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Waterpipe a gateway to cigarette smoking initiation among adolescents in Irbid, Jordan: a longitudinal study

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Abstract

SETTING—According to anecdotal evidence, waterpipe smoking may lead to the initiation of cigarette smoking among young people. This hypothesis is yet to be examined using an appropriate study design and a theoretical model for behavioral change.

OBJECTIVE—To compare the risk of cigarette smoking initiation among waterpipe-only smokers and never smokers in a school-based sample of adolescents from Irbid, Jordan.

METHODS—A total of 1454 cigarette-naïve participants were drawn from a longitudinal study on smoking behavior conducted in Irbid among 1781 seventh graders who were enrolled at baseline (2008) and completed the study questionnaire on smoking behavior annually until 2011. Grouped time-survival analysis was used to compare the risk of subsequent initiation of cigarette smoking between waterpipe smokers ($n = 298$) and never smokers ($n = 1156$) using adjusted hazard ratios (aHRs) and 95% confidence intervals (95%CI).

RESULTS—Risk of initiation of cigarette smoking among waterpipe smokers was significantly higher than among never smokers after adjusting for potential confounders (aHR 1.67, 95%CI 1.46–1.92). The association between waterpipe and cigarette smoking initiation was dose-dependent. The risk of initiating cigarette smoking increased with increase in the frequency of waterpipe smoking (P for linear trend < 0.001).

CONCLUSIONS—Waterpipe smoking led to the initiation of cigarette smoking among this cohort of Jordanian adolescents; the effect was dose-dependent.

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WATERPIPE SMOKING is popular among adolescents in the Eastern Mediterranean Region.[1,2] Evidence from many countries in the region suggests that the waterpipe is the most common form of tobacco use among youth.[1–3] The last Global Youth Tobacco Survey (GYTS 2009) found that 11.5% of adolescents in Jordan were current cigarette smokers compared to 20.7% current waterpipe smokers.[4] Both sexes, 27.1% of boys and 15.6% of girls, reported waterpipe smoking in Jordan.[4]

Waterpipe smoking is widely believed to be less harmful, less addictive and generally safer than cigarette smoking.[5] Given the recent spread of waterpipe smoking, evidence of long-term major health effects of waterpipe smoking, such as cancer and cardiovascular disease, is still scarce.[6] Available evidence, however, shows that waterpipe smoking exposes smokers to the main carcinogenic and cardiovascular toxic substances present in cigarettes.[7] For example, our team has recently reported that waterpipe smokers are exposed to tobacco-specific nitrosamines in comparable amounts to cigarette smokers.[8] Moreover, there is strong evidence to suggest that waterpipe smoking is associated with nicotine dependence, including abstinence-induced withdrawal and craving symptoms, which are relieved by subsequent waterpipe smoking.[9]

Several researchers have recently suggested that waterpipe smoking can lead to cigarette use.[10–13] This has major implications for tobacco control, especially in societies with high levels of waterpipe smoking among youth. As evidence for waterpipe use patterns and delivery of the addictive substance, nicotine, has accumulated, the waterpipe-to-cigarette gateway concept was developed further to suggest a possible pathway for this transition.[14–16]

Compared to cigarettes, waterpipe smoking is a stationary, time-consuming practice, and is not readily accessible. These features led one of our group (WM) to suggest that adolescents who become addicted to nicotine through waterpipe use are likely to resort to the more accessible cigarettes to satisfy their smoking urge.[15] The relation between dependence and access is therefore likely to be a major predictor of the transition from waterpipe to cigarette smoking.[15,16] On the other hand, the move from 'less harmful' tobacco products, such as waterpipes or ecigarettes, to harmful cigarettes represents a unique transition, characterized by the 'gateway' hypothesis, beyond the commonalities underlying youthful experimentation with different addictive substances.[17,18] The present study examines the potential role played by waterpipe smoking as a gateway to cigarette smoking using a longitudinal study design based on a theoretical framework of behavioral change (attitudes, social influences and self-efficacy),[19] as well as evidence of the patterns and determinants of waterpipe use.[20,21] We also compared the risk of initiation to cigarette smoking between waterpipe-only smokers and never smokers among schoolchildren (mean age 12.6 years at baseline) in Irbid, Jordan, and examined the dose-related gradient of this risk based on the frequency of waterpipe use as a proxy measure for nicotine dependence.[22]

METHODS

Study population and sampling

We used data from the Irbid Longitudinal Study of Smoking behavior (ILSS), a school-based study of adolescents that collected data in four periods between 2008 and 2011 in Irbid City (population ≈ 300 000), Jordan. A detailed description of the study methods is given elsewhere.[20] Briefly, 60 Irbid schools were stratified by sex (boys, girls, and mixed sex schools) and type (public and private). A random sample of 19 schools was selected with probability proportionate to size. A total of 1781 seventh graders (participation rate 95%) provided assent and parental consent. All students who reported ever smoking cigarettes at baseline ($n = 327$) were excluded from the analysis.[23] The final sample included 1454 participants: 1156 never smokers and 298 waterpipe-only smokers.

