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Comparing harm beliefs and risk perceptions among young adult waterpipe tobacco smokers and nonsmokers: Implications for cessation and prevention

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ABSTRACT

Introduction: Very little is known about how waterpipe tobacco smokers and nonsmokers compare on harm beliefs about waterpipe tobacco smoking (WTS) and how these beliefs are related to risk appraisals and intentions to engage in WTS. We investigated these issues among young adult waterpipe tobacco smokers, susceptible nonsmokers, and non-susceptible nonsmokers.

Methods: Young adults ages 18 to 30 who smoked waterpipe tobacco during the last 30 days or never used waterpipe tobacco were recruited online through Turkprime. Nonsmokers were grouped as susceptible or not. Participants completed measures of harm beliefs, risk appraisals (i.e., perceived risks and worry), and desire to quit among smokers or willingness/curiosity to try waterpipe among nonsmokers.

Results: Analyses were based on 247 smokers and 418 nonsmokers. Smokers endorsed most strongly harm beliefs that portrayed WTS as safe, followed by susceptible and then non-susceptible nonsmokers. Most harm beliefs were significantly related to risk appraisals, yet weakly associated with desire to quit or willingness/curiosity to try waterpipe tobacco, except among susceptible nonsmokers.

Conclusions: Greater efforts are needed to correct maladaptive beliefs about WTS harms, especially among smokers. Among susceptible nonsmokers, harm beliefs may be more influential in predicting willingness to try WTS than risk appraisals.

1. Introduction

In the United States, waterpipe tobacco smoking (WTS) among young adults is not trivial. During 2013–2014, prevalence of WTS every day to mostly monthly use was 18% among 18–24 year olds (Kasza, Ambrose, Conway, et al., 2017; Robinson, Wang, Jackson, Donaldson, & Ryant, 2017). Of importance, WTS is linked with illnesses such as lung cancer and heart disease (El-Zaatari, Chami, & Zaatari, 2015; Waziry, Jawad, Ballout, Al Akel, & Akl, 2016). Despite these harms, interventions to curb uptake and increase cessation of WTS among young adults is sparse (Lipkus, Eissenberg, Schwartz-Bloom, Prokhorov, & Levy, 2011; Maziak et al., 2015). Instead, studies have focused on cessation among frequent and addicted adult smokers (Maziak et al., 2015), often involving pharmacological agents and intensive counseling, making these interventions less appealing to younger adults.

Among younger adults, focusing on addiction and harm may decrease uptake and increase cessation. Indeed, many waterpipe tobacco smokers believe this product is safe, especially in relation to smoking cigarettes (Akl et al., 2015; Majeed, Sterling, Weaver, Pechacek, & Eriksen, 2017; Rayens et al., 2017). Thus, messaging raising awareness of the harms of WTS should influence risk perceptions and, in turn, affect intentions to either want to try or quit WTS. The limited experimental research shows that educating both young adult nonsmokers and smokers about the harms of WTS does increase perceptions of risk, undermines nonsmokers' willingness to try WTS and increases among smokers their desire to quit (Lipkus, Mays, & Tercyak, 2017; Mays, Tercyak, & Lipkus, 2016).

While this experimental evidence on WTS messaging is promising, there is a lack of research connecting harm beliefs and perceptions of risk. That is, very little is known about beliefs that influence WTS risk perceptions. In particular, lacking are studies comparing harms beliefs between young adult waterpipe tobacco smokers and nonsmokers and how harm beliefs relate to risk perceptions. Nonsmokers can be grouped further into individuals who oppose trying waterpipe (i.e., non-susceptible nonsmokers) and those willing to try waterpipe (i.e., susceptible nonsmokers). It remains unknown how these nonsmokers differ on WTS harm beliefs, if nonsmokers' beliefs differ from smokers, and how harm beliefs are related to perceived risk. According to the Theory of

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Planned Behavior (Ajzen, 1991) beliefs influence attitudes. For WTS, perceived risk can function as an attitude (Taber & Klein, 2016) influenced by harm beliefs. For example, the belief that toxins from WTS are removed as they pass through the water should correlate with lower perceived risk. Further, risk perceptions, rather than harm beliefs, are hypothesized to be stronger determinants of intentions to either try waterpipe tobacco or quit.

