Behavioral Associations with Waterpipe Tobacco Smoking Dependence among U.S. Young Adults

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Abstract

Background and Aims—Waterpipe tobacco smoking (WTS) is increasingly prevalent in the U.S., especially among young adults. We aimed to (1) adapt items from established dependence measures into a WTS dependence scale for U.S. young adults (the "U.S. Waterpipe Dependence Scale"), (2) determine the factor structure of the items, and (3) assess associations between scale values and behavioral use characteristics known to be linked to dependence.

Design—Cross-sectional survey.

Setting—United States.

Participants—436 past-year waterpipe tobacco users ages 18 to 30 selected at random from a national probability-based panel.

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Measurements—Participants responded to 6 tobacco dependence items adapted for WTS in U.S. populations. Behavioral use characteristics included factors such as frequency of use and age of initiation.

Findings—Principal components analysis yielded an unambiguous one-factor solution. About half (52.9%) of past-year waterpipe tobacco users received a score of 0, indicating none of the 6 WTS dependence items were endorsed. About one-quarter (25.4%) endorsed one dependence item, and 22.7% endorsed two or more items). Higher WTS dependence scores were significantly associated with all 5 behavioral use characteristics. For example, compared with those who endorsed no dependence items, those who endorsed 2 or more had an adjusted odds ratio (AOR) of 3.90 (95% CI = 1.56–9.78) for having had earlier age of initiation and an AOR of 32.75 (95% CI = 9.76–109.86) for more frequent WTS sessions.

Conclusions—Scores on a 6-item waterpipe tobacco smoking dependence scale (the "U.S. Waterpipe Dependence Scale") correlate with measures that would be expected to be related to dependence, such as amount used and age of initiation.

Keywords

hookah; waterpipe; dependence; addiction

Introduction

Waterpipe tobacco smoking (WTS) is the practice of smoking tobacco heated by lit charcoal through a small hose connected to a bowl filled with water or other liquids.[1] Although the precise origins of this centuries-old practice are unclear, a resurgence in WTS popularity in the Eastern Mediterranean Region (EMR) has resulted in an increase of tobacco use rates among its residents, especially among young adults.[2,3] Additionally, WTS is becoming more popular with the high school and adolescent age groups in this region, where WTS has surpassed the use of traditional cigarettes in some areas.[4] WTS rates have been increasing worldwide, resulting in what is now considered to be a global public health phenomenon.[5] For example, approximately one-third of young adults in the United States (U.S.) and Canada report ever WTS,[6,7] and WTS has been reported in Southeast Asia, Africa, and Europe.[8]

In the U.S., WTS is likely buoyed by its social acceptability and misperceptions of its harm reduction capability compared to cigarettes,[9–11] and despite evidence of its harmful components.[12,13] Although the predominant perception among U.S. users is that WTS is not addictive[9,14] and that WTS exposes the user to little or no nicotine,[14] there is emerging evidence that WTS may cause dependence in its users. One of the first investigations into WTS dependence in the EMR found that increased frequency of WTS was associated with self-report of being "hooked,"[15] a result that has also been found in preliminary investigations of WTS in US users.[16] More formal measures of dependence in the EMR, such as the Lebanon Waterpipe Dependence Scale-11 (LWDS-11)[17] have found that higher levels of dependence or risk of dependence were associated with factors such as more waterpipe tobacco users at home and work, Arab ethnicity, age of initiation, daily WTS, waterpipe ownership, and an increase in frequency and duration of WTS sessions.[18–21]

Additionally, it has been established that WTS exposes users to nicotine,[8,13,18,22] which is considered to be the main pharmacologic contributor to tobacco dependence,[23] although exposure varies with use patterns.[22] Research has also demonstrated that waterpipe tobacco users experience withdrawal symptoms—such as cravings during abstinence from WTS[24]—that are alleviated by returning to WTS.[25,26]

To our knowledge, WTS dependence has not been systematically and quantitatively evaluated among a nationally-representative sample of U.S. young adult users. Because WTS is culturally-rooted and most common among young adults in the U.S., assessments of dependence conducted with adult Middle Eastern populations may not be applicable to U.S. young adults. To address this, we conducted this study with three specific aims: (1) to select WTS dependence items from two tobacco dependence scales based on face validity in the U.S. young adult population, which we have called the "U.S. Waterpipe Dependence Scale"; (2) to determine the factor structure of the selected WTS dependence items; and (3) to measure the associations between a scale created from the selected WTS dependence items and established behavioral use characteristics related to tobacco dependence. Related to these aims, we had three specific hypotheses: (1) the selected WTS dependence items would load on one distinct factor; (2) the scale created from the selected WTS dependence items would be associated with the established behavioral use characteristics; and (3) a higher score on the scale created from the selected WTS dependence items would have a greater association with the established behavioral use characteristics. To our knowledge, this will be the first study to assess WTS dependence among a nationally-representative population of U.S. users.