Data collection and study instruments

Smoking behavior was assessed using a pilot-tested questionnaire developed in accordance with World Health Organization (WHO) international guidelines,[24] and several instruments validated in Arabic, such as the GYTS.[25] The questionnaire was composed of four modules: sociodemographics, cigarette smoking, waterpipe smoking and social factors shown to influence smoking. The students completed the questionnaire annually over the 4 years of the study, including baseline, at school with guidance from a study assistant. To ensure the validity of the responses, parents or school personnel were not allowed to attend the data collection session.

The study was approved by the Institutional Review Boards (IRBs) of Jordan University for Science and Technology (Irbid, Jordan), University of Memphis (Memphis, AR, USA), the Syrian Society Against Cancer (Aleppo, Syria) and the Florida International University (Miami, FL, USA).

Definitions and measures

Ever smoking—Ever smoking was defined as ever experimenting with tobacco, current smoking as smoking a cigarette or a waterpipe in the past 30 days, and never smoking as never experimenting with tobacco. The main outcome of the study was 'progression from waterpipe to cigarette smoking', i.e., change of smoking status from waterpipe-only smoking to cigarette smoking at any subsequent time point among students who had never smoked cigarettes.

The main predictor of interest was 'waterpipe-only vs. never smoking', examined as a binary variable. This variable was created by combining two questions that assessed 'ever smoking': 'Did you ever smoke waterpipe, even a puff or two? (no = 0, yes = 1)', and 'current smoking': 'How many times did you smoke waterpipe in the past 30 days? (did not smoke waterpipe in last month = 0, once a week = 1, more than once weekly but not daily = 2, daily = 3)'. Other covariates, such as self-efficacy, were measured by asking 'would you accept a cigarette if offered by a friend?'. Intention to smoke cigarettes in the following year was measured by the question 'Do you think that you may start to smoke cigarettes in the next year?'.

Statistical analysis—The baseline sociodemographic, individual and social factors were compared between the study groups (ever vs. never-smoked waterpipe) using Pearson's χ^2 analysis for difference in proportions and *t*-test for continuous measures. The hazards of initiating cigarette smoking between waterpipe and never smokers were compared using dichotomous multivariate grouped time-survival analyses[26–29] by including all covariates simultaneously in a single model. Grouped-time survival analysis is a combination of the grouped Cox model,[28] the discrete time-hazard model,[29] and the dichotomous approach.[28] We used items measured from period 1 through period 4 for time-varying predictors, linking predictors to the risk of progressing to waterpipe smoking at the subsequent interview (e.g., period 2 measures were used to predict smoking progression at period 3). 'Proc Phreg' commands were used in SAS (Statistical Analysis System Institute, Cary, NC, USA), with the shared frailty model considering the school as a random variable to account for the unobserved heterogeneity among schools.[27] This analysis allowed for maximum data use, inclusion of time-dependent covariates, and relaxing of the proportional hazards assumption. Finally, the probabilities of cigarette initiation were averaged and plotted against waterpipe smoking frequency (never, ever but not currently, once weekly, more than once weekly, including daily) reported at the previous timepoint. Trend analysis was performed to examine the type and significance of this relationship. As schools were selected using a cluster-stratified sampling design, all proportions were weighted by school. The calculation of study weights was reported by the baseline study.[20] The significance level was set at $P < 0.05$, and all analyses were conducted using SAS, V. 9.3 (SAS).

RESULTS

Descriptive results

Baseline prevalence of waterpipe-only smoking was 17% among the 1781 study participants. Incidence of waterpipe and cigarette smoking at year 1 was 7.5% and 7.7%, respectively. The current analysis was restricted to 1454 participants who reported never having smoked cigarettes at baseline (mean age 12.6 years ± standard deviation [SD] 0.61; 45.3% males). Of these, 1156 were never smokers and 298 were waterpipe-only smokers; these groups were studied in terms of future risk of cigarette initiation. Table 1 compares the distribution of study covariates between the two groups.

Interval-specific multivariable grouped-time survival analysis

A total of 569 (49%) never smokers completed the 3-year study period without being censored or progressing to waterpipe or cigarette smoking. The adjusted interval-specific 12-month risk of initiating cigarette smoking was significantly higher among the waterpipe-only smokers group than among never smokers. The highest effect of waterpipe smoking on the initiation of cigarette smoking was observed in the second year of follow-up (adjusted hazard ratio [aHR] 1.70, 95% confidence interval [CI] 1.83–2.44, $P < 0.004$; Table 2).

