Nicotine & Tobacco Research, Volume 13, Number 7 (July 2011) 599–610

Original Investigation

Affecting Perceptions of Harm and Addiction among College Waterpipe Tobacco Smokers

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Received September 28, 2010; accepted February 25, 2011

Abstract

Introduction: The spread of waterpipe tobacco use among youth may be due in part to perceptions that waterpipe tobacco use is safer than other tobacco products, such as cigarettes. In two pilot studies, we sought to modify college waterpipe smokers' perceived risks and worry about waterpipe tobacco smoking.

Methods: We conducted two web-based studies that varied whether college waterpipe users received information on (a) spread of and use of flavored tobacco in waterpipe and (b) harms of waterpipe smoking. Study 1 ($N = 91$) tested the "incremental" effects on perceptions of risk and worry of adding information about harms of waterpipe smoking to information on the spread of waterpipe and use of flavorings in the tobacco. Study 2 ($N = 112$) tested the effects on perceptions of risk and worry of reviewing information about harms of waterpipe smoking compared to a no information control group. In Study 1 only, we assessed as part of a 6-month follow-up ($n = 70$) the percentage of participants who reported no longer using waterpipe.

Results: Pooling data from both studies, participants who received information about the harms of waterpipe smoking reported greater perceived risk and worry about harm and addiction and expressed a stronger desire to quit. In Study 1, 62% of participants in the experimental group versus 33% in the control group reported having stopped waterpipe use.

Conclusions: These are the first studies to show that perceptions of addiction and harm from waterpipe use can be modified using minimally intensive interventions; such interventions show promise at decreasing waterpipe use.

Introduction

A waterpipe (also referred to as shisha, hookah, narghile, kalian, and hubble-bubble) is a nicotine delivery device in which tobacco smoke passes through water before it is inhaled. Waterpipe tobacco smoking is becoming more widespread in Europe and in the United States, especially among youth such as college students (American Lung Association, 2007; Cobb, Ward, Maziak, Shihadeh, and Eissenberg, 2010; Eissenberg,Ward, Smith-Simone, and Maziak, 2008; Grekin and Ayna, 2008; Martinasek, McDermott, and Martini, 2011; Maziak, 2011; Smith, Curbow, and Stillman, 2007). Recent cross-sectional studies reveal that between 15% and 48% of college students at some campuses in the United States have tried waterpipe smoking and between 9.5% and 20% report having engaged in the activity within the last 30 days (Eissenberg et al., 2008; Primack et al., 2008; Smith et al., 2007)

Perceiving waterpipe use as safe is assumed to play a causal role in the spread of waterpipe use among youth. Indeed, a large proportion of college waterpipe users believe it is less harmful and addictive than cigarettes (Eissenberg et al., 2008; Jackson and Aveyard, 2008; Roskin and Aveyard, 2009; Smith et al., 2007; Smith-Simone, Maziak, Ward, and Eissenberg, 2008; Smith-Simone, Curbow, and Stillman, 2008). For example, Eissenberg et al. (2008) found that among college students who used water pipes within the last 30 days ($n = 151$), 44% said it was less harmful than cigarettes compared to 56% of never users; about 58% of users rated their likelihood of being addicted when using the product socially as none compared to never users of whom about 42% rated their likelihood of being addicted when using the product socially as none. Similarly, Primack et al. (2008) found that among the 198 college students who have smoked water pipes, 47% viewed waterpipe smoking as less harmful than cigarettes and 79% rated it as less addictive than cigarettes. Of import, perceptions that waterpipe smoking is not as harmful and addictive as cigarettes may contribute to a general lack of interest in quitting (Smith-Simone, Maziak, Ward, and Eissenberg, 2008).

Based on the available data, the above perceptions may be misplaced. Waterpipe tobacco smoking is associated with many of the same tobacco-caused diseases as cigarette smoking. While

doi: 10.1093/ntr/ntr049
Advance Access published on April 6, 2011

more carefully designed and larger epidemiological studies are needed, studies to date reveal an association of waterpipe smoking with lung cancer (Akl et al., 2010), poorer pulmonary function (Raad et al., 2010), heart disease (Jabbour, El-Roueiheb, and Sibai, 2003), and via the sharing of the mouthpiece infections such as *Helicobacter pylori* (Knishkowy and Amitai, 2005). These health risks are likely linked to the harmful substances derived from tobacco and the charcoal used to heat the tobacco (Shihadeh, 2003; Shihadeh and Saleh, 2005). Such substances include heavy metals (arsenic, cobalt, chromium, lead), carcinogenic 4- and 5-membered ring polycyclic aromatic hydrocarbons (Sepetdjian, Shihadeh, and Saliba, 2008), pulmonary disease-causing volatile aldehydes (Al Rashidi, Shihadeh, and Saliba, 2008), and carbon monoxide (CO) (El-Nachef and Hammond, 2008; Monzer, Sepetdjian, Saliba, and Shihadeh, 2008; Shihadeh, 2003); waterpipe tobacco also includes nicotine (Neergaard, Singh, Job, and Montgomery, 2007). Exposure to these substances can be voluminous, especially in relation to cigarette use. For example, machine-generated smoke content using realistic puff parameters revealed that a single waterpipe session contains approximately 46 times the tar, 6.5 times the CO, and 1.7 times the nicotine produced by one cigarette (Cobb et al., 2010). Direct laboratory comparisons of smoker toxicant exposure levels between actual waterpipe tobacco smoking and cigarette smoking reveal similar findings (Eissenberg et al., 2009).

