International Journal of Behavioral Medicine (2020) 27:698–706
https://doi.org/10.1007/s12529-020-09910-8

FULL LENGTH MANUSCRIPT

The First Cigarette Smoking Experience and Future Smoking Behaviors Among Adolescents with Different Parental Risk: a Longitudinal Analysis in an Urban Iranian Population

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Published online: 15 July 2020

Abstract

Background Longitudinal research among Iranian adolescent smoking is limited. The current study aimed to investigate (1) the first smoking experience (FSE) and future smoking behaviors of adolescents with different parental risk factors and (2) the association between age of the FSE and future smoking behaviors over a 12-year follow-up.

Method Based on Tehran Lipid and Glucose Study (TLGS) database, 1487 adolescents (12–18 years) with complete baseline parental data were recruited. Using two-step cluster analysis, families were classified as either high or low risk; these were based on parental risk factors including age, education, employment, and smoking status. Participants were examined four times in 12 years and their data were used for survival analysis. After exclusion of 24 cases who were smokers at baseline, Cox proportional hazard modeling was used to evaluate the effect of parental clusters on the FSE in 1463 nonsmoking adolescents who completed all prospective follow-ups. Logistic regression analysis was used to examine the effect of the age of FSE on future smoking behaviors.

Results The mean age of adolescents was 14.63 ± 2.07 years at baseline. Adolescents in the high-risk cluster group were 49% more likely to try smoking for their first time, and 55% more likely to smoke in the future. Compared with girls, boys had 83% higher chance of trying their first cigarette. Moreover, 1-year delay in the FSE resulted in 25% reduction in the probability of smoking in the future.

Conclusion The findings show that compared with adolescents living in low-risk families, teenagers living in high-risk families are at greater risk of smoking at an earlier age; therefore, this group could benefit from gender- and culture specific preventive interventions.

Keywords Smoking initiation · Adolescents · Parental characteristics · Cluster analysis

Background

The World Health Organization (WHO) reports 1.1 billion smokers worldwide with more than 24 million smokers being children aged 13–15 years [1, 2]. Though there is a decreasing global trend in the prevalence of tobacco smoking, it appears to be increasing in low- and middle-income countries, where 80% of smokers worldwide are currently living. The WHO predicts that this upward trend will continue until 2025 in the Eastern Mediterranean region if preventive and educational measures on tobacco consumption are not strengthened [2]. Data from the Global Youth Tobacco Survey 2016 (GYTS) shows that 3.4% and 14.2% of Iranian students aged 13–15 years are current and ever cigarette smokers, respectively [3]. Recent Iranian studies also demonstrate an increase in

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cigarette smoking among Iranian adults and adolescents [4, 5]. Most adult smokers start smoking before the age of 18 [6], and the risk of continuing smoking into later life is directly associated with the age of its initiation; the younger the first experience of tobacco, the higher the risk of long-term persistent smoking [7]. This underscores the importance of designing intervention programs that target at-risk groups from an early age with the goal of thwarting initial tobacco use in adolescence.

Studies of youth smoking status have utilized varied definitions for smoking onset: ranging from "tried only a puff," "smoking first whole cigarette," "smoking occasionally" to "daily smoking" [8–12]; this variation in definitions along with different study and sampling designs makes it difficult to draw precise conclusions regarding the sets of predictors for each stage of smoking. However, in a recent systematic review, Wellman et al. [13] examined 53 longitudinal population-based studies of predictors of smoking onset in nonsmoking adolescents. Investigating 98 potential predictors at an individual and social (family or friend) level, they found that older adolescents, who had lower grades in school, rebelliousness, and lower socioeconomic status (SES) and had a smoker in their family/friends and media exposure, were consistently at higher risk of picking up the smoking habit [13]. Parental influences on children's smoking initiation have been widely investigated [14, 15]. Although a direct link between parental SES (education and occupation) and adolescents' smoking status has been shown previously, there may be complex interrelationships among these parental factors. In other words, high-risk behaviors (e.g., more smoking and less physical activity) tend to cluster in families with lower levels of SES [16]. Interrelationships of these factors in the family environment might discriminate family types in terms of level of risk for adolescent smoking. Moreover, parents' response and ability to manage adolescent problem behaviors (including tobacco use) through their parenting strategies were also shown to be heavily affected by SES [17]. Anti-smoking parenting strategies in the family environment (such as in-depth discussions about health and safety and clear communications about smoking) are quantitatively and qualitatively weaker in families with lower education levels; moreover, these strategies are far more effective in families with nonsmoking parents [18, 19].

