

Comparisons between young adult waterpipe smokers and nonsmokers' reactions to pictorial health warning labels in Lebanon: a randomized crossover experimental study

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Abstract

This study compares the impact of pictorial health warning labels (HWLs) and their placements on waterpipe parts (device, tobacco and charcoal packages) on health communication outcomes between waterpipe smokers and nonsmokers in Lebanon. An online randomized crossover experimental study was conducted among young adults ($n = 403$, August 2021) who observed three conditions of HWLs: pictorial HWLs on the tobacco package, pictorial HWLs on all waterpipe's parts and text-only HWL on the tobacco package in random order. Participants completed post-exposure assessments of health communication outcomes after each image. Using linear mixed models, we examined the differences in the effect of HWL conditions on several outcomes (i.e. warning reactions) between waterpipe smokers and nonsmokers, controlling for confounders (i.e. age, sex). Nonsmokers reported greater attention ($\beta = 0.54$ [95% confidence interval: 0.25–0.82]), cognitive

elaboration (0.31 [0.05–0.58]) and social interaction (0.41 [0.18–0.65]) for pictorial HWLs on the tobacco packages than text-only compared with smokers. Pictorial HWLs on three parts versus one part elicited higher cognitive reactions and perceived message effectiveness in nonsmokers compared with waterpipe smokers. These findings provide valuable information for policymakers about the potential of implementing HWLs specific to waterpipes to prevent their use among young adults and limit tobacco-related morbidity and mortality in Lebanon.

Introduction

Waterpipe tobacco smoking (WTS) is rising globally, particularly among young people in the Eastern Mediterranean Region (EMR) [1, 2]. For example, current WTS was 39.5% among people aged 18 years and above in Lebanon in 2019, marking it as the highest prevalence in the region [2]. Furthermore, most waterpipe smokers start smoking by the age of 18 years [3], and this period is

crucial for establishing long-term smoking-related attitudes and behaviors [4]. WTS among young people in the EMR is frequently associated with misperceptions of reduced harm compared with cigarettes, which can be countered by accurate risk communication strategies such as health warning labels (HWLs) [5, 6].

The implementation of pictorial HWLs on tobacco products is endorsed by the World Health Organization's Framework Convention on Tobacco Control (FCTC) to curb tobacco use and has been ratified by over 180 countries/territories for cigarette packages [7]. Using HWLs on tobacco products is an effective strategy to prevent smoking and reduce smoking-related morbidity and mortality [8]. Pictorial HWLs affect key elements of behavioral change, such as negative emotions and cognitive and affective reactions, and stimulate conversation about smoking health consequences [8–10]. Although Lebanon ratified the FCTC, only textual warnings on waterpipe tobacco packaging outlining several adverse effects of WTS are implemented [11].

Pictorial HWLs are an important source of health information for the public, including smokers and nonsmokers, displayed each time the product is used [8, 12, 13]. However, given the distinctive features of WTS as a multi-part tobacco use that requires tobacco, charcoal and the device, and the spread of waterpipe lounges and café where exposure to WTS is associated with higher smoking susceptibility and initiation among nonsmokers [14, 15], the introduction of pictorial HWLs on all waterpipe parts represents a powerful tool to communicate health risks associated with smoking for both smokers and nonsmokers.

Several studies have tested waterpipe-specific pictorial HWLs among smokers and nonsmokers [16–23]. These studies showed that pictorial HWLs on waterpipe tobacco packages could stimulate more attention [16–19], increase awareness of the health risks associated with smoking [16–19], encourage smokers to quit [16–19] and prevent nonsmokers from initiating WTS compared with text-only HWLs [22]. On the other

hand, fewer studies looked at the effect of the placement of HWLs [20, 23]. They showed that implementing HWLs on the device could effectively communicate the health risks associated with WTS, increase the intention to quit among smokers [20, 23] and reduce the initiation among nonsmokers [24]. However, no previous efforts were made to develop evidence-based, waterpipe-specific HWLs through a multi-stage qualitative and quantitative process involving waterpipe smokers and nonsmokers.