Nicotine exposure levels make waterpipe use potentially as addictive as cigarettes. A meta-analysis revealed that daily waterpipe usage is associated with a nicotine absorption rate (as revealed by 24-hr urinary cotinine levels) equivalent to 10 cigarettes; occasional waterpipe smoking (one session of waterpipe use during a 4-day period) was equivalent to smoking 2 cigarettes (Neergaard et al., 2007). Smoking 10 cigarettes a day supports dependence (Caraballo, Novak, and Asman, 2009; DiFranza et al., 2007). Thus, the daily waterpipe user is as much at risk of addiction to nicotine as the daily cigarette smoker. In sum, available evidence addressing actual health effects, toxicant content, and exposure levels shows that waterpipe tobacco smoking is likely associated with many of the same risks of cigarette smoking, including cancer, cardiovascular, and lung disease. Waterpipe tobacco use may also lead to nicotine dependence.

There is a need to educate college hookah smokers of associated harms (e.g., levels of and types of toxicants inhaled) and addictive potential of waterpipe use in order to modify smokers' perceptions of harms and addiction. There is also a need to test communication approaches that best achieve changes in perceptions of harms and addiction. Hence, we undertook two web-based pilot studies to inform college waterpipe users of the harms, toxicants inhaled, and addictive potential of waterpipe. Study 1 tested the "incremental" effects on our main outcomes (e.g., risk perceptions on harm and addiction, knowledge, desire to quit) of adding information about the health effects and exposure levels of chemicals found in waterpipe tobacco smoke to information on the spread of waterpipe tobacco use and flavorings added to the tobacco. We assumed the latter information would be themes most waterpipe users would be familiar with and likely serve to motivate continued use (Martinasek et al., 2011). Thus, Study 1 tested the effects of risk information when making salient other aspects of waterpipe use that would be known by most users that likely contribute to its use. Study 2, which was designed after review of findings from Study 1, provided a more direct test of how information from Study 1 about the health effects and chemical exposure influenced our main outcomes compared to a no information control group. Thus, Study 2 tested the effects of making risk information salient without making information about the spread and flavorings added to tobacco salient. Both studies contained experimental groups that had identical information about associated health effects, addictive potential, and chemicals found in waterpipe tobacco use. The educational materials for both studies were adapted from a relevant presentation (Eissenberg, 2009). Pooling data from both studies together provided insights, with added statistical power, to test the effects of the harm, addictive potential, and exposure information on our main outcomes (see below) and to determine whether any effects found would be moderated by the presence or absence of information pertaining to the spread of waterpipe use and the flavorings added to the tobacco, themes that may weaken the effects of risk information to motivate change. In general, risk information may have a more powerful effect on perceptions of risk and worry when other factors, such as spread and flavorings added to the tobacco, are not made salient.

The main outcomes of these studies were between group differences in perceived and factual knowledge of the harms and addictive potential of waterpipe use, perceived risk of physical harm and of becoming addicted, and desire to quit waterpipe smoking. For both studies, we hypothesized that participants in experimental groups would report greater (a) perceived and factual knowledge of the dangers of waterpipe use and addictive potential, (b) perceived risk and worry of experiencing harm from waterpipe smoking, (c) likelihood and worry of becoming addicted, and (d) desire to quit than participants in control groups. In addition, we examined in one study (Study 1) the effects of our intervention on self-reported use 6 months after receipt of study materials, as well as providing tests of interactions as described above by pooling data from both studies. Due to similarity in methods and measures, we report the methodology of Studies 1 and 2 together and highlight differences as appropriate. Both studies received approval from Duke University Medical Center's Institutional Review Board (IRB).

Methods

Participants

Waterpipe smokers were recruited from among a total of six college and university campuses in central North Carolina—selected because we had working relationships to conduct tobacco research in college populations—via the use of newspaper advertisements, flyers posted around campuses, Craig's list, and campus-wide Listserv. Eligibility included being enrolled in a 4-year college or university, aged 18 years or older, and having smoked a waterpipe at least once during the last month.

Overview of Procedures

College students who responded to advertisements and called the Duke Risk Communication Laboratory were given by a trained research assistant an overview of the study and screened for eligibility (e.g., age, use of waterpipe, enrollment in a college or university). Those found eligible and answered "yes" about their interest in participation were then consented verbally on the phone and E-mailed information about the study Web site with instructions for how to log on. Upon logging on to the Web site, participants completed an online baseline survey.

Among those who completed the baseline, a research assistant E-mailed participants 2 weeks later an E-mail message instructing them to log on to the study Web site and complete the next phase of the study within the next 2 weeks. Participants who did not log on to the Web site within a week of the E-mail notification were sent another E-mail reminder as well as a telephone reminder by the research assistant—we developed a program to keep track of which participants logged onto the Web site at various stages of the project and when to alert the research assistant to E-mail reminders. Those who logged on were randomized to either a control or an experimental group with equal probability by our program, reviewed educational materials as appropriate to their group and study, and then completed immediately afterward a series of questions.

For Study 1 only, we assessed waterpipe use, as well as other constructs (e.g., risk, worry) on the Web site 6 months after they reviewed the materials online—due to the limited grant period, we did not have the budgetary resources to do a 6-month follow-up for the second study. For the 6-month follow-up, a research assistant sent participants an E-mail with instructions to complete the survey online within 2 weeks of receipt of the message; an E-mail was sent a week after the E-mail reminder if the participant did not as yet complete the survey followed by a phone call reminder.

Participants in both studies were paid $40 for completing both the baseline and the online educational session; participants in Study 1 were paid $20 for completing the 6-month follow-up survey. Study 1 baseline and review of the educational online materials took place between October 2009 and January 2010 with the 6-month follow-up occurring between March to June 2010; Study 2 took place between February and March 2010. Details, beginning with the experimental manipulations of each study followed by measures, are presented below. Table 1 summarizes the similarities and differences in content provided between the two studies by study conditions.

