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ORIGINAL ARTICLE

Sex-specific initiation rates of tobacco smoking and its determinants among adults from a Middle Eastern population: a cohort study

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Abstract

Objectives To assess the initiation rate and determinants of tobacco smoking among adults.

Methods In the Tehran Lipid and Glucose Study, a population-based cohort from Iran, 6101 participants ≥ 18 years old who had never smoked tobacco at baseline (phase II: 2002–2006) were followed until phase VI (2015–2018). Sex-specific initiation rates per 1000 person-years for self-reported tobacco smoking and hazard ratios (HR) for its potential determinants (using Cox proportional hazards models) were calculated.

Results The age- and sex-adjusted smoking initiation rate was 13.77 [95% confidence interval (CI) 12.59–14.94] per 1000 person-years, of which 78% was attributed to water pipe use. Initiation rate was remarkably higher among men [19.1 (16.9–21.2)] than women [8.3 (7.4–9.2)] and declined in older age-groups. Among both genders, being married was protective [men: HR 0.67 (CI 95% 0.48–0.92); women: 0.58 (0.45–0.74)], while intermediate-level education (compared with high level) [men: 1.61 (1.14–2.26); women: 1.33 (0.95–1.84, p value = 0.092)] and passive smoking [men: 1.76 (1.36–2.28); women: 1.82 (1.42–2.33)] increased the risk. Educational intervention decreased the risk among women [0.74 (0.58–0.94)].

Conclusions The majority of adult smoking initiators started smoking with water pipe. The initiation rate was remarkably higher in men and younger age-groups. Passive smoking, being single and lower education were risk factors. Educational intervention was protective among women.

Keywords Tobacco · Water pipe · Cigarette · Smoking · Initiation rate · Intervention · The Tehran Lipid and Glucose Study

Introduction

Tobacco smoking is an addictive behavior that can lead to other substance abuse (Henningfield et al. 1990), being the second leading risk factor in 2015 for attributable deaths and disability-adjusted life years (DALYs) (Forouzanfar et al. 2016) and the first leading risk factor in 2016 for DALYs among men (Gakidou et al. 2017). Tobacco smoking is a main preventable cause of disease in most countries, and in 2017, globally 6.4 million deaths were related to smoking, which has increased since 2005 (Reitsma et al. 2017). Indeed, in 2012, 5.7% of global health expenditure, i.e., 422 billion USD, was spent on smoking-attributable diseases worldwide and the global economic burden of smoking, including health expenditures and productivity loss, reached 1436 billion USD (Goodchild et al. 2018).

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In 2015, the WHO reported a lower prevalence of tobacco smoking (18%) in the Eastern Mediterranean Region (EMR) compared to the Europe and Western Pacific regions. However, there was a rising trend of smoking in the EMR, opposing to the decreasing trends in most global regions (World Health Organization 2018). The high prevalence of water pipe use among EMR adults, as either regular or occasional use, (Jawad et al. 2018), may contribute to this rising trend.

In Iran, the WHO has reported a lower prevalence of current tobacco smoking compared to the average EMR rate. A national survey reported that 11% of Iranian adults (15–64 years old) were current tobacco smokers (20.8% among men and 0.9% among women) in 2011 (World Health Organization 2017) with no significant change in the prevalence of smoking in Iran from 1991 to 2007 based on three national studies (Meysamie et al. 2012). However, in the metropolitan city of Tehran, our results showed a significant increase (between 1999–2001 and 2008–2011) in the prevalence of current smoking, from 25 to 39% for men and from 3.5 to 6.8% for women among non-diabetic adults aged $\geq$ 20 years (Jahangiri-Noudeh et al. 2014).

To our knowledge, previous reports on smoking and its determinants in the EMR have been limited to cross-sectional surveys (Fotouhi et al. 2009; Jawad et al. 2018; Meysamie et al. 2012; Sozmen et al. 2015); hence, these studies could only report the prevalence and not the initiation rate of smoking. Moreover, based on the belief that most smoking initiation occurs during adolescence and young adulthood (National Center for Chronic Disease et al. 2012; O'Loughlin et al. 2014), the majority of these studies included only the younger age-groups (Bernat et al. 2012; Freedman et al. 2012; O'Loughlin et al. 2014; Wellman et al. 2016). Hence, data on the initiation of tobacco use and its predictors among adults are relatively scarce.