As part of a project aimed at developing waterpipe-specific pictorial HWLs for countries in the Middle East, we have previously reported the findings of a Delphi [25] followed by focus group studies [11, 26] that resulted in four HWLs specific to WTS. These HWLs were further tested in an experimental study assessing the effect of pictorial HWLs versus text-only by different placements among young adult waterpipe smokers in Lebanon [27]. We found that among smokers, pictorial HWLs compared with text-only elicited greater attention, negative affect and higher risk perceptions [27]. However, nonsmokers are an important target group for smoking-related health communications because they embody the large part of the population at risk of smoking initiation, and their reactions to pictorial HWLs may differ from smokers. For example, previous studies showed that nonsmokers are more likely to react to pictorial HWLs with higher risk perceptions, affective reactions and more thoughts about not smoking than smokers [22].

Here, we complement that report by testing the effect of waterpipe-specific pictorial HWLs and their placements among waterpipe nonsmokers on health communication outcomes and comparing their reactions to waterpipe smokers. In this study, we first assessed the effect of pictorial HWLs compared with text-only warnings on the tobacco package and pictorial HWLs on all three parts (device, tobacco and charcoal packages) among nonsmokers and then compared the results of nonsmokers with smokers on key risk communication outcomes. Our hypotheses were the following: exposure to pictorial HWLs among nonsmokers on all

three parts will be more effective than pictorial HWL on one part (tobacco package), and pictorial HWL on tobacco package will be more effective than text-only on tobacco package on health communication outcomes and will induce higher reactions in terms of health communication outcomes among nonsmokers compared with waterpipe smokers.

Methods

Participants

Four hundred and three young adult smokers ($n = 276$) and nonsmokers ($n = 127$) between 18 and 34 years old were eligible to participate in this study. Participants who smoked waterpipe in the past year were classified as waterpipe smokers, while nonsmokers were those who did not use any tobacco products in the past year [28]. Waterpipe smokers also included individuals who reported smoking cigarettes or other tobacco/nicotine products (i.e. e-cigarettes). Participants were recruited initially from students attending the American University of Beirut (AUB), Lebanon. We targeted young adults as they are the largest at-risk group for WTS in Lebanon [2]. Potential participants were recruited via email lists provided by the university's Institutional Review Board (IRB), which requested a random sample of students' emails from the Information Technology Department in collaboration with the Department of Student Services at the university. The email lists did not contain any identifying information.

Participants received emails that included study descriptions, the contact information of the research team and two links to complete the online survey in either English or Arabic based on their preferences. The survey was first translated from English to Arabic and then back-translated from Arabic to English. We resolved any inconsistency by discussion. Furthermore, participants were encouraged to forward emails to others who might be interested. Out of 1737 emails sent, 46% responded and accessed the study link.

Procedure

The methodology and protocol of this study can be found elsewhere [29]. In brief, we conducted a randomized crossover experimental study using the online survey platform Sphinx (August 2021). After e-signing the consent form, participants first completed a baseline assessment that included sociodemographic information and smoking status. They were then exposed to three conditions of HWLs: pictorial HWLs on the tobacco package, pictorial HWLs on three parts of the waterpipe (device, tobacco and charcoal packages) and the Lebanese text-only HWL on the tobacco package stating 'Smoking leads to fatal and serious disease' (control) displayed one at a time and in a random order for each participant to reduce carryover and order effect (Supplementary Fig. S1). After each image, participants completed a set of post-exposure assessments of health communication outcomes.

The entire study took an average of 15 min. At the end of the trial, participants received the equivalent of \$10 in credit transfers to their mobile phone numbers as a token of thanks.

This study was approved by the IRB of both Florida International University and the AUB.