Multivariate grouped-time survival analysis

Results from the unadjusted model showed that waterpipe-only smokers were twice as likely as never smokers to initiate cigarette smoking during the 3 years of follow-up (HR 2.05, 95%CI 1.82–2.30, $P < 0.001$). We extended the model by adding all the previously listed

potential confounders. Waterpipe smoking was among the strongest predictors of cigarette smoking initiation during the subsequent 12 months (aHR 1.66, 95%CI 1.33–2.08, $P <$ 0.001). Other independent predictors of cigarette smoking initiation included parents and friends smoking, low refusal of self-efficacy, and intention to smoke cigarettes in the following year (Table 3).

The hazard probability specifies the cumulative risk of initiating cigarette smoking — during the 3-year follow-up period for waterpipe and never smokers — to assess the probability that a randomly selected adolescent will initiate cigarette smoking during the 3-year study period. Figure 1 gives the results of the analysis and shows that at any timepoint, the probability of initiating cigarette smoking among waterpipe smokers was almost double that among never smokers (0.14 vs. 0.08, $P < 0.001$).

Transition analysis

All never smoking study participants at baseline were followed to year 1 to evaluate the incidence of waterpipe initiation. Students who initiated waterpipe smoking were compared with those who remained never smokers from baseline to year 2 for the initiation of cigarettes. The 12-month risk of initiating cigarette smoking at year 2 was higher among never smokers who progressed to waterpipe smoking at year 1 than among never smokers who did not progress during the same period (HR 2.00, 95%CI 1.46–2.76, $P < 0.001$).

Dose response

When examining the probability of cigarette smoking initiation among the different frequency gradients for waterpipe smoking, a dose-response relationship between the reported number using waterpipe and the 12-month probability of initiating cigarette smoking was observed (Figure 2). The probability of cigarette smoking initiation increased with increase in frequency of waterpipe smoking (P for linear trend < 0.001).

DISCUSSION

The present study provides strong support in favor of the hypothesis that waterpipe smoking leads to the initiation of cigarette smoking among adolescents. The longitudinal correspondence between waterpipe smoking as a predictor of future initiation of cigarette smoking and the dose-response gradient of this relationship lends support to our conceptual framework that the balance between dependence and access drives this transition. Given the limited access and portability of waterpipes, the more nicotine/tobacco-dependent the person becomes (measured by frequency of use), the more likely they are to turn to cigarettes to relieve their urge to smoke in a timely manner. While other explanations for our data are possible, our study results suggest that waterpipe smoking may be a risk factor for future cigarette smoking among youth in other societies; this highlights the need to conduct further studies on this interrelation in other cultures and contexts.

This study builds on the research conducted over the years by our team to identify important aspects of waterpipe smoking as addictive behavior. For example, we have shown that waterpipe smoking delivers nicotine efficiently to the smoker[30] and that waterpipe smoking

is associated with classical signs of tobacco/nicotine dependence, such as craving and withdrawal.[31]

We have also shown that perceived dependence among waterpipe smokers is proportionate to the frequency of waterpipe smoking.[32] Another line of inquiry was to characterize patterns and determinants of use among waterpipe smokers. This research showed that, unlike cigarette smokers, waterpipe smokers displayed intermittent use patterns, most likely due to the more restricted access/availability of waterpipes compared to cigarettes.[30] This led us to hypothesize that young people who start tobacco use with the waterpipe and become addicted to nicotine are more likely to switch to the more accessible/portable cigarettes to deal with their dependence.[30] As most waterpipe smokers perceive waterpipe smoking as being less harmful than cigarette smoking, the gateway hypothesis provides a suitable framework for studying the transition from waterpipe to cigarette smoking.[17] Such potential also applies to the increasingly popular e-cigarettes as a new means of creating a new generation of persons addicted to nicotine.[17,18] The analysis presented in this paper supports the view that waterpipe smoking may act as a potential gateway to cigarette smoking, and suggests that the balance between dependence and access plays a role in this relationship. However, we understand the suggestive nature of our results, as epidemiologic studies can only establish the sequence of use of different substances and measure associations, but cannot determine what causes the progression from one drug to the other without more direct measures of dependence and deeper exploration of suggested pathways.[17]

The association between waterpipe and cigarette smoking is supported by anecdotal observations. For example, Jensen et al. showed that intermittent cigarette smokers who smoked waterpipes were more likely to become regular cigarette smokers than their non-waterpipe smoking counterparts.[10] Another study found that cigarette smoking at age 20–21 years was higher among students who smoked waterpipe during high school.[33] Most of these studies, however, were cross-sectional or were not designed to investigate the gateway hypothesis, as they looked at waterpipe smoking as one of many factors influencing the risk of cigarette smoking initiation and lacked a conceptual framework for the possible mechanism for transitioning from waterpipes to cigarettes.