In the current study, we aimed to report the initiation rate and predictors of smoking among Iranian adults aged $\geq$ 18 years, in a large and long-term cohort called the Tehran Lipid and Glucose Study (TLGS).

Methods

Study design and sample

The TLGS is a longitudinal population-based study conducted in District No. 13 of Tehran, on a representative sample of the city's population, aiming to determine the prevalence and incidence of non-communicable disease risk factors and promote a healthy lifestyle. To date, it has been conducted in 6 phases at approximately 3-year intervals (phase I: 1999–2001, phase II: 2002–2005, phase III: 2005–2008, phase IV: 2008–2011, phase V: 2011–2014, phase VI: 2015–2018). After a cross-sectional survey in phase I, participants entered a cohort with educational–interventional design in phase II, the latter to be a prospective, non-randomized, controlled community intervention trial. Intervention included education on improving diet and physical activity and avoiding tobacco use and has been offered to about one-third of the TLGS participants according to their area of residence and regardless of their cardiovascular risk factors at baseline (2002–2005). However, the intervention and control groups had comparable baseline characteristics including age, body mass index, educational level, marital status, smoking and employment status (Azizi et al. 2009). The intervention was performed through face-to-face, community-based, family-based and school-based components: Community-based with health promotion advertisements in the area comprised public education during social events and community gatherings; family-based-measures included delivering educational material to the families, mostly by health liaisons and through health newsletters, pamphlets or booklets; and school-based included classroom and peer teachings and establishing school health teams, directed at both students and parents. Further information has been provided elsewhere (Azizi et al. 2009).

Study population

For the current study, due to differences in the indices of assessment used for several covariates including smoking status and physical activity between the first phase and the following phases, phase II was considered as baseline. From a total of 9658 participants aged $\geq$ 18 years in phase II, those who were current (n = 1766) or past (n = 729) smokers at baseline were excluded initially and 7163 (5000 women) never smokers remained. After further excluding participants with baseline missing data of smoking status (n = 359) or any of the model covariates (n = 144) and 554 participants with no follow-up data, 6106 (4359 women) were eligible for analysis, giving a response rate of 85% (81% for men and 87% for women). Figure 1 illustrates the selection of the study population in detail.

Ethics

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics Committee of Research Institute for Endocrine Sciences. All participants provided informed written consent.