Sample size

To have 80% power detecting a significant between-subject, within-subject and interaction effects of medium effect size Cohen's $f = 0.25$ for comparisons of the main outcomes (e.g. negative affect) [8] at the two-tailed 0.05 alpha level, we will need 28 participants per HWL and per smoking group. This is assuming a correlation among repeated measures within subject of 0.5 and nonsphericity correction of 1 and adjusted for two main comparisons (pictorial HWL on the tobacco versus pictorial HWL on all and pictorial HWL on the tobacco versus text-only on the tobacco) and Bonferroni correction for multiple comparisons. Thus, we need a total sample size of 28×4 (HWLs) \times 2 (smokers/nonsmokers) = 224 participants, which will provide 80% power for the planned analyses. However, we planned to recruit 246 participants

(123 participants per smoking group) to account for 10% of missing responses.

Measures

'Baseline assessment' consisted of sociodemographic variables, including gender, age, marital status, educational level, employment status and waterpipe smoking status.

Post-exposure assessments

Theoretical framework

The assessment of HWLs was based on the message impact framework that includes several communication outcomes used in previous tobacco warnings research [8].

This model assumes that features of the HWLs will lead to behavioral change through a chain of psychological events (e.g. attention and reaction) [8]. Based on the message impact framework, we grouped the outcome variables into five categories that include (i) attention, (ii) warning reactions (believability, cognitive elaboration, negative affect, reactance, anticipated avoidance and social interaction), (iii) perceived message effectiveness, (iv) attitudes and beliefs (e.g. perceived harm) and (v) intentions. See Table SI in the supplementary material for more details.

All the outcomes were measured on a 5-point Likert scale (1 = not at all progressing to 5 = very much). The total score obtained is 5 for each measure. We averaged responses of the multi-item scales, where a higher score indicates a stronger response. For all multi-item scales, Cronbach's alpha was 0.8 or greater, representing a high degree of internal consistency.

Statistical analysis

We reported means and standard deviations (SDs) for continuous variables and frequencies and proportions for categorical variables. To compare categorical and continuous baseline characteristics between smokers and nonsmokers, we used the chi-square test and independent *t*-test, respectively. We described the different outcome measures for each HWL placement (pictorial HWLs on the tobacco

package, pictorial HWLs on three parts of the waterpipe and text-only HWL on the tobacco package) for nonsmokers using means and SDs. Planned comparisons using repeated-measures analysis of variance followed by Bonferroni adjustment for multiple comparisons were used to test the equality of outcome means between the three conditions (pictorial HWLs on the tobacco package versus pictorial HWLs on three parts of the waterpipe; pictorial HWLs on the tobacco package versus text-only HWL on the tobacco package) for nonsmokers. Next, we modeled the main effects of HWLs in different conditions on dependent variables using linear mixed models with a random intercept and a fixed effect for HWL conditions. We added an interaction term between HWL conditions and waterpipe smoking status to test the potential differential effect of HWL conditions on the outcomes for smokers and nonsmokers. Under the assumed normal distribution with identity link, we checked the models' assumptions, including residual normality and homoscedasticity. We also adjusted for confounders in the analysis (age, sex, education level, work status and HWLs). Participants with missing responses ($n = 5$) were excluded from the analysis. Data were analyzed using R v 4.0.2. Knowing that the Bonferroni approach lowers the working significance level of each test to compensate for the increased chance of Type I errors among all tests performed in multiple comparisons [30], differences at an alpha level of 0.025 were considered statistically significant for the pairwise comparisons of HWL conditions (i.e. pictorial HWLs versus text-only on tobacco package and pictorial HWLs on three parts versus pictorial HWLs on tobacco package only).