Methods

Participants and Procedures

Participants were recruited from a nationally-representative probability-based online non-volunteer access panel, referred to as the KnowledgePanel®, which is recruited and maintained by GfK (formerly Knowledge Networks). Unlike most internet panels, which enroll individuals online and thus may not be representative, this panel is populated with a combination of random digit dialing (from 1999–2009) and address-based sampling (2009-present), and is not limited to pre-existing internet users.[27] Address-based sampling allowed recruitment from households without a landline telephone, increasing the sampling frame to an estimated 97% of U.S. households. The panel currently contains approximately 50,000 members ages 18 and older from across the U.S. Surveys are completed online; GfK provides computers and internet access to panel members that do not have one. In March 2013, 3254 adults aged 18–30 years old, randomly selected from the panel, completed a survey about WTS and related factors. Only non-institutionalized young adults in this age group were included in the study; there were no specific exclusion criteria. Participants were compensated $5 for completing surveys, consistent with panel norms. The vast majority of participants (85%) completed the survey in less than 25 minutes. This study was approved by the University of Pittsburgh Institutional Review Board and was granted a Certificate of Confidentiality from the National Cancer Institute at the National Institutes of Health.

Measures

Socio-demographic Factors—Socio-demographic information about panel members, including age, sex, race/ethnicity, and household income, were obtained from GfK.

Waterpipe Tobacco Smoking Behavior—Instructions immediately preceding the WTS items guided respondents to answer about "smoking tobacco from a hookah (also known as a waterpipe or narghile)." The word "tobacco" was underlined in order to distinguish it from marijuana or other substances which may be smoked in a waterpipe. The term "hookah" was used because it is the most commonly used term colloquially in the U.S. for this behavior.[28] Participants were asked about ever use, use in the past year, and frequency of use in the past 30 days, even a puff. We defined "ever use" as ever trying WTS; "past year" use as any use in the past 12 months; and "current use" as any use in the past 30 days.

WTS Dependence Items—Respondents who reported past-year WTS were presented with the 6 WTS dependence items. These items were adapted from the Lebanon Waterpipe Dependence Scale (LWDS), originally developed and validated in EMR populations,[17,21] and the Fagerström Test for Cigarette Dependence (FTCD), a general cigarette dependence scale[29]. Many items on the original Arabic-language LWDS are specific to WTS-endemic areas where WTS has become engrained in the culture (i.e., "are you ready not to eat in exchange for a waterpipe?"). In order to create a brief scale applicable to areas where WTS is not endemic, yet rising in popularity, we selected LWDS items that exhibited face validity for the U.S. young adult population. Likewise, the items selected from the FTCD were modified to ask about WTS instead of cigarette smoking. Although both traditional cigarettes and WTS expose the user to tobacco and nicotine, different behaviors and patterns of use are associated with each, and therefore traditional cigarette dependence measures cannot be directly applied to WTS.[8,15] Not all FTCD items were selected for this study because some were not likely to be applicable to WTS. For example, the FTCD item "do you smoke more frequently in the morning?" was excluded because most young people ages 18–30 tend to use WTS as an evening activity similar to seeing a movie or going out to a bar or club.[30,31] Instead, the FTCD item "How soon after you wake up do you smoke your first cigarette?" was adapted for this study extending the response scale to "10 or more hours" to capture the typical nature of this activity. Operationally, participating in WTS in a shorter time period after awakening may indicate movement of WTS into the afternoon and indicate a move away from more extrinsic social factors towards a more intrinsic dependence. While multiple response categories were provided for each statement, responses were also collapsed for primary analyses due to naturally restricted responses in some categories and according to an *a priori* protocol which distinguished any endorsement of the statement from no endorsement of the statement. For example, for the statement "How often do you smoke hookah alone," we collapsed data in order to compare those responding "I never smoke alone" (never) to those with all other responses (i.e., "some of the times I smoke" (sometimes), "most of the times I smoke" (most of the time), and "all of the times I smoke" (all of the time). All items, including response categories, are listed in Tables 1 and 3.