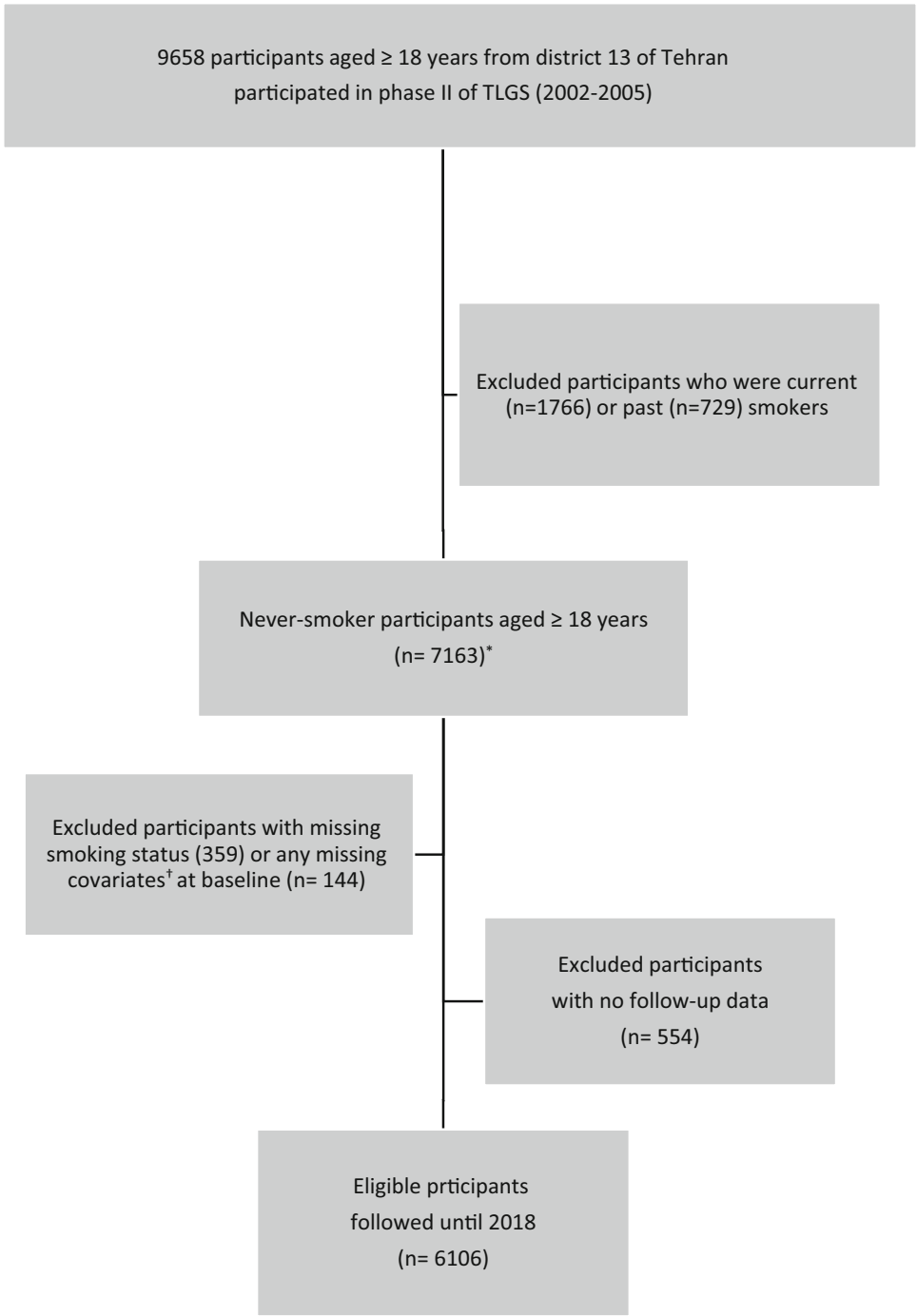

Fig. 1 Study population selection flowchart. Tehran Lipid and Glucose Study, Iran, 2002–2018. *Among these participants, 2027 belonged to the educational intervention section of the study, i.e., a prospective, non-randomized, controlled community intervention trial that included education on improving diet, physical activity and avoiding tobacco use. †Covariates include marital status, education, physical activity, passive smoking at home/workplace

Clinical and anthropometric measurements

Information on demographic characteristics and smoking status was obtained by a trained interviewer, using a questionnaire. Data on marital status, education level and smoking status were obtained by self-reports. Anthropometrics were measured during a brief physical examination based on a standard protocol (Azizi et al. 2009). BMI was calculated as weight in kilograms divided by height in meters squared. Physical activity level was assessed by the Modifiable Activity Questionnaire, which measures all three forms of activities including leisure time, job and household activities over the past year (IPAQ Research Committee 2005).

Definition of terms and outcome measurement

In the current study, age-groups were categorized as 18–34 years and 35–54 years to allow for comparisons in different adult developmental stages (young, middle and

older adulthood) and it to be in line with related studies (Yi et al. 2017). Education was categorized at three levels: (1) high (> 12 years of education, reference group), (2) intermediate (6–12 years) and (3) illiterate/low (< 6 years). Physical activity was considered high (reference group) if subjects achieved more than 600 MET (metabolic equivalent task)-minutes per week (IPAQ Research Committee 2005). Marital status was defined as married versus unmarried (single/divorced/widowed, reference group). Smoking status was categorized in three groups: 1—current smoker: subjects who reported use of any tobacco product (cigarettes or water pipe) daily or occasionally at the time of examination; 2—past smoker: subjects who had been smokers but had quit before the study initiation; and 3—never smokers. Passive smoking was attributed to non-smoker subjects who answered "yes" to the following questions: "Are you exposed to tobacco smoke at home?" or "are you exposed to tobacco smoke at your workplace or where you study?" Participants were also classified based on belonging to the intervention group (yes vs. no) at baseline. Smoking outcome was defined based on self-reports of smoking among subjects who were at risk of initiating smoking during the study period (i.e., never smokers at baseline). Accordingly, smoking initiators were subjects who became a current smoker at any of the follow-up examinations.