Results

As shown in Table I, this study included 403 participants, comprising 68.5% ($n = 276$) smokers and 31.5% ($n = 127$) nonsmokers. Among the nonsmokers, 81% ($n = 103$) were never smokers. More than half of the participants were females (59%),

Table I. Baseline demographic characteristics by waterpipe smoking status

Variables	Mean (SD)			P-value
	All (n = 403)	Nonsmokers (n = 127)	Smokers (n = 276)	
Age	25.5 (4.4)	24.6 (4.4)	25.9 (4.3)	0.0050
Sex (female)	237 (58.8)	91 (71.7)	146 (52.9)	0.0001
Education		N (%)		0.0040
High school or less	159 (39.5)	38 (30.0)	121 (43.8)	
Undergraduate/bachelor's degree	166 (41.1)	55 (43.2)	111 (40.3)	
Graduate/master's degree	78 (19.4)	34 (26.8)	44 (15.9)	
Work status (yes)	183 (45.4)	49 (38.6)	134 (48.6)	0.1750
Marital status				0.1890
Single	245 (60.8)	85 (66.9)	160 (60.1)	
Married	145 (36.0)	41 (32.3)	104 (37.7)	
Separated/divorced	13 (3.2)	1 (0.8)	12 (2.2)	
Waterpipe smoker (yes)	276 (68.5)			

and the mean age was 25.5 ± 4.4 years. Approximately 41% had undergraduate/bachelor's degrees, 45% were employed and 61% were single.

Nonsmokers' reactions to pictorial HWLs compared with text-only on tobacco package

Compared with text-only, pictorial HWLs on tobacco packages generated greater attention ($P = 0.0001$) and believability ($P = 0.0160$). Nonsmokers reported that pictorial HWLs on the tobacco package (versus text-only) triggered them to think more about the health problems caused by WTS ($P = 0.0005$). Moreover, young adults elicited higher negative affect reactions to pictorial HWLs on tobacco packages compared with text-only in terms of negative affect (feeling anxious, sad, scared and disgusted; all $P = 0.0001$) and social interaction around the HWLs ($P = 0.0001$). Pictorial HWLs on tobacco packages were rated more effective than text-only HWL in making waterpipe seem unpleasant ($P = 0.0001$) and discouraging from wanting to smoke waterpipe ($P = 0.0250$). Moreover, pictorial HWLs on tobacco packages were more effective in making people more concerned about the health risks of WTS, motivating waterpipe smokers to

quit and preventing young people from starting to smoke waterpipe (all $P = 0.0001$).

Nonsmokers' reactions to pictorial HWLs on three parts compared with pictorial HWLs on tobacco package only

No significant differences were noted between pictorial HWLs on three parts and pictorial HWLs on tobacco packages only for the health communication outcomes (Table II).

Comparison between nonsmokers and waterpipe smokers' reactions to pictorial HWLs

The linear mixed-model results showed significant interactions between waterpipe smoking status and pictorial HWLs compared with text-only on tobacco packages for different communication outcomes.

Attention

Pictorial HWLs compared with text-only evoked greater attention for nonsmokers than smokers ($\beta = 0.54$; 95% confidence interval [CI]: 0.25–0.82).

Table II. Comparison of health communication outcomes by experimental condition among young adults nonsmokers in Lebanon (*n* = 127)