Behavioral Use Characteristics—In order to explore associations between the WTS dependence items and behavior, the questionnaire assessed 5 behavioral use characteristics which we expected to be associated with WTS dependence, based on theory as well as prior empiric reports in non-American populations.[21,32] These items asked about (1) whether the participant owns his or her own waterpipe, which likely indicates a more intense involvement with and commitment to WTS; (2) the number of bowls smoked during the last WTS session, which indexes the volume of consumption; (3) the number of WTS sessions during the most recent day of smoking, which indicates the degree of behavioral involvement and the period of time over which nicotine levels might be maintained; (4) age of WTS initiation, for which earlier initiation is associated with greater dependence among cigarette smokers,[33] and (5) status as a current waterpipe tobacco smoker (vs. past smoker), which captures the persistence of WTS. The waterpipe ownership item was dichotomous (*yes* or *no*). Current waterpipe smoker status was determined by asking on how many days the participant smoked tobacco from a hookah in the past 30 days, with 1 or more days indicating current WTS. Number of bowls smoked and number of WTS sessions in one day were open-ended items that were collapsed into 3-level ordered categorical items (*1, 2,* or *3 or more*), as was age of initiation (*17 or younger, 18–20,* or *21 and older*).

Analysis

To examine the patterns of association among our WTS dependence items, we created a pairwise correlation matrix. Additionally, we performed Exploratory Factor Analysis using principal components analysis (PCA), with varimax rotation, to assess the underlying structure of the items. We determined the optimal number of factors with an *a priori* criterion of including factors with eigenvalues > 1. We also examined the scree plot visually in order to confirm the ideal number of factors. We used a post-estimate test to determine factor scores for individuals on any factors found. To examine the internal consistency of the dependence items, we computed Cronbach's α. These analyses were repeated using the original, non-collapsed WTS items. Next, for our primary analyses, we calculated a WTS dependence scale, representing the sum of positive responses for items associated with each factor. Additionally, we created a secondary dependence scale using the original, non-collapsed WTS items.

To assess the associations between WTS dependence and behavior, we performed separate regression analyses between each independent variable (WTS dependence scale, secondary dependence scale, and factor score) and each of the 5 behavioral use characteristics, adjusting each model for socio-demographic variables (age, sex, race/ethnicity, and household income). These separate, yet complementary independent variables were used in order to determine if collapsing responses of our WTS dependence items resulted in imprecision in results. For the dichotomous dependent variables (owning a waterpipe and current waterpipe use), we used logistic regression, and for the ordered categorical dependent variables (number of bowls, number of sessions in one day, and age of initiation), we used ordered logistic regression. No *a priori* power analyses were conducted, as participants in this study were a part of a larger study on health behaviors. All descriptive statistics and regression models were analyzed using probability-weighted survey data. For

all analyses, we defined statistical significance with a two-tailed alpha of 0.05. Data were analyzed using Stata 12.[34]

Results

Sample Socio-demographic Characteristics and Waterpipe Tobacco Smoking Behaviors

Completed surveys were obtained from 3254 individuals (response rate = 54%). Of these individuals, ever WTS was reported by 30.7%, past year WTS by 12.2%, and current (past 30-day) WTS by 5.1%. Our final sample for analysis included only those who had smoked tobacco from a waterpipe at least once in the past year (n = 436), the sample that was asked to complete dependence items. Socio-demographic information is reported in Table 1.

WTS Dependence Items

The range of endorsement for the WTS dependence items varied from 9.4–30.7% (Table 1). Being annoyed when WTS is not allowed ("annoyed when disallowed") was the least-endorsed item (9.4%), while preferring WTS over other activities ("prefer over others") was the most endorsed (30.7%).