The strengths of the study include the longitudinal, hypothesis-driven design and analysis. However, the study also has some limitations. First, our findings may not be generalizable to adolescents in other countries with different social and contextual factors involving tobacco use among the young. However, our underlying conceptual framework based on dependence and access is expected to have some universal application, and may be used to guide further research into the waterpipe as a potential gateway to cigarette smoking in other societies. Second, all measures were self-reported, which may have led to underreporting of smoking, especially among girls because of the taboo against smoking among girls in the Eastern Mediterranean Region. We do not believe this limitation to be significant, as our team has many years of experience of working in similar cultures and applying confidentiality measures to ensure that young people can express their opinions freely.[34] Third, as our data did not include direct measures of nicotine dependence, we had to rely on frequency of use as proxy for waterpipe dependence to assess the dose-response relationship between

dependence and future cigarette smoking initiation. However, studies that used specific scales to measure waterpipe dependence among university students in the Eastern Mediterranean Region showed strong correlation between dependence and the frequency of waterpipe use.[22] While other explanations, such as the known clustering of health risk behaviors among the youth, remain valid,[35] the demonstrated dose-response relationship is consistent with our guiding hypothesis of the balance between dependence and access as an important factor influencing the initiation of cigarette smoking.

CONCLUSIONS

Our study provides strong evidence in support of a relationship between waterpipe and cigarette smoking among adolescents in Jordan. It shows that waterpipe use may lead to the initiation of cigarette smoking among never-smoking adolescents. Further studies investigating such potential in other cultures, with the application of more direct measures of dependence, are required.

Acknowledgements

References

1. Akl EA, Gunukula SK, Aleem S, et al. The prevalence of waterpipe tobacco smoking among the general and specific populations: a systematic review. BMC Public Health. 2011; 11:244. [PubMed: 21504559]

2. Martinasek MP, McDermott RJ, Martini L. Waterpipe (hookah) tobacco smoking among youth. Curr Probl Pediatr Adolesc Health Care. 2011; 41:34–57. [PubMed: 21232693]

3. Maziak W, Taleb ZB, Bahelah R, et al. The global epidemiology of waterpipe smoking. Tob Control. 2014 Oct 8. pii.

4. Centers for Disease Control and Prevention. Atlanta, GA, USA: CDC; Global Tobacco Surveillance System Data. http://nccd.cdc.gov/gtssdata/Ancillary/DataReports.aspx?CAID=2. [Accessed January 2015]

5. Akl EA, Jawad M, Lam WY, Co CN, Obeid R, Irani J. Motives, beliefs and attitudes towards waterpipe tobacco smoking: a systematic review. Harm Reduct J. 2013; 10:12. [PubMed: 23816366]

6. Maziak W. Commentary: The waterpipe—a global epidemic or a passing fad. Int J Epidemiol. 2010; 39:857–859. [PubMed: 20348109]

7. Maziak W. The waterpipe: an emerging global risk for cancer. Cancer Epidemiol. 2013; 37:1–4. [PubMed: 23196170]

8. Al Ali R, Rastam S, Ibrahim I, et al. A comparative study of systemic carcinogen exposure in waterpipe smokers, cigarette smokers and non-smokers. Tob Control. 2013 Sep 2. [Epub ahead of print].

9. Cobb CO, Shihadeh A, Weaver MF, Eissenberg T. Waterpipe tobacco smoking and cigarette smoking: a direct comparison of toxicant exposure and subjective effects. Nicotine Tob Res. 2011; 13:78–87. [PubMed: 21127030]

10. Jensen PD, Cortes R, Engholm G, Kremers S, Gislum M. Waterpipe use predicts progression to regular cigarette smoking among Danish youth. Subst Use Misuse. 2010; 45:1245–1261. [PubMed: 20441461]

11. Mzayek F, Khader Y, Eissenberg T, Al Ali R, Ward KD, Maziak W. Patterns of water-pipe and cigarette smoking initiation in schoolchildren: Irbid longitudinal smoking study. Nicotine Tob Res. 2012; 14:448–454. [PubMed: 22140149]

12. Kheirallah KA, Alzyoud S, Ward KD. Waterpipe use and cognitive susceptibility to cigarette smoking among never-cigarette smoking Jordanian youth: analysis of the 2009 global youth tobacco survey. Nicotine Tob Res. 2014 Aug 26. pii: ntu140. [Epub ahead of print].