To address these noted gaps, we examined relations between harm beliefs and perceived risk of WTS comparing young adult waterpipe tobacco smokers, non-susceptible nonsmokers, and susceptible nonsmokers. We hypothesized that harm beliefs would correlate with perceived personal risk. Further, we hypothesized that smokers would maintain the strongest beliefs that WTS is safe and view their personal risks as low, followed by susceptible nonsmokers, and lastly by non-susceptible nonsmokers. Examining these patterns can provide evidence on maladaptive harm beliefs to target in WTS prevention and cessation interventions. Because positive correlations are predicted among these variables, targeting one construct may influence others. We examined further how harm beliefs and risk perceptions were related to the desire to quit and willingness to try WTS among smokers and nonsmokers, respectively. Among smokers, we predicted that the desire to quit would be positively associated with greater perceived risks and beliefs that WTS is harmful, while having a similar directional pattern of reducing willingness to try WTS among nonsmokers.

2. Materials and methods

2.1. Participants and procedures

Participants were recruited using TurkPrime(TP) (Litman, Robinson, & Abberbock, 2017), a research platform that supports data collection using the Internet crowdsourcing platform Amazon Mechanical Turk (AMT) (Sheehan & Pittman, 2016). The use of this data collection approach (e.g., AMT) is supported by studies of tobacco use (Mays et al., 2016; Pearson, Richardson, Feirman, et al., 2016; Shi, Wang, Emery, Sheerin, & Romer, 2017). The study involved completing an online survey administered separately for smokers and nonsmokers. There were two waves of data collection. The first wave consisted of a larger sample that contained harm beliefs and risk perceptions. A second wave was created to include harm beliefs that were not initially considered in Wave 1. Wave 2 took place one month after the end of Wave 1.

Wave 1 AMT members residing in the U.S. interested in participating reviewed a study description with a link to the online consent and eligibility screener. To be eligible as a smoker, participants had to be 18 to 30 years of age and report WTS within the last 30 days. To be eligible as a nonsmoker, participants had to be 18 to 30 years of age and report never smoking waterpipe tobacco. Recruitment for Wave 2 differed slightly. Interested AMT members residing in the U.S. reviewed a study description with a link to the online consent and eligibility screener – paid 5 cents for the screener. Those eligible and interested in the larger survey were emailed to take the survey within three days of eligibility screening. [The difference in recruitment was merely for exploratory purposes to investigate differential recruitment rates between the two formats]. Participants completing the study received $1.50. The Duke University Medical Center Institutional Review Board approved this study.

2.2. Measures

The following questions, aside from demographic information, were posed to nonsmokers and smokers.

2.2.1. Other tobacco product use

Participants reported past month use of cigarettes, large cigars, little cigars/cigarillos, smokeless tobacco, regular pipe and electronic cigarettes. Waterpipe smokers were asked what best described their use: monthly (at least once a month but less than weekly), weekly (at least once a week but less than daily), and daily (at least once a day or on most days of the month).

2.2.2. Susceptibility to WTS

Captured by four questions: 1) “Do you think that you will smoke tobacco from a waterpipe soon?”; 2) “Do you think that you will smoke tobacco from a waterpipe in the next year?”; 3) “Do you think that in the future you might experiment with waterpipe tobacco smoking?” and 4) “If one of your best friends asked you to smoke tobacco from a waterpipe, would you?” (Lipkus, Reboussin, Wolfson, & Sutfin, 2015). Response options included: Definitely yes; Probably yes; Probably no; and Definitely no. Consistent with how susceptibility has been operationalized mostly with cigarettes (Pierce, Choi, Gilpin, Farkas, & Merritt, 1996), participants were deemed susceptible if they responded other than *Definitely No* to any item; participants responding *Definitely No* to all items were deemed to be non-susceptible.

2.2.3. Harm beliefs

Beliefs about harms of WTS were created from the epidemiological literature, questions testing knowledge and beliefs about WTS, and beliefs about harms of cigarette smoking (Akl et al., 2015; Creamer, Loukas, Li, et al., 2016; El-Zaatari et al., 2015; Lipkus, Eissenberg, Schwartz-Bloom, Prokhorov, & Levy, 2014; Oakes, Chapman, Borland, Balmford, & Trotter, 2004; Weinstein, Marcus, & Moser, 2005). Two categories of harm beliefs were created and assessed on 7-point Likert scales: 1 = Strongly agree to 7 = Strongly disagree. One category represented beliefs whereby stronger disagreement represented greater perceived harm. These seven beliefs were: 1) “The health risks of waterpipe tobacco smoking are over-exaggerated”; 2) “Smoking waterpipe once or twice a month is not harmful”;3) “Smoking waterpipe for an hour or two in such settings as hookah bars, café and lounges is not harmful to your health”; 4) “Waterpipe tobacco does not have enough nicotine to cause addiction”; 5) “If you did smoke waterpipe tobacco, you wouldn't smoke enough to be hurting your health”/“You don't smoke enough to be hurting your health” (for smokers); 6) “If you did smoke waterpipe tobacco, you will have quit long before you need to worry about getting health problems”/“You will have quit long before you need to worry about getting health problems” (for smokers); and 7) “The water in the waterpipe filters out the most harmful chemicals from waterpipe tobacco smoke” (Wave 2 only).