Exploratory Factor Analysis

Pair-wise correlations among the 6 WTS dependence items demonstrated coefficients ranging from 0.24–0.42 (Table 2). PCA yielded one factor with an eigenvalue = 2.48 (all other eigenvalues were 0.88 and less), a scree plot consistent with retention of one factor, with all 6 WTS dependence items loading with values of 0.52 or greater (Table 3). Internal consistency based on simple inter-item correlations was calculated to be $\alpha = 0.70$. Results from analyses with non-collapsed WTS dependence items are presented in Tables 2 and 3.

WTS Dependence and Factor Scores (Independent Variables)

Based on our single-factor solution, we calculated a WTS dependence scale using all 6 WTS dependence items. While a score of 0–6 was possible, response choices were collapsed into 3 levels. A total of 52.9% of past-year waterpipe tobacco users received a score of "0" (indicating that the respondent did not endorse any of the 6 WTS dependence items), while 25.4% received a score of "1" (indicating that the respondent endorsed one item), and 22.7% received a score of "2 or more" (indicating that the respondent endorsed two or more items) (Table 4). For items in their original, non-collapsed scales, the secondary WTS dependence scale ranged from 0–25, with a median score of 1 (IQR = 0–2). Factor scores ranged from −0.58 to 6.89, with a median score of −0.36 (IQR = −0.58–0.75).

Behavioral Use Characteristics (Dependent Variables)

Over one fourth (27.3%) of our final sample reported owning a waterpipe. A majority of the sample reported smoking only 1 bowl the last time they smoked tobacco from a waterpipe (61.0%), as well as reported engaging in only 1 WTS session on the last day they smoked (85.3%). About half of participants reported initiating waterpipe tobacco smoking at 18–20 years of age (50.5%), as well as using at least once in the past 30 days (42.3%) (Table 4).

Associations between WTS Dependence Scale and Behavioral Use Characteristics

Compared with a score of "0", a score of "1" was associated with significantly increased odds of owning a waterpipe (AOR = 2.98, 95% CI = 1.34–6.60). Associations with other behavioral use characteristics were also positive, but not significant. Compared to a score of "0", a score of "2 or more" was associated with significantly greater odds of all 5 of the behavioral use characteristics (Table 4). In order to make meaningful comparisons, both WTS dependence scales were rescaled to range from 0–10. We found significant positive associations between the re-scaled WTS dependence scale and all 5 of the behavioral use characteristics, as well as between the secondary WTS dependence scale and 4 of the 5 behavioral use characteristics, which is consistent with results using the factor score (Table 4).

Discussion

In this sample of 436 U.S. young adult past-year waterpipe smokers, 42.3% were current (i.e., past 30 day) users and 27.3% owned their own waterpipe. Six WTS dependence items adapted from traditional tobacco dependence measures loaded onto one internally consistent factor. A WTS dependence scale was created from these items with 52.9% of participants receiving a score of "0" (0 of 6 WTS dependence items were endorsed), 25.4% receiving a score of "1" (1 item was endorsed), and 22.7% receiving a score of "2 or more" (two or more items). A score of "2 or more" was significantly associated with all 5 behavioral use characteristics, with odds ratios ranging from 3 to 33. This suggests that the scale may capture substantial individual differences in dependence on WTS.

The six items selected from traditional tobacco dependence measures and adapted for this scale appear to be useful for assessing WTS dependence through initial psychometric evaluations. The items formed an internally-consistent one factor solution with factor loadings of greater than 0.50 for each item, consistent with accepted standards.[35] This supported our first hypothesis. Future research may extend validity by determining associations between these 6 items and "gold standard" measurements such as changes in WTS behavior over time or difficulty quitting WTS. Other potentially valuable future psychometric work may include exploration of these items in an item-response theory (IRT) framework.

For this study, the second and third hypotheses postulated that the WTS dependence scale would be associated with the selected behavioral use characteristics (Hypothesis 2) and that these associations would be greatest for those participants with higher dependence scores (Hypothesis 3). Hypothesis 2 was supported. For example, compared to a score of "0," a score of "1" was significantly associated with one behavioral use characteristic—ownership of a waterpipe. Compared to a score of "0," a score of "2 or more" was significantly associated with all 5 of the behavioral use characteristics. Furthermore, there was a steep increase in the odds for some of the behavioral use characteristics when going from endorsement of 1 item to endorsement of 2 items (e.g., from an odds ratio of 3.3 to an odds ratio of 32.75 for having more WTS sessions per day). This suggests that a cut-off of 2 or more positive responses may be useful in identifying WTS dependence, also supporting Hypothesis 3. Additional data and determination of associations of these items with different

behavioral use characteristics, as well as assessing the sensitivity and specificity of these items in another sample, may help confirm or refute the cut-off value of 2.