13. Fielder RL, Carey KB, Carey MP. Hookah, cigarette, and marijuana use: a prospective study of smoking behaviors among first-year college women. Addict Behav. 2013; 38:2729–2735. [PubMed: 23934004]

14. Maziak W. The waterpipe: time for action. Addiction. 2008; 103:1763–1767. [PubMed: 18778388]

15. Maziak W. The global epidemic of waterpipe smoking. Addict Behav. 2011; 36:1–5. [PubMed: 20888700]

16. Maziak W. The waterpipe: a new way of hooking youth on tobacco waterpipe and tobacco dependence. Am J Addict. 2014; 23:103–107. [PubMed: 25187045]

17. Kandel ER, Kandel DB. A molecular basis for nicotine as a gateway drug. N Engl J Med. 2014; 371:932–943. [PubMed: 25184865]

18. Dutra LM, Glantz SA. Electronic cigarettes and conventional cigarette use among U.S. adolescents: a cross-sectional study. JAMA Pediatr. 2014; 168:610–617. [PubMed: 24604023]

19. De Vries H, Mudde A, Leijs I, et al. The European smoking prevention framework approach (EFSA): an example of integral prevention. Health Educ Res. 2003; 18:611–626. [PubMed: 14572020]

20. Mzayek F, Khader Y, Eissenberg T, Ward KD, Maziak W. Design, baseline results of Irbid longitudinal, school-based smoking study. Am J Health Behav. 2011; 35:746–755. [PubMed: 22251765]

21. McKelvey K, Attonito J, Madhivanan P, et al. Determinants of waterpipe smoking initiation among school children in Irbid, Jordan: a 4-year longitudinal analysis. Drug Alcohol Depend. 2014; 142:307–313. [PubMed: 25060962]

22. Salameh P, Waked M, Aoun Z. Waterpipe smoking: construction and validation of the Lebanon waterpipe dependence scale (LWDS-11). Nicotine Tob Res. 2008; 10:149–158. [PubMed: 18188755]

23. Kozlowski LT, Harford MR. On the significance of never using a drug: an example from cigarette smoking. J Abnorm Psychol. 1976; 85:433–434. [PubMed: 956512]

24. World Health Organization. Geneva, Switzerland: WHO; 1998. Guidelines for controlling and monitoring the tobacco epidemic.

25. Global Youth Tobacco Survey Collaborative Group. Tobacco use among youth: a cross country comparison. Tob Control. 2002; 11:252–270. [PubMed: 12198280]

26. Allison, PD. Survival analysis using SAS: a practical guide. Cary, NC, USA: SAS Institute; 1995. http://www.statisticalhorizons.com/wpcontent/uploads/2012/01/Allison_SurvivalAnalysis.pdf. [Accessed January 2015]

27. Hedeker D, Siddiqui O, Hu FB. Random-effects regression analysis of correlated grouped-time survival data. Stat Methods Med Res. 2000; 9:161–179. [PubMed: 10946432]

28. D'Agostino RB, Lee M-L, Belanger AJ, Cupples LA, Anderson K, Kannel WB. Relation of pooled logistic regression to time dependent Cox regression analysis: the Framingham Heart Study. Stat Med. 1990; 9:1501–1515. [PubMed: 2281238]

29. Singer JD, Willett JB. It's about time: using discrete-time survival analysis to study duration and the timing of events. J Educ Stat. 1993; 18:155–195.

30. Maziak W, Rastam S, Shihadeh AL, et al. Nicotine exposure in daily waterpipe smokers and its relation to puff topography. Addict Behav. 2011; 36:397–399. [PubMed: 21185126]

31. Maziak W, Rastam S, Ibrahim I, Ward KD, Shihadeh A, Eissenberg T. CO exposure, puff topography and subjective effects in waterpipe tobacco smokers. Nicotine Tob Res. 2009; 11:806–811. [PubMed: 19420278]

32. Asfar T, Ward KD, Eissenberg T, Maziak W. Comparison of patterns of use, beliefs, and attitudes related to waterpipe between beginning and established smokers. BMC Public Health. 2005; 5:19. [PubMed: 15733316]

33. Hampson SE, Tildesley E, Andrews JA, Barckley M, Peterson M. Smoking trajectories across high school: sensation seeking and hookah use. Nicotine Tob Res. 2013; 15:1400–1408. [PubMed: 23322766]

34. Maziak W, Mzayek F. Characterization of the smoking habits among high school students in Syria. Eur J Epidemiol. 2000; 17:1169–1176. [PubMed: 11484808]