The second category represented beliefs whereby stronger disagreement represented less perceived harm. These five beliefs were: 1) “Smoking waterpipe tobacco once or twice a month can lead to addiction”; 2) “When you smoke waterpipe tobacco, you inhale cancer causing chemicals”; 3) “Waterpipe tobacco smoking can cause severe health consequences”; 4) “The burning of the charcoal to heat the waterpipe tobacco produces harmful chemicals” (Wave 2 only); and 5) “Sharing of the waterpipe mouthpiece with other smokers can lead to infections” (Wave 2 only).

2.2.4. Risk appraisals

Risk appraisals capture emotions and cognitions about risk (Sheeran, Harris, & Epton, 2014). This variable was composed of four items pertaining to perceived risk and worry about harms and addiction. For perceived risks, smokers were asked, “What do you think is your chance of getting a serious smoking-related disease in your lifetime, such as cancer, lung disease or heart disease if you did not quit waterpipe tobacco smoking” and “What do you think is your chance of becoming addicted to nicotine in tobacco from waterpipe if you did not quit”. Responses were on 7-point Likert scales anchored from 1 = No chance to 7 = Certain to happen. Worry was assessed by “How worried are you about getting a serious smoking-related disease, such as cancer, lung disease, or heart disease, if you did not quit waterpipe tobacco smoking?” and “How worried are you about becoming addicted to

Table 1
Demographic and smoking profile by smoking status and total sample.

Outcome	Total Sample		Nonsmoker susceptibility status				Waterpipe Smokers	
			Not susceptible		Susceptible			
Mean age (SD)	25.0 (3.6)		24.8_{ab} (4.0)		24.7_{b} (3.7)		25.6_{a} (3.2)	
Male (N, %)	277	41.6	53	25.4	86	40.9	138	55.9
Race (N, %)								
Caucasian	508	76.4	157	75.5	160	76.2	191	77.3
African-American	65	9.8	20	9.6	23	11.0	22	8.9
Asian	47	7.1	17	8.2	13	6.2	17	6.9
Indian	5	0.8	1	0.5	3	1.4	1	0.4
Native Hawaiian or Pacific Islander	4	0.6	2	1.0	2	1.0	0	0.0
American Indian or Alaska Native	5	0.8	0	0.0	2	1.0	3	1.2
Middle Eastern	6	0.9	3	1.4	1	0.5	2	0.8
Other	25	3.8	8	3.8	6	2.9	11	4.4
Hispanic or Latino (%)	66	9.9	9	4.3	24	11.4	33	13.4
Education (N, %)								
Less than high school	2	0.3	0	0.0	1	0.2	1	0.2
Some high school	8	1.2	3	0.4	3	1.4	2	0.3
High school graduate or GED	72	10.8	19	2.9	20	9.5	33	13.4
Some college	271	40.8	69	33.2	87	41.4	115	46.6
College graduate or post-graduate	312	46.9	117	56.3	99	47.1	96	38.9
Current student (%)	232	34.9	65	31.2	75	35.7	92	37.2
Employment status (N, %)								
Full-time	345	51.9	99	47.6	51	24.3	148	59.9
Part-time	169	25.4	51	24.5	98	46.7	67	27.1
Not employed	151	22.7	58	27.9	61	29.0	32	13.0
Tobacco products used past 30 days (N, %)								
Cigarettes	150	22.6	2	1.0	17	8.1	131	53.0
Cigars	45	6.8	1	0.5	3	1.4	41	16.7
Cigarillo	6	9.8	1	0.5	4	1.9	60	24.3
Smokeless tobacco	27	4.1	0	0.0	4	1.9	23	9.3

(*continued on next page*)

Table 1 (*continued*)