Statistical analysis

Sex-specific baseline characteristics of respondents and non-respondents (participants with missing data of smoking status or any model covariates at baseline (2002–2005) or with no follow-up data regarding smoking status) are presented as mean (standard deviation: SD) or frequency (%), for continuous and categorical variables, respectively, and compared using Student's T test or Chi-squared test, as appropriate. Cumulative initiation ratio of smoking and the 95% CIs were calculated for each gender and age-group by dividing the total number of new smokers by the total number of subjects in that group; initiation rate of smoking was also calculated per 1000 person-years of follow-up and was age-standardized using 2006 data from the National Census Bureau on the Iranian population. To be comparable with other studies, the corresponding rates were also calculated for the whole population. Cox proportional hazards models were applied to assess the effect size of potential determinants with smoking initiation. Event date was defined as the mid-time between the dates of the follow-up visit at which a subject reported smoking for the first time and the last follow-up visit preceding smoking initiation; for new smokers, follow-up duration was the time interval between entering the study and the event date. Censoring was defined as leaving the residential area, death, loss to follow-up or remaining in the study without initiating smoking until the end of follow-up (18 April 2018). For censored and lost to follow-up subjects, follow-up duration was the time interval between the first and last observation dates. To build the multivariate Cox proportional hazards models, age-group, education, physical activity, marital status, passive smoking at home or workplace and intervention group were entered as covariates. Interactions between sex and intervention with all of the other covariates were investigated by producing interaction terms in the multivariable models. Accordingly, there were marginally significant interactions between sex with age-group ≥ 55 years ($p = 0.058$) and education < 6 years ($p = 0.051$) in the multivariate sex-adjusted model; hence, the models were stratified by sex to further explore the potential gender differences in smoking determinants. However, no significant interactions were found between model covariates with intervention group in the multivariate sex-stratified models (all p values > 0.4); hence, the models were not stratified by intervention group to reach full statistical power. The proportional hazards assumption was not rejected using the Schoenfeld global test of residuals and log–log survival plots.

Kaplan–Meier analysis with log-rank test was performed to compare smoking initiation among men and women. Potential determinants of smoking initiation were selected based on the existing literature (Freedman et al. 2012; O'Loughlin et al. 2014; Yi et al. 2017).

All analyses were performed using IBM SPSS for Windows version 21 and STATA version 12 SE (StataCorp LP, TX, USA), with two-tailed p values < 0.05 considered significant.

Results

The study population consisted of 1747 men and 4359 women with mean ages (SD) of 44.3 and 41.4 years, respectively. As shown in Table 1, compared with non-respondents, respondents were about 2 years older, had about 2 cm higher WC, higher rate of marriage (15% among men and 18.9% among women), 9% higher rate of passive smoking among men versus 4.1% lower rate among women, and were more educated among men. Other characteristics, including physical inactivity and receiving intervention, were similar between respondents and non-respondents.

Figure 2 illustrates the Kaplan–Meier failure curves for men and women, indicating a significantly higher probability of initiation during the follow-up period among men ($p < 0.001$). During median 12.11-year follow-up (interquartile range: IQR, 2.46) of 6106 eligible participants, i.e., 63021.3 person-years of follow-up, 252 men (14%)

Table 1 Baseline (2002–2005) characteristics of study participants and non-responders by gender: Tehran Lipid and Glucose Study, Iran, 2002–2018

