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Validation of an Arabic version of an instrument to measure waterpipe smoking behavior

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ABSTRACT

Objectives: Reliable and valid measures of waterpipe smoking are essential to study its health effects. The purpose of this study was to examine the reliability and validity of an Arabic translation of Maziak questionnaire that assesses various aspects of waterpipe smoking in epidemiological studies.

Study design: A cross-sectional study.

Methods: This questionnaire was translated, back translated, and culturally adapted to the local Arabic dialect. Construct and convergent validity were assessed in a sample of 119 daily waterpipe smokers (WPS) and 30 occasional WPS, defined as smoking at least one waterpipe per week but less than daily from Beirut and Doha (mean age = 52.4 years, males = 61.7%). Construct validity was assessed by comparing the smoking behavior of daily and occasional WPS. Convergent validity was assessed by correlating daily smoking intensity ('number of waterpipe smoked per day') with 'number of waterpipe smoked yesterday' and by correlating lifetime smoking exposure (waterpipe-year) calculated by multiplying number of waterpipe smoked per day × duration of waterpipe smoking with alternate measures obtained graphically (graphical waterpipe-year) or adjusted (adjusted waterpipe-year). Criterion validity was assessed by correlating daily smoking intensity and lifetime smoking exposure with serum cotinine level. Test–retest reliability was analyzed by re-administering the questionnaire to 30 daily and 30 occasional WPS after 2 weeks.

Results: Smoking intensity, patterns of use, and willingness to quit differed significantly between daily and occasional WPS. Daily smoking intensity correlated strongly with the number of waterpipe smoked yesterday ($r_s = 0.68$, $P < 0.001$), but not in the occasional WPS ($r_s = 0.13$, $P = 0.70$). Waterpipe-year correlated very strongly with adjusted waterpipe-year and graphical waterpipe-year ($r_s = 0.98$, $P < 0.001$ and $r_s = 0.92$, $P < 0.001$, respectively). Waterpipe-year, daily smoking intensity, and number of waterpipe smoked yesterday,

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correlated weakly but significantly with serum cotinine levels (r_s = 0.243, P = 0.01; r_s = 0.359, $P < 0.01$ and r_s = 0.387, $P < 0.01$, respectively). The type and pattern of waterpipe use items showed high test-retest reliability with near perfect agreement (k > 0.9), the sharing and intention to quit waterpipe items had substantial agreement (k > 0.6), and the intent to quit item showed moderate agreement (k > 0.4).

Conclusion: The questionnaire showed strong reliability, face validity, construct and convergent validity, and a weak but statistically significant criterion validity. Maziak questionnaire is valid and reliable for assessing waterpipe smoking patterns, intensity, and willingness to quit.

Introduction

Waterpipe tobacco smoking is thought to originate in Southeast Asia, North Africa, and India.[1,2] In the early 1990s, when flavored tobacco was introduced, waterpipe smoking grew in popularity and became the most common method of tobacco use among Arab youth aged between 13 and 15 years.[3–5] Waterpipe smoking also appeared to be spreading among new populations such as college students in the United States and in European countries.[1,6–9]

Facing this global waterpipe smoking epidemic, several researchers studied different aspects of waterpipe smoking and its potential harmful health effects. Multiple instruments for measuring the use of and dependence on waterpipe smoking were used.[10–14] Although these instruments allow better evaluation of the waterpipe smoking epidemic, a recent meta-analysis concluded that they lack validation.[10] These instruments may therefore introduce a potential bias and decrease the confidence in the estimates of waterpipe smoking prevalence and its adverse health effects.[10]

One of these instruments developed by Maziak et al. (2005), is a 10-item questionnaire that assesses different aspects of waterpipe smoking including smoking intensity, patterns of use, and willingness to quit.[13] This questionnaire was generated using literature review along with tobacco research experts' opinion. To our knowledge, the reliability and validity of this instrument was not assessed (personal communication with Dr. Maziak). The purpose of this study is to assess the reliability and validity of an Arabic translation of the Maziak questionnaire.