Outcome	Total Sample		Nonsmoker susceptibility status				Waterpipe Smokers	
			Not susceptible		Susceptible			
Pipe	60	9.0	2	1.0	7	3.3	51	20.6
Electronic cigarettes	108	16.2	2	1.0	17	8.1	89	36.0

Note. Means with different lettered subscripts differ by $p < .05$ via Tukey contrasts. Percentages have been rounded.

nicotine in waterpipe tobacco if you not quit waterpipe tobacco smoking." Responses were on 7-point Likert scales anchored from 1 = Not at all worried to 7 = Very worried. Among nonsmokers, the same questions were posed, conditional on hypothetical smoking. For example, perceived risk of harm was asked by, "What do you think is your chance of getting a serious smoking-related disease in your lifetime, such as cancer, lung disease or heart disease if you were to smoke waterpipe tobacco and did not quit." Among smokers and nonsmokers, based on principal axis factor analyses, all items loaded on a single factor that explained 53% and 62% of the variance, respectively. Item loadings ranged from 0.65 to 0.79 among smokers and 0.74 to 0.82 among nonsmokers. Thus, the items were summed and averaged to create a total risk appraisal score (alphas > 0.81).

2.2.5. Willingness/curiosity to try waterpipe

Among nonsmokers, this outcome was composed of four items: 1) "Overall, how tempted are you to try waterpipe tobacco smoking within the next year, just for the experience?" (1 = Not at all to 7 = Very tempted); 2) "Overall, how curious are you about trying waterpipe tobacco smoking" (1 = Not at all to 7 = Very curious); 3) "Do you see yourself smoking tobacco from a waterpipe within the next year, just to see how it's like?" (1 = Definitely not to 7 = Definitely yes), and 4) "If you were with friends and they offered you to smoke waterpipe within the next year, how likely is it that you would try it, even a puff?" (1 = No Chance to 7 = Certain to happen). Based on principal axis factor analysis, all items loaded on a single factor that exampled 87% of the variance (loadings 0.82 to 0.95). The items were summed and averaged (alpha = 0.94).

2.2.6. Desire to quit

Among smokers, desire to quit was assessed using the following 7-point Likert scale, "How strong is your desire to quit waterpipe smoking right now?" Response anchors were 1 = Not at all strong to 7 = Very strong.

2.3. Data analysis

Comparisons on demographics and smoking profiles by smoking status were tested using chi-square for categorical variables and ANOVA for continuous variables. Although differences emerged, adjustment for these differences in ANCOVAs or partial correlations did not appreciably change interpretations or effect sizes; hence unadjusted results are reported. To control for Type 1 error, differences in harm beliefs by smoking status were tested using MANOVA (i.e., Wilk's Lambda) in two sets of analyses. In one set, a MANOVA was conducted on the nine beliefs common to Waves 1 and 2; in set two, a MANOVA was conducted on the three harm beliefs unique to Wave 2. Both MANOVAs were followed by ANOVAs using Tukey's adjustment for multiple comparisons. Mean differences in risk appraisals by smoking status were tested using ANOVA followed by Tukey's adjustment for multiple comparisons. Relationships among constructs were tested using Pearson correlations.

To ease interpretation of the harm beliefs, we reversed scored the second group of beliefs whereby stronger disagreement represented less perceived harm. As modified, stronger agreements reflect beliefs indicative of greater risk. All told, higher mean scores on the 12 harm beliefs reflect greater harm.

No mean differences emerged for harm beliefs, risk appraisals, willingness to try waterpipe tobacco and desire to quit comparing Wave 1 and 2 as a main effect, and Wave 1 and 2 interacting with smoking status. The same results were found for demographic and smoking profiles, except more women were recruited in Wave 2 than Wave 1. For these reasons, Wave 1 and 2 data were collapsed. Analyses were conducted using SAS 9.3 (Cary, North Carolina).

3. Results

3.1. Sample characteristics

Combining Wave 1 and 2 data, 7830 AMT members took the non-smoker survey; 707 screened as eligible. Among those deemed ineligible, the main reasons for disqualification were ever having smoked waterpipe tobacco (79.9%) and age (60.9%). After data quality control checks (e.g., removing individuals who failed a validity check question or those who attempted to screen more than once), a total of 418 nonsmokers (282 from Wave 1, 136 from Wave 2) were used in analyses. Overall, 208 were non-susceptible (140 from Wave 1, 68 from wave 2), and 210 were susceptible (142 from Wave 1, 68 from Wave 2). Combining Wave 1 and 2 data, 1893 people responded to the smoker survey; 378 screened as eligible. The main reasons for disqualification were not smoking waterpipe within the last 30 days (76.3%) and age (63.6%). After data quality control checks, 247 smokers were used in analyses (175 from Wave 1, 72 from Wave 2).