The two highest associations between the WTS dependence scale and the behavioral use characteristics were between a score of "2 or more" and the two frequency of use items—bowls per session and sessions per day. Interestingly, the correlation between frequency of smoking and dependence is surprisingly modest among cigarette smokers.[36] The association between WTS dependence and frequency is particularly interesting considering the level of behavioral involvement this indicates. Participation in WTS can be time-consuming; a typical WTS session lasts about one hour, although some are longer,[37,38] and involves a multi-step set-up process.[39] Therefore, it is conceivable that an individual who participates in numerous WTS sessions exhibits considerable commitment to the behavior, which may indicate dependence.[40] Thus, the data of Table 4 lend a measure of confidence to the ability of the scale to capture dependence.

Our WTS dependence scale, derived from collapsed items, was used in primary analyses for ease of interpretation. However, considering one of the risks of collapsing data is loss of information, we also conducted all analyses using a secondary WTS dependence scale derived from the original, non-collapsed items. Furthermore, we re-scaled both the of these dependence scales in multivariable analyses in order to present meaningful comparisons. The results in Table 4 demonstrate consistency between the two scales derived from collapsed and non-collapsed items. Additionally, factor scores derived from the factor analysis reflect results similar to both WTS dependence scales. These additional analyses demonstrate the robustness of results using the WTS dependence scale based upon collapsed items.

Future research should determine whether social factors, such as number of peers and family members who participate in WTS, personal factors, such as other substance use, as well as perceived norms and perceived harms regarding WTS are associated with behavioral markers of WTS dependence. Such research would provide additional evidence for the validity of this WTS dependence scale. Finally, future research may extend the generalizability of this WTS scale validating it in other age groups in the U.S. or in international populations.

An important limitation of this work is that we did not have a "gold standard" measure of tobacco dependence, such as an interview by a trained diagnostician or behavioral observation of use or withdrawal. Because this was not feasible for our design, we relied on comparing our dependence items to behavioral use characteristics known to be linked to dependence. While this preliminary work is valuable in beginning the process of assessing validity, it will be valuable for future work to utilize other factors associated with dependence, such as increase in use over time and/or progression from smoking with others to smoking alone. A second limitation is that the analysis would have been more rigorous had a confirmatory factor analysis (CFA) of the one-factor solution been tested on another sample. Therefore, it would be valuable for studies to perform CFA with other samples. A third limitation of this work is that internet panels are sometimes regarded as unrepresentative, as computer ownership and internet connectivity may skew toward a

younger and more affluent cohort. However, the panel used here was created via address-based methods, and computers and internet were provided if needed. A fourth limitation is that we did not inquire about state-specific laws regarding indoor WTS, and how this relates to individual frequency of WTS. However, considering WTS is generally exempted from tobacco control policies,[41,42] the impact is expected to be minimal. A final limitation is that our response rate was 54%; however, this is a relatively strong response rate compared with other studies using panels to recruit study subjects.[43,44]

In conclusion, this work describes the utility of a WTS dependence scale created by adapting 6 WTS dependence items from traditional tobacco dependence measures in a national sample of U.S. young adults, which we have called the "U.S. Waterpipe Dependence Scale". The scale was significantly associated with 5 measures of WTS-related behavior for those in the highest category of dependence, suggesting its efficacy with this population.

Acknowledgements

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Table 1

Whole Sample Distribution of Sociodemographic Characteristics and Individual Dependence Items.