Methods

Sample and procedure

The study sample includes 149 participants from two Arab countries, Lebanon and Qatar. One hundred and fifteen participants were recruited from the community in Beirut, Lebanon, including 95 daily waterpipe smokers (WPS) and 20 occasional WPS, whereas 34 participants were recruited from the community in Doha, Qatar, including 24 daily WPS and 10 occasional WPS. Participants were approached directly while smoking waterpipes in cafes and through advertisements in newspapers and on social media. All participants signed an informed consent. The study was approved by the American University of Beirut Institutional Review Board (IM.HC.03) and Hamad Medical Center Institutional Review Board (13-00054).

An Arabic translation of the waterpipe smoking questionnaire was administered in a face-to-face interview to all the participants by study personnel. Cotinine levels for the daily WPS were measured using the cotinine direct ELISA kit (Bio-Quantin Kits) on fasting morning serum samples after 6 h of abstinence from smoking and values were reported in nanograms per milliliter.

To evaluate the test–retest reliability, the questionnaire was re-administered 2 weeks later to 60 participants, including the first 30 enrolled daily WPS and the 30 occasional WPS.[15] Forty of those participants were from Beirut (20 daily and 20 occasional WPS) and 20 from Doha (10 daily and 10 occasional WPS).

Generalizability

The questionnaire was translated into Arabic and back translated to English by experienced translators to increase the quality and accuracy of the translation. Due to diversity in the local terms used in describing waterpipe smoking in Lebanon and Qatar, alternate words were used in the Arabic version (arguileh vs sheesha; ras vs nafas; ajami vs tambak vs gidou vs salloum) to enhance the linguistic clarity of the Arabic version of the questionnaire. An additional item about the type of waterpipe tobacco used (maasal or ajami/tambak/gidou/salloum) was added to the questionnaire to assess for generalization of the questionnaire to different types of waterpipe tobacco smoked.

Test–retest reliability

Sixty participants, 30 daily and 30 occasional WPS, from Lebanon and Qatar were interviewed twice, at least 2 weeks apart. Test–retest reliability was evaluated to investigate consistency of the questionnaire items by comparing the answers of each participant on the first and second interview.

Face validity

The waterpipe smoking questionnaire was adopted from an English version by Maziak et al.[13] The English version was

based on literature review and different experts' opinions in the Eastern Mediterranean region.[13] The Arabic translation was also reviewed and validated by a team of local experts consisting of pulmonologists, a cardiologist, and public health experts from Beirut and Doha as part of this study.

Construct validity

The answers of the daily and occasional WPS were compared to assess the construct validity of this instrument.

Convergent validity

Waterpipe-year, a measure of lifetime smoking exposure is calculated by multiplying the number of waterpipes smoked per day by the duration of waterpipe smoking in years. This measure has been used in several recent publications.[16–19] The convergent validity of the waterpipe-year calculated from the Maziak waterpipe questionnaire was correlated with an adjusted waterpipe-year and a graphically measured waterpipe-year. The adjusted waterpipe-year was obtained by accounting for any period of abstinence or change in the pattern of waterpipe smoking using the following additional questions: (1) did you have the same pattern of smoking for your whole life?; (2) Did you completely stop waterpipe smoking at any time of your life? If yes, for how long?; and (3) Did you smoke less than your current pattern at any time of your life? If yes, how many waterpipes (headful, nafas, ras, depending on the local dialect) did you smoke? And for how long did you smoke waterpipe less than your current pattern? Adjusted waterpipe-year was calculated by subtracting the number of years the participants quit waterpipe and accounting for the years the participant smoked less:

([Total smoking years − years stopped − years smoked less than current rate] × [number of current waterpipe smoked per day]) + ([years smoked less than current rate] × [number of waterpipe smoked per day previously])

The graphical waterpipe-year was assessed using a graphical representation of smoking duration and intensity (Appendix 1) by asking the participants to highlight the intervals corresponding to the duration of waterpipe smoking on a 5-year interval scale and indicate for each interval the number of waterpipe smoked per day (for daily smokers) or per month (for occasional smokers).

The convergent validity of the daily smoking intensity measured by the 'number of waterpipe smoked per day' item was assessed by comparing the answers on this item with a fifth item that was added to the questionnaire 'Did you smoke waterpipe yesterday or the day before? If yes how many waterpipes did you smoke?' The full versions of the administered questionnaire in English and Arabic are included in Appendices 1 and 2.