Table 1 presents the demographic profile for the overall sample and by smoking status. Smokers were older than susceptible nonsmokers ($F_{(2)} = 3.9$, $p < .02$) and more men were smokers than nonsmokers ($X^2_{(2)} = 43.0$, $p < .0001$). Whereas there were no differences in racial composition, there was a greater proportion of smokers and susceptible nonsmokers who were Hispanic or Latino/a compared to non-susceptible nonsmokers ($X^2_{(2)} = 11.1$, $p < .004$). Differences emerged for education ($X^2_{MH} = 9.63$, $p < .002$); among non-susceptible nonsmokers there was a lower than expected proportion of participants having some college and higher than expected being college graduates or having post-graduate education; among smokers a higher than expected proportion of participants had some college and lower than expected proportion were college graduates or had post-graduate education. Smokers were the least unemployed whereas susceptible nonsmokers had the lowest full-time employment/highest part-time employment ($X^2_{(4)} = 21.9$, $p < .0002$).

Among smokers, 49% smoked waterpipe tobacco monthly but less than weekly, 41% smoked weekly, and 10% smoked daily. Cigarettes were the most commonly used other tobacco product. Waterpipe tobacco smokers on average used more tobacco products (M = 1.6, SD = 1.5) than non-susceptible nonsmokers (M = 0.4, SD = 0.3) and susceptible nonsmokers (M = 0.25, SD = 0.7) ($F_{(2)} = 168.8$, $p < .0001$).

3.2. Harm beliefs by smoking status

The MANOVAs revealed a significant smoking status main effect for the nine harm beliefs common to Wave 1 and Wave 2 [Wilks's Lambda = 19.0, $p < .0001$] and for the three beliefs assessed in Wave 2 only [Wilks's Lambda = 4.0, $p < .0007$]. Table 2 presents harm beliefs by smoking status. We predicted that non-susceptible nonsmokers would maintain beliefs that would reflect greater harm (i.e., higher mean scores on the 12 beliefs), followed by susceptible nonsmokers and then smokers.

The findings support the predicted pattern among beliefs whereby a *stronger disagreement* reflected more harm – top seven beliefs in Table 2. For example, for the belief "smoking waterpipe once or twice a month is not harmful", non-susceptible non-smokers had the highest means score, followed by susceptible nonsmokers and then smokers (Ms of 5.86, 4.41 and 3.34, respectively). The same pattern held for the belief, "the health risks of waterpipe tobacco smoking are over-exaggerated" where the means were 6.08 for non-susceptible nonsmokers, 5.14 for susceptible nonsmokers, and 4.21 for smokers. Based on group contrasts, mean endorsement of these beliefs differed significantly between all three groups, with few exceptions.

Comparable patterns of results were found for beliefs whereby *stronger agreement* reflected greater harm – bottom five beliefs in Table 2. For example, non-susceptible nonsmokers had the highest means score, followed by susceptible nonsmokers and then smokers for such beliefs as: "Smoking waterpipe tobacco once or twice a month can lead to addiction" (Ms of 5.58, 4.78 and 3.87, respectively), "When you smoke waterpipe tobacco, you inhale cancer causing chemicals" (Ms of 6.23, 5.53 and 5.03, respectively), and "Waterpipe tobacco smoking can cause severe health consequences." (Ms of 6.22, 5.52 and 5.00, respectively). Based on group contrasts, mean endorsement of these beliefs differed significantly between all groups.

3.3. Relations between harm beliefs and risk appraisals

We predicted and found that mean risk appraisals differed among all groups (bottom Table 2). Non-susceptible participants reported higher mean risk appraisals than susceptible participants if they were to hypothetically engage in WTS and did not quit (Ms 5.72 vs. 5.03). Smokers' viewed themselves at significantly lower risk (M = 3.77) than both groups of nonsmokers (ps < 0.001).