Experimental Manipulations (Study 1)

Participants in the experimental group were shown 20 MS PowerPoint slides that covered 1) what is a waterpipe and how it works (e.g., names it goes by, schematic of a waterpipe), 2) what is in waterpipe, focusing on the flavorings added to the tobacco, 3) who smokes waterpipe, concentrating on origins, spread, and use by subgroups, 4) amount of smoke inhaled by waterpipe in laboratory studies and in relation to smoking cigarettes, 5) production of tar, CO, and nicotine in waterpipe tobacco compared to cigarettes, 6) exposure levels of toxic compounds (e.g., aldehyde), and 7) health effects associated with waterpipe tobacco smoking (e.g., cancer, heart disease, infections)—slides are available from the first author upon request. Control participants reviewed eight slides that covered points one through three listed above only (see Table 1). After review of the educational materials, participants in both conditions completed the main study measures. The average length of time reviewing these materials online was 3.6 min for the control condition and 7.5 min for the experimental condition.

Experimental Manipulations (Study 2)

The purpose of Study 2 was to determine the unique effects of the educational materials focusing on harm and exposure levels by comparing it to a no information control. Thus, we tested whether the experimental effects would be more powerful without making salient information discussing the spread and popularity of waterpipe and the use of flavored additive in tobacco. Using the same MS PowerPoint slides as in Study 1, participants in the experimental group viewed 15 slides online that covered the following topics: 1) differing names of waterpipe, what is a waterpipe, and how it works, 2) amount of smoke inhaled by waterpipe in laboratory studies and in relation to smoking cigarettes, 3) production of tar, CO, and nicotine in waterpipe tobacco compared to cigarettes, 4) types and exposure levels of toxic compounds, and 5) health effects associated with waterpipe tobacco smoking (see Table 1). After review of the materials, these participants completed the main study measures. Participants spent an average of 5.5 min reviewing the educational materials.

Control participants logged onto the study Web site and were asked to complete a series of questions online about waterpipe that were identical to those posed and completed by participants randomized to the experimental condition after they reviewed the educational materials. Control participants did not review any educational materials.

Table 1. Comparing Content by Group in Study 1 and Study 2

	Study 1		Study 2	
Content area	Control	Experimental	Control	Experimental
Names used for waterpipe	X	X		X
How does a waterpipe work	X	X		X
Flavoring added to tobacco	X	X		
Origins, spread of, and subgroups who use waterpipe	X	X		
Comparing amounts of CO, nicotine, tar, and aldehydes between waterpipe and cigarettes		X		X
Types and exposure levels of other harmful chemicals in waterpipe (e.g., naphthalene, flourene, acenapththene pyrene, phenantrene, and anthracene)[a]		X		X
Misleading labels about amount of tar in waterpipe		X		X
Health effects related to waterpipe use (e.g., heart disease, lung/mouth cancer, and infections due to sharing of mouthpiece)		X		X

Note. X = topic covered.

[a]Chemicals were associated with a common product (e.g., naphthalene was associated with moth balls).

Measures

Unless otherwise stated, participants in both studies completed the same measures described below at baseline and at the end of the online educational session.

Frequency of Waterpipe Use

Participants were asked which pattern best described their waterpipe 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) (Maziak, Eissenberg, and Ward, 2005). For the Study 1 6-month follow-up, these options were presented with the additional option of no longer smoking waterpipe. Participants who responded to the latter were considered to have quit waterpipe use.

Smoking History and Patterns of Waterpipe and Tobacco Use

Completed at baseline only, participants were asked 1) age they started waterpipe tobacco smoking (open-ended); 2) reasons for starting smoking waterpipe (curiosity, liked how water pipes are crafted, liked the smell, liked the taste, a hookah bar/cafe opened nearby, use by friends, other); 3) how they learned about waterpipe smoking (from friends, parents, media ads [e.g., newspapers, web advertisements], movie, other); 4) length of typical waterpipe smoking session in minutes and hours (open-ended); 5) part of the day they usually smoked (mornings, afternoons, evenings); 6) how soon after waking did they smoke waterpipe (5 min or less, 6–30 min, 31–60 min, more than 60 min); 7) which waterpipe they hated to give up most (the first always/in general/maybe, any other one); 8) whether they smoked a waterpipe even if ill (yes, absolutely/probably/maybe, no); 9) if they smoked waterpipe as a social habit (yes, absolutely/probably/maybe, no) and with others (no, yes); 10) location where they typically smoked (home/dorm, café or restaurant, friend's house, other); and 11) whether they owned a waterpipe (no, yes). Several items were adapted from previous surveys used among college populations (Eissenberg et al., 2008; Smith-Simone et al., 2008) or in tests for developing measures of nicotine dependence with waterpipe use (Salameh, Waked, and Aoun, 2008; e.g., items 6–9 above). In addition, participants indicated whether they currently used the following tobacco products: cigarettes, cigars, little cigars/cigarillos (e.g., Black and mild), pipe, chew or dip tobacco, snuff, and bidis.

Perceived Personal Risk of Harm

Perceived risk was assessed by two ways: 1) "What do you think is your chance of getting a serious health problem in your lifetime from your waterpipe tobacco smoking if you don't quit?" (1 = no chance, very unlikely, unlikely, moderately likely, likely, very likely, 7 = certain to happen) and 2) "I feel I am going to have a serious health problem if I keep waterpipe tobacco smoking." (1 = strongly disagree to 7 = strongly agree). Items correlated at $r > .62$ across studies and timepoints and hence were summed and averaged.

Perceived Worry of Harm

We assessed worry about the physical consequences of waterpipe smoking based on modification of a 4-item worry scale used for cigarette smoking by Dijkstra and Brosschot (2003). For example, participants were asked "How afraid are you of medical problems from waterpipe tobacco smoking?" and "How much do you worry that your health is being affected by your waterpipe tobacco smoking?" Response anchors ranged from 1 = not at all to 7 = very much. Alphas exceeded 0.75 across studies and experimental conditions.

