 2

Multinomial logistic regression of dual waterpipe and cigarette use compared to exclusive cigarette use and compared to exclusive waterpipe use.

Variable	Dual versus exclusive cigarette use		Dual versus exclusive waterpipe use	
	OR (95% CI)	P	OR (95% CI)	P
Age (years)				
19	Referent		Referent	
>19	0.49 (0.37–0.70)	<0.005	1.09 (0.66–1.82)	0.740
Ethnicity / Race				
White	Referent		Referent	
Black or African American	1.91 (0.96, 3.79)	0.066	0.88 (0.37, 2.09)	0.766
Asian	0.55 (0.29, 1.05)	0.070	0.65 (0.30, 1.44)	0.292
Other ^a	1.26 (0.74, 2.16)	0.398	0.38 (0.20, 0.72)	0.003
Year				
2011	Referent		Referent	
2010	1.65 (0.89, 3.06)	0.111	2.57 (1.20, 5.50)	0.015
2009	0.82 (0.43, 1.58)	0.561	2.72 (1.14, 6.49)	0.024
2008	1.33 (0.72, 2.43)	0.360	3.22 (1.48, 7.00)	0.003
2007	1.01 (0.51, 1.97)	0.988	2.63 (1.10, 6.31)	0.030
2006	0.81 (0.45, 1.46)	0.487	2.76 (1.31, 5.81)	0.007
Peers look cool-cigarette				
Not cool	Referent		Referent	
Cool	0.79 (0.51, 1.22)	0.293	2.81 (1.52, 5.21)	0.001
Very cool	1.16 (0.57, 2.35)	0.682	5.88 (1.21, 28.44)	0.028
Peers look cool-waterpipe				
Not cool	Referent		Referent	
Cool	1.69 (1.06, 2.71)	0.029	0.82 (0.45, 1.49)	0.516
Very cool	2.77 (1.46, 5.24)	0.002	0.78 (0.35, 1.76)	0.555
Peer influence-cigarette				
None	Referent		Referent	
Low	0.48 (0.26, 0.88)	0.018	5.46 (2.70, 11.04)	<0.005
Medium	0.48 (0.26, 0.89)	0.020	8.34 (3.98, 17.45)	<0.005
High	0.30 (0.16, 0.57)	<0.005	29.91 (11.70, 76.46)	<0.005
Peer influence-waterpipe				
None	Referent		Referent	
Low	2.36 (1.21, 4.61)	0.012	0.73 (0.31, 1.73)	0.471
Medium	5.07 (2.57, 9.99)	<0.005	0.52 (0.22, 1.22)	0.131
High	9.18 (4.41, 19.09)	<0.005	0.29 (0.12, 0.72)	0.007
Addiction from social use-waterpipe				
None	Referent		Referent	
Low	0.81 (0.49, 1.34)	0.413	0.85 (0.41, 1.73)	0.649
Medium	0.85 (0.50, 1.47)	0.569	0.78 (0.36, 1.66)	0.517

Variable	Dual versus exclusive cigarette use		Dual versus exclusive waterpipe use	
	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>
High	0.55 (0.30, 1.02)	0.059	0.45 (0.20, 0.97)	0.049

^aHispanic or Latino, American Indian, and Pacific Islander