Baseline characteristics	Men			Women		
	Respondents (n = 1747)	Non-respondents (n = 416)	Difference (95% CI)	Respondents (n = 4359)	Non-respondents (n = 641)	Difference (95% CI)
Continuous variables						
Age (years)	44.3 (16.4)	42.2 (20.5)	**2.2 (0.0, 4.3)**	41.4 (14.8)	39.4 (17.9)	**2.0 (0.6, 3.5)**
BMI (kg/m^2)*	26.4 (4.1)	25.8 (5.3)	0.6 (− 0.1, 1.2)	28.0 (5.1)	27.3 (5.9)	**0.6 (0.1, 1.1)**
Waist circumference (cm)*	93.4 (11.0)	91.2 (12.8)	**2.2 (0.6, 3.8)**	89.2 (13.2)	87.7 (15.5)	**1.5 (0.2, 2.8)**
Categorical variables						
Age-group (y/o)						
18–34	558 (31.9)	185 (44.5)	**− 12.5% (− 17.7, − 7.2)**	1639 (37.6)	304 (47.4)	**− 9.8% (− 13.9, − 5.7)**
35–54	658 (37.7)	102 (24.5)	**13.1% (8.4, 17.8)**	1773 (40.7)	184 (28.7)	**12.0% (8.2, 15.8)**
≥ 55	531 (30.4)	129 (31.0)	− 0.6% (− 5.5, 4.3)	947 (21.7)	153 (23.9)	**− 2.1% (− 5.7, 1.4)**
Married	1390 (79.6)	268 (64.6)	**15.0% (10.0, 20.0)**	3301 (75.7)	364 (56.9)	**18.9% (14.8, 22.9)**
Education level (years)						
> 12	356 (20.4)	64 (15.5)	**4.8% (0.8–8.8)**	534 (12.3)	71 (11.2)	1.1% (− 1.5, 3.7)
6–12	961 (55.0)	221 (53.6)	1.4% (− 4.0, 6.7)	2330 (53.5)	340 (53.5)	0.0% (− 4.2, 4.1)
< 6	430 (24.6)	127 (30.8)	**− 6.2% (− 11.1, − 1.3)**	1495 (34.3)	224 (35.3)	1.0% (− 4.9, 3.0)
Low physical activity	967 (55.4)	98 (63.2)	− 7.8% (− 15.8, 0.0)	2816 (64.6)	261 (61.8)	2.8% (− 2.1, 7.6)
Passive smoker	406 (23.2)	32 (14.2)	**9.0% (4.0, 14.0)**	782 (17.9)	106 (22.1)	**− 4.1% (− 8.1, − 0.3)**
Intervention group†	803 (46.0)	194 (46.6)	− 0.6% (− 6.0, 4.7)	2047 (47.0)	322 (50.2)	− 3.3 (− 7.4, 0.9)

Data are mean (SD) for continuous variables and n (%) for categorical variables. Non-respondents were participants with missing data of smoking status (n = 359) or any model covariates at baseline (n = 144) or with no any follow-up data regarding smoking status (n = 554)

*Data were available for 1715 male and 4072 female respondents and 278 male and 506 female non-respondents, respectively

†The intervention group was offered education on lifestyle modifications including avoidance of smoking, as part of a prospective, non-randomized, controlled community intervention trial. BMI, body mass index. Data are means (SD) or proportions. p values for between-group differences were calculated with the Student's T test or Chi-squared tests as appropriate. Significant values (p value ≤ 0.05) are bold

and 294 women (7%) initiated smoking; crude initiation rates (95% CI) of smoking were 13.99 (12.37–15.83), 6.10 (5.44–6.84) and 8.25 (7.58–8.97) per 1000 person-years for men, women and the whole population, respectively. The corresponding age-standardized initiation rates per 1000 person-years (95% CI) were 19.05 (19.04–19.07) among men and 8.33 (8.31–8.34) among women, and the age- and sex-adjusted initiation rate was 13.77 (12.59–14.94) in the whole population. The highest rate of initiation was related to the youngest age-group (18–34 years) among both men and women and decreased considerably after the age of 35 years among both genders (Table 2). Seventy-eight percent of the initiators were using only water pipes (75% men and 81% women). The remaining initiators were using just cigarettes (13%) or along with water pipes (9%).

The associations of potential determinants of smoking initiation in the multivariable model are illustrated in Table 3 for both genders. Accordingly, among men, compared with subjects 18–34 years old, older age-groups including subjects 35–54 and ≥ 55 years old were at lower risk of initiation by HRs 0.43 (0.30–0.62) and 0.23 (0.14–0.38), respectively. Being married also decreased the risk [0.67 (0.48–0.92)]. Significant risk factors for smoking initiation were intermediate level of education [1.61