It was expected that risk appraisals would correlate positively with beliefs endorsed to reflect greater harm. These patterns, separated by smoking status, were largely supported (Table 3). For example, among both groups of nonsmokers and smokers, participants reported higher risk appraisals among those who *disagreed with* "The health risks of waterpipe tobacco smoking are over-exaggerated", "Smoking waterpipe once or twice a month is not harmful", and "Waterpipe tobacco does not have enough nicotine to cause addiction." For these beliefs, the correlations ranged between 0.37 to. 49 for nonsmokers and between 0.36 and 0.46 for smokers (ps < 0.001).

Similarly, among both groups of nonsmokers and smokers, participants reported higher risk appraisals among those who *agreed more* with such beliefs as "Smoking waterpipe tobacco once or twice a month can lead to addiction", "When you smoke waterpipe tobacco, you inhale cancer causing chemicals", and "Waterpipe tobacco smoking can cause severe health consequences." For these beliefs, the correlations ranged between 0.29 to. 50 for nonsmokers and between 0.37 and 0.56 for smokers (ps < 0.001). Only the belief that "Water in the waterpipe filters out the most harmful chemicals from waterpipe tobacco smoke" did not correlate with risk appraisals for any group.

3.4. Relations between harm beliefs, risk appraisals, and willingness to try waterpipe

Among nonsmokers, we expected higher scores on harm beliefs and risk appraisals would correlate negatively with willingness to try waterpipe tobacco (Table 4). Overall, willingness to try WTS was significantly lower among non-susceptible nonsmokers (M = 1.14, SD = 0.40) than susceptible nonsmokers (M = 2.78, SD = 1.50, $p < .001$). Among non-susceptible nonsmokers, five beliefs of low magnitude (between −0.19 and − 0.14, ps < 0.05) correlated significantly with willingness to try WTS. Risk appraisals did not correlate significantly with willingness to try WTS ($r = -0.01$). Among susceptible nonsmokers, ten beliefs correlated with willingness to try WTS (range − 0.44 to −0.19, ps < 0.05); further, a higher risk appraisal correlated significantly with a lower willingness to try WTS ($r = -27$, $p < .001$).

3.5. Relations between harm beliefs, risk appraisals, and desire to quit

Among smokers, we expected higher scores on harm beliefs and risk appraisals would correlate positively with desire to quit (Table 4). Overall, desire to quit was low (M = 3.00, SD = 1.77). Four harm beliefs correlated with desire to quit. Desire to quit was greater when participants disagreed more strongly with "You don't smoke enough to be hurting your health" ($r = 0.15$, $p < .05$) and "Smoking waterpipe once or twice a month is not harmful." ($r = 0.23$, $p < .001$). A stronger desire to quit was also related to greater agreement with, "Smoking waterpipe tobacco once or twice a month can lead to addiction"

Table 2
Mean and Standard Deviations of Harm Beliefs and Risk Appraisals by Smoking Status

	Nonsmoker Status		Waterpipe Smoker	F	p <	η^2
	Not susceptible	Susceptible				
1. The health risks of waterpipe tobacco smoking are over-exaggerated.	6.08_a (1.30)	5.14_b (1.43)	4.21_c (1.61)	92.1	.0001	.22
2. If you did smoke waterpipe tobacco, you wouldn't smoke enough to be hurting your health. [For smokers, You don't smoke enough to be hurting your health].	5.65_a (1.76)	4.05_b (1.87)	3.52_c (1.61)	89.3	.0001	.21
3. Smoking waterpipe once or twice a month is not harmful.	5.86_a (1.33)	4.41_b (1.64)	3.34_c (1.66)	148.4	.0001	.31
4. If you did smoke waterpipe tobacco, you will have quit long before you need to worry about getting health problems. [For smokers: You will have quit long before you need to worry about getting health problems].	4.69_a (2.02)	3.62_b (1.70)	3.56_b (1.51)	28.7	.0001	.08
5. Smoking waterpipe for an hour or two in such settings as hookah bars, café and lounges is not harmful to your health.	6.12_a (1.21)	5.12_b (1.45)	4.26_c (1.73)	97.0	.0001	.21
6. Waterpipe tobacco does not have enough nicotine to cause addiction.	5.94_a (1.27)	5.10_b (1.37)	4.46_c (1.63)	59.4	.0001	.15
7. The water in the waterpipe filters out the most harmful chemicals from waterpipe tobacco smoke. (Wave 2 only)	5.42_a (1.59)	5.00_{ab} (1.39)	4.50_b (1.57)	6.5	.002	.06
8. Smoking waterpipe tobacco once or twice a month can lead to addiction.	5.58_a (1.42)	4.78_b (1.46)	3.87_c (1.59)	74.0	.0001	.18
9. When you smoke waterpipe tobacco, you inhale cancer causing chemicals.	6.23_a (1.05)	5.53_b (1.26)	5.03_c (1.52)	45.8	.0001	.13
10. Waterpipe tobacco smoking can cause severe health consequences.	6.22_a (1.12)	5.52_b (1.24)	5.00_c (1.55)	47.5	.0001	.13
11. The burning of the charcoal to heat the waterpipe tobacco produces harmful chemicals. (Wave 2 only)	5.63_a (1.40)	4.84_b (1.14)	5.15_{ab} (1.38)	6.3	.003	.06
12. Sharing of the waterpipe mouthpiece with other smokers can lead to infections. (Wave 2 only)	5.87 (1.27)	5.43 (1.15)	5.54 (1.32)	2.3	.11	.02
Overall risk appraisal	5.72_a (1.22)	5.03_b (1.28)	3.77_c (1.30)	140.5	.0001	.30