35. DuRant R, Smith JA, Kreiter SR, Krowchuk DP. The relationship between early age of onset of initial substance use and engaging in multiple health risk behaviors among young adolescents. Arch Pediatr Adolesc Med. 1999; 153:286. [PubMed: 10086407]
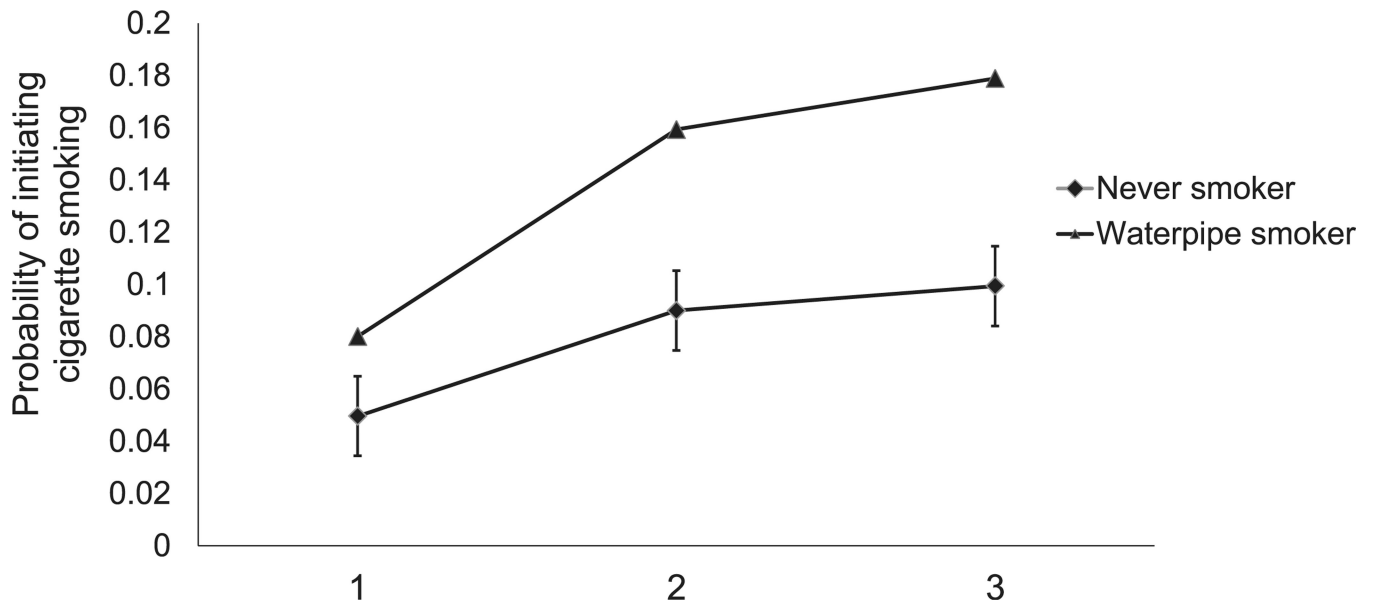
Figure 1.
Adjusted probabilities* of initiating cigarette smoking for waterpipe-only smokers compared
with never smokers in a school-based sample of adolescents in Irbid, Jordan, 2008–2011 (*n*
= 1454). Note: probabilities were obtained from the adjusted grouped-time survival analysis.
Modeling included sex; age; pocket money; educational level of parents; whether parents,
siblings, friends, teacher smoked cigarettes; relation with parents, siblings, teachers and
classmates; intention to smoke; refusal of self-efficacy; beliefs (cigarette smoker has more
friends, cigarette smoking is more attractive, cigarette smoking reduces weight, cigarette
smoking harms health, easy to quit cigarette after smoking a year); intention to smoke next
year; and whether the student has seen advertisements promoting or warning against
cigarette smoking or actor smoking in the media, and warning label on cigarette packs.*
Based on dose-response linear trend analysis.
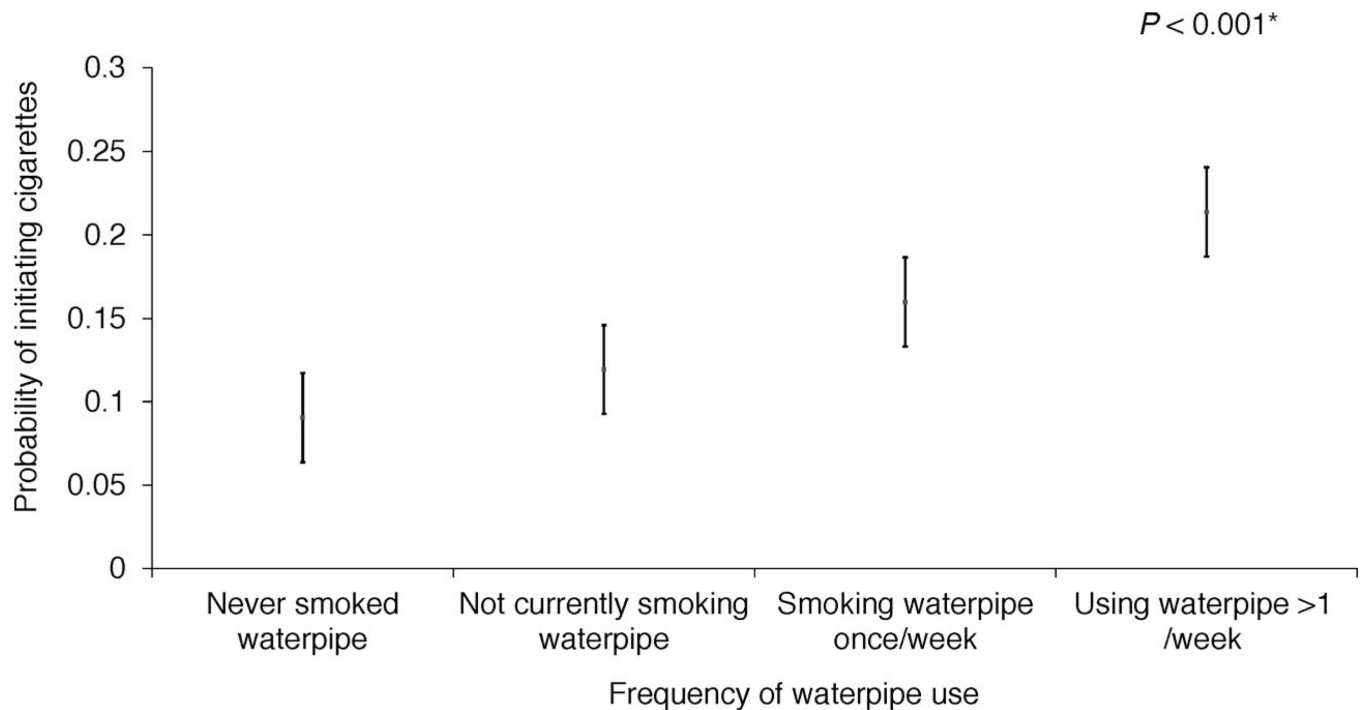
Figure 2.
The 12-month average predicted probabilities of initiating cigarette smoking as a function of frequency of waterpipe smoking in the previous year among a school-based sample of adolescents in Irbid, Jordan, 2008–2011 (*n* = 1454). Note: adjusted for sex; age; pocket money; educational level of parents; whether parents, siblings, friends, teacher smoked cigarettes; relation with parents, siblings, teachers and classmates; intention to smoke; refusal of self-efficacy; beliefs (cigarette smoker has more friends, cigarette smoking is more attractive, cigarette smoking reduces weight, cigarette smoking harms health, easy to quit cigarette after smoking for a year; intention to smoke next year; and whether the student has seen advertisements promoting or warning against cigarette smoking or actor smoking in the media, and warning label on cigarette packs.* Based on dose-response linear trend analysis.