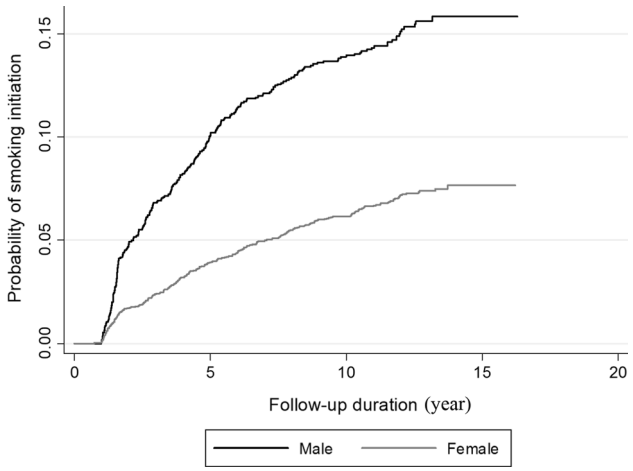

Fig. 2 Kaplan–Meier curves for initiation of smoking among adult men and women. Tehran Lipid and Glucose Study, Iran, 2002–2018 (log-rank $\chi^2 = 96.08$, $p < 0.001$ for equality of failure functions between men and women)

(1.14–2.26)] and passive smoking [1.76 (1.36–2.28)]. Low-level education also increased the risk among men by 49%, although not significantly. Similarly, among women, older age-groups decreased the risk [0.34 (0.25–0.46) for 35–54-year-olds and 0.15 (0.08–0.27) for ≥ 55-year-olds]. Marriage decreased the risk of smoking initiation [0.58 (0.45–0.74)]. Intermediate level of education [1.33 (0.95–1.84), p value = 0.092] and passive smoking [1.82 (1.42–2.33)] increased the risk. Educational intervention decreased risk of smoking initiation among both genders but was statistically significant only among women [0.74 (0.58–0.94)]. Physical activity level was not a significant determinant factor in any gender.

Discussion

In this large cohort study with median 12-year follow-up, we found the initiation rate of smoking to be 19.1 for men and 8.3 for women, per 1000 person-years among Tehranian adults. Moreover, we showed that the incidence of smoking was significantly higher in men across all age-groups. Among both genders, the highest initiation rate was at the youngest age-group (18–34 years old) but was drastically lower in older groups. In addition to younger age, passive smoking and lower level of education generally increased the risk of smoking initiation in both genders, while being married had a protective effect. Importantly, we also showed that the educational intervention significantly reduced smoking initiation by over 25% among women.

Table 2 Smoking initiation rate per 1000 person-years by age-group. Tehran Lipid and Glucose Study, Iran, 2002–2018

Age, year	No. of participants	Person-years of follow-up	New smokers	Initiation rate (95% CI) per 1000 person-years
Men				
18–34	558	5298.8	158	29.8 (25.5–34.9)
35–54	658	7352.6	68	9.3 (7.3–11.7)
≥ 55	531	5359.2	26	4.9 (3.3–7.1)
Total	1747	18,010.6	252	14.0 (12.4–15.8)[†]
				19.1 (16.9–21.2)[‡]
Women				
18–34	1639	17,618.2	211	12.0 (10.5–13.7)
35–54	1773	20,557.3	69	3.36 (2.65–4.25)
≥ 55	947	10,033.8	14	1.4 (0.8–2.4)
Total	4359	48,209.2	294	6.1 (5.4–6.8)[†]
				8.3 (7.4–9.2)[‡]
Whole population				
18–34	2197	22,917.0	369	16.1 (14.5–17.8)
35–54	2431	27,909.9	137	4.9 (4.2–5.8)
≥ 55	1478	15,393.0	40	2.6 (1.9–3.5)
Total	6106	66,219.9	546	8.3 (7.6–9.0)[†]
				13.77 (12.59–14.94)[§]

[†]Crude smoking initiation rate

[‡]Age-standardized initiation rate based on the 2006 Iranian population data from the National Census Bureau

[§]Age- and sex-adjusted initiation rate

Table 3 Sex-specific hazard ratios (HR) and 95% confidence intervals (CI) from the multivariable analysis of potential determinants of smoking initiation. Tehran Lipid and Glucose Study, Iran, 2002–2018

Risk factors	Men		Women	
	HR (95% CI)	*p* value	HR (95% CI)	*p* value
Age (years)				
18–34	Reference	–	Reference	–
35–54	**0.43 (0.30–0.62)**	**< 0.001**	**0.34 (0.25–0.46)**	**< 0.001**
≥ 55	**0.23 (0.14–0.38)**	**< 0.001**	**0.15 (0.08–0.27)**	**< 0.001**
Education (years)				
> 12	Reference	–	Reference	–
6–12	**1.61 (1.14–2.26)**	**0.007**	1.33 (0.95–1.84)	0.092
< 6	1.49 (0.90–2.46)	0.122	1.00 (0.61–1.64)	0.998
Low physical activity	1.04 (0.81–1.34)	0.743	0.99 (0.78–1.26)	0.938
Married	**0.67 (0.48–0.92)**	**0.014**	**0.58 (0.45–0.74)**	**< 0.001**
Passive smoker	**1.76 (1.36–2.28)**	**< 0.001**	**1.82 (1.42–2.33)**	**< 0.001**
Intervention group*	0.81 (0.63–1.05)	0.106	**0.74 (0.58–0.94)**	**0.013**

