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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

DETERMINANTS OF WATERPIPE AND CIGARETTE SMOKING PROGRESSION
AMONG A SCHOOL-BASED SAMPLE OF ADOLESCENTS IN IRBID, JORDAN: A
THREE-YEAR LONGITUDINAL STUDY (2008-2011)

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

PUBLIC HEALTH

by

Rana Mohammed Jaber

2015

To: Interim Dean Mark Williams
Robert Stempel College of Public Health and Social Work

This dissertation, written by Rana Mohammed Jaber, and entitled Determinants of Waterpipe and Cigarette Smoking Progression among a School-Based Sample of Adolescents in Irbid, Jordan: A Three-Year Longitudinal Study (2008-2011), having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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Date of Defense: March 2, 2015

The dissertation of Rana Mohammed Jaber is approved.

Interim Dean Mark Williams
Robert Stempel College of public health and social work

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Florida International University, 2015

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DEDICATION

I dedicate this dissertation to the Jaber family. Special dedication is to my parents, husband, and children. Without their patience, understanding, support, and most of all love, the completion of this work would not be possible.

ACKNOWLEDGMENTS

First of all, I want to thank Allah for giving me the strength to successfully complete this work, despite all difficulties that I faced during the course of my study. I want to thank my parents for their continuous support through my long academic trip. My grateful appreciation is to my husband and my kids for their patience and support. I also wish to thank the members of my committee for their continuous help. Their gentle but firm direction has been most appreciated. Finally, I would like to thank my major professor, Dr. Wasim Maziak for his unlimited patience and support. His attitude in teaching and guiding research creates a challenging and competitive atmosphere that helped me to explore new methodologies and statistical techniques that are the most appropriate to my study. This work was supported by the National Institute on Drug Abuse (NIDA), (grants R01 DA024876 and R01 DA035160).

ABSTRACT OF THE DISSERTATION

DETERMINANTS OF WATERPIPE AND CIGARETTE SMOKING PROGRESSION
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Rana Mohammed Jaber

Florida International University, 2015

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Professor Wasim Maziak, Major Professor

The prevalence of waterpipe smoking exceeds that of cigarettes among adolescents in the Middle East where waterpipe is believed as less harmful, less addictive and can be a safer alternative to cigarettes. This dissertation tested the gateway hypothesis that waterpipe can provide a bridge to initiate cigarette smoking, identified the predictors of cigarette smoking progression, and identified predictors of waterpipe smoking progression among a school-based sample of Jordanian adolescents (mean age \pm SD) (12.7 ± 0.61) years at baseline.

Data for this research have been drawn from Irbid Longitudinal Study of smoking behavior, Jordan (2008-2011). The grouped-time survival analysis showed that waterpipe smoking was associated with a higher risk of cigarette smoking initiation compared to never smokers ($P < 0.001$) and this association was dose dependent ($P < 0.001$). Predictors of cigarette smoking progression were peer smoking and attending public schools for boys, siblings' smoking for girls, and the urge to smoke for both genders. Predictors of waterpipe smoking progression were enrollment in public schools, frequent physical activity, and low refusal self-efficacy for boys, ever smoking cigarettes, friends' and siblings' waterpipe smoking for girls. Awareness of harms of waterpipe among boys and seeing warning labels on the tobacco packs by girls were protective against waterpipe smoking progression.

In Conclusion, waterpipe can serve as a gateway to cigarette smoking initiation among adolescents. Waterpipe and cigarette smoking progressions among initiators were solely family-related among girls, and mainly peer-related among boys. The unique gender differences for both cigarette and waterpipe smoking among Jordanian adolescents in Irbid call for cultural and gender-specific smoking prevention interventions to prevent the progression of smoking among initiators.

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ABBREVIATIONS AND ACRONYMS

ASE	Attitude–Social Influence–Self-Efficacy Theoretical Model
AHR	Adjusted Hazard Ratio
CI	Confidence Interval
EMR	Eastern Mediterranean Region
GYTS	Global Youth Tobacco Survey
HR	Hazard Ratio
ILS	Irbid Longitudinal Study of Smoking Behavior
IRBs	Institutional Review Boards
NIDA	National Institute on Drug Abuse
SD	Standard Deviation
SES	Socio-Economic Status.

INTRODUCTION

Although most tobacco control efforts focus on preventing the initiation of cigarette smoking, 80,000 to 100,000 adolescents worldwide begin smoking every day, and almost half of them become regular smokers (World Health Organization [WHO], 2002). In the Eastern Mediterranean Region [EMR], the percentage of adolescents who smoke cigarettes is increasing. Findings from the global youth tobacco survey [GYTS] show that 2% of girls and 7% of boys in the EMR are current cigarette smokers (Warren *et al*, 2008).

Waterpipe is the other form of tobacco that is commonly smoked by youth in the EMR. Currently, the prevalence of waterpipe smoking among youth exceeds that of cigarettes in many of the EMR countries. Findings from the GYTS, that involved more than 90,000 Arab children (13-15 years old), indicated that waterpipe smoking surpassed cigarette smoking among youth (El-Awa *et al*, 2010; Warren *et al*, 2006). Jordan for instance, is one of the EMR countries that has higher prevalence of waterpipe smoking compared to cigarettes. Recent findings among our research cohort showed 30% of students ever having smoked waterpipe while 14% were current waterpipe smokers, and 14.8% of students had ever smoked cigarettes while 5.7% were current cigarette smokers. Similar patterns were observed for both males and females (Mzayek *et al*, 2011). These findings call for programs to prevent smoking among youth in Jordan with specific emphasis on waterpipe as a newly emerging method of tobacco use.

Generally, a waterpipe consists of a head, body, water bowl and hose with a mouth piece (Maziak *et al*, 2004). The mechanism of waterpipe smoking requires smoke to pass through water (erroneously believed as filtered). Hence, waterpipe smoking is widely believed as less harmful, less addictive (Eissenberg *et al*, 2008; Maziak *et al*, 2005; Smith-Simone *et al*, 2008), and can be a safer alternative to cigarette smoking (Kandela, 2000; Smith-Simone *et al*, 2008; Varsano *et al*, 2003). However, available evidence suggests that waterpipe smoking is associated with many deleterious health effects such as lung cancer, respiratory illness, low birth weight and

periodontal disease (Akl *et al*, 2010). Moreover, there is strong evidence that waterpipe smoking is associated with nicotine dependence including abstinence-induced withdrawal and craving symptoms that are relieved by subsequent waterpipe smoking (Cobb *et al*, 2011).

Recently, several researchers have suggested that waterpipe smoking is addictive and can serve as a gateway to cigarette use (Fielder *et al*, 2013; Kheirallah *et al*, 2014; Jensen *et al*, 2010; Mzayek *et al*, 2012). This potential 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 such as “nicotine” accumulated, the waterpipe-cigarette gateway concept was developed further to suggest a possible pathway for such transition (Maziak, 2008, 2011, 2014).

Compared to cigarettes, waterpipe smoking is a stationary, time-consuming practice, and is not readily accessible. These features led Maziak to suggest that those who become nicotine addicted through waterpipe use will likely resort to the more accessible cigarettes to deal with their smoking urges (Maziak, 2011). Accordingly, the balance between dependence and access will be a major predictor of the transition from waterpipe to cigarettes (Maziak, 2011, 2014). This study investigates the gateway potential of waterpipe smoking using longitudinal study design that is guided by a theoretical framework of behavioral change - Attitudes, Social Influences and Self-Efficacy (De Vries *et al*, 2003) as well as evidence about waterpipe use patterns and determinants (McKelvey *et al*, 2014; Mzayek *et al*, 2011). Accordingly, the first aim of this research was to compare the risk of later cigarette smoking initiation between waterpipe-only smokers and never smokers among school children in Irbid, Jordan.

Beyond the initiation and experimentation stages of tobacco use, studying cigarette smoking trajectories showed that 75% of experimenters will not continue smoking later in their life (Karp *et al*, 2005; Mayhew *et al*, 2000). Such information is not yet available for waterpipe. Accordingly, it is important to know the percentage of waterpipe experimenters who will

continue to smoke waterpipe as well. Additionally, understanding the factors that distinguish adolescents who progress in tobacco use beyond the experimentation stage is crucial for early intervention before the development of addiction.

Understanding the determinants of waterpipe and cigarette smoking progression among youth within the social context of the EMR is important to design specific tobacco control interventions. Local evidence from cross-sectional studies among adults and youth can be valuable for establishing cigarette and waterpipe smoking prevalence (Al-Haddad *et al*, 2003; Maurice *et al*, 2005; Narayan *et al*, 1996), but not to distinguish tobacco experimenters who progress in smoking from those who do not. Evidence from developed countries elucidates the strength of longitudinal study designs in gaining valuable information about determinants of cigarette smoking progression (Kim *et al*, 2009; O'Loughlin *et al*, 2009). Such research has identified a number of individual (intra-personal) and social (familial and non-familial) predictors of cigarette smoking progression among youth (Mayhew *et al*, 2005; Turner *et al*, 2004). Since these factors are likely to be context-dependent (Asfar *et al*, 2005; Islam and Johnson 2005), research about population-specific determinants of smoking progression is needed to inform tobacco control interventions among youth. Additionally, findings from those studies may not be applicable to waterpipe use, which is associated with potentially unique social use patterns, cues, perceptions of harm, and societal/familial tolerance particularly for girls (Maziak *et al*, 2005). In summary, the EMR does not have the data necessary for understanding the determinants of cigarette and waterpipe smoking progression that can guide prevention efforts among youth. Consequently, to cover this gap in knowledge, the second and third aims of this research were to identify the temporal and gender-specific individual and social predictors of cigarette and waterpipe smoking progression respectively, among a school-based sample of adolescents in Irbid, Jordan.

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MANUSCRIPT 1

Waterpipe as a Gateway to Cigarette Smoking Initiation among Adolescents in Irbid, Jordan: A Longitudinal Study

Abstract

BACKGROUND: Based on anecdotal evidence, waterpipe may provide gateway to cigarette smoking onset among youth. This hypothesis is yet to be examined using appropriate study design and a theoretical model of behavioral change. **AIM:** To compare the risk of cigarette smoking initiation for waterpipe-only and never-smokers among a school-based sample of adolescents from Irbid, Jordan. **METHODS:** A total of 1454 cigarette naive participants were drawn from the Irbid longitudinal study of smoking behavior out of 1781 seventh-graders who were enrolled at baseline (2008) and completed the study questionnaire of smoking behavior annually through 2011. Grouped-time survival analysis was used to compare the risk of a subsequent initiation of cigarette smoking between waterpipe smokers (n=298) and never smokers (n=1156) using Adjusted Hazard Ratio [AHR] and 95% Confidence Interval [95%CI]. **RESULTS:** Risk of cigarette initiation among waterpipe smokers was significantly higher than 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. As frequency of waterpipe smoking increased, the probability of cigarette initiation increased (*P for linear trend* < 0.001). **CONCLUSIONS:** Waterpipe smoking temporally predicted cigarette initiation among this cohort of Jordanian adolescents and this effect was dose-dependent. **KEYWORDS:** Adolescents, cigarette, initiation, longitudinal, waterpipe.

Introduction

Waterpipe smoking is popular among adolescents in the EMR (Akl, *et al*, 2011; Martinasek *et al*, 2011). Evidence from many countries in the region shows waterpipe smoking is the most common tobacco use method among youth (Akl, *et al*, 2011; Martinasek *et al*, 2011, Maziak *et al*, 2014) The most recent GYTS found that 11.5% of adolescents in Jordan were current cigarette smokers compared to 20.7% current waterpipe smokers (CDC, 2009). The uptake appears to be across both sexes, where 27.1% of boys and 15.6% of girls reported waterpipe smoking in Jordan (CDC, 2009).

Waterpipe smoking is widely believed to be less harmful, less addictive, and generally safer than cigarette smoking (Akl *et al*, 2013). Because of the recentness of the waterpipe epidemic, evidence of long term major health effects of waterpipe smoking such as cancer and cardiovascular disease are still scarce (Maziak, 2010). Available evidence however shows that waterpipe smoking is associated with exposure to main carcinogenic and cardiovascular toxic substances known to be present in cigarettes (Maziak, 2013). For example, our team has shown recently that waterpipe smokers are exposed to tobacco-specific nitrosamines comparable to cigarette smokers (Al Ali *et al*, 2013). Moreover, there is strong evidence that waterpipe smoking is associated with nicotine dependence including abstinence-induced withdrawal and craving symptoms that are relieved by subsequent waterpipe smoking (Cobb *et al*, 2011).

Recently, several researchers have suggested that waterpipe smoking can serve as a gateway to cigarette use (Fielder *et al*, 2013; Jensen *et al*, 2010; Kheirallah *et al*, 2014; Mzayek *et al*, 2012). This potential 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” accumulated, the waterpipe-cigarette gateway

concept was developed further to suggest a possible pathway for such transition (Maziak, 2008, 2011, 2014).

Compared to cigarettes, waterpipe smoking is a stationary, time-consuming practice, and is not readily accessible. These features led Maziak to suggest that those who become nicotine addicted through waterpipe use will likely resort to the more accessible cigarettes to deal with their smoking urges (Maziak, 2011). Accordingly, the balance between dependence and access will be a major predictor of the transition from waterpipe to cigarettes (Maziak, 2011, 2014). On the other hand, the move from “harm-reduced” tobacco product, such as the waterpipe or e-cigarettes to harmful cigarettes represents a unique transition, characterized by the gateway hypothesis, beyond the commonalities underlying experimentation with different addictive substances known among youth (Dutra & Glantz, 2014; Kandel & Kandel, 2014). This study investigates the gateway potential of waterpipe smoking using longitudinal study design guided by a theoretical framework of behavioral change -Attitudes, Social Influences and Self-Efficacy Model-(De Vries *et al*, 2003), as well as evidence about waterpipe use patterns and determinants (McKelvey *et al*, 2014; Mzayek *et al*, 2011). Accordingly, we compare in this study the risk of later cigarette smoking initiation between waterpipe-only smokers and never smokers among school children (mean age: 12.6 years at baseline) in Irbid, Jordan, and look for dose-related gradient of such risk based on a frequency of waterpipe use as a proxy measure of nicotine dependence (Salameh *et al*, 2008).

Methods

Study participants

This study used data from Irbid Longitudinal Study of Smoking behavior (ILSS), a school-based study of adolescents that collected data in four waves between 2008 and 2011 in Irbid city (population ≈300,000), Jordan. A detailed description of the study methods are reported elsewhere (Mzayek *et al*, 2011). Briefly, Irbid’s schools (60 schools) were stratified by gender

(boys, girls, and mixed gender schools), and type (public and private). A random sample of 19 schools was selected with probability proportionate-to-size. A total of 1,781 7th graders (participation rate = 95%) returned their assent and parental consent. All students who reported ever-smoking cigarettes at baseline (n=327) were excluded from the analysis (Kozlowski & Harford, 1976). The final sample included 1,454 participants (1,156 never smokers and 298 waterpipe only smokers).