Outcomes	Mean (SD)			Overall comparison, <i>P</i> -value*
	Pictorial HWLs on three parts	Pictorial HWLs on tobacco package	Text-only on tobacco package	
Attention ^a	3.72 (1.34)	3.89 (1.20)	3.12 (1.38)	0.0001
Warning reactions				
Believability ^a	3.73 (1.37)	3.86 (1.21)	3.55 (1.28)	0.0203
Cognitive elaboration ^a				
How much does the warning cause to think about				
The health problems caused by WTS ^a	3.87 (1.21)	3.85 (1.26)	3.39 (1.35)	0.0001
The information they convey ^a	3.87 (1.18)	3.81 (1.20)	3.30 (1.35)	0.0001
Negative affect ^a	3.51 (1.20)	3.60 (1.17)	3.03 (1.30)	0.0001
Anxious ^a	3.67 (1.35)	3.87 (1.22)	3.13 (1.41)	0.0001
Sad ^a	3.50 (1.37)	3.49 (1.38)	3.02 (1.47)	0.0001
Scared ^a	3.55 (1.33)	3.59 (1.36)	3.05 (1.43)	0.0001
Guilty	3.17 (1.45)	3.18 (1.52)	2.89 (1.43)	0.0142
Disgusted ^a	3.65 (1.38)	3.89 (1.33)	3.07 (1.45)	0.0001
Reactance	2.37 (1.20)	2.40 (1.30)	2.21 (1.13)	0.0615
This warning is trying to manipulate me	2.39 (1.39)	2.46 (1.44)	2.46 (1.37)	0.8040
This warning annoys me ^a	2.50 (1.46)	2.49 (1.55)	2.16 (1.38)	0.0094
This warning is overblown	2.21 (1.37)	2.27 (1.47)	2.02 (1.23)	0.0380
Anticipated avoidance	2.82 (1.33)	2.74 (1.36)	2.48 (1.35)	0.0168
How likely is it that you would try				
To avoid thinking about this warning?	2.72 (1.33)	2.71 (1.40)	2.55 (1.46)	0.3360
To avoid looking at this warning?	2.91 (1.51)	2.76 (1.50)	2.41 (1.40)	0.0011
Social interaction ^a	3.31 (1.34)	3.34(1.36)	2.81 (1.49)	0.0001
Perceived message effectiveness ^a	3.95 (1.17)	4.02 (1.15)	3.63 (1.18)	0.0001
This message makes me concerned about the health effects of waterpipe	3.94 (1.28)	3.92 (1.27)	3.68 (1.25)	0.0215
This message makes waterpipe seem unpleasant to me ^a	3.85 (1.35)	4.07 (1.25)	3.45 (1.43)	0.0001
This message discourages me from wanting to smoke waterpipe ^a	4.06 (1.19)	4.06 (1.25)	3.76 (1.27)	0.0069
Perceived message effectiveness on others ^a	3.61 (1.14)	3.65 (1.18)	3.08 (1.32)	0.0001
How effective would the warning be in				
Making people more concerned about the health risks of WTS? ^a	3.65 (1.16)	3.66 (1.26)	3.16 (1.29)	0.0001
Motivating waterpipe smokers to quit? ^a	3.57 (1.28)	3.65 (1.24)	3.02 (1.43)	0.0001
Preventing young people from starting to smoke waterpipe? ^a	3.62 (1.27)	3.63 (1.33)	3.08 (1.48)	0.0001
Attitudes and beliefs				
Perceived harm	4.24 (1.04)	4.14 (1.12)	4.06 (1.18)	0.0967
Experiential risk	3.81 (1.33)	3.81 (1.24)	3.81 (1.25)	0.1730
Affective risk	3.71 (1.27)	3.76 (1.24)	3.57 (1.36)	0.1220
Intention to start	1.68 (1.28)	1.71 (1.28)	1.58 (1.12)	0.4280

**P*-values indicate the overall comparison between the three conditions: pictorial HWLs on three parts, pictorial HWLs on tobacco package and text-only on tobacco package.

^aIndicates a significant difference between pictorial HWLs on tobacco package and text-only on tobacco package.