Perceived Risk of Addiction

Perceived risk of addiction was assessed by "What do you think is the chance of you becoming addicted to nicotine in tobacco from waterpipe if you continue to smoke?" (1 = no chance, very unlikely, unlikely, moderately likely, likely, very likely, 7 = certain to happen).

Perceived Worry for Addiction

Perceived worry for addiction was assessed by "How worried are you about becoming addicted to nicotine in waterpipe if you continue to smoke?" Response anchors were 1 = not at all to 7 = very much.

Factual Knowledge of Dangers of Waterpipe

Knowledge of waterpipe dangers was assessed by five questions, four that began with the stem "When you consider one person completing a single 45-minute waterpipe smoking session and a single 5-minute cigarette smoking session, which . . ." followedby: 1) "delivers more dependence-producing nicotine to the smoker?"; 2) "delivers more heart disease-causing CO to the smoker?"; 3) "produces more tar in the smoke?"; and 4) "produces more arsenic and lead in the smoke?" The fifth question asked "When you consider the harm associated with tobacco smoking, which of the following has been associated with heart disease." Response options for each question were waterpipe, cigarette, both waterpipe and cigarette smoking, and neither waterpipe nor cigarette smoking. The correct response to the first four questions was waterpipe and for the last question both waterpipe and cigarette smoking. A correct score was given a point value of 1 or a 0 otherwise. We created a total mean summed score (range 0–5).

Perceived Knowledge of Dangers of Waterpipe Use

Participants' views as to how much they knew about risks related to waterpipe tobacco use were assessed using eight 7-point Likert scales. For example, participants were asked "How much would you say you know about the risk of waterpipe tobacco smoking? (1 = not much to 7 = a lot), "Do you need more information about the risks of waterpipe tobacco smoking to be well-informed?" (1 = definitely no to 7 = definitely yes—reverse scored), and "There is little someone can tell you about the risks of waterpipe tobacco smoking that you do not already know" (1 = strongly disagree to 7 = strongly agree). Items were summed and averaged. Alphas exceeded 0.70 at baseline and at follow-up.

Desire to Quit Waterpipe Use

Participants' desire to quit waterpipe use was assessed by "How strong is your desire to quit waterpipe smoking right now? (1 = not at all to 7 = very).

Evaluation of Educational Materials

After review of the materials, all participants in Study 1, and those in the experimental group in Study 2, evaluated the educational materials on 11 bipolar 7-point scales that assessed personal relevance, credibility, and understandability. Personal relevance was assessed using six items from Zaichkowsky's 10-item personal relevance scale: insignificant/significant, doesn't matter to me/does matter to me, unimportant/important, of no concern/of much concern, means nothing/means a lot,

and irrelevant/relevant (Zaichkowsky, 1994). Credibility was assessed using three scales measuring accuracy, credibility, and trustworthiness (1 = not at all to 7 = completely). Items for personal relevance and credibility were summed and averaged; alphas exceeded 0.90 across studies and conditions. Materials were also rated on a 7-point Likert scale as not at all (scored 1) to completely (scored 7) understandable.

Statistical Methods

Changes in perceptions of harms, addiction, knowledge, and desire to quit from baseline to the online educational session as a function of experimental condition were analyzed using analysis of covariance (ANCOVA), partialling the relevant baseline measure. Cessation of waterpipe use at the 6-month follow-up as a function of study group was analyzed via logistic regression. Analyses pooling the data from both studies were based on ANCOVAs using a 2 (risk information given: no/yes) × 2 (information on spread and flavoring given: no/yes) factorial design partialling the relevant baseline measure as well as a variable found to differ between both samples, whether the participant smokes waterpipe when seriously ill; this variable was not associated with any of our main outcomes, however. Tests of difference between samples on demographic characteristics, smoking history, and patterns of use were assessed using either two-group independent *t* tests or chi-square tests. Use of tobacco products other than waterpipe, age, race, and gender were not related to our outcomes and hence were not included in our statistical models.

Results

Participant Recruitment and Characteristics

For Study 1, 177 persons were screened of which 72 were ineligible. The main reasons for ineligibility were not enrolled in college ($n = 25$), enrolled in a college from which we did not obtain institutional review board (IRB) approval to recruit from ($n = 19$), and not having smoked a waterpipe within the last 30 days ($n = 25$). Of the 108 found eligible, three declined to participate after being informed of study details, four agreed to participate but never provided consent, seven did not complete the baseline survey, and two consented but withdrew prior to completing the baseline, leaving a total of 92 completed baseline surveys. We subsequently learned that one participant who completed the baseline survey falsified his/her data; these data were eliminated from the study, leaving a total of 91 completed baseline records. Among those who completed the baseline, 88 participants completed the online educational session, of which 42 were randomized to the control group and 46 were randomized to the experimental group. Overall, 70 participants completed the 6-month follow-up ($n = 33$ control group, $n = 37$ experimental group). Participants who completed the online educational session and the follow-up ($n = 70$) did not differ from participants who completed the educational session but not the follow-up ($n = 18$) on gender, race, age, baseline frequency of waterpipe use, or by study condition—details of these attritional analyses are available from the first author upon request.

For Study 2, 153 persons were screened, of which 26 were ineligible. The main reasons for ineligibility were as follows: not enrolled in college ($n = 2$), enrolled in a college from which we did not obtain IRB approval to recruit ($n = 1$), and not having smoked a waterpipe within the last 30 days ($n = 23$). Of the 126 who were eligible, five did not consent (one declined and four agreed to participate but did not consent) and 11 did not complete the baseline. Thus, 112 participants completed the baseline. Among these 112 participants, 110 completed the online educational session, of which 55 were randomized to the control group and 55 to the experimental group. Baseline demographic characteristics, smoking history, and patterns of waterpipe and tobacco use for each study sample are presented in Table 2.