Procedures

Smoking behaviors were assessed using a pilot-tested questionnaire (Appendix 1) developed in accordance with the WHO international guidelines (WHO, 1998), and several instruments that were validated in Arabic, such as the GYTS (GYTS, 2002). The questionnaire was composed of four modules: socio-demographics, cigarette smoking, waterpipe smoking and social factors that have shown to influence smoking. The students completed the questionnaire annually (four waves including the baseline) in their classrooms with guidance from a study assistant. Parents or school personnel were not allowed to attend the data collection session to ensure the validity of responses. This study was approved by the Institutional Review Boards (IRBs) of Jordan University for Science and Technology, University of Memphis, Syrian Society against Cancer and Florida International University.

Measures

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 experimented with cigarettes.

The main predictor of interest is ‘waterpipe-only versus 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? (didn't 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 was measured by asking “would you accept a cigarette if offered by a friend. Intention to smoke cigarettes in the following year was measured by asking “Do you think that you may start to smoke cigarettes in the next year?” (Please, see Appendix 2, Table 1 for details about the other covariates and how they were measured and coded).

Statistical analysis

The baseline socio-demographic, individual and social factors were compared between the study groups (ever-versus never-smoked waterpipe) using Pearson chi-square analysis for difference in proportions and t-test for continuous measures. The hazards of initiating cigarette smoking were compared between waterpipe- and never-smokers using dichotomous multivariate grouped-time survival analyses (Allison, 1995; D'Agostino *et al*, 1990; Hedeker *et al*, 2000; Singer & Willet, 1993), by including all covariates simultaneously in a single model. Grouped-time survival analysis is a combination of grouped-Cox model (D'Agostino *et al*, 1990), discrete time-hazard model (Singer & Willet, 1993), and the dichotomous approach (Hedeker *et al*, 2000). We used items measured from wave 1 through wave 4 for time-varying predictors, linking predictors to the risk of waterpipe smoking progression at the subsequent interview (e.g., wave 2 measures were used to predict smoking progression at wave 3). “Proc Phreg” commands were used in SAS with shared frailty model considering school as a random variable to account for the unobserved heterogeneity among the schools (Hedeker *et al*, 2000). This analysis allowed for maximum data use, inclusion of the time-dependent covariates, and relaxing of the proportional hazards assumption. Finally, the probabilities of cigarette initiation were averaged and plotted against the frequency of waterpipe smoking (never, ever but not currently, once weekly, more than once weekly including daily) that was reported in the previous time point. Trend analysis

was performed to examine the type and significance of this relationship. Because schools were selected using a cluster-stratified sampling design, all proportions were weighted by school. Calculation of study weights was previously reported by the baseline study (Mzayek *et al*, 2011). Significance level was set to $P < 0.05$ and all analyses were conducted using statistical analysis software SAS V. 9.3 (SAS Institute Inc., NC; USA).

Results

Descriptive results

Baseline prevalence of waterpipe-only smoking was 17% among the 1,781 study participants. Incidence of waterpipe and cigarette smoking at year one was 7.5% and 7.7% respectively. The current analysis was restricted to 1,454 participants who reported never having smoked cigarettes at baseline (mean age: 12.57 [standard deviation: \pm SD: 0.61]; 45.3% males). Of these, 1,156 were never-smokers and 298 were waterpipe-only smokers, and these were the groups studied in terms of future risk of cigarette initiation. Table 1 compares the distribution of the 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 cigarettes was significantly higher among the waterpipe-only smokers group compared with never smokers. The highest effect of waterpipe smoking on initiation of cigarette was observed in the second year of follow-up (AHR: 1.70 [CI: 1.83-2.44]; $P < 0.004$) (details in Table 2).

Multivariate grouped-time survival analysis

Findings from the unadjusted model showed that waterpipe-only smokers were twice as likely as never-smokers to initiate smoking cigarettes during the three 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. Smoking waterpipe was among the strongest predictors of cigarette initiation during the subsequent 12 months (AHR: 1.66 [95% CI: 1.33-2.08]; $P < 0.001$). The other independent predictors of cigarette initiation included parents and friends smoking, low refusal self-efficacy, and intention to smoke cigarettes in the next year (Table 3).

The hazard probability specifies the cumulative risk of initiating cigarettes during the 3-year follow-up period for the waterpipe and never-smokers in order to assess the probability that a randomly selected adolescent will initiate cigarettes during the 3-year study period. Figure 1 illustrates the results of the analysis and shows that at any time point, the probability of initiating cigarettes for waterpipe-smokers was almost double that for never-smokers (0.14 v/s 0.08; $P < 0.001$).

Transition analysis

All never smoking study participants at baseline were followed to year one to find the incidence of waterpipe initiation. Students who initiated waterpipe were compared with those who maintained their status as never-smokers from the baseline to year two for initiation of cigarettes. The 12-month hazard of initiating cigarette smoking at year two was higher among never-smokers who progressed to waterpipe at year one compared with never-smokers who didn't 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 initiation among different gradients of waterpipe smoking frequency, there was a dose-response relationship between the reported number of waterpipe use and the 12-month probability of initiating cigarettes (Figure 2). As the frequency of waterpipe smoking increased, the probability of cigarette initiation increased (*P for linear trend* < 0.001).

Discussion

This study provides a strong support of waterpipe's potential as a gateway to cigarette initiation among youth. The longitudinal salience of waterpipe smoking as a predictor of future initiation of cigarette and the dose-response gradient of this relationship lend support to our conceptual framework based on the balance between dependence and access driving such a transition. Accordingly, given waterpipe's limited access and portability, the more nicotine/tobacco dependent the youth are (measured by frequency of use), the more likely they will resort to cigarettes to deal with their smoking urges in a timely manner. While other explanations remain possible for our data, such results suggest that waterpipe can be a risk for future cigarette up-take among youth in other societies, and emphasize the need to study such relations 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 an addictive behavior. For example, we have shown that waterpipe smoking delivers nicotine efficiently to the smoker (Maziak *et al*, 2011), and that waterpipe smoking is associated with classical signs of tobacco/nicotine dependence such as craving, and withdrawal (Maziak *et al*, 2009)

Furthermore, we have shown that perceived dependence among waterpipe smokers is proportionate to their frequency of waterpipe smoking (Asfar *et al*, 2005). Another line of inquiry by our team was to characterize patterns of use and determinants among waterpipe smokers. This research showed that unlike cigarette smokers, waterpipe smokers were expressing intermittent use patterns, most likely due to the less access/availability of waterpipe compared to cigarettes (Maziak *et al*, 2011). Consequently, this has led us to hypothesize that youth who start their tobacco use with the waterpipe and become addicted on nicotine, are more likely to switch to the more accessible/portable cigarettes to deal with their dependence symptoms (Maziak *et al*, 2011). On the other hand, since most waterpipe smokers perceive it as less harmful compared to

cigarettes, the gateway hypothesis provide a suitable framework to study transition from waterpipe to cigarettes (Kandel & Kandel, 2014). Such potential also applies to the emerging e-cigarettes as a new means of creating a new generation of persons addicted to nicotine (Dutra & Glantz, 2014; Kandel & Kandel, 2014). Analysis presented in this paper supports waterpipe's potential as a gateway to cigarettes, and suggests a role for the balance between dependence and access in governing this relationship. However, we understand the suggestive nature of our results since epidemiologic studies can establish the sequence of use of different substances and measure their associations, but cannot determine what causes the progression from one drug to the other without more direct measures of dependence and deeper exploration of the suggested pathways (Kandel & Kandel, 2014).

Outside of our own work, the association between waterpipe and cigarette smoking has been supported by anecdotal observations. For instance, Jensen *et al.* (2010) reported that intermittent cigarette smokers who smoked waterpipe were more likely to become regular cigarette smokers compared to their non-waterpipe smoking counterparts (Jensen *et al.*, 2010). Another study found cigarette smoking at age 20-21 was higher among students who smoked waterpipe during high school (Hampson *et al.*, 2013). Most of these studies however, were cross sectional or not designed to investigate the gateway hypothesis, as they looked at waterpipe smoking as one of many factors influencing the risk of cigarette initiation and without a conceptual framework of possible mechanism of transition from waterpipe to cigarettes.

The strength of the study includes the longitudinal, hypothesis driven design and analysis. However, the study has few limitations. First, our findings may not be generalizable to adolescents in other countries that have different social and contextual factors governing youth tobacco use behavior. However, our underlying conceptual framework based on dependence and access is expected to have some universal application, and thus can guide further research about waterpipe's gateway potential to cigarettes in other societies. Second, all measures were self-

reported, which could have resulted in underreporting of smoking, especially among girls because of social undesirability of girls' smoking in the EMR. We do not think that the extent of this limitation is considerable, as our team has years of experience working in similar cultures and applying extensive confidentiality measures to ensure that youth can freely express their opinion (Maziak & Mzayek, 2000). Third, our data did not include direct measures of nicotine dependence, so we had to rely on frequency of use as a proxy for waterpipe dependence in order to assess the dose-response relationship between dependence and future cigarette initiation. However, studies that used specific scales to measure waterpipe dependence among university students in the EMR showed strong correlation between dependence and the frequency of waterpipe use (Salameh *et al*, 2008). So, while other explanations of our results such as the known clustering of health risk behaviors among youth remain valid (DuRant, 1999), the demonstrated dose response relationship is consistent with our guiding framework of the balance between dependence and access being an important factor influencing cigarette initiation.

Conclusions

This study provides strong evidence for a relationship between waterpipe and cigarette smoking among adolescence in Jordan. It shows that waterpipe use can be a gateway to cigarette initiation among never-smoking adolescents. Further studies investigating such potential in other cultures with the application of more direct measures of dependence are warranted.

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Tables and figures

Table 1. Difference in proportions of potential confounders between cigarette (Cig) naive waterpipe smokers and never smokers at baseline from a school-based sample of adolescents in Irbid Jordan 2008-2011^a

Baseline characteristics	All study participants (N=1454) %	Waterpipe smokers (N=298) %	Never smokers (N=1156) %	P-value
Socio-demographic factors				
Age in years (Mean ±SD)	(12.73 ± 0.61)	(12.76±0.59)	(12.66±0.60)	0.015
Male	45.30	56.40	42.20	< 0.001
Daily pocket money > 50 Piaster ^b	21.00	29.00	18.80	< 0.001
Mother education < high school	19.30	20.60	18.90	0.236
Father education < high school	18.00	18.40	17.90	0.773
Social factors				
Good relation with parents	97.20	95.00	97.80	< 0.001
Good relation with siblings	96.90	94.00	97.80	< 0.001
Good relation with classmates	96.10	95.60	96.3	0.299
Good relation with teachers	94.50	91.40	95.40	< 0.001
Parents smoking cig.	49.50	53.10	48.50	0.014
Having friends smoking cig.	17.10	28.80	13.80	< 0.001
Siblings smoking cig.	15.70	26.20	12.70	< 0.001
Personal factors				
Cig. smoking affect health	93.60	93.60	93.70	0.886
Cigarette smoking decrease weight	57.60	52.20	59.00	< 0.001
Easy to quit cig. after a year	35.90	29.10	30.00	0.586
Cig. smoking is attractive	33.20	36.50	32.30	0.015
Cig. smokers have more friends	22.50	28.60	20.70	< 0.001
Tendency to smoke cig. next year	7.70	10.70	6.90	< 0.001
Tendency to accept cig. From friends	3.50	6.80	2.60	< 0.001
Factors related to smoking policies				
Saw actors smoking in the media	87.10	85.30	87.60	0.066
Saw warning label on cig. pack	87.40	90.30	86.60	0.002
Saw advertisements promote cig.	54.60	49.50	44.30	0.005
Saw teachers smoke cig.	30.00	36.20	28.30	< 0.001
Saw advertisements warn from cig.	79.69	74.10	81.30	< 0.001

^a Proportions reported were weighted by the inverse probability of school chosen

^b \$1=70 Jordanian Piaster.

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 cigarettes N (%)	Censored in the interval N (%)^a	Not progressed to cigarettes N (%)	Progressed to waterpipe N^b	AHR (95% CI)^c	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)			

^a Participants lost to follow-up or their information about “event” is missing.

^b Will be subtracted from never smokers and added to waterpipe smokers in the subsequent interval

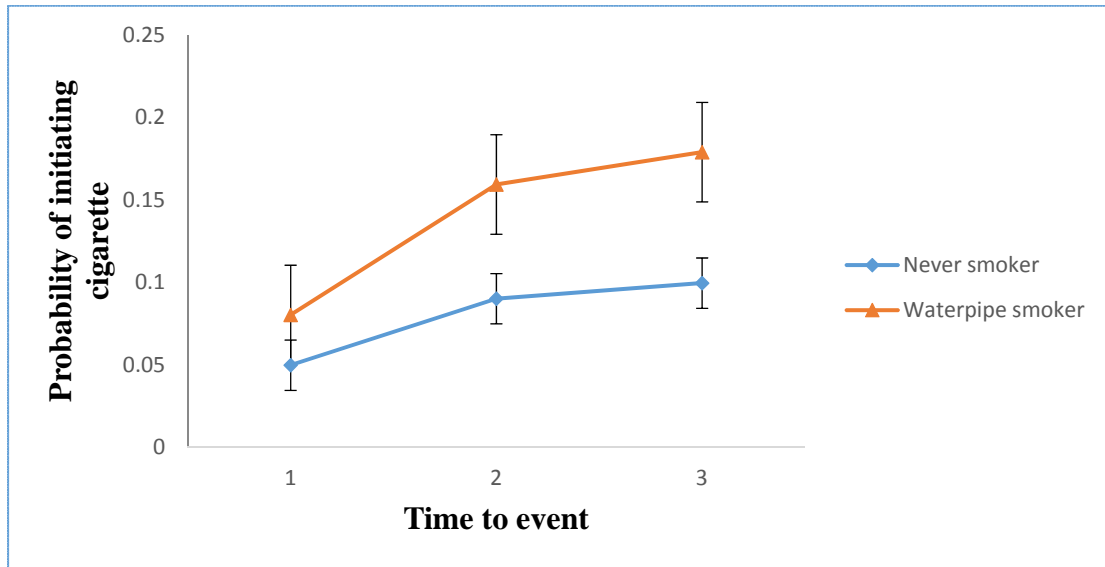
^c Interval-specific Adjusted Hazard Ratio and its 95% Confidence Interval.