Note. Higher mean scores represent endorsement of beliefs that support notions of greater harm. Means with different lettered subscripts differ by $p < .05$ via Tukey contrasts.

Table 3
Correlations between harm beliefs and risk appraisals by smoking status.

Risk beliefs	Nonsmoker status		Waterpipe smoker
	Not susceptible	Susceptible	
1. The health risks of waterpipe tobacco smoking are over-exaggerated.	0.44***	0.49***	0.46***
2. If you did smoke waterpipe tobacco, you wouldn't smoke enough to be hurting your health. [For smokers: You don't smoke enough to be hurting your health].	0.26***	0.34***	0.49***
3. Smoking waterpipe once or twice a month is not harmful.	0.42***	0.43***	0.44***
4. If you did smoke waterpipe tobacco, you will have quit long before you need to worry about getting health problems. [For smokers: You will have quit long before you need to worry about getting health problems].	0.27***	0.32***	0.18**
5. Smoking waterpipe for an hour or two in such settings as hookah bars, café and lounges is not harmful to your health.	0.30***	0.40***	0.36***
6. Waterpipe tobacco does not have enough nicotine to cause addiction.	0.37***	0.44***	0.36***
7. The water in the waterpipe filters out the most harmful chemicals from waterpipe tobacco smoke.	0.15	0.23	0.05
8. Smoking waterpipe tobacco once or twice a month can lead to addiction.	0.40***	0.44***	0.56***
9. When you smoke waterpipe tobacco, you inhale cancer causing chemicals.	0.36***	0.50***	0.37***
10. Waterpipe tobacco smoking can cause severe health consequences.	0.29***	0.50***	0.40***
11. The burning of the charcoal to heat the waterpipe tobacco produces harmful chemicals.	0.16	0.33**	0.12
12. Sharing of the waterpipe mouthpiece with other smokers can lead to infections.	0.17	0.37**	0.01

* $p < .05$.
** $p < .01$.
*** $p < .001$.

($r = 0.34, p < .001$) and "Waterpipe tobacco smoking can cause severe health consequences." ($r = 0.14$, $p < .05$). Smokers who reported higher risk appraisals expressed a stronger desire to quit ($r = 0.38$, $p < .001$).

4. Discussion

To the best of our knowledge, this is the first study to compare several WTS harm beliefs and their relations with risk appraisals among non-susceptible nonsmokers, susceptible nonsmokers, and waterpipe smokers. Smokers were least likely to endorse greater harm beliefs while non-susceptible nonsmokers were the most likely to agree. The same pattern held for risk appraisals. Harm beliefs consistently correlated with risk appraisals across groups; thus, targeting harm beliefs may influence risk appraisals and, in turn, intentions to quit or experiment with WTS (Lipkus et al., 2017; Mays et al., 2016). A few beliefs were largely unassociated with risk appraisals: "The water in the waterpipe filters out the most harmful chemicals from waterpipe tobacco smoke" and, except among susceptible nonsmokers, "Burning of the charcoal to heat the waterpipe tobacco produces harmful chemicals", and "Sharing of the waterpipe mouthpiece with other smokers can lead to infections". This may reflect decreased statistical power to detect significant correlations since these beliefs were assessed in Wave 2 only. While weak support exists that sharing of the mouthpiece leads

Table 4
Correlations between harm beliefs and willingness to smoke waterpipe (nonsmokers) and desire to quit (smokers).