Multivariate Cox proportional hazards models were built to calculate HRs and 95% CIs for age-group, education, physical activity, marital status, passive smoking and intervention group. Statistically significant values (p value < 0.05) are in bold

*The intervention group was offered education on lifestyle modifications including avoidance of smoking, as part of a prospective, non-randomized, controlled community intervention trial

To our knowledge, studies on smoking initiation among adults were limited and used different definitions and approaches to calculate initiation rates; therefore, it is difficult to compare our findings with other studies in this field. Compared with the crude initiation rate per 1000 person-years in Europe, the corresponding rate in our male population was remarkably higher than those reported among men residents in different parts of Europe in the 21–35-year age-group during 2000–2009 (Marcon et al. 2018). However, data from Europe were mainly attributed to cigarette smoking. Indeed, the highest initiation rate in this period was reported to be 8.9 per 1000 person-years, attributable to the male residents, aged 21–25 years, in East Europe (Marcon et al. 2018). Moreover, in longitudinal cohorts from US adults the initiation rates of cigarette smoking were 3.8% in 2002–2003 and 3.2% in 2010–2011, among the 18–29-year-old population, over twofold that of tobacco use for the 18–34-year-old population in our study (1.6 per 100 person-years) (Yi et al. 2017).

Regarding gender differences in smoking habits, previous studies showed significantly higher prevalence of smoking among men compared to women in Iran (Fotouhi et al. 2009; Meysamie et al. 2010, 2012; Moosazadeh et al. 2013). In the current study, our results confirm data available, i.e., men have remarkably higher rates of smoking initiation, across all age-groups, a rate > twofold that of women. It is important to note that Iranian women are more likely to underreport smoking habits, given the social stigma of smoking for them (Sarraf-Zadegan et al. 2004). Similar gender differences have been indicated by other studies conducted among US young adult and adult populations (Bernat et al. 2012; Yi et al. 2017).

Regarding the determinants of smoking initiation, the risk increased remarkably among younger men and women of our study, which was in line with studies from the USA (Yi et al. 2017) and New Zealand (Edwards et al. 2013). Furthermore, Iranian cross-sectional studies have reported the mean ages of smoking initiation to be 20.5 years at the national level (Meysamie et al. 2010) and 25.5 years in Tehran (Fotouhi et al. 2009). It is important to note that in our study, about 80% of the smoking initiators in the younger age-group smoked tobacco with water pipes only. National reports from Iran also attribute the highest prevalence of water pipe smoking to young males, aged 15–24 years (Nemati et al. 2017). Generally, this high popularity of water pipe smoking might be due to the common belief that this form of tobacco use is less harmful and addictive, and more socially acceptable than cigarette smoking (Akl et al. 2013); the fact is that water pipe smoking has been associated with major diseases such as chronic obstructive pulmonary disease, oral cancer and lung cancer (Waziry et al. 2016) and is an addictive behavior which can also lead to cigarette initiation (Akl et al. 2013). In addition, younger smokers have been shown to worry less about the impact of smoking on their health (Kviz et al. 1995). Moreover, immaturity, impulsive behaviors and susceptibility to initiating smoking under environmental influences might additionally fuel smoking initiation among the youth (Edwards et al. 2013). Overall, these findings indicate that preventive smoking strategies

in Iran are vital to managing water pipe smoking in young adults.

In addition to age, we found that lower education (intermediate-level versus high-level education) increased the risk of smoking initiation among both genders. Although in a population-based cross-sectional study from Tehran, Fotouhi et al. indicated that compared with the illiterate, higher education was associated with prevalent cigarette smoking among adults, the intensity of smoking was higher in those with lower levels of education (Fotouhi et al. 2009). In line with our findings, smoking initiation has been observed to decrease with increasing levels of education (Yi et al. 2017). Overall, these data demonstrate that the highly educated may be less susceptible to initiate health-risking behaviors.