Table 3. Adjusted risk of cigarette smoking initiation for waterpipe smoking and other potential confounders in a school-based sample of adolescents in Irbid Jordan, 2008-2011 (N=1454)

Parameter	Adjusted Hazard Ratio [AHR]	95% Confidence Interval [95% CI]	P-value
Waterpipe versus never smokers	1.66	(1.33, 2.08)	< 0.001
Socio-demographic factors			
Age (years)	0.95	(0.85, 1.05)	0.296
Males compared to females	1.37	(0.90, 2.09)	0.137
Father education less than high school	1.13	(0.86, 1.47)	0.383
Mother education less than high school	1.09	(0.84, 1.43)	0.506
Daily pocket money > 50 Piaster ^a	0.94	(0.73, 1.21)	0.632
Social factors			
Having friends smoking cigarettes	1.42	(1.12, 1.80)	0.004
Any of parents smoking cigarettes	1.35	(1.10, 1.65)	0.005
Any of siblings smoking 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 (refusal self-efficacy)	1.79	(1.24, 2.57)	0.002
Intention to smoke cigarette next year	1.30	(0.93, 1.82)	0.125
Belief cigarettes decreases body weight	0.98	(0.80, 1.21)	0.842
Belief cigarette smoking is attractive	0.95	(0.75, 1.19)	0.632
Belief cigarette smoking increases number of friends	1.09	(0.86, 1.39)	0.483
Belief cigarettes is harmful for health	1.02	(0.67, 1.55)	0.913
Belief it is easy to quit cigarettes after smoking 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 promote cigarettes	1.05	(0.86, 1.29)	0.615
Have seen advertisements warn from cigarettes	1.14	(0.88, 1.48)	0.314
Warning labels were seen on cigarettes packs	1.02	(0.72, 1.43)	0.930
Actors seen smoking in the media	1.05	(0.76, 1.45)	0.783

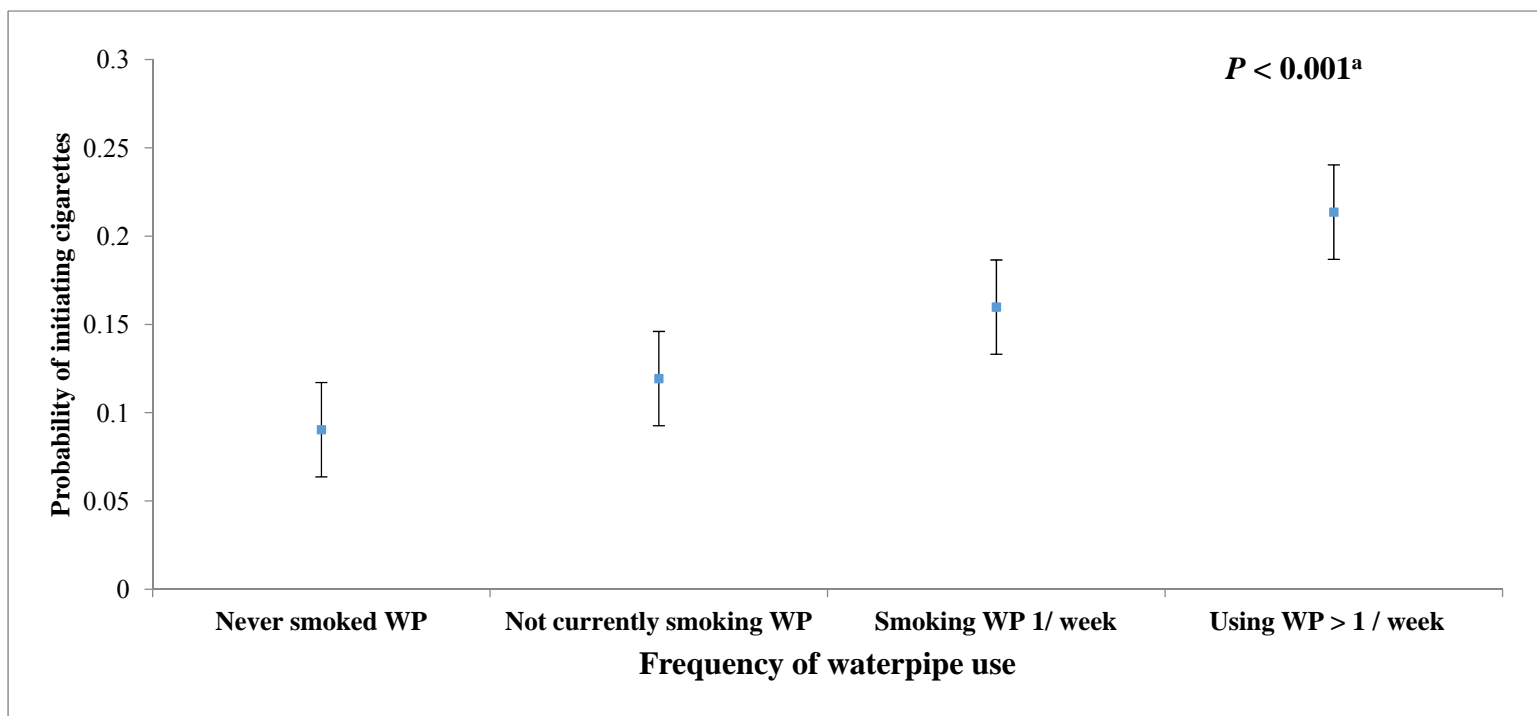
^a \$1=70 Jordanian Piaster

Figure 1. Adjusted^a probabilities of initiating cigarette smoking for waterpipe-only smokers compared with never smokers among a school-based sample of adolescents in Irbid, Jordan, from 2008 through 2011. (N =1454).



^aProbabilities were obtained from the adjusted grouped-time survival analysis. Modeling included gender, age, pocket money, parents' education, parents, sibling, friends, teacher smoking cigarettes, relation with parents, siblings, teachers, and classmates, intention to smoke, refusal self-efficacy, beliefs (cigarette smoker has more friends, cigarette smoking is more attractive, cigarette smoking decrease weight, cigarette smoking harms health, easy to quit cigarette after smoking a year), tendency to smoke next year, and whether the student noticed advertisements promoting or warning from cigarettes or actor smoking in the media, and warning label on the pack of cigarettes.

Figure 2. The 12-month average predicted probabilities of initiating cigarette smoking as a function of previous year frequency of waterpipe (WP) smoking among a school-based sample of adolescents in Irbid, Jordan, 2008-2011. (N = 1454).



Note: Adjusted for gender, age, pocket money, parents' education, parents' sibling, friends, teacher smoking cigarettes, relation with parents, siblings, teachers, and classmates, intention to smoke, refusal self-efficacy, beliefs (cigarette smoker has more friends, cigarette smoking is more attractive, cigarette smoking decrease weight, cigarette smoking harms health, easy to quit cigarette after smoking a year), tendency to smoke next year, and whether the student noticed advertisements promoting or warning from cigarettes or actor smoking in the media, and warning label on the pack of cigarettes.

^aBased on dose response linear trend analysis.

MANUSCRIPT 2

Predictors of Cigarette Smoking Progression among a School-Based Sample of Adolescents in Irbid, Jordan: A Longitudinal Study (2008-2011)

Abstract

BACKGROUND: Little evidence regarding longitudinal predictors of cigarette smoking progression is available from developing countries. **AIM:** To identify gender-specific individual and social predictors of cigarette smoking progression among a school-based sample of adolescents in Irbid, Jordan. **METHODS:** A total of 1,781 seventh graders (participation rate 95%) completed an annual self-administered questionnaire from 2008 through 2011. Students who reported ‘ever-smoking a cigarette’ at baseline or in the subsequent follow-up but were not ‘heavy daily smokers’ (>10 cigarettes per day) were eligible to be included in this analysis (N=669). Grouped-time survival analyses were used to identify predictors of cigarette smoking progression in both genders. **RESULTS:** During the three years of follow-up, 38.3% of students have increased the frequency and /or amount of cigarettes that they smoke. The independent predictors of cigarette smoking progression were friends’ smoking and attending public schools in boys, siblings’ smoking in girls, and the urge to smoke in the morning for both genders. Discussing the dangers of smoking with family members was protective for girls. **CONCLUSIONS:** Both genders progressed similarly in cigarette smoking once they initiated the habit. The progression was solely family-related among girls, and mainly peer-related among boys. **KEYWORDS:** Adolescents, cigarettes, Jordan, longitudinal, predictors, progression.

Introduction

Although, most tobacco control efforts focus on preventing initiation of cigarette smoking, there are 80,000 to 100,000 adolescents worldwide begin smoking every day, and almost half of them become regular smokers (WHO, 2002). In the Eastern Mediterranean Region (EMR), the percentage of adolescents who smoke cigarettes is increasing. Findings from the global youth tobacco survey (GYTS) show that 2% of girls and 7% of boys in the EMR are current cigarette smokers (Warren *et al*, 2007) Jordan, an EMR country, has a high prevalence of current cigarette smoking at 17.4% and 6.6% for boys and girls respectively (WHO, 2008).

Smoking behavior among adolescents can be characterized into several developmental stages including: pre-contemplation, contemplation, trial or initiation, experimentation, regular smoking, and nicotine addiction or daily smoking (Mayhew *et al*, 2000). The majority of adolescents who smoke daily will continue to smoke later in their life (Chassin *et al*, 1990). However, not all adolescents who initiate cigarette smoking become daily smokers (Costello *et al*, 2008; Karp *et al*, 2005). It is important therefore to understand the factors that are associated with progression of smoking from early experimentation to regular smoking. Such knowledge will help inform interventions that aim to prevent nicotine addiction and the adverse health consequences of lifetime tobacco use. Smoking progression differs by gender. For example, female adolescents (12-17 years old) have been shown to be at higher risk of addiction to nicotine once they start smoking, compared to boys (Difranza *et al*, 2002; Thorner *et al*, 2007). Additionally, since cigarette smoking is generally a socially unacceptable habit for girls in the EMR (Maziak *et al*, 2004; Maziak *et al*, 2013), gender roles may influence cigarette smoking progression differentially by gender (Maziak *et al*, 2004).

Evidence from developed countries showed the strength of the longitudinal study designs in gaining valuable information about determinants of cigarette smoking progression (Kim *et al*,

2009; O'Loughlin *et al*, 2009) Such research has resulted in identification of a number of individual (intra-personal) and social (family and non-family) predictors (Mayhew *et al*, 2000; Turner *et al*, 2004). As these factors are likely to be context-dependent (Asfar *et al*, 2005, Islam *et al*, 2005) evidence about population-specific determinants of smoking progression is needed to inform tobacco control interventions among youth. This study aims to identify the individual as well as the contextual predictors of cigarette smoking progression among adolescents in Jordan using a longitudinal study design.

Methods

Study participants

This study used data from the Irbid Longitudinal Study of Smoking behavior [ILS]. Details about the study methods were previously reported by our group (Mzayek *et al*, 2011). Briefly, a total of 60 schools in Irbid, Jordan were stratified by gender (male, female, and mixed) and type of school (public or private). A total of 19 schools were randomly selected with probability proportionate to size. All 7th grade students in the selected schools were invited to participate, and 1,781 participants were enrolled at baseline (wave one) with a 95% participation rate. All the students were followed annually for three years (4 waves) from 2008 through 2011. For the purpose of this study, only students who reported ever smoking cigarettes at any point of data collection were included in the analysis. Non-smokers who reported smoking more than 10 cigarettes per day for the first time they reported ever smoking were considered progressed, and therefore were excluded from the analysis. The final sample included 669 students, of whom 90% remained in the study to the end of follow-up (see Figure 1 for details about participants' selection).

Procedures

Data were collected using a validated questionnaire that was developed using international guidelines (WHO, 1998) and instruments tested and validated in Arabic such as the Global Youth Tobacco Survey (GYTS, 2002). The questionnaire had four modules: the demographics and socio-economic status module, cigarette smoking behavior module, waterpipe smoking behavior module, and a module that included questions about smoking-related social influences and perceptions. The questionnaires were completed during class hours, and were facilitated by trained study personnel who explained the purpose of the study and answered the students' questions. To increase the data validity, no school personnel were allowed in the classroom during data collection. Parent consent and student assent were obtained before enrollment. This study was reviewed and approved by the institutional review boards (IRBs) of Jordan University for Science and Technology, University of Memphis, Syrian Society against Cancer, and Florida International University.

Measures

The outcome was "progression of cigarette smoking." Progression was defined as the escalation in the frequency and/or count of cigarettes smoked between any time point of data collection and the subsequent ones. The smoking status categories were defined as: ever smoked but not currently smoking = 0, currently smoking (at least once during the last month) = 1, smoking once a week = 2, smoking more than once a week but not daily = 3, smoking one cigarette per day = 4, smoking daily but less than 10 cigarettes a day = 5, and smoking more than 10 cigarettes a day = 6. Any escalation in cigarette smoking from '0' through '6' during the subsequent follow-up was considered "progression" and given a value of '1', while "no progression" was given a value of '0'.

Potential predictors

Selection of the study variables was guided by a broad theoretical model of behavioral change "Attitude–Social influence–self-Efficacy model [ASE]." This model states that behavior results from intentions, abilities and motivational factors such as attitudes, social influences and self-efficacy that determine intentions. Abilities and environmental barriers (e.g., availability and restrictions) determine whether intentions will be realized (De Vries *et al*, 2003). This framework includes several individual and environmental factors that can be examined as potential predictors for progression of cigarette smoking among youth. Socio economic status was established using 'room density' as a proxy measure (Maziak *et al*, 2004; Maziak & Asfar, 2003). Details about the individual and social factors and the way they were measured are summarized in Table 1.

Statistical analysis

Life-table estimates (product-limit) were obtained to determine the hazard probabilities of cigarette smoking progression associated with each time interval. Dichotomous grouped-time survival analyses were conducted to examine the association between each potential predictor and the hazard of cigarette smoking progression using Hazard ratio [HR] and its 95% confidence intervals [95% CI]. In this statistical approach, survival time is represented as a set of indicators of whether or not the participant failed in each time point (until the individual experiences the event or is censored). This approach considers the timing as well as the occurrence of the first progression in cigarette smoking. It also handles censoring and allows for a discrete specification of time since our data are interval-censored. Items measured from wave 1 through wave 4 were used for time-varying predictors, linking predictors to the risk of cigarette smoking progression at the subsequent student's interview (Hedeker, 2000). Multivariate grouped-time survival analyses were performed by including all potential predictors that were associated with the outcome in the bivariate analysis at a $P \leq 0.20$ simultaneously in one model in order to protect against residual

confounding. Maldonado and Greenland suggest that potential confounders be eliminated only if $p > 0.20$ (Maldonado & Greenland, 1993). Multi co-linearity and interaction between variables were examined. All of the analyses were stratified by gender and were weighted by school weight to account for differences among schools. The detailed method of calculating school weights has been described by our group elsewhere (Mzayek *et al*, 2012). The significance level for multivariate analyses was set to $P < 0.05$. All analyses were conducted using Statistical Analysis Software SAS V. 9.3 (SAS Institute Inc., NC; USA).