Criterion (concurrent) validity

To assess the criterion validity, we evaluated the association of serum cotinine levels with daily smoking intensity (measured using the 'number of waterpipe smoked per day' item) and with lifetime smoking exposure (measured using the calculated waterpipe-year). Serum cotinine levels were also correlated with graphical waterpipe-year, adjusted waterpipe-year, and number of waterpipe smoked yesterday.

Statistical analysis

The characteristics and smoking behaviours of daily and occasional WPS were compared using the Chi-squared test for categorical and Student *t* test for continuous data. Test–retest reliability was assessed for all items of the questionnaire using paired *t* test for continuous variables and McNemar's test for categorical variables. The agreement between the first and second interview answers was measured using the non-parametric Spearman's rho correlation for the continuous variables and kappa coefficient for categorical variables. Kappa coefficients were interpreted based on Landis and Koch values.[20] The correlation between different measures of waterpipe smoking was assessed using the non-parametric Spearman's rho correlation coefficient to evaluate convergent and criterion validity. These correlations were re-assessed using the parametric Pearsons correlation in alternate analyses, when the sample size allowed and after natural log-transformation of the variables with skewed distribution. The correlation between daily smoking intensity (number of waterpipe smoked per day) and the reported number of waterpipe smoked yesterday was evaluated in the whole sample and within strata of daily and occasional WPS.

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS version 22, IBM, Armonk, NY, USA). Two-sided $P < 0.05$ was considered to be statistically significant.

Results

Demographic characteristics of the total sample, the daily, and the occasional WPS are presented in Table 1. All participants were from Arabic ethnicity, the mean age of the participants was 52.4 years, with males constituting the majority of the sample (61.7%). There was no meaningful difference in demographic characteristics between daily and occasional WPS. The majority of participants smoked maasal (49.7%) in comparison with ajami (46.3%), and only six participants (4.0%) smoked both (Table 1).

Construct validity

All smoking behaviour assessed by the questionnaire, including several measures of waterpipe smoking intensity, patterns of use, and willingness to quit, differed significantly between daily WPS and occasional WPS, except for the number of waterpipes smoked yesterday (Table 1). On average, daily WPS started smoking at a younger age (mean age = 26.7 vs 35.2 years in occasional WPS $P < 0.001$) and had smoked for a longer duration (mean duration = 27.2 vs 15.0 years in occasional WPS $P < 0.001$). Seventy percent of occasional WPS reported having the same pattern of waterpipe smoking throughout their life vs 23.5% of the daily WPS ($P < 0.001$). In

Table 1 – Characteristics and smoking profile of the total sample, daily smokers, and occasional smokers.

Characteristics	Total sample (N = 149)	Smoking status		
		Daily smokers (N = 119)	Occasional smokers (N = 30)	P-value
Demographics				
Gender: males, *n* (%)	92 (61.7)	72 (60.5)	20 (66.7)	0.54
Age (years), M (SD)	52.4 (8.9)	52.9 (9.2)	50.2 (7.5)	0.14
Site, *n* (%)				0.13
Beirut	115 (77.2)	95 (79.8)	20 (66.7)	
Doha	34 (22.8)	24 (20.2)	10 (33.3)	
Smoking profile				
Type of waterpipe, *n* (%)				**0.03**
Maasal	74 (49.7)	54 (45.4)	20 (66.7)	
Ajami/tambak	69 (46.3)	61 (51.3)	8 (26.7)	
Both	6 (4.0)	4 (3.4)	2 (6.7)	
Age started smoking (years), M (SD)	27.6 (9.3)	25.7 (8.0)	35.2 (10.3)	**<0.001**
Number of waterpipe smoked per day (Daily smoking intensity), M (SD)	1.9 (1.5)	2.3 (1.5)	0.3 (0.2)	**<0.001**
Duration of smoking (years), M (SD)	24.8 (11.9)	27.2 (11.2)	15.0 (9.3)	**<0.001**
Share waterpipe with others, *n* (%)	67 (45.0)	48 (40.3)	19 (63.3)	**0.02**
Smoked waterpipe yesterday or the day before, *n* (%)	120 (80.5)	108 (90.8)	12 (40.0)	**<0.001**
Number of waterpipe smoked yesterday, M (SD)	2.2 (2.0)	2.3 (2.1)	1.3 (0.6)	0.12
Can quit waterpipe anytime they want, *n* (%)	118 (79.2)	90 (75.6)	28 (93.3)	**0.03**
Intend to quit waterpipe smoking, *n* (%)	94 (63.1)	67 (56.3)	27 (90.0)	**<0.001**
Same pattern of waterpipe smoking their whole life, *n* (%)	49 (32.9)	28 (23.5)	21 (70.0)	**<0.001**
Completely stopped smoking in their life, *n* (%)	46 (34.6)	42 (40.8)	4 (13.3)	**0.01**
Smoking less than their current pattern, *n* (%)	81 (60.9)	75 (72.8)	6 (20.0)	**<0.001**
Waterpipe-year, M (SD)	54.2 (60.7)	66.4 (62.2)	5.7 (6.4)	**<0.001**
Adjusted waterpipe-year, M (SD)	47.4 (53.9)	57.9 (55.5)	5.4 (6.0)	**<0.001**
Graphical waterpipe-year (graphical), M (SD)	45.0 (51.4)	53.7 (52.1)	10.9 (30.9)	**<0.001**