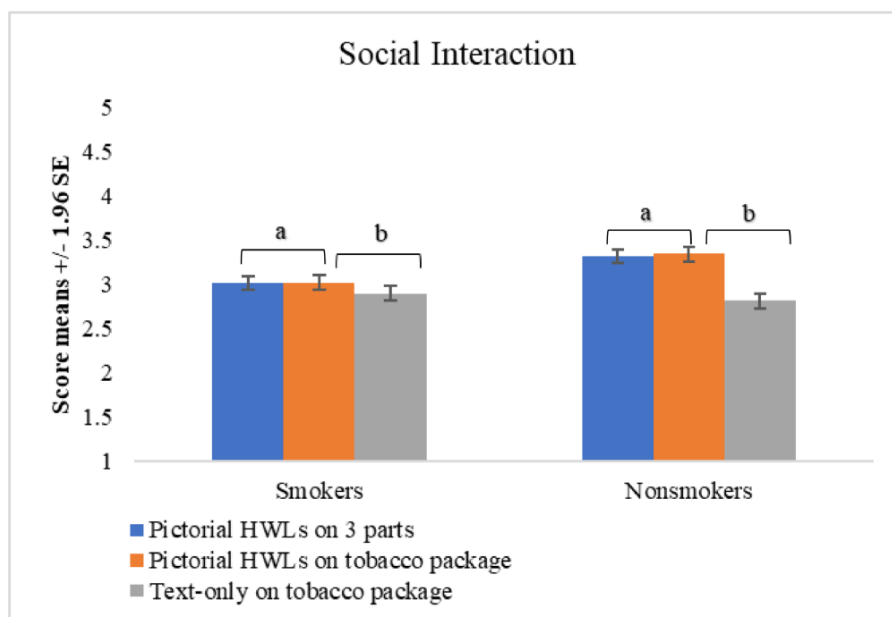


Fig. 1. The comparison of means scores of social interaction for different HWL conditions between waterpipe smoker and nonsmoker young adults in Lebanon. $P^a = 0.8333$, $P^b = 0.0007$. ^aThe comparison between waterpipe smokers and nonsmokers' reactions to pictorial HWLs on three parts compared with pictorial HWLs on tobacco package. ^bThe comparison between waterpipe smokers and nonsmokers' reactions to pictorial HWLs compared with text-only on tobacco package.

Warning reactions

Pictorial HWLs versus text-only made nonsmokers think about the health problems caused by WTS more than smokers ($\beta = 0.31$ [95% CI: 0.05–0.58]). Compared with waterpipe smokers, pictorial HWLs on tobacco packages stimulated more anxiety ($\beta = 0.50$ [95% CI: 0.23–0.76]), fear ($\beta = 0.30$ [95% CI: 0.02–0.52]) and disgust feelings ($\beta = 0.52$ [95% CI: 0.24–0.80]) among nonsmokers. No significant interactions were observed for other measures of negative effects (sadness or guilty). In terms of social interaction, nonsmokers reported higher social interactions about pictorial HWLs on tobacco packages versus text-only ($\beta = 0.41$ [95% CI: 0.18–0.65]) compared with smokers (Fig. 1). No significant differences were observed for any measure of anticipated avoidance or attitudes and beliefs between smokers and nonsmokers.

Perceived message effectiveness

Pictorial HWLs (versus text-only HWLs) were rated as more effective by nonsmokers compared with waterpipe smokers in terms of making waterpipe seem unpleasant ($\beta = 0.40$ [95% CI: 0.13–0.68]), making people more concerned about the health risks of WTS ($\beta = 0.38$ [95% CI: 0.12–0.63]) and preventing young people from starting to smoke waterpipe ($\beta = 0.33$ [95% CI: 0.06–0.59]).

We did not find any significant differences between nonsmokers and waterpipe smokers' reactions to pictorial HWLs on three parts compared with tobacco packages only (Table III).

Discussion

This study contributes to the literature examining the potential of pictorial HWLs in deterring

Table III. Comparison between waterpipe smokers and nonsmokers' reactions to HWLs in Lebanon