Results

Descriptive analysis

This study included 669 participants who reported ever smoking cigarettes at baseline or for the first time at any subsequent data collection point. There were 67% male participants. The mean (standard deviation) for ages at baseline were 12.9 (0.59) and 12.7 (0.59) for boys and girls respectively. Among all participants, 30% had progressed in cigarette smoking and 10% censored (lost to follow-up at any time point) during the whole course of the follow-up. Analysis by gender showed faster progression among girls compared to boys during the first year, where the incidence rate of cigarette smoking progression among girls was almost the double that for boys (Table 2). Although cigarette smoking progression was higher for boys (43%) compared to girls (32%), including gender as a predictor in the final model showed no significant difference in the overall risk of progression (male: female HR: 1.17; [CI: 0.89-1.52]; $P = 0.254$).

Bivariate analysis

There was an association with some measures of socioeconomic status. The 12-month risk of cigarette smoking progression among boys in public schools was twice that of those in private schools. Additionally, a one-unit increase in home density (indicating lower income) was associated with an 87% increase in risk of cigarette smoking progression among girls. Among

individual factors, *'refusal self-efficacy'*, *'feeling the urge to smoke in the morning'*, and *'ever smoking waterpipe'* were the main predictors of cigarette smoking progression for both boys and girls. Belief that *'cigarette smoking is harmful to health'* was associated with a lower risk of progression among girls. Among social factors, the highest risk of cigarette smoking progression was associated with *'friends smoking'* among boys, and *'siblings smoking'* among girls (Please see Appendix 2, Table 2 for details).

Multivariate analysis

The independent predictors among boys were *'older age'*, *'attending public schools'*, *'the urge to smoke in the morning'*, *'belief that cigarette smoking decreases body weight'*, *'belief it is easy to quit cigarettes after smoking for a year'*, and *'friends smoking'*. Among girls, the independent predictors were: *'high home density'*, *'the urge to smoke in the morning'*, and *'siblings smoking'*. On the other hand, *'belief that cigarette smoking was harmful to health'* and *'discussing the dangers of smoking with any family member'* in girls were associated with 90% and 75% reduction in risk of cigarette smoking progression respectively. *'Higher father education'* was protective in males (Figure 2).

Discussion

To the best of our knowledge, this is the first longitudinal study guided by a theoretical model of behavioral change to identify the risk and gender-specific predictors of cigarette smoking progression among adolescents in the Middle East. Among adolescents who initiate cigarettes, 38% were expected to progress in cigarette smoking within a period of 3 years. This estimate lies within the range of 30% - 50% progression rate that was reported from national studies among youth in the United States (CDC, 1998; USDHHS, 1994). Cigarette smoking progression was merely influenced by familial factors among girls and by extra-familial factors, such as schools and peers among boys. These findings increase our understanding of the social

context that delineate a specific pattern of predictors of cigarette smoking progression by gender, and identify some modifiable risk factors that may be useful in tobacco cessation programs that are targeting youth in Jordan and possibly in other EMR countries.

The present study shows an inverse association between risk of cigarette smoking progression and some socioeconomic status [SES] measures such as father's education and attending private school for boys and low income as indicated by high room density for girls, suggesting more progression among adolescents with lower socioeconomic status. These findings are consistent with those previously reported for cigarette smoking onset (Conrad *et al*, 1992).

Rather than being causal, low socioeconomic status may reflect a constellation of factors that are more directly related to smoking. Consistent with previous research findings in the EMR (Bejjani *et al*, 2012; El-Roueiheb *et al*, 2008), we found that attending public schools predicts cigarette smoking progression only in boys. This variation by school type and gender may have several contextual explanations and implications. First, public schools may not be strictly enforcing tobacco control policies that prevent smoking among their students and staff which make them more tolerant to smoking compared with private schools in Jordan. On the other hand, private schools are for-profit institutions. They attract customers (parents) by maintaining their reputation in both educational and behavioral aspects. Thus, they apply stricter rules to prevent smoking among their students and staff which make them less tolerant to smoking. Similarly, being a smoking-tolerant school was shown to be associated with a cigarette smoking onset (O'Loughlin *et al*, 2009). Our findings suggest a persistent relationship between schools' tolerance to smoking and cigarette smoking even beyond the onset stage. Secondly, teachers' smoking has been shown to influence adolescent smoking through modeling of behavior (Huang *et al*, 2014). Due to the social undesirability of cigarette smoking among girls in the EMR (Maziak *et al*, 2004; Maziak *et al*, 2013), female teachers may avoid smoking at schools and thus

they provide positive role models for their students against smoking. On the other hand, male teachers do not face the same social taboos, and smoke in front of their students, thereby affecting the student's smoking behavior. Finally, compared to parents whose children attend public schools, parents whose children attend private schools may be more concerned about the future of their children's behavior (Distefan *et al*, 1998).

Among individual factors, *'feeling the urge to smoke in the morning'* was predictive of the progression in both genders. However this factor predicted a higher risk of smoking progression among girls. These findings are not surprising. Previous evidence among adolescents showed that girls are at a higher risk of becoming nicotine dependent once they start smoking than boys (Difranza *et al*, 2002; Thorner *et al*, 2007). These findings also are consistent with our results showing that girls smoking progressed considerably faster than boys (double incidence rate) in cigarette smoking during the first year of follow-up. Tobacco control strategies could be more efficient if they are tailored to address these disparities.

The main social predictors of cigarette smoking progression in the present study were *'friends smoking'* among boys, and *'sibling smoking'* among girls. Peer smoking has been consistently reported as the most robust predictor of cigarette smoking progression among youth (Ditefan *et al*, 1998; Kim *et al*, 2009; O'Loughlin *et al*, 2009). It has been found to be associated with all smoking trajectory groups (Costello *et al*, 2008), suggesting a persistent influence of peer smoking through modeling of behavior even beyond the initiation stage (Bandura 1977, Kobus, 2003). However, our findings do not support the contribution of peer smoking to progression among girls. This may in part be due to the gender roles and the conservative nature of the Jordanian families, where outing with friends is allowed for boys, while girls mostly stay at home and help their mother (Mahdi, 2003). Furthermore, the social undesirability of cigarette smoking for women may provide fewer opportunities for girls to meet with their smoking peers and more

opportunities to progress in cigarette smoking through the influences of family members smoking (Okoli *et al*, 2013). We examined this relationship by testing the interaction between “sibling relation” and “sibling smoking” on cigarette smoking progression among girls. We found that girls who had strong social bonds with their smoking siblings were 3 times as likely to progress in cigarette smoking as those who did not (male: female AHR: 3.01; [CI: 1.82-4.99]; $P < 0.001$). These findings suggest that sibling’s behavior may lead to a progression of cigarette smoking among girls in a manner similar to friend’s smoking among boys. Given these findings, tobacco use prevention among adolescent girls should involve their smoking siblings in order to help them to quit and strengthen negative norms around cigarette smoking. Among boys, tobacco prevention efforts should target peers within their networks in order to support development of negative smoking norms. Furthermore, peers could also be a source of change i.e., positive peer pressure could contribute to encouraging the adolescents to quit their smoking habits (Maxwell, 2002).

One of our findings that may have direct implications among female adolescents is the inverse relationship between ‘discussing the dangers of cigarette smoking with family members’ and the risk of cigarette smoking progression. Since this relationship is not seen among boys, we hypothesize that progression in cigarette smoking among youth is a function of the balance between negative influences (e.g., sibling smoking for girls and peer smoking among boys) and positive influences (e.g., parental monitoring and negative beliefs about cigarette smoking) within the context of gender and roles of the specific culture. For example, more social freedom, lack of parental monitoring, and modeling peer behavior among male adolescents may outweigh the influence of family through the discussion of the dangers of cigarette smoking.

Finally, unlike developed countries, where tobacco control policies have been shown to be effective in curbing youth smoking (Wakefield *et al*, 2003), none of the policy-related factors were shown to be influential in our study except “cigarette promotion in the media” and only

among female adolescents. Although this factor was not shown to be associated with cigarette smoking progression in the bivariate analysis, it exhibited a strong association when other factors were added. It appears that all those factors played together to reflect a social construct that distinguished girls within their well-defined gender roles. In another way, female adolescents in Jordan may use media as an alternative recreational activity because they are not allowed for outings, thus they are more likely to be influenced by media advertisements. As such, female adolescents in Jordan are considered a vulnerable group that can be targeted by the tobacco industry. However tobacco control efforts can use media as well to reverse the influences of tobacco industry forces and change female adolescents' behavior, attitudes, and norms toward smoking (Davis *et al*, 2008). Additionally, banning the advertisements that promote cigarettes is a challenging issue that should be resolved using strong tobacco control policies.

This study has some limitations. First, all measures were assessed using self-reporting. Therefore, underreporting of smoking behavior may have been likely, especially among girls because of gender norms in the region. However, our previous work among adolescents in the EMR suggests that girls may share honest smoking information, if confidentiality is assured (Maziak & Mzayek, 2000). Secondly, we were unable to examine the association with other potential predictors because responses for those were missing for more than 50% of the sample (e.g., inability to buy cigarettes due to the student's age, intention to quit, and attempts to quit). Finally, our findings may not generalize to populations in other countries with different social and economic structures. Despite these limitations, this study provides strong evidence regarding the relative importance of individual and social predictors of cigarette smoking progression among adolescents in Jordan, and possibly in the EMR. Future research in the EMR should examine the social determinants of gender disparity in smoking. Qualitative studies are especially needed to enrich evidence regarding the context in which smoking progression occurs.

Conclusions

In conclusion, this study showed that nearly 32% of adolescents who initiated cigarettes have progressed during the 3-year follow-up. If no effective interventions are made to stop smoking escalation of young students, they will become adult smokers who will have difficulty quitting and responding to cessation programs. Different socially related predictors were observed for each gender. The progression of cigarette smoking was predicted by extra-family factors among males, and by intra-family factors among females. Strategies to address nicotine dependence should target families, encourage smoking cessation among siblings, and promote negative attitudes toward smoking among all adolescents, their friends, and their family members. Tobacco control efforts for boys should focus on smoking in schools and on peer-modeled smoking. For young girls, more focus on involving the whole family in tobacco control intervention may be a better approach.

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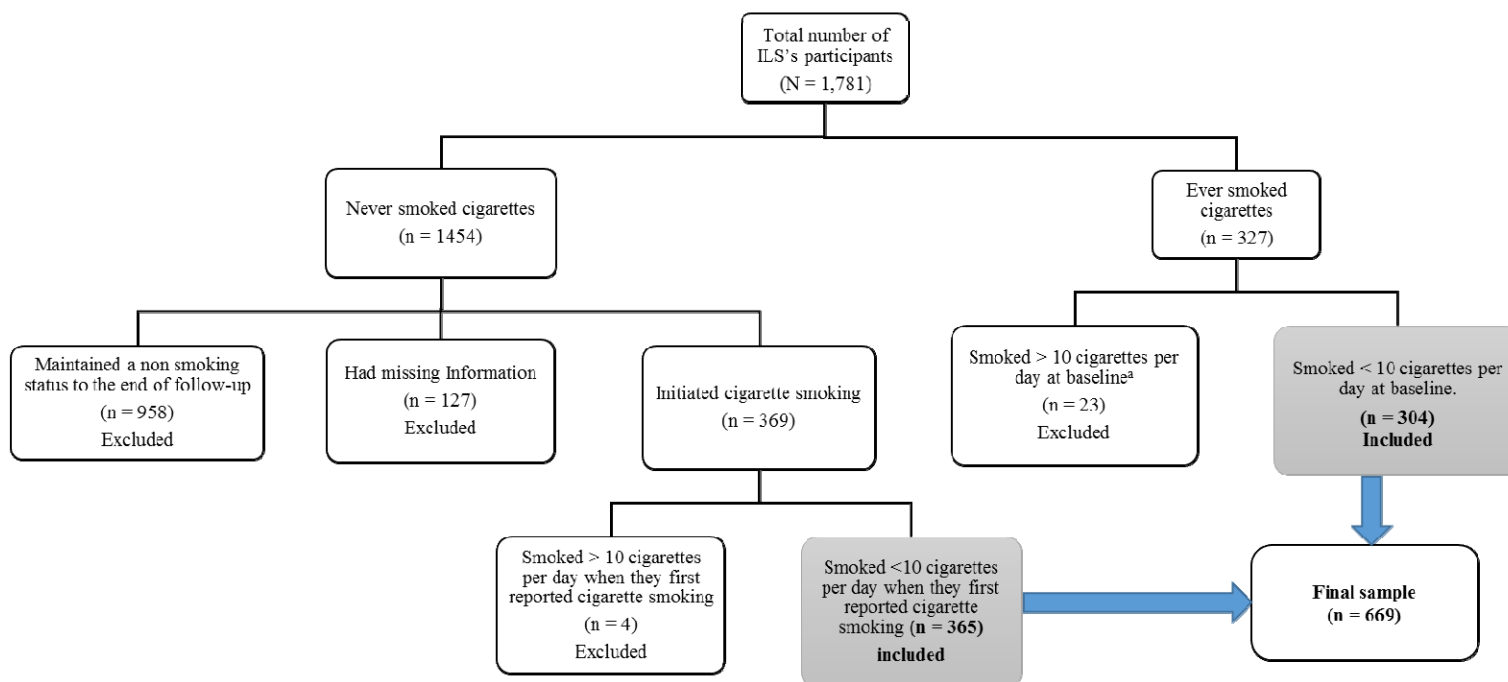
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Tables and figures

Figure1. Participants' selection from Irbid longitudinal study of smoking behavior (ILS) to examine the predictors of cigarette smoking progression among school adolescents in Jordan (2008-2011).



*Smoking > 10 cigarettes is considered the highest level of progression in this study since there is no information about the exact number of cigarettes smoked.

Table 1. Potential Individual and Social Predictors of Cigarette (Cig.) Smoking Progression and how They Were Measured in a School-Based Sample of Adolescents in Irbid, Jordan, (2008-2011).