Table 1

Proportions of potential confounders between cigarette-naïve waterpipe smokers and never smokers at baseline from a school-based sample of adolescents in Irbid, Jordan, 2008–2011[*]

Baseline characteristics	All study participants (*n* = 1454) %	Waterpipe smokers (*n* = 298) %	Never smokers (*n* = 1156) %	*P* value
Sociodemographic factors				
Age, years, mean ±SD	12.7 ± 0.61	12.8 ± 0.59	12.7 ± 0.60	0.015
Male	45.3	56.4	42.2	<0.001
Daily pocket money >50 piaster[†]	21.0	29.0	18.8	<0.001
Mother's education less than high school	19.3	20.6	18.9	0.236
Father's education less than high school	18.0	18.4	17.9	0.773
Social factors				
Good relation with parents	97.2	95.0	97.8	<0.001
Good relation with siblings	96.9	94.0	97.8	<0.001
Good relation with classmates	96.1	95.6	96.3	0.299
Good relation with teachers	94.5	91.4	95.4	<0.001
Parents smoking cigarettes	49.5	53.1	48.5	0.014
Having friends who smoke cigarettes	17.1	28.8	13.8	<0.001
Siblings who smoke cigarettes	15.7	26.2	12.7	<0.001
Personal factors (knowledge, beliefs and attitude toward cigarettes)				
Cigarette smoking affects health	93.6	93.6	93.7	0.886
Cigarette smoking reduces weight	57.6	52.2	59.0	<0.001
Easy to quit cigarettes after smoking for a year	35.9	29.1	30.0	0.586
Cigarette smoking is attractive	33.2	36.5	32.3	0.015
Cigarette smokers have more friends	22.5	28.6	20.7	<0.001
Intention to smoke cigarette next year	7.7	10.7	6.9	<0.001
Intention to accept cigarette if offered by friend	3.5	6.8	2.6	<0.001
Factors related to smoking policies				
Student saw actors smoking in the media	87.1	85.3	87.6	0.066
Student saw warning label on cigarette pack	87.4	90.3	86.6	0.002
Student saw cigarette advertisements	54.6	49.5	44.3	0.005
Teachers smoke in front of students	30.0	36.2	28.3	<0.001
Student saw advertisements warning against cigarettes	79.7	74.1	81.3	<0.001

[*] Proportions reported were weighted by the inverse probability of school chosen.