Characteristic	Whole Sample
Age	
18 to 20	29.6
21 to 23	30.6
24 to 26	22.8
27 to 30	17.1
Sex	
Female	44.8
Male	55.2
Race	
White, non-Hispanic	57.9
Black, non-Hispanic	11.4
Hispanic	24.3
Other[a]	6.4
Household Income	
Low (under $30,000)	19.5
Medium ($30,000 to 74,999)	35.8
High ($75,000 and above)	44.7
Dependence Item[b]	
Go without	
0 days	1.9
1 day	0.6
2 days	0.2
3 days	0.7
4 days	0.4
5 days	0.9
6 days	0.0
7 or more days	8.0
Rest of my life	**87.4**
Annoyed when disallowed	
All the time	1.8
Most of the time	1.4
Sometimes	6.1
Never	**90.6**
Prefer over others	
All the time	0.6
Most of the time	2.6
Sometimes	27.5
Never	**69.3**
When sick	

Characteristic	Whole Sample
Definitely	0.9
Probably	1.9
Possibly	12.1
No	**85.1**
Smoke alone	
All the time	1.1
Most of the time	2.2
Sometimes	10.6
Never	**86.2**
After waking	
Within 5 minutes	0.6
6–30 minutes	1.7
1–3 hours	3.5
4–6 hours	3.9
7–9 hours	**16.8**
10 or more hours	**73.5**

[a] Includes Multi-racial.

[b] Individual dependence items are presented in their original, non-collapsed scales. Bolded categories represent the not endorsed category (0); all other categories were collapsed to form the endorsed category for primary analyses.

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Table 2

Pair-wise Correlation Matrix[a].

WTS Dependence Item[b]	Go without	Annoyed when disallowed	Prefer over others	When sick	Smoke alone	After waking
Go witdout	1.00					
Annoyed when disallowed	0.49 (0.42,0.56) 0.41 (0.33,0.49)	1.00				
Prefer over others	0.39 (0.31,0.47) 0.24 (0.16,0.33)	0.40 (0.32,0.47) 0.25 (0.16,0.34)	1.00			
When sick	0.39 (0.31,0.47) 0.28 (0.19,0.37)	0.49 (0.42,0.56) 0.38 (0.30,0.46)	0.41 (0.33,0.49) 0.38 (0.30,0.46)	1.00		
Smoke alone	0.34 (0.25,0.42) 0.27 (0.18,0.36)	0.39 (0.31,0.47) 0.32 (0.23,0.40)	0.37 (0.29,0.45) 0.42 (0.34,0.50)	0.40 (0.32,0.47) 0.31 (0.22,0.39)	1.00	
After waking	0.41 (0.33,0.49) 0.30 (0.21,0.38)	0.36 (0.28,0.44) 0.32 (0.23,0.40)	0.30 (0.21,0.38) 0.29 (0.20,0.38)	0.45 (0.38,0.53) 0.37 (0.29,0.45)	0.33 (0.24,0.41) 0.29 (0.20,0.38)	1.00

[a] The first correlation coefficient provided in each cell represents that of the originally-scaled, non-collapsed items; the second represents that of the items with collapsed response scales. 95% confidence intervals are given in parentheses and were calculated using Fisher's r to z transformation.

[b] Please see Table 3 for complete item wording.

Table 3

Factor Structure for Dependence Items among U.S. Young Adults.

Complete Item (Response Categories)	Brief Item[a]	Factor Loading	
		Non-Collapsed[b]	Collapsed[c]
How many days in a row could you comfortably go without smoking hookah? (Not the rest of my life vs. the rest of my life)	Go without	0.72	**0.65**
How often do you get annoyed when hookah smoking is not allowed (such as in someone's home who doesn't allow it)? (At least sometimes vs. never)	Annoyed when disallowed	0.75	**0.71**
How often do you prefer smoking hookah instead of doing other activities? (At least sometimes vs. never)	Prefer over others	0.67	**0.52**
Would you smoke hookah if you were so sick that you stayed home from work or school? (At least sometimes vs. never)	When sick	0.75	**0.70**
How often do you smoke hookah alone? (At least sometimes vs. never)	Smoke alone	0.66	**0.62**
The last time you smoked hookah, how soon after waking up in the morning did you smoke your first bowl of hookah? (Less than 6 hours vs. more than 6 hours)	After waking	0.67	**0.63**
Cronbach's alpha[d]		0.74	0.70
Factor 1 variance[e]		0.50	0.41

[a]Brief item descriptors are used in the text and other tables to improve clarity.

[b]Rotated factor loadings after Varimax rotation for the originally-scaled, non-collapsed item, ranging from 4 to 9 response categories.

[c]Rotated factor loadings after Varimax rotation for items with collapsed response categories as shown; bolded numbers indicate loadings > 0.40, which were considered significant *a priori*.

[d]Calculated to measure internal consistency of all 6 items.