M (SD) = mean (SD). Waterpipe-year is the product of average daily waterpipe smoked and duration in years; adjusted waterpipe-year takes into consideration the time stopped smoking or smoked less; Graphical waterpipe-year is obtained from the graph in Appendix 1.
Significant results are represented in bold ($P < 0.05$).

addition, daily WPS reported smoking more waterpipes daily compared with occasional WPS with an average of 2.3 vs 0.3 waterpipes per day, respectively ($P < 0.001$). Daily WPS also reported higher lifetime smoking exposure compared with occasional WPS as measured by waterpipe-year (66.4 vs 5.7, $P < 0.001$), adjusted waterpipe-year (57.9 vs 5.4, $P < 0.001$), and graphical waterpipe-year (53.7 vs 10.9, $P < 0.001$) scales. Daily WPS were less likely to share waterpipe with others in comparison with occasional WPS (40.3% vs 63.3%, respectively $P = 0.02$). Finally, around 93% of occasional WPS reported being confident that they can quit waterpipe smoking anytime they want and 90% intend to quit compared with 75.6% and 56.3% of daily WPS, respectively.

Test–retest reliability

Agreement between the two interviews is presented in Table 2. Two items (type of waterpipe and pattern of use) had an almost perfect agreement between the first and second interview ($k = 0.929$, $P < 0.001$ and $k = 0.967$, $P < 0.001$, respectively). Two items (share waterpipe with others and can quit waterpipe anytime they want) had a substantial agreement ($k = 0.663$, $P < 0.001$; and $k = 0.715$, $P < 0.001$, respectively). One item (intend to quit waterpipe smoking) had moderate agreement ($k = 0.540$, $P < 0.001$), and the new item (smoked yesterday or the day before) had a fair agreement ($k = 0.328$, $P = 0.02$). There was no significant difference in the answers between the first and the repeat interview for all these items. In addition, the answers on the two interviews also correlated strongly for the 'number of waterpipe smoked daily' ($r_s = 0.94$, $P < 0.001$), 'duration of smoking' ($r_s = 0.81$, $P < 0.001$), and for 'age-started smoking' items ($r_s = 0.83$, $P < 0.001$, Table 3).

Convergent validity

Waterpipe-year correlated very strongly with both graphical and adjusted waterpipe-year ($r_s = 0.92$, $P < 0.001$ and $r_s = 0.98$, $P < 0.001$, respectively; Table 4). Waterpipe-year also correlated very strongly with graphical waterpipe-year when accounting for the participants who did not change their smoking pattern ($n = 49$; $r_s = 0.98$, $P < 0.001$). The average smoking exposure was 54.2 waterpipe-year; however, the number of waterpipe-years was significantly less with adjustment for smoking pattern variation (47.4, $P < 0.001$) or when measured using a graphical scale (45.0, $P < 0.001$).