Risk beliefs	Nonsmoker status (willingness/curiosity to smoke)		Waterpipe smoker (desire to quit)
	Not susceptible	Susceptible	
1. The health risks of waterpipe tobacco smoking are over-exaggerated.	−0.13	−0.38***	0.11
2. If you did smoke waterpipe tobacco, you wouldn't smoke enough to be hurting your health. [For smokers: You don't smoke enough to be hurting your health].	−0.19**	−0.33***	0.15*
3. Smoking waterpipe once or twice a month is not harmful.	−0.17*	−0.44***	0.23***
4. If you did smoke waterpipe tobacco, you will have quit long before you need to worry about getting health problems. [For smokers: You will have quit long before you need to worry about getting health problems].	−0.15*	−0.19**	−0.03
5. Smoking waterpipe for an hour or two in such settings as hookah bars, café and lounges is not harmful to your health.	−0.10	−0.43***	0.06
6. Waterpipe tobacco does not have enough nicotine to cause addiction.	−0.11	−0.32***	0.06
7. The water in the waterpipe filters out the most harmful chemicals from waterpipe tobacco smoke.	−0.11	−0.27*	0.14
8. Smoking waterpipe tobacco once or twice a month can lead to addiction.	−0.14*	−0.20**	0.34***
9. When you smoke waterpipe tobacco, you inhale cancer causing chemicals.	−0.10	−0.29***	0.07
10. Waterpipe tobacco smoking can cause severe health consequences.	−0.18**	−0.36***	0.14*
11. The burning of the charcoal to heat the waterpipe tobacco produces harmful chemicals.	0.04	−0.20	0.03
12. Sharing of the waterpipe mouthpiece with other smokers can lead to infections.	−0.04	−0.08	−0.06

* $p < .05$.
** $p < .01$.
*** $p < .001$.

to infections, burning of the charcoal releases relatively large doses of toxins (Elsayed, Dalibalta, & Abu-Farha, 2016). Messaging campaigns have largely not educated the public about health effects of burning charcoal to heat waterpipe tobacco and should be addressed.

We predicted relations between health beliefs with intentions to quit among smokers, and willingness to try WTS among nonsmokers, would be weaker than risk appraisals. This pattern was not supported consistently. Among smokers, the correlation between risk appraisals and desire to quit was stronger than any harm belief. Among non-susceptible nonsmokers, willingness to try waterpipe had weak association with few harm beliefs, and unrelated with risk appraisals. Among susceptible nonsmokers, 10 harm beliefs correlated with willingness to try waterpipe; seven were of higher magnitude than risk appraisals. For this group, targeting several beliefs may greatly influence WTS. Prospective studies are needed to determine whether (and which) harm beliefs or risk appraisals are tied to cessation among smokers and initiation of WTS among nonsmokers.

Study findings have implications to inform public education messaging on WTS risks. In 2016, the U.S. Food and Drug Administration (FDA) deeming rule brought all tobacco products under the agency's regulatory authority, including waterpipe (Federal Register, 2016). This positions the FDA to engage in public education messaging about WTS risks. Our findings highlight specific harm beliefs the FDA can avail when targeting messages to young adult waterpipe tobacco smokers and susceptible nonsmokers at risk of initiation (Sutfin, Soule, McKelvey, & Jenson, 2017).

This study has several limitations. First, it is cross-sectional. Second, whether findings replicate in more representative samples is unknown, although samples obtained using crowdsourcing platforms are useful to test hypotheses in experimental and correlational studies (Sheehan & Pittman, 2016). Third, more psychometric work is needed pertaining to the validity and reliability of the health beliefs. Fourth, the chosen harm beliefs represent but a few of the many possible; for example, we did not capture beliefs with social health implications (e.g., secondhand smoke). Relatedly, we did not assess how social norms (e.g., peer acceptance of WTS) influence harm beliefs and risk appraisals. Young adults who perceive greater peer use and acceptability of WTS should endorse beliefs reflecting less harm and view themselves at lower personal risk (Rayens et al., 2017). Lastly, the sample size from Wave 2 was smaller. Despite these limitations, comparing relationships between harm beliefs, risk appraisals and behavioral intentions provides a useful strategy to identify beliefs to target by smoking status. Future research should examine which beliefs are easily modifiable and assess their effects on risk appraisals and behaviors prospectively. Such efforts may lend themselves to effective messaging campaigns that can curb WTS.

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