Outcomes	Pictorial HWLs versus text-only on tobacco package	Pictorial HWLs on three parts versus pictorial HWLs on tobacco package only
Ref = smokers	β -estimate (95% CI)	
Attention	0.54 (0.25–0.82)	0.02 (–0.26 to 0.30)
Warning reactions		
Believability	0.18 (–0.09 to 0.45)	0.10 (–0.18 to 0.37)
Cognitive elaboration		
How much does the warning cause to think about		
The health problems caused by WTS	0.31 (0.05–0.58)	0.08 (–0.19 to 0.35)
The information they convey	0.25 (–0.01 to 0.51)	0.10 (–0.16 to 0.36)
Negative affect	0.32 (0.11–0.52)	–0.03 (–0.24 to 0.17)
Anxious	0.50 (0.23–0.76)	–0.20 (–0.46 to 0.07)
Sad	0.25 (–0.01 to 0.51)	0.03 (–0.23 to 0.30)
Scared	0.30 (0.02–0.52)	0.11 (–0.14 to 0.36)
Guilty	0.04 (–0.21 to 0.30)	0.09 (–0.17 to 0.34)
Disgusted	0.52 (0.24–0.80)	–0.19 (–0.47 to 0.09)
Reactance	0.02 (–0.19 to 0.23)	0.04 (–0.16 to 0.25)
This warning is trying to manipulate me	–0.13 (–0.40 to 0.14)	0.01 (–0.25 to 0.28)
This warning annoys me	0.06 (–0.22 to 0.34)	0.11 (–0.17 to 0.39)
This warning is overblown	0.13 (–0.14 to 0.40)	0.01 (–0.26 to 0.28)
Anticipated avoidance	0.09 (–0.18 to 0.36)	0.14 (–0.12 to 0.41)
How likely is it that you would try		
To avoid thinking about this warning?	0.01 (–0.30 to 0.30)	0.10 (–0.19 to 0.39)
To avoid looking at this warning?	0.17 (–0.13 to 0.47)	0.19 (–0.12 to 0.49)
Social interaction	0.41 (0.18–0.65)	–0.03 (–0.26 to 0.21)
Perceived effectiveness of the warning		
Perceived message effectiveness	0.19 (–0.03 to 0.41)	0.01 (–0.21 to 0.23)
This message makes me concerned about the health effects of waterpipe	0.03 (–0.22 to 0.28)	0.18 (–0.07 to 0.43)
This message makes waterpipe seem unpleasant to me	0.40 (0.13–0.68)	–0.17 (–0.44 to 0.10)
This message discourages me from wanting to smoke waterpipe	0.13 (–0.14 to 0.39)	0.03 (–0.24 to 0.29)
Perceived message effectiveness on others	0.37 (0.16–0.58)	0.05 (–0.16 to 0.26)
How effective would the warning be in		
Making people more concerned about the health risks of WTS?	0.38 (0.12–0.63)	0.04 (–0.21 to 0.30)
Motivating waterpipe smokers to quit?	0.42 (0.16–0.68)	–0.03 (–0.29 to 0.24)
Preventing young people from starting to smoke waterpipe?	0.33 (0.06–0.59)	0.13 (–0.13 to 0.39)
Attitudes and beliefs		
Perceived harm	0.02 (–0.20 to 0.24)	0.16 (–0.06 to 0.38)
Experiential risk	0.13 (–0.11 to 0.38)	–0.15 (–0.40 to 0.10)
Affective risk	0.08 (–0.15 to 0.32)	0.01 (–0.24 to 0.23)

Values in bold indicate significant differences between waterpipe smokers and nonsmokers' reactions to pictorial HWLs versus text-only HWLs.

nonsmokers from waterpipe use. Results suggest that pictorial HWLs on waterpipe tobacco

packaging generate more attention, warning reactions and perceived message effectiveness than

text-only warnings among nonsmokers and that these reactions were more pronounced among nonsmokers compared with waterpipe smokers. Additionally, pictorial HWLs on three parts of the waterpipe compared with tobacco package only had a slightly greater effect on cognitive reactions, anticipated avoidance and perceived harm in nonsmokers compared with waterpipe smokers although the difference was not statistically significant. These findings demonstrate the promise of pictorial HWLs as an effective tool to prevent WTS initiation in young adults.

Pictorial HWLs were able to stimulate key antecedents of behavioral change in nonsmokers. Nonsmokers rated pictorial HWLs on the tobacco package higher for attention, negative affect and fear-oriented reactions such as anxiety, sadness, fear and disgust than text-only HWLs. Based on the message impact framework, affective response and cognitive reasoning in response to pictorial HWLs represent important milestones in the cascade of behavioral change [8]. For example, enhanced cognitive processing of HWLs has been shown to reduce smoking intentions among young adults [31]. Consistent with previous studies assessing waterpipe HWLs [22], our results also showed that nonsmoking young adults rated pictorial HWLs as more effective in causing them to think about the health problems caused by WTS.