[e]Percentage of variance explained by the single factor solution for both non-collapsed and collapsed items.

Table 4

Cross Tabulations and Multivariable Associations Between WTS Dependence and Behavioral Use Characteristics Among Past Year WTS Users (N = 436).

WTS Dependence	%	Own a Waterpipe[a]		Number of Bowls[b]			Number of Sessions in One Day[c]			Age of Initiation[d]			Current Waterpipe Use[a]	
		No (72.7)	Yes (27.3)	1 (61.0)	2 (29.9)	3+ (9.1)	1 (85.3)	2 (9.4)	3+ (5.3)	21+ (27.2)	18–20 (50.5)	17 (22.3)	No (57.7)	Yes (42.3)
Dependence Scale[e]		Row %		Row %			Row %			Row %			Row %	
0	52.9	81.6	18.4	69.2	26.3	4.5	96.7	2.9	0.4	33.7	51.7	14.7	64.2	35.8
1	25.4	62.8	37.2	61.6	29.1	9.3	88.8	10.6	0.6	26.7	54.3	19.1	62.5	37.5
2 or more	22.7	63.4	36.7	41.6	39.0	19.4	55.2	23.0	21.9	13.0	43.5	43.5	37.5	62.5
Dependence Scale[e]		AOR (95%CI)[f]		AOR (95%CI)[f]			AOR (95%CI)[f]			AOR (95%CI)[f]			AOR (95%CI)[f]	
0		Ref		Ref			Ref			Ref			Ref	
1		2.98 (1.34–6.60)		1.43 (0.69–2.99)			3.30 (0.98–11.16)			1.57 (0.79–3.11)			1.01 (0.50–2.01)	
2 or more		3.63 (1.48–8.89)		4.18 (1.86–9.39)			32.75 (9.76–109.86)			3.90 (1.56–9.78)			2.78 (1.26–6.14)	
Dependence Scale[g]		1.32 (1.15–1.52)		1.32 (1.15–1.52)			1.82 (1.50–2.21)			1.36 (1.15–1.62)			1.18 (1.02–1.36)	
Secondary Dependence Scale[h]		1.61 (1.21–2.14)		1.51 (1.20–1.89)			2.32 (1.54–3.50)			1.72 (1.20–2.47)			1.17 (0.92–1.49)	
Factor Score[i]		2.12 (1.44–3.11)		1.82 (1.28–2.57)			3.97 (2.22–7.09)			1.99 (1.29–3.08)			1.39 (0.98–1.99)	

[a] Response choices were *yes* or *no*; this item is a dichotomous outcome variable analyzed using the *svy: logit* command; current is defined as having smoked tobacco from a waterpipe at least once in the past 30 days.

[b] Participants were asked how many bowls they smoked *the last time they engaged in WTS*. Responses were *1, 2, or 3 or more*. This is a 3-level ordinal categorical outcome variable and was analyzed using the *svy: ologit* command.

[c] Participants were asked how many times in one day they smoked *the last day they engaged in WTS*. Responses were *1, 2, or 3 or more*. This is a 3-level ordinal categorical outcome variable and was analyzed using the *svy: ologit* command

[d] Participants were asked how old they were when they first smoked tobacco from a waterpipe. Responses were *21 or older, 18 to 20, or 17 or younger*. This is a 3-level ordinal categorical outcome variable and was analyzed using the *svy: ologit* command.

[e] This item represents the sum of positive responses (i.e., responses indicating higher risk of dependence) for each of the 6 individual WTS dependence items. Thus, scores range from 0–6. Due to rounding, percents may not equal 100.

f AOR = odds ratio; CI = Confidence interval. All analyses adjusted for age, sex, race, and household income.

g This item represents the dependence scale rescaled to range from 0–10. This item is analyzed as a continuous variable; associated odds ratios represent the odds for each 1-point increase on the scale.

h This item represents the sum of responses for the 6 individual WTS dependence items in their original, non-collapsed scale. Scores range from 0–25 but have been rescaled to range from 0–10 for comparison with the collapsed-item dependence scale above. This item is analyzed as a continuous variable; associated odds ratios represent the odds for each 1-point increase on the scale.

i This item represents the linear composite of individual standings on the factor derived from WTS dependence items in their original, non-collapsed scale; associated odds ratios represent the odds for each 1-point increase on the scale.