Potential predictors	Questions and responses
Individual factors	
Ever smoking waterpipe	Did you ever smoke waterpipe, a buff or two? (0 = No, 1= Yes).
Physical activity	Do you participate in sports such as jogging, soccer, basketball, swimming, etc.? (0=No, 1=Sometimes, 2 = Often, 3 = Regular).
The urge to smoke	Do you smoke Cig or feel the urge to smoke, when you wake up in the morning? (0=No, 1=Eventually, 3=Daily).
More friend belief	Do you think that students who smoke Cig have more friends? (0= No, 1= Yes)
Attractiveness belief	Do you think that students who smoke Cig are more attractive? (0 = No, 1= Yes)
Body weight belief	Do you think smoking Cig decrease body weight? (0 = No, 1= Yes).
Harm belief	Do you think smoking Cig is harmful for health?
Easy to quit belief	Do you think it is easy to stop smoking Cig after smoking for a year or two? (0 = No, 1= Yes).
Refusal self-efficacy	If a friend offers you a Cig would you smoke it? (0 = no, 1 = Maybe, 2= Absolutely yes). The responses1 and 2 were collapse into one category as both indicate a susceptibility to smoke. ²²
Social factors	
angers discussion	Did any of your family members talk to you about the dangers of Cig smoking? (0 = No, 1= Yes)
Parents knowledge	Do your parents know that you smoke Cig? (0 = Parents don't know, 1 = Any of the parents knows, 2 = Both parents know). Responses were re-coded as binary due to inadequate cell counts.
Parents smoking	Do your parents smoke cig? (0 = None of them smoke, 1= Both smoke, 2 = Father only, 3 = Mother only).
Friends smoking	Do you have close friends who smoke Cig? (0 = No, 1= Yes)
Sibling smoking	Do your brothers or sisters smoke Cig.?, (0 = No, 1= Yes)
Social bonds	In general, how would you describe your relations with your parents/siblings/classmates/ teachers (0 = Not good, 1 = Good).
Promote smoking	In the past month, did you see ads promoting smoking in the media (e.g., TV, radio, newspapers, or movies)? (0 = No, 1 = Sometimes)
Warning from smoking	In the past month, did you see ads warning of the dangers of smoking on health in the (e.g., TV, radio, newspapers, or movies)? (0 = No, 1 = Yes).
Teacher smoking	Do your teachers smoke in front of the students? (0=No, 1=Yes)
Warning labels	In the past month, did you notice the health warnings on the Cig packs? (0 = No, 1=Sometimes).
Actor smoking	Have you seen actors/actresses smoking in the movies or on TV? (0 = No, 1= Sometimes).

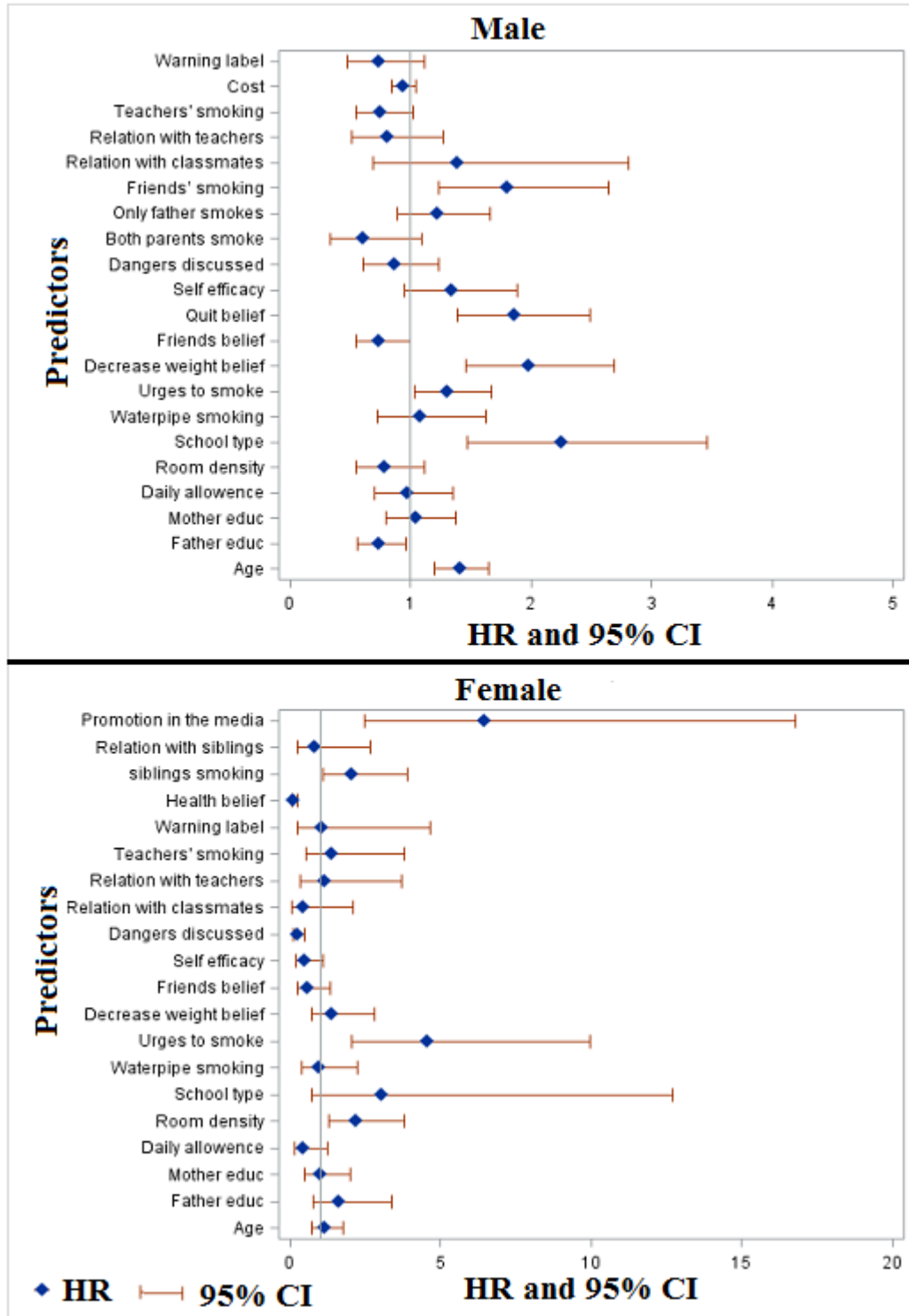
Table 2. Progression of Cigarette Smoking by Time Interval and Gender Among School-Based Sample of Adolescents in Irbid, Jordan, 2008-2011. (N=864)

Male (N= 448)						
Time Interval	Entered N	Progressed N (%)^a	Censored N (%)^a	Remained (not progress) N (%)^a	Hazard probability	Cumulative hazard probability
Baseline - Year1	237	28 (8.1)	18 (12.0)	191 (79.8)	0.08	0.08
Year1 - Year2	283 ^b	61(20.1)	4 (1.2)	218 (78.7)	0.2	0.26
Year2 - Year3	337 ^b	75 (22.7)	20 (5.4)	242 (71.9)	0.23	0.43
Female (N = 221)						
Baseline - Year1	81	12 (15.7)	5 (6.6)	64 (77.8)	0.16	0.16
Year1 - Year2	133 ^b	12 (9.0)	4 (3.7)	117 (87.3)	0.09	0.24
Year2 - Year3	188 ^b	23 (10.7)	7 (3.7)	158 (85.6)	0.11	0.32

^aAll percentages are weighted.

^bThe difference between the total number of students who didn't progress in the previous interval and the total number entered the subsequent interval is due to the initiation of cigarette smoking by participants who were never smokers. Participants entered: Year1-Year2 = (Male = 92, Female =69); Year2-Year3 (Male= 119, Female =71).

Figure 2. Adjusted gender-specific predictors of cigarette smoking progression among school-based sample of adolescents in Irbid, Jordan (2008-2011).



MANUSCRIPT 3

Predictors of waterpipe smoking progression among youth in Irbid, Jordan: A Longitudinal Study (2008-2011)

Abstract

BACKGROUND: The predictors of waterpipe smoking progression are yet to be examined using longitudinal study that is guided by a theoretical model of behavioral change. **AIM:** This study identifies the gender-specific individual and social predictors of waterpipe smoking progression among adolescents in Irbid, Jordan. **METHODS:** This study uses data from a school longitudinal study of smoking behavior in Irbid, Jordan. A random sample of 19 from 60 schools was selected by probability proportionate to size. A total of 1781 seventh graders were enrolled at baseline and completed a questionnaire annually from 2008 through 2011. Students who reported ever smoking waterpipe (N=864) at any time point were analyzed in 2014. Grouped-time survival analysis was used to identify the risk of progression. **RESULTS:** During the three years of follow-up, 40% of students have increased the frequency of waterpipe smoking. Predictors of waterpipe smoking progression were higher mother's education, enrollment in public schools, frequent physical activity and low refusal self-efficacy among boys, having ever smoked cigarettes, and having friends and siblings who smoke waterpipe among girls. Awareness of harms of waterpipe among boys and seeing warning labels on the tobacco packs by girls were protective. **CONCLUSIONS:** Predictors of waterpipe smoking are solely family-related in girls and mainly peer-related in boys.

KEY WORDS: Adolescents, Jordan, longitudinal, predictors, progression, waterpipe

Introduction

Based on the Global Youth Tobacco Survey (GYTS) that involved more than 90,000 Arab children (13-15 years old), the prevalence of waterpipe smoking surpassed that for cigarettes among youth (El-Awa *et al*, 2010; Warren *et al*, 2006). Nevertheless, most national and international tobacco control strategies are not specifically addressing this method of tobacco use (Maziak, 2011). This may be partly attributed to the dearth of evidence on specific determinants of initiation and progression of waterpipe smoking.

Evidence from studying cigarette smoking trajectories showed that 75% of experimenters will not continue smoking later in their life (Karp *et al*, 2005; Mayhew *et al*, 2000). Like cigarettes, it is necessary to know the percentage of waterpipe experimenters who will continue to smoke waterpipe. Additionally, understanding the factors that distinguish adolescents who progress in waterpipe smoking beyond the experimentation stage is crucial for early intervention before the development of addiction that is manifested by the increased frequency of waterpipe use (Salameh *et al*, 2008), or the onset of cigarette smoking (Mckelvey *et al*, 2014).

Longitudinal studies in developed nations have identified the individual and social predictors that are associated with cigarette smoking trajectories (Mayhew *et al*, 2000). However, findings from these studies may not be applicable to waterpipe smoking which has unique social use patterns, cues, perceptions of harm, and societal/family tolerance, particularly among girls (Amin *et al*, 2012; Maziak *et al*, 2005). Moreover, findings from studies among youth in developed nations may not be generalizable to youth in the EMR who have different knowledge, beliefs, and attitudes (Asfar *et al*, 2005; Islam *et al*, 2005; Maziak *et al*, 2004).

Like cigarettes, waterpipe smoking requires longitudinal studies to identify the determinants of progression among youth. This is the first longitudinal study that specifically addresses waterpipe smoking progression among youth. Guided by a broad theoretical framework

of behavioral change (Attitude, social influence, and self-efficacy model [ASE] (De Vries *et al*, 2003) the hazard of waterpipe smoking progression was compared between levels of individual and social determinants among a school-based sample of adolescents (mean age = 12.8 years old at baseline) who reported ever smoking waterpipe in Irbid, Jordan.

Methods

Study participants

This study used data from the Irbid longitudinal study of smoking behavior (ILS). Detailed methods were published elsewhere by our group (Mzayek *et al*, 2011). Briefly, 60 schools in Irbid city were stratified by gender (male, female, and mixed) and type (public and private). A random sample of 19 schools was selected with probability proportional to size. All seventh grade students at the selected schools were invited to participate in the study. A total of 1781 (94.9%) students enrolled at baseline by turning in assent and their parents' consent forms. The students were surveyed annually from 2008 through 2011 (4 data collection waves including the baseline). For the purpose of this study, all students who reported ever smoking a waterpipe from wave 1 to wave 3 were analyzed in 2014. Students who reported daily smoking the first time they report smoking (48 students), or never smoking during the study period or had missing information on their smoking progression (n=869) were excluded from the analysis. The final sample included 864 students with at least two consecutive waves.

Procedures

Data were collected using a pilot-tested questionnaire developed in accordance with international guidelines (WHO, 1998), using instruments that were tested and validated in Arabic such as the Global Youth Tobacco Survey (GYTS, 2002). The questionnaire was composed of four sections: socio-demographic status, cigarette smoking, waterpipe smoking, and other factors such as students' beliefs, exposure to tobacco advertisements.

Using the same items, the self-administered questionnaire was completed annually in the classrooms and facilitated by well-trained study personnel who explained the purpose of the study and responded to the students' questions. To improve the validity of the students' responses, no parents or school personnel were allowed in the classroom during data collection. This study was approved by the Institutional Review Boards (IRBs) of Jordan University for Science and Technology, University of Memphis, Syrian Society against Cancer, and Florida International University.

Measures

At each wave, students were asked, "How many times did you smoke waterpipe in the past month (30 days)?" The responses were as follows: 0=not at all, 1=once weekly, 2=more than once weekly but not daily, and 3=daily. The participant was coded as having progressed if he/she reported a higher frequency of waterpipe smoking compared with that reported at baseline, or from that reported for the first time among never smokers who initiated waterpipe smoking subsequently. Guided by ASE model (De Vries *et al*, 2003), we included a wide range of individual and social factors as potential predictors of waterpipe smoking progression (Figure 1).

Statistical analysis

Life tables were used to estimate the hazard probabilities of waterpipe smoking progression associated with each time interval by gender. The hazard of waterpipe smoking progression was estimated for each potential predictor using dichotomous grouped-time survival analyses (Allison, 1995; D'Agostino *et al*, 1990; Hedeker *et al*, 2000; Singer & Willet, 1993). This analysis is a combination of grouped-Cox model (D'Agostino *et al*, 1990), discrete time-hazard model (Singer & Willet, 1993), and the dichotomous approach (Hedeker *et al*, 2000). Items measured from wave 1 through wave 4 for time-varying predictors linking the predictors to the risk of waterpipe smoking progression at the subsequent student's interview (e.g., wave 2

measures were used to predict smoking progression at wave 3). This analysis allowed for maximum data use, inclusion of the time-dependent covariates, and relaxing of the proportional hazards assumption.

In the last step, multivariate grouped-time survival analyses were performed by including all potential predictors that demonstrated an association with the outcome in the bivariate analyses at a significance level < 0.20 simultaneously in a single model (Mickey & Greenland, 1989). Multi-collinearity and interaction were examined for factors that were not associated with outcome in the bivariate analyses and demonstrated association in the multivariate ones (Lo *et al*, 1995). Akaike Information Criterion [AIC] was used to test the goodness of fit. All the analyses were performed for boys and girls separately and were weighted by school to get unbiased estimates. Detailed method of calculating school weight was previously reported by our group (Mzayek *et al*, 2012). The significance level was set at $\alpha < 0.05$. All analyses were conducted using statistical analysis software SAS V. 9.3 (SAS Institute Inc., NC; USA).