[†] $1 = 70 Jordanian piaster.

SD = standard deviation.

Table 2

Group dynamics and adjusted risk of initiating cigarette smoking by time interval among school-based sample of adolescents in Irbid, Jordan, 2008–2011 (n = 1454)

Smoking status by time interval	Entered the interval n (%)	Progressed to cigarette smoking n (%)	Censored in the interval n (%)*	Did not progress to cigarette smoking n (%)	Progressed to waterpipe smoking n†	aHR (95%CI)‡	P value
Baseline to year 1 (grade 7)							
Never smoker (reference)	1156	115 (7.7)	53 (6.2)	988 (86.1)	82	1.00	
Waterpipe only	298	54 (14.9)	21 (9.1)	223 (76.0)		1.52 (1.04–2.22)	<0.032
Total	1454	169 (9.3)	74 (6.9)	1211 (83.3)			
Year 1 to year 2 (grade 8)							
Never smoker (reference)	906	102 (10.1)	8 (0.6)	796 (89.3)	76	1.00	
Waterpipe only	305	74 (21.2)	3 (0.9)	228 (78.0)		1.70 (1.83–2.44)	<0.004
Total	1211	176 (12.9)	11 (0.7)	1024 (86.4)			
Year 2 to year 3 (grade 9)							
Never smoker (reference)	720	70 (8.5)	45 (9.1)	605 (82.4)	36	1.00	
Waterpipe only	304	56 (15.6)	14 (6.9)	234 (77.5)		1.58 (1.04–2.42)	0.033
Total	1024	126 (10.6)	59 (8.4)	839 (88.9)			

* Participants lost to follow-up or their information about 'event' is missing.

† Subtracted from never smokers and added to waterpipe smokers in the following interval.

‡ Interval-specific aHR and its 95%CI obtained from grouped-time survival analysis separately performed for each interval.

aHR = adjusted hazard ratio; CI = confidence interval.

Table 3

Adjusted risk of initiating cigarette smoking for waterpipe smoking and other potential confounders in a school-based sample of adolescents in Irbid, Jordan, 2008–2011 (n = 1454)

Parameter	aHR (95%CI)	*P* value
Waterpipe vs. never smokers	1.66 (1.33–2.08)	<0.001
Sociodemographic factors		
Age, years	0.95 (0.85–1.05)	0.296
Male vs. female	1.37 (0.90–2.09)	0.137
Father's education less than high school	1.13 (0.86–1.47)	0.383
Mother's education less than high school	1.09 (0.84–1.43)	0.506
Daily pocket money >50 piaster*	0.94 (0.73–1.21)	0.632
Social factors		
Having friends who smoke cigarettes	1.42 (1.12–1.80)	0.004
One parent who smokes cigarettes	1.35 (1.10–1.65)	0.005
A sibling who smokes cigarettes	1.17 (0.92–1.49)	0.202
Good relation with teachers	0.61 (0.40–0.94)	0.024
Good relation with parents	1.25 (0.62–2.51)	0.529
Good relation with siblings	1.40 (0.71–2.78)	0.332
Good relation with classmates	1.14 (0.63–2.06)	0.656
Personal factors (knowledge, attitude, and beliefs)		
Tend to accept cigarettes offered by friend (self-efficacy)	1.79 (1.24–2.57)	0.002
Intention to smoke cigarettes next year	1.30 (0.93–1.82)	0.125
Believes cigarettes reduce body weight	0.98 (0.80–1.21)	0.842
Believes cigarette smoking is attractive	0.95 (0.75–1.19)	0.632
Believes cigarette smoking increases number of friends	1.09 (0.86–1.39)	0.483
Believes cigarettes is harmful for health	1.02 (0.67–1.55)	0.913
Believes it is easy to quit cigarettes after smoking for a year	0.98 (0.78–1.22)	0.840
Factors related to smoking policies		
Teachers smoke in front of students	1.16 (0.92–1.47)	0.221
Have seen advertisements promoting cigarettes	1.05 (0.86–1.29)	0.615
Have seen advertisements warning against cigarettes	1.14 (0.88–1.48)	0.314
Warning labels were seen on cigarette packs	1.02 (0.72–1.43)	0.930
Actors seen smoking in the media	1.05 (0.76–1.45)	0.783

$1 = 70 Jordanian piaster.
aHR = adjusted hazard ratio; CI = confidence interval.