Overall, the mean age of participants was 20, with the majority of users being men and Caucasian. Our samples represented participants across the school years, with few graduate students. In terms of smoking history and patterns of use, mean age of initiation was before the age of 18 and as a result from learning about waterpipe from a friend; use from a friend was the main reason, albeit among several, for why they started. About 95% of the sample smoked waterpipe monthly or weekly and usually in the evenings, with the average length based on self-reported use per session ranging from 34 to 37 min. More than 60% of participants did not have difficulty giving up their first smoking session, and about 80% did not smoke when seriously ill. Many smoked waterpipe as a social habit and always with others, with the home/dorm being the most common places. About 40% overall owned a waterpipe. On average, participants smoked one other tobacco product in addition to waterpipe, with cigarettes being the most common other product used (about 50% of participants). Samples did not differ significantly on the characteristics listed in Table 1 with one exception; participants in Study 2 were less likely to smoke when seriously ill (Mantel–Haenszel $\chi^2_{(1)} = 12.3$, $p < .0005$).

Reaction to the Educational Materials

Across studies and conditions, participants viewed the information as understandable (mean scores of 5.65–5.95), credible (4.75–5.76), and personally relevant (4.20–5.56).

Perceived Personal Risk and Worry of Harm

For Study 1, participants who received information about harms and exposures, in addition to information about spread of waterpipe and flavoring added to the tobacco, reported greater perceived personal risk of getting a serious smoking-related disease and expressed more worry about the physical consequences of waterpipe tobacco use than participants who did not get information about harms and exposure (see Table 3). For Study 2, there were no significant mean differences between participants who received information about harms and exposure and the observational controls.

Perceived Personal Risk and Worry of Becoming Addicted

For Study 1, participants who received information about harms and exposures, in addition to information about spread of waterpipe and flavoring added to the tobacco, reported greater perceived personal risk and expressed more worry of becoming addicted than participants who did not get information about harms and exposures (rows 3 and 4 in Table 3). For Study 2, there were no significant mean differences between participants who received information about harms and exposure and controls.

Table 2. Baseline Demographic, Smoking History, and Patterns of Use

Variable	Study 1 ($N = 91$)	Study 2 ($N = 112$)	p value
Mean age (*SD*)	20.4 (2.0)	20.6 (2.1)	0.46
Percent women	24.2	33.3	0.14
Race			0.09
Caucasian	76.7	64.3	
African American	5.6	4.5	
Hispanic	6.7	4.5	
Asian or Pacific Islander	7.8	20.5	
Other	3.3	6.2	
Year in school			0.49
Freshman	14.4	17.9	
Sophomore	31.1	21.4	
Junior	14.4	16.1	
Senior	34.4	34.8	
Graduate	5.6	9.8	
Smoking history and patterns of use			
Mean age started hookah use (*SD*)	17.8 (1.4)	17.6 (1.5)	0.38
Learned about waterpipe from friends	95.6	94.6	0.28
Why did you start waterpipe smoking			0.50
Curious about tobacco used	71.0	70.5	
Like the way waterpipe are crafted	20.0	6.2	
Like the smell of waterpipe tobacco	48.9	46.4	
Like the taste	61.1	54.5	
Hookah bar/café opened nearby	41.1	43.8	
My friends use waterpipe	82.2	83.9	
Frequency of waterpipe use			0.38
Monthly	61.1	65.2	
Weekly	32.2	32.1	
Daily	6.7	2.7	
When usually smoke waterpipe			0.22
Mornings	0.0	0.0	
Afternoons	3.3	0.9	
Evenings	96.7	99.1	
Mean minutes per waterpipe session	37.2 (23.3)	34.3 (19.3)	0.34
Smokes more than 60 min after waking up	100.0	100.0	NE
Waterpipe most difficult to give up			0.83
The first, always	11.1	10.0	
The first, in general	24.4	25.4	
The first, maybe	42.2	37.3	
Any other one	22.2	27.3	
Smoke when seriously ill			0.0061
Yes, absolutely	1.1	0.0	
Yes, probably	6.7	0.9	
Yes, maybe	20.0	8.9	
No	72.2	90.2	
Do you smoke waterpipe as a social habit			0.24
Yes, absolutely	21.1	31.2	
Yes, probably	40.0	34.8	
Yes, maybe	21.1	23.2	
No	17.8	10.7	
Smokes waterpipe with others	100.0	100.0	NE

(Table continued)

Table 2. (continued)

Where typically smokes waterpipe			0.59
Home/dorm	43.3	46.4	
Café or restaurant	24.4	25.9	
Friend's house	25.6	25.0	
Other	6.7	2.7	
Owns a waterpipe	51.1	39.3	0.09
Current use of other tobacco products			
Cigarettes	49.4	50.9	0.84
Cigar	27.5	20.5	0.25
Black and mild	24.2	16.1	0.15
Pipe	13.2	8.9	0.33
Chew or dip tobacco	2.2	5.4	0.25
Snuff	1.1	0.9	0.88
Bidis	0.0	0.9	0.37
Mean number of other tobacco products used other than waterpipe	1.2 (1.1)	1.03 (1.0)	0.35

Note. Unless otherwise stated (*M*s and *SD*s), numbers represent percentages. For categorical variables, the hypothesis that the distribution of counts across categories was the same for the populations from which the two study samples were drawn was tested by a chi-square test statistic. For continuously distributed variables, the hypothesis that the means were the same for the populations from which the two study samples were drawn was tested by a *t* test. Numbers have been rounded. NE = not estimable.

Perceived and Factual Knowledge

For both studies, participants in the experimental conditions reported greater perceived knowledge and were more likely to answer correctly more factual knowledge questions (rows 5 and 6 in Table 3).

Desire to Quit

Participants in the experimental condition in Study 1 reported a greater desire to quit than participants in the control group. In Study 2, no difference emerged between groups.