Compared with waterpipe smokers, nonsmokers reported higher reactions to pictorial HWLs and were more likely to respond with higher risk perceptions. Similar findings were also obtained in prior studies examining waterpipe HWLs [22, 24]. Furthermore, pictorial HWLs elicited higher perceived message effectiveness in nonsmokers compared with smokers in terms of making waterpipe seem unpleasant to them and making people more concerned about the health risks of WTS. Evidence suggests that HWLs with a greater perceived message effectiveness score have a higher impact on attitudes, behavioral intentions and behavior [10]. The higher impact of pictorial HWLs among nonsmokers than smokers may be because nonsmokers' thoughts about the potential harms of WTS are not restrained by addiction [32, 33]. Smokers

may be addicted to nicotine and therefore may prioritize satisfying their addiction over health concerns, which could reduce the impact of HWLs [32, 33].

One of the interesting findings of this study is that pictorial HWLs induced higher social interactions than text-only and that this effect was more pronounced among nonsmokers than smokers. Because peer and social networks are essential drivers of WTS, social conversations about the potential health effects of WTS can be an important mediator of HWLs' positive effect among young people [34–36].

Our findings comparing pictorial HWLs on three parts versus pictorial HWLs on the tobacco package only on health communication outcomes were less conclusive. Nonsmokers reported higher ratings than smokers for warning reaction measures such as cognitive elaboration measures, anticipated avoidance, perceived message effectiveness and perceived harm, favoring pictorial HWL on three parts compared with pictorial HWL on one part. In addition, our online experimental design, which placed HWLs on all three parts of the waterpipe simultaneously, failed to demonstrate the cumulative impact of HWL exposure on different waterpipe components that is typical in real-life settings. Additionally, our design did not allow for prolonged exposure to HWLs on waterpipe device, which characterizes WTS [25]. Future studies with larger samples and more real-world simulated exposure to HWLs where participants can be exposed to pictorial HWLs on tobacco, charcoal packages and the device in real-life scenarios can help sort out the issue of multiple placements of HWLs for the waterpipe.

This study has limitations. As mentioned earlier, participants were exposed to HWLs online due to corona virus disease restrictions at the time of the study limiting in-person studies. This online design differs from a real-life setting characterized by cumulative and long-term exposure to HWLs. Nevertheless, our study provides clear evidence of the efficacy of pictorial HWLs compared with text-only for most communications and tobacco control outcomes in a developing country with a high

waterpipe smoking rate. Another limitation may be recruiting participants mainly from one university in an urban setting. However, AUB is a major university in Lebanon where students from rural and urban areas study. Furthermore, participants were encouraged to forward the email to others outside the university interested in participating in the study. This helped in the recruitment of a large and more representative sample of young adult waterpipe smokers and nonsmokers in Lebanon. Although our findings may not be generalizable to the whole population in Lebanon and beyond, they provide the first evidence of the potential efficacy of pictorial HWLs specific to WTS compared with text-only using a within-between-subject comparison that can inform future real-world testing with representative samples.

In summary, this study shows that pictorial HWLs on the tobacco packages elicited greater attention, warning reactions and perceived message effectiveness than text-only among nonsmokers. These reactions were more pronounced among nonsmokers than waterpipe smokers. These findings provide valuable information for policy-makers as they work to implement HWLs for tobacco products to curb WTS among young adults and limit tobacco-related morbidity and mortality in Lebanon. Future studies with larger samples and more real-world simulated exposure to HWLs can help establish the value, or lack thereof, of multiple placements of HWLs for the waterpipe.

Supplementary data

Supplementary data are available at *HEAL* online.

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Conflict of interest statement

None declared.

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