Results

Descriptive findings

A total of 864 participants (57.1% boys at baseline) reported ever-smoking waterpipe during waves 1 through 3). The ages (mean \pm standard deviation) at baseline were 12.9 ± 0.63 for boys, and 12.7 ± 0.55 for girls. During the study period, 278 (29.6%) students progressed in waterpipe smoking, 504 (58.5%) did not progress, and 82 (12%) were censored (lost to follow-up) at some time point. The overall annual hazard probabilities and cumulative hazard probability for progression in waterpipe smoking are shown in Figure 2.

Results from bivariate and multivariate analyses

Findings from bivariate analysis are all summarized in Table 1. Results from multivariate analysis that included gender as an independent variable showed boys were less likely to progress

in waterpipe smoking than girls. However, this difference was not statistically significant (HR male: female 0.76 [95% CI: 0.58-1.00]; $P = 0.050$). On the other hand, multivariate analysis by gender showed different patterns of predictors. The independent predictors among boys were '*higher mother education*', '*attending public school*', '*actor smoking*', '*frequent physical activity*' and accepting offers to smoke from friends who smoke waterpipe (Table 2). Some factors were associated with waterpipe smoking progression in the multivariate analyses, but not in the bivariate analyses such as, belief that '*waterpipe smokers are attractive*', and '*waterpipe smokers have more friends*'. After conducting a series of interactions between the variables and constructing the correlation matrix for all potential predictors, beliefs that '*waterpipe smokers look attractive*', and '*waterpipe smokers have more friends*' were correlated (Spearman rho = 0.42). Hence, each variable was included separately in the multivariate analysis and the model that included '*attractiveness belief*' was selected because it had higher goodness-of-fit i.e., lower *AIC*. However, similar findings were obtained from both models.

The independent predictors of waterpipe smoking progression among girls were older age, having ever smoked cigarettes, having siblings or friends who smoke waterpipe, and having noticed warning labels on waterpipe tobacco packs (Table 3). In addition, there was a statistically significant interaction between having discussed the dangers of waterpipe smoking with family and refusal self-efficacy. This interaction was decomposed by examining the effect of discussing the dangers of waterpipe smoking with family at 2 levels of refusal self-efficacy, using a binary split (low v/s high self-efficacy). For students with lower refusal self-efficacy, having had discussed the dangers of waterpipe smoking with family did not prevent progression in waterpipe use, and in fact was associated with greater likelihood of progressing (HR: 1.43 [95% CI: 1.03 - 1.97]; $P = < 0.032$). On the other hand, for students with higher refusal self-efficacy, discussing

the dangers of waterpipe use did not influence progression (HR: 0.79 [95% CI: 0.94 -1.27]; $P = 0.329$).

Discussion

This is the first longitudinal study to examine the determinants of waterpipe smoking progression among youth in Jordan. About 40% of the students who reported ever smoking waterpipe from grade 7 through grade 9 progressed during the three years of follow-up. While there were no significant difference in the risk of waterpipe smoking progression between boys and girls, the predictors of progression were different. The independent predictors among boys were higher mother's education, attending public school, higher physical activity, and accepting offers to smoke waterpipe from friends who also smoke it. In contrast, the predictors among girls were older age, ever smoking cigarettes, peer smoking, and siblings' smoking. Additionally, belief that waterpipe smoking is harmful was protective among boys and reading the warning label on waterpipe tobacco packs was protective among girls.

Unlike cigarette smoking, which is inversely related to socioeconomic status (Conrad *et al*, 1992), waterpipe smoking was shown to be associated with higher socioeconomic status (Palamar *et al*, 2014). Although how socioeconomic factors influence waterpipe smoking behavior is still not fully understood, evidence from the EMR supports that waterpipe smoking is viewed as a fashionable, prestigious, and pleasurable social activity (Afifi *et al*, 2013) that is not harmful (Hammal *et al*, 2008). Consistent with this perspective, higher mother's education predicted waterpipe smoking progression among boys. One explanation is that within the social context of the EMR, educated mothers may grant implicit approval to their sons to smoke waterpipe, but explicit strong disapproval to smoke cigarettes. Furthermore, educated mothers who also work may provide financial support to their sons, but not daughters, to be able to afford the costly waterpipe habit in public places where waterpipe smoking is more acceptable for boys

compared to girls (Afifi *et al*, 2013; Hammal *et al*, 2008; Khalil *et al*, 2013). Developing negative norms and encouraging parental strict rules against waterpipe are highly recommended to prevent the escalation in waterpipe smoking among boys.

This study shows the importance of social and cultural norms in delineating gender differences in waterpipe smoking. For example, we found that attending public schools predicted waterpipe smoking progression in boys but was protective in girls. One possible explanation is that parents who enroll their children in private schools are more concerned about the future of their adolescents' behavior (Distefan *et al*, 1998), and therefore, apply strict rules to prevent waterpipe smoking equally to both genders (Kim *et al*, 2009). Conversely, parents who enroll their children in public schools within the EMR context are applying stricter rules on waterpipe smoking for girls than boys.

Peers' smoking and family members' smoking have been frequently reported as important predictors of adolescents' cigarette (Distefan *et al*, 1998; Kim *et al*, 2009) as well as waterpipe smoking (Amin *et al*, 2012). Based on social learning theory, adolescents copy their peers and close family members' behavior either directly by observing them, or indirectly through acquiring positive norms about the behavior. In line with this theory, waterpipe smoking progression is independently predicted by peers' and siblings' smoking among girls and by friends' smoking in boys who have low refusal self-efficacy.

One of the interesting findings of this study is that discussing the dangers of waterpipe smoking with girls who have lower refusal self-efficacy was associated with an elevated risk of waterpipe smoking progression. It appears that discussing the dangers of waterpipe smoking by a family member did not include all girls who initiated waterpipe, but was limited to the girls who accept offers to smoke from friends. As such, families may try to limit their female children from smoking in public places or with friends, which is considered unacceptable for girls compared to

boys within this social context (Afifi *et al*, 2013). Moreover, smoking by friends and siblings remained independent predictors of waterpipe smoking progression among girls suggesting less parental objection if girls smoke waterpipe at home (Afifi *et al*, 2013).

Within the prevalent gender roles in the EMR, smoking with friends appears more important for boys who have more flexible rules regarding outing with friends compared with girls (Mahdi, 2003). For example we found that the tendency to accept a waterpipe if offered by friends who also smoke a waterpipe is a strong predictor of waterpipe smoking progression among boys. These findings suggest that boys smoke a waterpipe to seek pleasure in social gathering and consider waterpipe smoking as a leisure activity (Akl *et al*, 2013). This explanation is further supported by the finding that more frequent physical activity predicts a higher progression in waterpipe smoking in boys but not in girls.

On the other hand, waterpipe smoking among girls appears to be a kind of un-conscious response to nicotine dependence rather than seeking pleasure and social gathering. For example, in the present study, girls who ever smoked cigarettes, but not boys, were at higher risk of waterpipe smoking progression than those who reported never experimenting with cigarettes. One possible explanation is that, once boys develop nicotine addiction from initial waterpipe use, given that they already experimented with cigarettes, may switch to cigarette smoking which is more convenient and can meet their needs for nicotine in a timely manner and with fewer restrictions than those imposed on girls. To examine this notion specifically among boys, further analysis was conducted among students who reported ever smoking cigarettes at any point of follow-up. The progression to current cigarette smoking in the subsequent follow-up was much higher in boys (35%) compared with girls (22.5%). Since waterpipe is more socially acceptable in the EMR than cigarette smoking, especially for (Maziak *et al*, 2004), girls may continue to smoke a waterpipe to satisfy their needs for nicotine rather than to switch to cigarette smoking.

Finally, the popularity of waterpipe smoking among adolescents, and even among adults, may be attributed to the myths associated with its use. One of these myths is that smoke passes through water (erroneously believed as filtered) and thus waterpipe smoking is less harmful and addictive than cigarette smoking (Maziak *et al*, 2005). However, waterpipe smoking is less prevalent among adolescents who perceive waterpipe smoking to be as harmful as cigarette (Alzyoud *et al*, 2013). Consistent with these studies, this study showed that the belief that ‘*waterpipe is harmful*’ was associated with a lower risk of waterpipe smoking progression among boys but not girls. This finding provides further support to the previously mentioned explanation that boys consider waterpipe an entertaining social activity that is less harmful than cigarettes, and once they know it is harmful they are likely to abandon it. On the other hand, awareness of harm that results from reading the warning label on waterpipe tobacco packs was associated with a lower risk of progression among girls. It seems whether waterpipe is perceived as harmful or not, reading labels had a protective effect among girls. This may be because girls are more likely to read warning labels and comply with them than boys, as documented in the literature (LaRue & Cohen, 1987).

Jordan adopted the Framework Convention on Tobacco Control (FCTC) in 2003. In response to the obligations that this entails, much has been done such as anti-smoking legislation and banning advertisements that promote smoking and smoking in public places (Ma’ayeh, 2003). However, these strategies have focused on cigarettes but not waterpipe. This study did not find any influence of policy-related factors except the protective effect of seeing warning label in girls. It appears that many challenges hinder the continuity of tobacco control efforts and the seriousness in their enforcement in the region.

This study has few limitations. First, all measures assessed were self-reported, which could result in underreporting of smoking, especially among girls because of social undesirability

of girls' smoking in this region (Khalil *et al*, 2013). However, self-reported smoking has been strongly correlated with biomarkers of smoking in cohort studies of adolescents (Murray *et al*, 2002). Previous experience studying smoking habits of youth in the EMR showed that adolescents will share openly their smoking experiences provided that confidentiality and anonymity are assured, as we did in our study (Maziak & Mzayek, 2000). Second, some variables were not included in the analysis due to high missing rates that exceeded 50% (e.g. intention, barriers, and abilities). However, their inclusion did not change the results but increased the standard errors, and consequently expanded the confidence intervals. Similar studies in different social contexts are recommended to examine whether the current study findings can be generalized to all youth worldwide.

Conclusions

This is the first longitudinal study to investigate the predictors of waterpipe smoking progression among youth in Jordan. During the three years of follow-up, 40% of adolescents progressed in waterpipe smoking. This study shows the importance of social and cultural norms as well as the prevalent beliefs regarding the reduced harm of waterpipe smoking in delineating the gender differences in waterpipe smoking. The predictors among boys were higher mother's education, attending public school, higher physical activity, and accepting offers to smoke waterpipe from friends. The predictors among girls were age, ever smoking cigarettes, peer smoking, and siblings' smoking. Belief that waterpipe smoking is harmful was protective among boys and reading the warning label on waterpipe tobacco packs was protective among girls.

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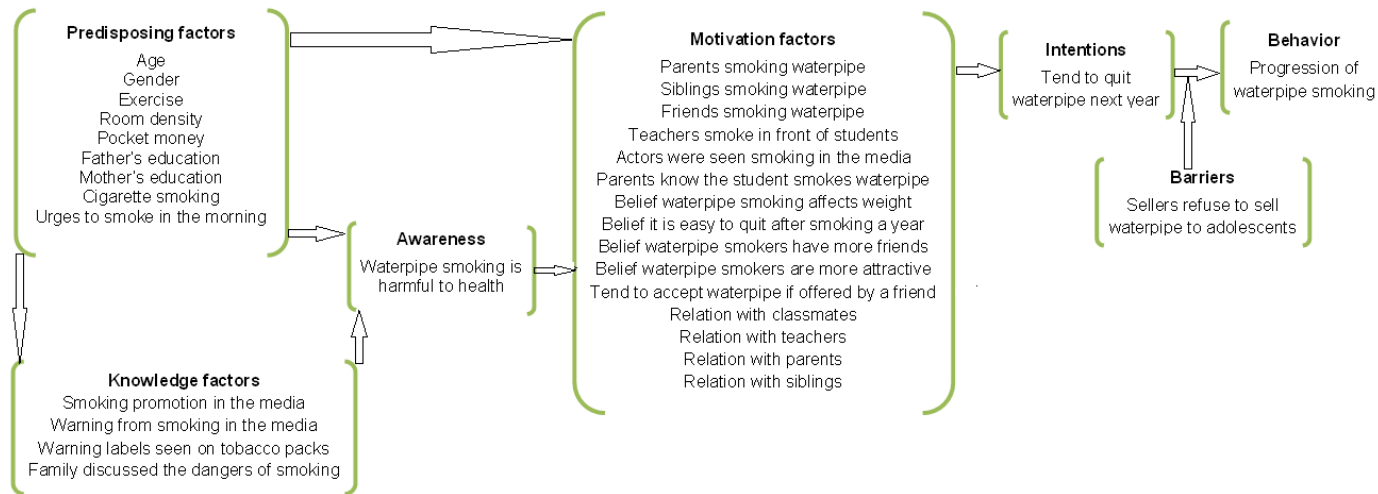
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Tables and figures

Figure 1. Attitude, social influence, and self-efficacy [ASE] theoretical framework to study the predictors of waterpipe smoking progression among a school-based sample of adolescents in Irbid, Jordan between 2008 and 2011 (N=864).



Note: This model was adapted from de Vries et al., 2003.

Figure 2. Risk of waterpipe smoking progression among a school-based sample of adolescents in Irbid, Jordan, 2008-2011 (N=864).