Results Combining Both Studies

Studies 1 and 2 had conditions in which participants did or did not review "identical" information about the health effects and chemical exposures related to waterpipe tobacco use. Furthermore, the educational material on health effects and exposure were presented with or without information on the spread of waterpipe use and the flavorings added to the tobacco. Pooling both studies together allowed (a) more statistical power to test effects of harm, addiction, and exposure information on our main outcomes and (b) a determination whether effects found due to the above information would be moderated by the presence or absence of information pertaining to the spread of waterpipe use and the flavorings added to the tobacco.

We pooled data from both studies and created four groups that varied along two dimensions akin to a factorial design. The first dimension was whether participants received information about harms and exposure levels (no/yes)—a yes represented data from the experimental group in both studies. The second dimension was whether participants received information on the spread of waterpipe and flavoring added to tobacco (i.e., spread and tobacco flavoring, no/yes)—a yes represented data from both conditions in Study 1 only. These two dimensions are

Table 3. Perceptions of Risk of Harm and Addiction and Desire to Quit as a Function of Experimental Condition in Study 1 and Study 2

	Study 1				Study 2			
Outcome	Control ($N = 42$)	Experimental ($N = 46$)	*P* value	*F*	Control ($N = 55$)	Experimental ($N = 55$)	*p* value	*F*
Perceived personal risk of harm	2.83 (0.16)	3.46 (0.15)	.007	7.70	3.06 (0.18)	3.34 (0.18)	.26	0.25
Worry about physical consequences	2.35 (0.15)	3.30 (0.14)	.0001	21.25	2.79 (0.16)	3.09 (0.16)	.19	1.78
Chance of becoming addicted	2.32 (0.14)	2.88 (0.14)	.0005	8.84	2.54 (0.15)	2.79 (0.15)	.24	0.23
Worry of becoming addicted	1.81 (0.17)	2.57 (0.16)	.0001	10.27	2.37 (0.18)	2.32 (0.18)	.86	0.85
Perceived knowledge of harms	4.21 (0.11)	4.64 (0.11)	.008	7.74	4.04 (0.11)	4.62 (0.11)	.0003	13.75
Factual knowledge of harms	1.78 (0.19)	3.96 (0.19)	.0001	64.90	2.02 (0.19)	3.91 (0.19)	.0001	50.76
Desire to quit	2.12 (0.25)	3.04 (0.24)	.009	7.07	2.40 (0.15)	2.34 (0.15)	.80	0.06

Note. Numbers represent least square means. Number in parenthesis is the *SEM*. Values range from 1 to 7, the exception being factual knowledge (0–5), with higher values representing greater risk, worry, and knowledge. Numbers have been rounded.

Table 4. Mean Perceptions of Risk, Worry, Knowledge and Desire to Quit as a Function of Experimental Condition Combining Both Studies

	No risk information provided		Risk information provided		Main effect for risk		Interaction	
Outcome	No spread/flavor ($N = 55$)	Spread/flavor ($N = 42$)	No spread/flavor ($N = 55$)	Spread/flavor ($N = 46$)	F	p value	F	p value
Perceived risk of harm	2.82 (0.26)	3.13 (0.27)	3.09 (0.23)	3.78 (0.27)	7.04	<.009	1.03	.312
Worry about physical consequences	2.57 (0.20)	2.63 (0.24)	2.86 (0.20)	3.58 (0.24)	15.93	<.0001	4.53	.035
Perceived risk of addiction	2.51(0.19)	2.35 (0.23)	2.76 (0.19)	2.92 (0.23)	7.65	.0063	1.05	.306
Worry about becoming addicted	2.04 (0.22)	2.24 (0.27)	1.98 (0.23)	3.00 (0.27)	3.84	<.052	5.41	.021
Perceived knowledge of harms	3.79 (0.16)	4.12 (0.19)	4.45 (0.16)	4.64 (0.19)	21.75	<.0001	0.31	.576
Factual knowledge of harms	1.76 (0.24)	2.11 (0.29)	3.64 (0.25)	4.29 (0.29)	113.31	<.0001	0.61	.437
Desire to quit	2.13 (0.25)	2.46 (0.30)	2.07 (0.25)	3.39 (0.30)	4.90	.028	6.46	.012

Note. No spread/flavor denotes participants did not get information about the spread of waterpipe and flavorings added to the tobacco. Number in parenthesis represents the *SEM*.

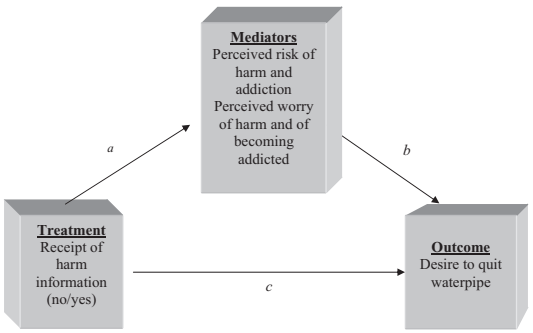
referred to in the presentation of the ANCOVA results presented in Table 4 as "risk information" and "spread/flavor," respectively.

The ANCOVAs revealed main effects for provision of risk information (i.e., harm and exposure levels). As main effects, compared to participants who did not receive risk information, those who did reported greater perceived risk of harm ($M = 3.02$ vs. 3.42) and of becoming addicted ($M = 2.43$ vs. 3.02) were more knowledgeable ($M = 1.94$ vs. 3.96) and perceived themselves as more knowledgeable ($M = 3.96$ vs. 4.54). Interactions were found for worry about the physical consequences of waterpipe use and of becoming addicted, as well as desire to quit. Tests of simple effects revealed that mean worry about the physical consequences of waterpipe use was significantly higher among participants who reviewed information on risks, spread of waterpipe, and flavorings compared to participants who did not review any information or information about the spread of waterpipe and flavorings only ($M = 3.58$ vs. 2.57 and 2.63, ps < .0008). Furthermore, tests of simple effects revealed mean worry about becoming addicted was significantly higher among participants who reviewed information on risks, spread of waterpipe, and flavorings added to the tobacco than any other group (ps < .03). Test of simple effects revealed mean desire to quit was significantly higher among participants who reviewed information on risks, spread of water pipe, and flavorings added to the tobacco than any other group (ps < .009).