Daily WPS were more likely to report smoking yesterday or the day before compared with occasional WPS (90.8% vs 40%,

Table 2 – Agreement between initial (first) and repeat (second) waterpipe questionnaire administration (categorical variables).

First interview (initial)	Second interview (repeat) [n (%)]			Total	P-value	% agreement	Kappa	P-value
	(1)	(2)	(3)					
Type of waterpipe					0.37	96.7	0.929	**<0.001**
(1) Maasal	39 (100.0)	0 (0.0)	0 (0.0)	39				
(2) Ajami/tambak	1 (5.6)	17 (94.4)	0 (0.0)	18				
(3) Both	1 (33.3)	0 (0.0)	2 (66.7)	3				
Pattern of use					1.00	98.3	0.967	**<0.001**
(1) Monthly or weekly (< daily)	29 (100.0)	0 (0.0)	–	29				
(2) Daily (at least once a week but < daily)	1 (3.2)	30 (96.8)	–	31				
Smoked yesterday or the day before					0.48	70.0	0.328	**0.02**
(1) No	11 (61.1)	7 (38.9)	–	18				
(2) Yes	11 (26.2)	31 (73.8)	–	42				
Share waterpipe with others					1.00	83.8	0.663	**<0.001**
(1) No	28 (87.8)	5 (15.2)	–	33				
(2) Yes	5 (18.5)	22 (81.5)	–	27				
Can quit waterpipe anytime they want					0.06	91.7	0.715	**<0.001**
(3) No	8 (61.5)	5 (38.5)	–	13				
(4) Yes	0 (0.0)	47 (100.0)	–	47				
Intend to quit waterpipe smoking					0.39	80.0	0.540	**<0.001**
(1) No	13 (61.9)	8 (38.1)	–	21				
(2) Yes	4 (10.3)	35 (89.7)	–	39				

Significant results are represented in bold ($P < 0.05$).

Table 3 – Correlation between Initial (first) and repeat (second) waterpipe questionnaire administration (continuous variables; N = 60).

Questionnaire item	First interview	Second interview	P-value	Spearman's rho (P-value)
Number of waterpipe smoked daily (daily smoking intensity), M (SD)	1.6 (1.9)	1.5 (1.7)	0.52[a]	**0.945 (<0.001)**
Age (years) started smoking, M (SD)	30.9 (10.3)	29.7 (9.1)	0.11	**0.832 (<0.001)**[b]
Duration of smoking (years), M (SD)	18.6 (10.6)	19.8 (10.1)	0.14[a]	**0.811 (<0.001)**

M (SD) = mean (SD). Significant results are represented in bold ($P < 0.05$).
[a] Using Wilcoxon-signed ranks non-parametric test.
[b] Using Pearson correlation coefficient.

respectively, $P < 0.001$). The number of waterpipe smoked yesterday correlated strongly with the number of waterpipe smoked daily in daily WPS ($r_s = 0.68$, $P < 0.001$); however, this association was not significant among occasional WPS ($r_s = 0.13$, $P = 0.70$).

Criterion validity

Serum cotinine levels measured in 109 daily WPS ranged between 0.00 and 100 ng/ml with a mean of 55.0 ng/ml (SD = 40.1; Table 5). Seventy-eight of daily WPS had serum cotinine above 10 ng/ml, the usual cutoff used to differentiate between smokers and non-smokers.[21] While 14.7% of daily WPS had a value between 0.01 and 9.99 ng/ml and 7.3% had undetectable levels. Of those who reported smoking yesterday or the day before, 82% had a cotinine above 10 ng/ml, 12% had a value between 0.01 and 9.99 ng/ml, and 6% had undetectable levels. Serum cotinine levels correlated significantly but weakly with waterpipe-year ($r_s = 0.24$, $P = 0.01$), adjusted waterpipe-year ($r_s = 0.23$, $P = 0.02$), graphical waterpipe-year ($r_s = 0.218$, $P = 0.02$), number of waterpipe smoked yesterday ($r_s = 0.39$, $P < 0.01$), and the number of waterpipe smoked daily ($r_s = 0.36$, $P < 0.01$). Findings were similar using Pearson's correlation (not shown).