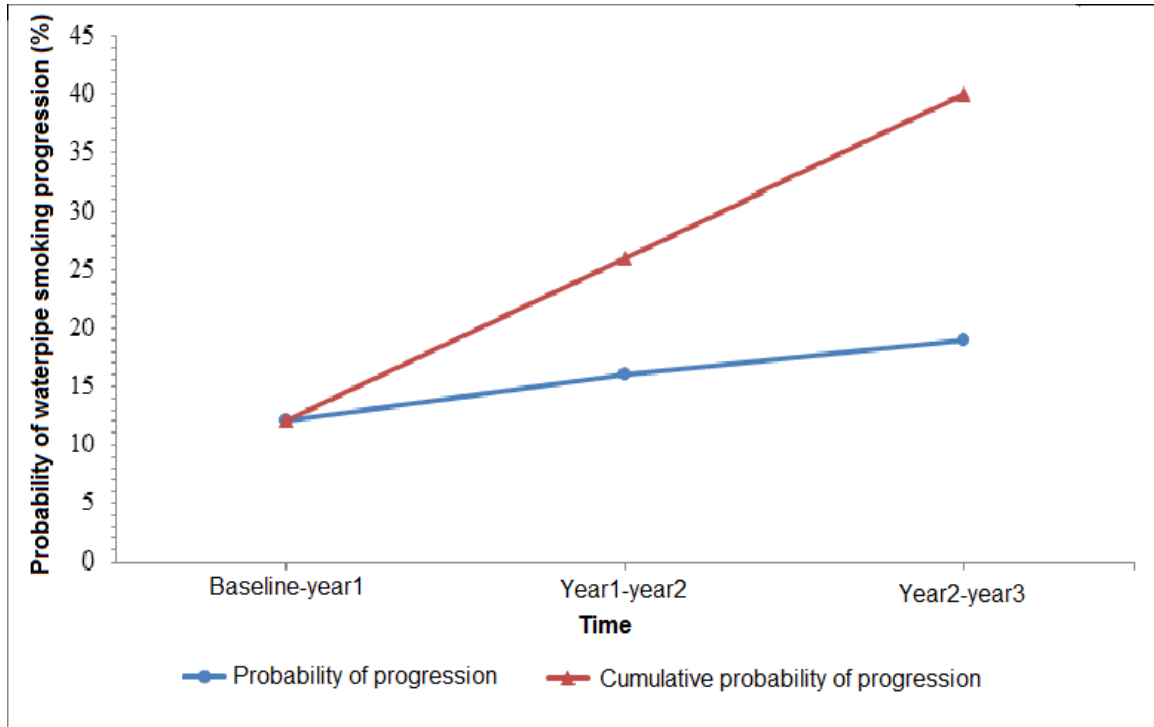


Table 1. Gender-specific unadjusted risk of waterpipe (WP) smoking progression among school-based sample of adolescents in Irbid, Jordan 2008-2011^a

Potential predictors	Boys HR (95% CI)^b	Girls HR (95% CI)
Socio-demographic factors		
Age (Years)	1.12 (1.02-1.23)*	1.19 (1.06-1.33)*
Father's education (>High school)	1.15 (0.96-1.36)	0.91 (0.74-1.12)
Mother's education (>High school)	1.24 (1.05-1.47)*	0.86 (0.70-1.05)
Daily allowance (Piaster/day) ^c	1.34 (1.10-1.62)*	0.79 (0.62-0.99)*
Room density ^d	1.10 (0.93-1.29)	1.03 (0.87-1.23)
School type (public)	1.99 (1.56-2.54)**	0.66 (0.50-0.87)*
Individual factors		
Ever smoke cigarettes	1.13 (0.93-1.37)	1.53 (1.22-1.91)**
Higher physical activity	1.23 (1.12-1.36)**	0.95 (0.84-1.07)
Has the urge to smoke in the morning	1.06 (0.86-1.31)	1.17 (0.71-1.91)
Belief that WP smoker has more friends	0.83 (0.67-1.02)	1.02 (0.77-1.35)
Belief that WP smoker is attractive	1.16 (0.93-1.44)	0.94 (0.73-1.21)
Belief WP decreases body weight	1.21 (0.99-1.48)	0.87 (0.69-1.09)
Belief WP is harmful for health	0.76 (0.61-0.95)*	0.77 (0.58-1.04)
Belief it is easy to quit WP after a year	0.93 (0.76-1.12)	1.68 (1.34-2.11)**
Tend to accept WP offered by friend	1.35 (1.09-1.66)*	2.38 (1.83-3.09)**
Social factors		
Dangers of smoking discussed by family	0.81 (0.66-1.00)*	0.81 (0.64-1.01)
At least one parent knows you smoke WP	1.03 (0.84-1.27)	0.83 (0.64-1.06)
At least one parent smokes WP	0.86 (0.70-1.05)	0.84 (0.67-1.06)
Has friends' smoke WP	1.53 (1.24-1.89)**	1.98 (1.57-2.49)**
Has siblings' smoke WP	0.80 (0.64-0.99)*	1.92 (1.53-2.40)**
Good relation with parents	1.12 (0.73-1.73)	1.18 (0.64-2.17)
Good relation with siblings	0.93 (0.60-1.43)	0.72 (0.48-1.07)
Good relation with classmates	1.40 (0.93-2.12)	1.05 (0.54-2.02)
Good relation with teachers	0.71 (0.53-0.96)*	0.62 (0.45-0.87)*
Has seen media advert. promote smoking	0.89 (0.74-1.09)	0.96 (0.77-1.20)
Has seen media advert. warn from smoking	0.82 (0.67-0.99)*	0.96 (0.73-1.26)
Has seen teacher smoke in front of the students	1.98 (1.61-2.44)**	1.27 (0.99-1.64)
Has seen warning label on WP tobacco	1.16 (0.95-1.40)	0.71 (0.56-0.90)*
Has seen actor smoke in the movies	0.68 (0.55-0.85)*	1.63 (0.95-2.80)
Has intention to quit smoking	0.67 (0.50-0.90)*	0.67 (0.46-0.97)*
Attempted to quit smoking	1.08 (0.80-1.46)	0.95 (0.67-1.35)

^aAll analyses presented here are weighted

^bHazard ratio and its 95% confidence interval.

^cJordanian currency (\$1=70 Piaster = 0.70 JD)

^dProxy measure for income = number of the persons / the number of rooms in the dwelling (kitchen and bathrooms are not included). *P-value < 0.05. **P-value < 0.001.

Table 2. Adjusted risk of waterpipe smoking progression among school-based sample of boys in Irbid, Jordan 2008-2011^a

Potential predictors	AHR (95% CI) ^b	p-value
Socio-demographic		
Age (Years)	0.97 (0.81-1.15)	0.720
Father's education (>High school)	1.27 (0.94-1.70)	0.117
Mother's education (>High school)	1.39 (1.04-1.85)	0.025
Daily allowance (Piaster/day) ^c	1.26 (0.96-1.65)	0.093
School type (public)	3.19 (2.01-5.05)	<0.001
Individual factors		
Higher physical activity	1.24 (1.08-1.41)	0.002
Belief waterpipe smoker has more friends ^d	0.84 (0.64-1.12)	0.233
Belief waterpipe smoker is attractive ^d	1.20 (0.90-1.60)	0.205
Belief waterpipe decreases body weight	1.28 (0.97-1.69)	0.078
Belief waterpipe is harmful for health	0.65 (0.47-0.88)	0.006
Refusal self-efficacy (accept waterpipe from friend)	1.08 (0.60-1.94)	0.807
Social factors		
Dangers of smoking discussed by family member	0.95 (0.71-1.27)	0.743
Has at least one parent smokes waterpipe	0.78 (0.58-1.04)	0.093
Has siblings smoke waterpipe	0.97 (0.72-1.29)	0.818
Has friends smoke waterpipe	0.60 (0.36-1.01)	0.055
Good relation with classmates	1.26 (0.71-2.23)	0.436
Good relation with teachers	0.70 (0.44-1.11)	0.133
Advertisement to warn from smoking seen	1.07 (0.80-1.44)	0.657
Teachers were seen smoking in front of the students	0.95 (0.69-1.31)	0.744
Warning labels seen waterpipe tobacco packs	0.92 (0.69-1.21)	0.536
Actors seen smoking in the media	0.58 (0.41-0.80)	0.001
Friend smoking* Refusal self-efficacy	3.25 (1.54-6.88)	0.002

^aAnalysis is weighted by the inverse probability of school chosen.

^bAdjusted hazard ratio and its 95% confidence interval.

^cJordanian currency (\$1=70 Piaster).

^dWere correlated (correlation coefficient = 0.42) and thus they were entered to the model separately and the model that has the higher fit was reported here [lower Akaike Information Criterion (AIC)].

*P-value <0.05.

**P-value <0.001.

Table 3. Adjusted risk of waterpipe smoking progression among a school-based sample of girls in Irbid, Jordan 2008-2011^a

Potential predictors	AHR (95% CI)^b	p-value
Socio-demographic		
Age (Years)	1.19 (1.02-1.38)	0.025
Mother's education (>High school)	0.91 (0.70-1.19)	0.491
Daily allowance (Piaster/day) ^c	0.80 (0.58-1.10)	0.169
School type (public)	1.23 (0.85-1.79)	0.270
Individual factors		
Ever smoked cigarettes	1.51 (1.12-2.04)	0.007
Belief waterpipe is harmful for health	0.83 (0.58-1.20)	0.316
Belief it is easy to quit waterpipe after smoking a year	1.29 (0.97-1.73)	0.082
Refusal self-efficacy (accept waterpipe from friend)	1.21 (0.68-2.14)	0.520
Social factors		
Dangers of smoking discussed by family member	0.76 (0.41-1.41)	0.384
At least one parent knows you smoke	1.01 (0.75-1.36)	0.939
Has at least one parent smokes waterpipe	1.01 (0.76-1.35)	0.929
Has siblings smoke waterpipe	1.39 (1.03-1.89)	0.034
Has friends smoke waterpipe	1.86 (1.33-2.60)	<0.001
Good relation with siblings	0.88 (0.55-1.40)	0.589
Good relation with teachers	0.97 (0.63-1.49)	0.871
Teachers were seen smoking in front of the students	0.98 (0.78-1.34)	0.911
Warning labels seen waterpipe tobacco packs	0.54 (0.40-0.73)	<0.001
Actors seen smoking in the media	1.54 (0.76-3.11)	0.231
Dangers discussed with family* Refusal self-efficacy	2.24 (1.12-4.51)	0.023

^aAnalysis is weighed by the inverse probability of school chosen.

^bAdjusted hazard ratio and its 95% confidence interval.

^cJordanian currency (\$1=70 Piaster).

*P-value <0.05.

**P-value <0.00

CONCLUSIONS

This work provides the first comprehensive evidence that waterpipe smoking can be a gateway to cigarette initiation among cigarette-naive adolescents. The implication of such work can be profound in addressing tobacco use and addiction among youth in the EMR and perhaps around the world. As the waterpipe becomes increasingly the first method that introduces youth to tobacco and hooks them on nicotine, the need to increasingly focus on the waterpipe for tobacco prevention efforts among youth is real, and becoming urgent. The major focus should be devoted to spreading knowledge about the harmful and addictive nature of waterpipe that lies in contrast to its perceived safety among youth. What is very clear from this study is that unless we start working systematically to confront this emerging public health problem, we stand to have an accelerated tobacco epidemic among youth and to lose even the limited success achieved in controlling cigarette smoking among them.

This research also provides the first evidence regarding the risk and gender-specific predictors of cigarette smoking progression among youth in a country from the EMR (Jordan). There was no difference in the overall rate of cigarette smoking progression by gender. However, gender differences were noticed in the predictors of cigarette smoking progression among the study cohort. The predictors of cigarette smoking progression were the belief that cigarette smoking decreases body weight, the belief that it is easy to quit after smoking cigarettes for a year, peers' smoking and attending public schools among boys, siblings' smoking among girls, and the urge to smoke in the morning among all participants. Discussing the dangers of smoking with a family member and the belief that cigarette smoking is harmful to health were protective against cigarette smoking progression among females.

Additionally, our research shows the importance of social and cultural norms as well as the prevalent beliefs regarding the reduced harm of waterpipe smoking in delineating the gender

differences in waterpipe smoking. The predictors of waterpipe smoking progression were higher mother's education, attending public school, higher physical activity, and accepting offers to smoke waterpipe from friends among boys, age, ever smoking cigarettes, peer smoking, and siblings' smoking among girls. Belief that waterpipe smoking is harmful was protective against smoking among boys and reading the warning label on waterpipe tobacco packs was protective among girls.

These findings increase our understanding of cigarette and waterpipe smoking progression among youth, as well as identify the modifiable risk factors in an effort to prevent the escalation of smoking among youth in Jordan and in other countries with similar social context.

APPENDICES

Appendix1. Questionnaires that were used at baseline and subsequent follow ups (Time1, 2, and 3)

Irbid Schoolchildren Longitudinal Smoking Study

Survey number: - - -

Year: - - - -

School ID: - - - Class ID: - - - - Student ID: - - - - - - - Student initials: - - - - - - - - - -

Part One

Instructions:

- Read each question carefully before answering
 - Read the answers to each question and chose one answer that most describes your situation
 - Put an (X) inside the small square corresponding to the answer you chose
-

1- How old are you?

- a. 11 years old
- b. 12 years old
- c. 13 years old
- d. 14 years old
- e. 15 years old
- f. 16 years old

2- What is your gender?

- a. Male
- b. Female

3- How many persons live in your house (including you?)

- a. 2 - 4
- b. 5 - 7
- c. 8 - 10
- d. 11 or more

4- How many rooms in your house (excluding the kitchen and the bathroom?)

- a. 1 - 2
- b. 3 - 4
- c. 5 - 6
- d. 7 or more

5- How many years of education do your father have?

- a. Father cannot read or write
- b. Father has less than 6 years of education
- c. Father has 6 – 12 years of education
- d. Father has university degree

6- How many years of education do your mother have?

- a. Mother cannot read or write
- b. Mother has less than 6 years of education
- c. Mother has 6 – 12 years of education
- d. Mother has university degree

7- How much is your daily allowance?

- a. Less than 25 piaster
- b. 25 piaster
- c. 50 piaster

- d. 75 piaster or more
- e. 1 dinar
- f. More than 1 dinar

8- Do you participate in sports (such as jogging, soccer, basketball, swimming, etc.?)

- a. No.
- b. Sometimes (once or twice per month)
- c. Usually (at least once a week)
- d. Regularly (more than once a week)

The following questions are about cigarette smoking

9- How many times did you smoke cigarettes in the past month (30 days?)

- a. I did not smoke cigarettes in the past month.
- b. I smoked less than once a week
- c. I smoked at least once a week, but not everyday
- d. I smoke everyday

10- Did you ever smoke cigarettes, even a puff or two?

- a. No
- b. Yes

If you answered “No” to question number (10) above, go directly to “Part Two” on page (6).

If you answered “Yes” to question number (10), continue to the next question.

11- How old were you when you smoked a cigarette for the first time?

- a. 8 years or less
- b. 9-10 years
- c. 11-12 years
- d. 13-14 years

e. 15-16 years

12- During the days in which you smoked in the last month, how many cigarettes per day did you usually smoke?

a. One cigarette per day

b. less than 10 cigarettes per day

c. More than 10 cigarettes per day

13- During the last month, where from did you usually obtain your cigarettes?

a. I bought them from a store

b. I bought them from a street vendor

c. I asked someone to buy them for me

d. I got them from a friend

e. I got them from my house

f. I got them from an adult

g. Other method

14- During the last month, what brand did you usually smoke?

a. Marlboro

b. Viceroy

c. Kent

d. Winston

e. Merit

f. Other brand

g. I smoked different brands

15- How much do you usually pay for a pack of cigarettes?

- a. I do not buy cigarettes
- b. I do not buy a whole pack
- c. I pay 1 dinar
- d. I pay 1.25 dinar
- e. I pay 1.5 dinar
- f. I pay 1.75 dinar
- g. I pay 2 dinars
- h. I pay more than 2 dinars

16- During the last month, how much did you approximately spend to buy cigarettes?