Mediational Analyses

According to models of health behavior change, participants who report greater perceived risk and worry about harm and addiction should increase their desire to quit waterpipe use. Pooling data from both studies—and hence providing more statistical power—we tested whether change in desire to quit due to the receipt of information about harms of waterpipe smoking was mediated by changes in perceived risk of harm, worry about physical consequences, perceived risk of becoming addicted, or worry about becoming addicted. Four separate analyses were performed, one for each proposed mediator. In each analysis, the independent variable was treatment assignment (i.e., received risk information, no/yes) and the dependent variable was desire to quit as reported at the follow-up session. Covariates were desire to quit at baseline as well as the response to the mediator at baseline —essentially producing change scores. Testing of the meditational effect was conducted using a bootstrapped sampling distribution as suggested by MacKinnon et al. (2002). Figure 1 displays the meditational pathways with the accompanying statistical findings presented below the figure.

The receipt of harm information produced significant change in each mediator (a path). Furthermore, a change in each mediator produced change in desire to quit, controlling for treatment (b path). Of import, the direct effect of treatment (c path) no longer produced changes in desire to quit when controlling for each mediator separately, suggesting complete mediation (a × b pathway). Indeed, the 95% *CI*



Mediator	a path	b path	c path	a*b (mediation effect)	95% CI for a*b (mediation effect)
Perceived risk of harm	.395*	.281**	.280	.111	.019 - .254
Perceived risk of becoming addicted	.379**	.231*	.341	.088	.011 - .257
Worry about physical harms	.570***	.452***	.144	.261	.128 - .468
Worry about becoming addicted	.708**	.526**	.592	.373	.116 - .912

Note. Confidence intervals for mediation effects that do not encompass a value of 0 are statistically significant.

* p<05, ** p<.01, *** p<.001.

Figure 1. Mediational diagram and results.

constructed with bootstrapped sampling for each mediation effect did not encompass the value of 0, indicating statistical significance.

Follow-up Pattern of Waterpipe Use

Among the 70 participants reached at 6 months in Study 1, 29 (41%) reported no longer smoking waterpipe. Among those in the control group, 33% reported not smoking waterpipe compared to 62% in the experimental group (*OR* = 1.89, 95% *CI* = 0.72, 5.00). Among participants randomized to the control condition, quit rates at 6 months were 33.3% among those who at baseline smoked monthly (n = 21), 30% among those who at baseline smoked weekly (n = 10), and 50% among those who at baseline smoked daily (n = 2). Among participants randomized to the experimental condition, quit rates at 6 months were 56% among those who at baseline smoked monthly (n = 23), 44% among those who at baseline smoked weekly (n = 9), and 0% among those who at baseline smoked daily (n = 4). Quit rates did not differ as a function of an interaction between study condition and baseline frequency of use (monthly use vs. weekly and daily combined; *OR* for interaction, 0.34; 95% *CI* = 0.04, 2.74, p = .31).

Controlling for study groups, neither perceived risk of harm and worry about the physical consequence of waterpipe smoking assessed immediately after review of the materials online were significantly associated with quitting (*OR* = 0.968, 95% *CI* = 0.674, 1.390 for perceived risk; *OR* = 1.055, 95% *CI* = 0.724, 1.536 for worry), nor was perceived risk of addiction or worry about becoming addicted (*OR* = 0.917, 95% *CI* = 0.585, 1.438 for perceived risk; *OR* = 0.921, 95% *CI* = 0.620, 1.367 for worry). Desire to quit was also not associated with cessation (*OR* = 1.184, 95% *CI* = 0.898, 1.562).

Discussion

Dispelling misperceptions that waterpipe tobacco smoking is not a health threat is critical to curbing its use. To this end, and to the best of our knowledge, these pilot studies are the first attempts using experimental designs to test how best to enhance accurate knowledge in order to increase perceived risk and worry about waterpipe tobacco smoking. Within each study, participants who received information on harm and toxicant exposure increased their factual and perceived knowledge compared to those who did not receive this information. Only in Study 1 did we see statistically significant changes in perceived risk and worry about harm and addiction as well as the desire to quit. The lack of replication in Study 2 on these outcomes may stem from the fact that in Study 1, unlike Study 2, we included for both conditions a discussion of the spread and use of flavored additives in tobacco (which the users may have already known). Adding this information may have helped to demonstrate the credibility of our materials; this credibility can serve as a necessary component to making the participants receptive to the more novel information regarding risk/exposure. Although in the predicted direction, our data revealed no mean perceived differences in rated credibility of the information as a function of whether spread and use of flavored additives in tobacco were discussed (M = 4.8 vs. 5.3 for discussed or not discussed, respectively, p = .57). Rather than credibility, perceived relevance of the information was enhanced when participants were exposed to discussions of spread and use of flavored additives in tobacco than when it was not included (M = 4.2 vs. 4.9 for discussed or not discussed, respectively, $p < .0001$). As such, participants were perhaps more likely to apply the information to their situation in Study 1 when discussions of spread and use of flavored additives are included as content. When pooling data from both studies, participants who reviewed information on harms and exposures had significantly higher perceptions of risk and worry of harm and addiction than participants who did not review this information.