Discussion

This study examined the reliability and validity of an Arabic translation of the waterpipe smoking questionnaire developed by Maziak et al.[13] in two communities (Beirut, Lebanon, and Doha, Qatar) using the same methods of questionnaire administration, data evaluation, and cotinine level measurements. The findings are important as instrument validation is essential and standardized methods are required to study tobacco smoking in epidemiological studies.[22]

Most items showed excellent construct validity and test-retest reliability except for the quitting subscale items and the waterpipe sharing item which had a weaker but satisfactory reliability. The number of waterpipes smoked per day item, a measure of smoking intensity showed a moderate convergent validity with the number of waterpipes smoked

Table 4 – Agreement between different items within the same questionnaire (N = 149).

Questionnaire item	Mean (SD)	P-value*	Spearman's rho (P-value)
Waterpipe-year‡ Graphical waterpipe-year‡	54.2 (60.7) 45.0 (51.4)	**<0.001**	**0.92 (<0.001)**
Waterpipe-year‡ Adjusted waterpipe-year‡	54.2 (60.7) 47.4 (53.9)	**<0.001**	**0.98 (<0.001)**
Among participants who smoked yesterday/day before (n = 119)			
Number of waterpipe smoked per day (waterpipe smoking intensity), mean (SD) Reported number of waterpipe smoked yesterday	2.2 (1.5) 2.2 (2.0)	0.22	**0.67 (<0.001)**
Among occasional smokers who smoked yesterday/day before (n = 11)			
Number of waterpipe smoked per day (waterpipe smoking intensity), mean (SD) Reported number of waterpipe smoked yesterday	0.4 (0.1) 1.3 (0.6)	**0.003**	0.13 (0.70)
Among daily smokers who smoked yesterday/day before (n = 108)			
Number of waterpipe smoked per day (waterpipe smoking intensity), mean (SD) Reported number of waterpipe smoked yesterday	2.3 (1.5) 2.3 (2.1)	0.07	**0.68 (<0.001)**
Among those who did not change their smoking pattern (n = 49)			
Graphical waterpipe-year‡ Waterpipe-year‡	24.3 (29.0) 30.9 (42.6)	**<0.001**	**0.98 (<0.001)**

Bold value represents statistically significant results with P < 0.05.
‡Waterpipe-year is the product of average daily waterpipe smoked and duration in years; adjusted waterpipe-year takes into consideration the time stopped smoking or smoked less; graphical waterpipe-year is obtained from the graph in Appendix 1.
*Using Wilcoxon-signed ranks non-parametric test.

the day before among daily WPS, and a weak but statistically significant criterion correlation with serum cotinine levels. As expected, however, convergent validity was non-significant for this item among occasional WPS due to their variable smoking pattern.

The waterpipe-year scale, a measure of lifetime smoking exposure also proved to be highly reliable and showed weak but significant criterion validity with serum cotinine levels. Although waterpipe-year overestimated the lifetime smoking exposure compared with the adjusted and graphical waterpipe-year, these measures correlated very strongly. Furthermore, prior studies have correlated waterpipe-year with several clinical outcomes such as heart diseases, chronic bronchitis, and chronic respiratory diseases.[16–19,23] Heavy waterpipe smoking defined as >50 waterpipe-year was significantly associated with heart diseases.[16] Likewise, patients with >40 waterpipe-year smoking history had three-fold the odds of severe coronary stenosis compared with non-smokers in another study.[17]

Table 5 – Associations between self-reported waterpipe smoking intensity and serum cotinine levels in daily smokers (N = 109).

Waterpipe smoking intensity measure	Mean (SD)	Spearman's rho (P-value)
Waterpipe-year[a] Cotinine (n = 109)	65.7 (62.2) 55.0 (40.1)	**0.24 (0.01)**
Adjusted waterpipe-year[a] Cotinine (n = 109)	58.5 (56.1) 55.0 (40.1)	**0.23 (0.02)**
Graphical waterpipe-year[a] Cotinine (n = 109)	54.5 (53.4) 55.0 (40.1)	**0.22 (0.02)**
Number of waterpipes smoked yesterday Cotinine (n = 100)	2.2 (2.1) 59.2 (39.1)	**0.39 (<0.01)**
Number of waterpipes smoked daily (waterpipe smoking intensity) Cotinine (n = 109)	2.2 (1.4) 55.0 (40.1)	**0.36 (<0.01)**

Bold value represents statistically significant results with P < 0.05.
[a] Waterpipe-year is the product of average daily waterpipe smoked and duration in years; adjusted waterpipe-year takes into consideration the time stopped smoking or smoked less; Graphical waterpipe-year is obtained from the graph in Appendix 1.