In our study, we failed to find any significant association between low physical activity and smoking initiation, a finding in agreement with a previous study documented on young Canadian adults (O'Loughlin et al. 2014). However, nearly 60% of the studies from a relevant systematic review showed a negative association between smoking and physical activity; yet, this association was often attenuated or reversed in men (Kaczynski et al. 2008). Hence, as acknowledged by Kaczynski et al. "Smoking and physical activity are largely incongruent behaviors" (Kaczynski et al. 2008).

Our results regarding marital status were in line with a study from the USA (Yi et al. 2017), indicating the positive impact of marriage on smoking behaviors; in fact, Yi et al. showed that not only married people were less likely to initiate smoking, but they were also more likely to quit (Yi et al. 2017). Notably, this favorable impact of marriage may be modified by economic conditions (Lindstrom 2010).

Exposure to household smoking in a meta-analysis was shown to be a strong determinant of smoking initiation among adolescents (aged $\leq$ 19 years), although there is a remarkable heterogeneity between studies ($I2 = 80\%$) (Leonardi-Bee et al. 2011). However, passive smoking during adolescence was not associated with smoking initiation during young adulthood among Canadians (O'Loughlin et al. 2014). Among young adults, it appears that passive smoking, especially by friends, increases the risk of initiation (Bernat et al. 2012); our findings support evidence of the above-mentioned studies by reporting passive smoking, including household or work/study place exposure, as one of the strongest determinants of smoking initiation among adults, increasing the risk by 80% in both genders.

Considering adolescents as the population most vulnerable to smoking initiation (National Center for Chronic Disease et al. 2012; O'Loughlin et al. 2014), most previous studies investigating the implementation of anti-smoking educational interventions have been limited to adolescents, showing positive effects, especially when using family-based approaches (Thomas et al. 2016). Our results indicate the positive impact of the educational intervention among adults to be significant only among women, indicating that women might be more attentive to their health and also more likely to accept health education information from professionals. Previous studies also showed that women were more sensitive to anti-smoking warning labels (Kollath-Cattano et al. 2017; Villanti et al. 2013).

The strengths of our study are that it was a long-term cohort study conducted on a large population with valid data of smoking status and its potential determinants and high response rates for both genders. Moreover, to our best knowledge, this is the first study to report on smoking initiation rate and its risk factors among adults in the EMR.

There are also limitations to consider. Firstly, we have relied on self-reports for smoking status instead of using the cotinine test, which may lead to underestimation in our results (Sarraf-Zadegan et al. 2004); however, this underestimation might be more relevant among adolescents (Newell et al. 1999). Moreover, we tried to minimize this limitation by maintaining the privacy of individuals during interviews (Parizadeh et al. 2018). Secondly, due to the 3-year intervals between follow-ups, we cannot precisely determine the exact age and time of smoking initiation; hence, similar to epidemiological studies with such outcomes (Mirbolouk et al. 2016; Ruiz-Alejos et al. 2018), we have used the mid-time of follow-ups as an estimation of the event date. Thirdly, our results are derived from a metropolitan city and might not be generalizable to rural populations. Fourthly, due to the time-varying nature of education, physical activity, marital status and passive smoking, our results are subject to unadjusted time-varying confounding (Mansournia et al. 2017). Fifthly, we could not present more detailed age-groups since this would lead to very low number of events, especially among the elderly age-groups, e.g., less than 14 events among women $\geq$ 55 years. Finally, our study is subject to residual confounding, considering the various social, environmental and personal factors that could potentially contribute to smoking. Some examples are use of alcohol or other substances, stress, income and self-esteem (Freedman et al. 2012; Wellman et al. 2016).

In conclusion, we showed that in a Middle Eastern adult population, during over a decade of follow-up, an initiation rate of over 11 per 1000 person-years for smoking was observed, which was mostly attributed to water pipe use. This rate was remarkably higher among men compared with women (30 vs. 12) and in younger age-groups. Among modifiable risk factors, passive smoking, being single and having lower levels of education are more conducive to smoking initiation. Importantly, we also showed that

among adults, educational interventions could be protective against smoking initiation, particularly among women.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict interest.

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