We also found that providing information solely on how waterpipe is used, its spread, and flavorings added to tobacco has a detrimental effect on perceptions of worry and desire to quit relative to the other groups. This observation supports our assumption that making these issues salient can hinder the perceived threat of waterpipe use and cessation. Further supporting this assumption is that at baseline slightly more than half of the sample stated liking the taste as a reason for smoking waterpipe, while slightly over 80% did so because it was a social activity, stressing the notion of its popularity. As such, our study manipulations of comparing the effects of risk information in the context of making salient or not information about the spread of waterpipe and flavorings added to the tobacco are justified. Indeed, adding information about harms and toxicant exposure nullifies the above findings and achieves the highest mean scores on perceptions of risk and worry and desire to quit (i.e., experimental group in Study 1). In sum, based on these data, it appears that the content in the experimental group in Study 1 may best serve as an educational tool while increasing perceptions of risk and worry as well as desire to quit.

Using the combined datasets, we found group differences in desire to quit was mediated by changes in perceptions of harm and worry about physical consequences of waterpipe tobacco use and perceived risk and worry about becoming addicted. In general, effects were stronger for worry than beliefs about risk. These findings provide critical support that intervention strategies affecting the above constructs, especially emotional responses to harm and addiction, do influence processes considered more proximal to changing waterpipe smoking behaviors, such as intentions. These results are consistent with models of health behavior change which maintain that affecting cognitive and emotional beliefs about risk can lead to changes in behaviors as well as with interventions that have modified intentions to quit by targeting misperceptions related to other tobacco products deemed as being "safer" (e.g., light cigarettes) (Kozlowski, Yost, Stine, and Celebucki, 2000; Shiffman, Pillitteri, Burton, Rohay, and Gitchell, 2001).

The data for Study 1 revealed promising trends of our intervention on cessation. Compared to participants who received materials about the use, spread, and flavorings added to tobacco, those who received materials on harms of waterpipe use engaged in less waterpipe use. Specifically, 62% of participants in the experimental group versus 33% in the control group reported having stopped waterpipe use. Variation in quit rates did not differ statistically as a function of baseline frequency of waterpipe use as a main effect or as an interaction with study group. However, the trend was such that higher quit rates were reported among monthly and weekly users randomized to the experimental rather than the control group. Hence, the experimental condition from Study 1 may be most effective to promote cessation in weekly and monthly users. There was no evidence that participants who reported higher perception of risk and worry for harm or addiction engaged in less waterpipe use. These findings should not be viewed as evidence to suggest that perceived risks and worry are

not determinants of changes in waterpipe usage. In this regard, we note that although our study manipulations of conveying risk and toxicant exposures influenced these mediators, the means were consistently below scale midpoints (i.e., scale value of 4).

As theories of health behavior change maintain (Janz and Becker, 1984; Rogers, 1983; Weinstein, 1988), future research should test strategies that can bolster intervention effects on perceived harm and worry in order to maximize their potency as mediators to decrease waterpipe use. For example, greater increases in perceived risk and worry might be obtained through an interactive multimedia approach. This approach would deliver risk-related information by combining in-depth explanations and illustrations that address the science of harm and addiction related to waterpipe use with an interactive and vivid medium that engages participants (e.g., visual reality simulation). To a greater extent than our PowerPoint presentations, this multimedia approach should lead to attitudes about personal risk and addiction that are more stable, resistant to counter-persuasion, and hence more likely to influence behaviors.

Our studies have limitations. First, because the studies were conducted online and materials reviewed at participants' leisure, it is unclear how environmental factors (e.g., peers, noise) and especially historical effects (e.g., media reports on water pipes) may have influenced findings. Similarly, it is not clear the extent to which peer discussions of our study materials may have contaminated the results. Second, some measures of risk and worry were not the same for domains of harm and addiction. For example, we used a 4-item measure to assess worry about physical consequences of harm but did not use a comparable 4-item worry measure for addiction. The failure to use comparable measures limits making comparisons of effect sizes. Third, our samples may not be representative when compared to the larger population of college waterpipe users. For example, among the six campuses we recruited from in Study 1, we had only two students eligible who participated from one campus, whereas we had 44 students eligible who participated from another campus—others ranged in number from 7 to 20; in Study 2, only one student was found eligible who participated from one campus while 92 students were eligible who participated from another campus—other numbers ranged from 2 to 22. Fourth, our interventions were brief and may not be powerful enough to induce change among weekly and most likely daily users. However, the ability of our brief interventions to produce any significant changes on our measures of risk, worry, knowledge, and desire to quit speak to their promise and potential ease of dissemination using the web. Fifth, we pooled our data to test main effects and interactions as well as mediation. Although the samples appeared comparable (see Table 2), a more formal test would involve randomizing participants to one of the four conditions we created based on the risk information and the provision of information on spread and to tobacco flavorings. Lastly, we did not use any biomarkers to confirm cessation of waterpipe use among those who reported having quit.

In sum, our results provide preliminary and promising evidence that minimally intensive interventions delivered online that educate college waterpipe smokers of harm, addiction, and toxicant exposure of waterpipe tobacco use can increase factual understanding of the harms of waterpipe use, perceptions of risk, worry, and desire to quit. In addition, there is some evidence that our most promising intervention materials (Study 1 experimental group) may increase cessation. Future studies should examine the effects of our intervention on change in waterpipe use based on adequately powered studies. In doing so, interventions should also test alternative interactive, multimedia approaches to bolster further perceptions of harms and worry to maximize their potential to curb the spread among youth of this emerging strain in our nation's tobacco epidemic.

Funding

National Cancer Institute Grant (R01 CA114389); National Institute on Drug Abuse Grant (P30 DA023026).

Declaration of Interests

None declared.

Acknowledgments

We thank Ken McKee for developing and managing the study Web site. We thank Shelly Epps for serving as study coordinator and Teresa Collins for serving as the research assistant. The contents of the study are solely the responsibility of the authors and do not necessarily represent the official views of the National Cancer Institute or National Institute on Drug Abuse.

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