All measures of waterpipe lifetime smoking exposure and daily smoking intensity showed a weak but statistically significant criterion correlation with serum cotinine levels obtained after 6 h of abstinence from smoking. Similar to cigarette smoking, waterpipe smoking is associated with an acute increase in serum nicotine and cotinine levels.[24] Furthermore, cotinine, a primary nicotine metabolite is considered the best biomarker for tobacco smoking[21,25,26] and has been used in evaluating waterpipe tobacco smoking.[16,24,27]

The magnitude of the correlation between serum cotinine levels and self-reported daily smoking intensity in our study is comparable to the previously reported magnitude of the correlation between serum nicotine levels and intensity of acute waterpipe smoking in laboratory-based experiments.[28] The correlation between serum cotinine levels and cigarette smoking intensity is also of similar magnitude.[29–32] Indeed waterpipe tobacco smoking is associated with exposure to nicotine in levels similar to cigarette smoking.[33] However, the association between waterpipe smoking and nicotine levels is affected by the amount of waterpipe tobacco used and its nicotine content as well as the smoking behavior (total session time, total puff time, cumulative puff duration, and total smoke inhaled per session).[28] Furthermore, the bioavailability of cotinine is affected by gender[34] and varies among different ethnicities and age groups[21,35–38] as well as other individual

pharmacogenetic factors.[39] This could explain the weak correlation between serum cotinine levels and the number of waterpipe smoked daily in our study.

This study has several limitations. The study sample included adults aged 40 years and older, which could limit the generalizability of our findings to older individuals. Furthermore, serum cotinine level was not measured in occasional WPS in whom the variability in smoking pattern is expected to lead to a weaker correlation between cotinine levels and smoking intensity thus limiting criterion validation to the daily WPS. Finally, the use of two interviewing methods, face-to-face followed by telephone interviews in the test-retest reliability assessment, could affect the quality of the data collected[40] although this would tend to underestimate the reliability of the instrument.

Balancing these limitations are several strengths including novelty, as it is the first study to validate a waterpipe smoking questionnaire that assesses smoking behavior and intensity. Previously evaluated questionnaires assessed other aspects of waterpipe smoking including dependence,[14] knowledge, attitudes, and practices of waterpipe use among pregnant women,[11] exposure to risk, second-hand smoke, cessation, risk perception, knowledge, and attitude.[22] Furthermore, the study is community-based and the sample included both males and females from two different communities in the Near East and the Gulf regions. Finally, the questionnaire was cross-culturally adapted, which is an essential aspect of validation for instruments measuring waterpipe tobacco consumption.

In conclusion, our study demonstrated that the waterpipe smoking questionnaire developed by Maziak et al. is a valid and reliable instrument that can be used to assess waterpipe use among different Arabic-speaking communities. This questionnaire is valid and reliable to assess smoking intensity (daily and lifetime exposure), patterns of use, and willingness to quit smoking among waterpipe smokers. As the waterpipe epidemic is rapidly spreading, more efforts should be invested in the validation of the different waterpipe smoking instruments, as widely accepted and cross-culturally adapted instruments are required for a better assessment of the waterpipe epidemic.

Author statements

Author contributions

HC and SA drafted the manuscript and were responsible for data interpretation. HC and BG were responsible for data analysis and interpretation. HC, SA, RD, NY, and AA have made substantial contribution to conception and design and revised the manuscript critically for important intellectual content. NA, BG, and MA acquired the data and revised the manuscript critically for important intellectual content. HC had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

All the authors of this paper have read, approved the final version submitted and agree to be held accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics approval and consent to participate

This study was approved by American University of Beirut Institutional Review Board (IM.HC.03) and Hamad Medical Center Institutional Review Board (13-00054). All participants signed informed consent.

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Competing interests

None declared.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.puhe.2016.12.007.