- a. I do not buy cigarettes
- b. I spent less than 2 dinars
- c. I spent 2-4 dinars
- d. I spent 5-7 dinars
- e. I spent 8-10 dinars
- f. I spent more than 10 dinars

17- During the last month, were you not able to buy cigarettes because of your young age?

- a. I do not buy cigarettes
- b. Yes
- c. No

18- Where do you usually smoke cigarettes?

- a. At home
- b. At school
- c. At a friend's home

d. In public places (e.g., street, park)

e. Other places

19- Do you smoke, or feel the urge to smoke, when you wake up in the morning?

a. No

b. Yes, sometimes

c. Yes, always

20- Do your parents know that you smoke cigarettes?

a. No

b. Only my mother knows

c. Only my father knows

d. Both my parents know

Part Two

21- Do your parents smoke cigarettes?

a. No

b. Only my mother smokes

c. Only my father smokes

d. Both my parents smoke

e. I don't know

22- Do your brothers or sisters smoke cigarettes?

a. No

b. Some of my brothers smoke

c. Some of my sisters smoke

d. I don't know

23- Do you have close friends who smoke cigarettes?

- a. No
- b. Some of them smoke
- c. All of them smoke

24- If a friend gives you a cigarette, would you smoke it?

- a. Absolutely not.
- b. Maybe
- c. Yes, of course

25- Did any of your family members talked to you about the dangers of cigarette smoking?

- a. No
- b. Yes

26- Do you think that students who smoke have more friends?

- a. No
- b. Yes
- c. No difference

27- Do you think that students who smoke are more attractive?

- a. No
- b. Yes
- c. No difference

28- Do you think smoking cigarettes affects the body weight?

- a. No
- b. Yes, it makes you gain weight
- c. Yes, it makes you lose weight

29- Do you think smoking cigarettes is harmful for health?

a. No

b. Yes

30- Do you think it is easy to stop smoking after smoking cigarettes for a year or two?

a. No

b. Yes

31- Do you think that you may start to smoke cigarettes next year?

a. Absolutely not.

b. Maybe

c. Yes, of course

The following questions are about waterpipe smoking

32- How many times did you smoke waterpipe in the past month (30 days?)

a. I did not smoke waterpipe in the past month.

b. I smoked less than once a week

c. I smoked at least once a week, but not everyday

d. I smoke everyday

33- Did you ever smoke waterpipe, even a puff or two?

a. No

b. Yes

If you answered “No” to question number (33) above, go directly to “Part Three” on page

(10). If you answered “Yes” to question number (33), continue to the next question.

34- How old were you when you smoked a waterpipe for the first time?

- a. 8 years or less
- b. 9-10 years
- c. 11-12 years
- d. 13-14 years
- e. 15-16 years

35- During the days in which you smoked in the last month, how many waterpipe per day did you usually smoke?

- a. One per day
- b. More than one per day

36- During the last month, where from did you usually get your waterpipe?

- a. I bought the waterpipe in a cafe or a restaurant
- b. I got it from a friend
- c. I got it from home
- d. Other method

37- During the last month, what kind of waterpipe did you usually smoke?

- a. Regular
- b. Fruit flavored
- c. Other

38- During the last month, how much did you approximately spend to buy waterpipe?

- a. I do not buy waterpipe
- b. I spent less than 10 dinars
- c. I spent 10-15 dinars
- d. I spent 16-20 dinars

e. I spent more than 20 dinars

39- During the last month, were you not able to buy waterpipe because of your young age?

a. I do not buy waterpipe

b. Yes

c. No

40- Where do you usually smoke waterpipe?

a. At home

b. At a friend's home

c. In public places (e.g., a café or a restaurant)

e. Other places

41- Do you smoke waterpipe, or feel the urge to smoke, when you wake up in the morning?

a. No

b. Yes, sometimes

c. Yes, always

42- Do your parents know that you smoke waterpipe?

a. No

b. Only my mother knows

c. Only my father knows

d. Both my parents know

Part Three

43- Do your parents smoke waterpipe?

- a. No
- b. Only my mother smokes waterpipe
- c. Only my father smokes waterpipe
- d. Both my parents smoke waterpipe
- e. I don't know

44- Do your brothers or sisters smoke waterpipe?

- a. No
- b. Some of my brothers smoke waterpipe
- c. Some of my sisters smoke waterpipe
- e. I don't know

45- Do you have close friends who smoke waterpipe?

- a. No
- b. Some of them smoke waterpipe
- c. All of them smoke waterpipe

46- If a friend offers you a waterpipe, would you smoke it?

- a. Absolutely not
- b. Maybe
- c. Yes, of course

47- Did any of your family members talked to you about the dangers of waterpipe smoking?

- a. No
- b. Yes

48- Do you think that students who smoke waterpipe have more friends?

- a. No
- b. Yes
- c. No difference

49- Do you think that students who smoke waterpipe are more attractive?

- a. No
- b. Yes
- c. No difference

50- Do you think smoking waterpipe affects the body weight?

- a. No
- b. Yes, it makes you gain weight
- c. Yes, it makes you lose weight

51- Do you think smoking cigarettes is harmful for health?

- a. No
- b. Yes

52- Do you think it is easy to stop smoking after smoking waterpipe for a year or two?

- a. No
- b. Yes

53- Do you think that you may start to smoke waterpipe next year?

- a. Absolutely not
- b. Maybe
- c. Yes, of course

The following questions are about the media and tobacco control

54- In the past month, have you seen ads promoting cigarette smoking in the media (e.g., TV, radio, newspapers, or movies)?

a. No

b. Yes, sometimes

55- In the past month, have you seen ads warning from the dangers of smoking on health in the media (e.g., TV, radio, newspapers, or movies)?

a. No

b. Yes, sometimes

56- Have you seen actors/actresses smoking in the movies or on TV?

a. I don't watch movies or TV

b. No

c. Yes, sometimes

57- In the past month, have you noticed the health warnings on the cigarette pack?

a. No

b. Yes, sometimes

c. Yes, always

58- In the past month, have you noticed the health warnings on the waterpipe tobacco pack?

a. No

b. Yes, sometimes

c. Yes, always

The following questions are about the relationships at home and in school

59- In general, how would you describe your relations with your parents?

a. Good

b. Normal

c. Not good

60- In general, how would you describe your relations with your brothers and sisters?

a. Good

b. Normal

c. Not good

61- In general, how would you describe your relations with your classmates?

a. Good

b. Normal

c. Not good

62- In general, how would you describe your relations with your school teachers?

a. Good

b. Normal

c. Not good

63- Do your teachers smoke in front of the students?

a. No

b. Yes

The following questions are about quitting smoking (if you do not smoke, do not answer these questions)

64- Do you want to quit smoking?

a. No

b. Yes

65- Did you try to quit smoking during the last year?

a. No

b. Yes

66- What is the main reason that makes you want to quit smoking?

a. I do not want to quit smoking

b. To protect my health

c. To save money

d. Because my family hates smoking

e. Because my friends hate smoking

f. Because of religious beliefs

67- Do you think you can quit smoking whenever you want?

a. No

b. Yes

66- Have you ever received counseling or any kind of help to quit smoking?

a. No

b. Yes, in an antismoking program

c. Yes, from a friend

d. Yes, from a family member

Appendix 2: Supplemental Tables and Figures.

Table 1. List of study covariates original coding and recoding performed to test the gateway hypothesis from waterpipe to cigarette (Cig.) smoking.

Original coding	Recoding label	Value	Original coding	Recoding label	Value
Gender	Male	1	Attractiveness belief		
	Female	0	No difference	Else	0
Pocket money			Don't know		
No pocket money	≤ 50 Piaster	0	Cig. smoking less attractive		
10-25 Piaster			Cig. smoking more attractive	More attractive	1
26-50 Piaster			Weight belief		
51-75 Piaster	> 50 Piaster	1	No difference	Else	0
>75 Piaster			Belief smoking cig increase Wt.		
Mother education			Belief smoking cig decrease Wt.	Reduce weight	1
Illiterate	less than high school	1	Belief smoking is harmful	No	0
Elementary				Yes	1
Intermediate			Belief easy to quit after smoking a year	No	0
High school	≥ high school	0		Yes	1
Community college			Intention to smoke cig next year		
Bachelor			Absolutely no	No	0
Father education			Don't think		
Illiterate	less than high school	1	May be	Tend to smoke next year	1
Elementary			Absolutely yes		
Intermediate			Relations with parents		
High school	≥ high school	0	Not good	Not good	0
Community college			Good	Good	1
Bachelor			Very good		
Parent smoking Cig.			Relations with siblings		
No one smoking	Else	0	Not good	Not good	0
Don't know			Good	Good	1
Only father smokes	Any parent smoke	1	Very good		
Only mother smokes			Relations with classmates		
Both are smoking			Not good	Not good	0
Sibling smoking Cig.			Good	Good	1

Not smoking Don't know	Else	0	Very good		
Relation with teachers.					
Some brothers smoke	Any of sibling smoke	1	Not good	Not good	0
Some sisters smoke			Good	Good	1
Some of them smoke			Very good		
Friends smoking Cig.			Warning label noticed		
No	No friend smoke	0	No	No	0
Some of them smoke	Friends smoke	1	Sometimes	Yes	1
All smoke			Always		
Accept Cig. from friend			Saw actor smoking		
Absolutely no Don't think	Else	0	Don't watch TV.	No	0
May be Absolutely yes	Tend to smoke from friend	1	Sometimes	Yes	1
More friends belief			Saw media promote Cig.		
No difference Don't know	Else	0	Not at all	No	0
Cig. smoker has less friends			sometimes	Yes	1
Cig. smoker has more friends	Belief smokers Have more friends	1	Teachers smoke in front of students	No	0
				Yes	1
			Age	used as continuous	

Table 2. Unadjusted Gender-Specific Risk of Cigarettes (Cig.) Smoking Progression Among School-Based Sample of Adolescents in Irbid, Jordan, 2008-2011(N=669)

Potential predictors	Male (N=448)		Female (N=221)	
	HR ^a	95% CI ^b	HR ^a	95% CI ^b
Socio-demographic factors				
Age (years)	1.40	1.26, 1.55	1.00	0.85, 1.18
Father's education (> high school)	0.71	0.61, 0.84	1.02	0.75, 1.40
Mother's education (> high school)	0.97	0.81, 1.15	0.71	0.53, 0.96
Daily allowance (Piaster/day) ^c	0.79	0.63, 0.98	0.42	0.27, 0.67
Room density ^d	0.98	0.78, 1.22	1.87	1.51, 2.33
School type (public)	3.36	2.52, 4.48	1.48	0.93, 2.35
Individual factors				
Ever smoke waterpipe	1.54	1.20, 2.00	1.77	1.08-2.92
Higher physical activity	0.96	0.86, 1.07	0.88	0.72, 1.06
Has the urge to smoke in the morning	1.55	1.31, 1.82	1.92	1.22, 3.02
Belief Cig. smokers have more friends	0.82	0.65, 1.02	1.42	0.96, 2.11
Belief that smoker is attractive	1.03	0.82, 1.29	1.15	0.80, 1.66
Belief Cig. decreases body weight	1.69	1.38, 2.07	0.71	0.51, 0.98
Belief Cig. is harmful for health	1.09	0.80, 1.48	0.39	0.25, 0.60
Belief it is easy to quit Cig. after one year	1.48	1.21, 1.81	0.96	0.66, 1.38
Accept Cig. offered by friend (self-efficacy)	2.10	0.66, 1.38	2.31	1.61, 3.32
Environmental factors				
Dangers of smoking discussed by family member	0.81	0.65, 1.03	0.33	0.24, 0.46
At least one parent knows you smoke Cig.	0.87	0.69, 1.11	0.87	0.59, 1.30
Both parents smoke Cig.	1.45	1.00, 2.08	1.09	0.68, 1.74
Only father smoke Cig.	0.81	0.67, 0.98	0.87	0.62, 1.21
Only mother smoke Cig.	0.70	0.32, 1.55	1.67	0.68, 4.07
Friends' smoking	2.54	1.96, 3.29	1.20	0.86, 1.69
Siblings' smoking	1.16	0.92, 1.45	2.17	1.55, 3.04
Good relation with parents	1.15	0.74, 1.76	0.97	0.45, 2.06
Good relation with siblings	0.93	0.60, 1.43	0.51	0.32, 0.80
Good relation with classmates	1.58	1.03, 2.42	0.64	0.36, 1.15
Good relation with teachers	0.59	0.44, 0.80	0.56	0.36, 0.86
Have seen advertisements promote Cig.	0.93	0.76, 1.14	1.27	0.91, 1.78
Have seen advertisements warn from Cig.	1.08	0.87, 1.35	1.16	0.78, 1.73
Teachers smoke in front of students	1.39	1.12, 1.71	1.54	1.08, 2.20
Warning labels were seen on Cig. packs	0.72	0.54, 0.96	2.11	0.85, 5.26
Actors seen smoking in the media	1.10	0.83, 1.45	1.02	0.59, 1.76

Note: All Analyses were weighted by the inverse probability of school chosen.

^aHazard ratio. ^bHazard ratio's 95% confidence interval from a bivariate survival analysis.

^cJordanian currency (\$1=70 Piaster = 0.7 Jordanian Dinar [JD]).

^dProxy measure for income =number of persons / number of rooms in the dwelling.

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1. Jaber, R., Madhivanan, P., Veledar, E., Khader, Y., Mzayek, F., Maziak, W. (2015). Waterpipe as a gateway to cigarette smoking among adolescents: A three-year longitudinal study. Accepted *International Journal of Tuberculosis and Lung diseases*.
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5. Al-Sakkak, M., Al-Nowaiser, N., Al-Khashan, H., Al-Abdrabulnabi, A., & Jaber, R. (2008). Patient satisfaction with primary health care services in Riyadh. *Saudi Medical Journal*, 29(3), 432-436.
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7. Jaber, R., Madhivanan, P., Veledar, E., Khader, Y., Mzayek, F., Maziak, W. Waterpipe as a gateway to cigarette smoking among adolescents: A three-year longitudinal study. Presented at the Graduate Student Appreciation Week (GSAW) Scholarly Forum, FIU, March 31 – April 1, 2014.
8. Jaber, R., Khader, Y., Mzayek, F., Kenneth, W., Maziak, W. Determinants of waterpipe smoking progression among school-based sample of adolescents in Irbid, Jordan: A longitudinal study 2008-2011. Presented as poster in the Exploring the Health Gap conference: Global Gender Disparities and their Impact on Girls, Children's hospital in Philadelphia, November 3-4, 2014.