Children from different racial and cultural backgrounds exhibit different smoking behaviors [13]. It has been shown that disparities in smoking behavior originate from individual and environmental factors [20]. This fact highlights the necessity to individually examine the causes of initiating smoking in children and teens with different backgrounds. Although valuable information is gained from data of longitudinal studies conducted on stages of adolescent smoking in developed countries, developing countries still lack substantial information about adolescents' smoking patterns and the related predictors. The only prospective study in the Eastern Mediterranean region was conducted in Jordan [21], which reported the mean age of initiating/starting smoking to be 14.6 years for students. According to studies conducted in Iran, the mean age of smoking initiation was 12.5 years [22]. Family SES, poor family relationships, peer pressure, and feeling of enjoyment after using tobacco were associated with smoking initiation in Iranian adolescents [22, 23]. Age, parent's occupation, and parental and peer smoking status were among the strongest predictors of current smoking in Iranian adolescents [22, 24, 25].

To the best of our knowledge, the current study is the second longitudinal report on smoking initiation among adolescents in the Eastern Mediterranean region and the first one in Iran. In addition, a thorough review of literature revealed that the current investigation is the first endeavor to examine the simultaneous effect of parental risk factors by using cluster analysis and also to demonstrate their relationships with adolescent smoking behaviors. Most existing studies have neglected the synergistic effect of parental factors, and hence have not reported their simultaneous outcome. The present study therefore aimed to investigate (1) the first smoking experience and its parental correlates and (2) the association between future smoking behaviors and the age of their first smoking experience in Tehranian adolescents over a 12-year community-based study.

Methods

Study Design and Population

This study was carried out within the framework of the Tehran Lipid and Glucose study (TLGS), a longitudinal population-based prospective study which was designed to determine the risk factors of non-communicable diseases in a sample of residents from district 13 of Tehran, Iran. Age distribution and socioeconomic status of the population in district no. 13 are representative of the overall population of Tehran [26]. Details of the study rationale, design, and sampling procedure of the TLGS have been published elsewhere [27]. To summarize, in the TLGS, a multistage cluster random sampling method was used to recruit the study population; three medical health centers in district no. 13 of Tehran were selected to collect data of almost all the families covered (over 90%) after gaining complete child and parental informed consent. All the members of each family were invited in the cross-sectional phase of the TLGS for baseline measurements (phase I: 1999–2001) and were followed in ongoing prospective follow-ups every 3 years.

In the current study, using TLGS database, 1567 adolescents (aged 12 to 18 years) who participated in the second phase (2002–2004) were recruited. After exclusion of those

with missing baseline parental information ($n = 80$), cluster analysis was performed on the data of 1487 remaining adolescents. Following the exclusion of 24 cases (12 cases who were already smoker at baseline and 12 cases who failed to participate in all prospective follow-ups), a final sample of 1463 nonsmoker adolescents remained and were followed up for the median duration of 12 years. Participants were assessed 4 times (every 3 years) and their data was documented for survival analysis.

Baseline Measurements

Physical Activity Parental physical activity was assessed using the Modifiable Activity Questionnaire (MAQ) [28]; the Persian translation of which has been assessed with acceptable validity and high reliability [29]. In the current study, to calculate the energy expenditure for sport, job, and travel during 1 week, the related metabolic equivalent task (MET) of each particular activity was multiplied by weight and the sum of these was considered total energy expenditure in adults. After calculating total MET value for adults, physical activity level was categorized into three groups of low (< 3000), moderate (3000–6000), and high (> 6000).

Education Education was also categorized into 3 levels based on the participants' total years of education: primary as 0–5 years, secondary as 6–12 years, and higher as having over 12 years of education, including university/tertiary education.

Employment Employment status was classified as employed and unemployed.

Smoking Baseline parental smoking was noted with current smoker being defined as a person who smokes cigarettes daily or occasionally. To assess baseline adolescent smoking, only nonsmoking teenagers were included in the study; they were defined as someone who has never smoked an entire cigarette before.

Outcome Measurements

First Smoking Experience The age of first smoking experience was the primary outcome and was designated as the time variable in the survival analysis. The age of the first smoking experience was defined as the participants' age when having smoked his/her first cigarette in its entirety.

Smoking Status Data on smoking status among adolescents in the Tehran Lipid and Glucose Study (TLGS) was collected using a self-administered questionnaire adapted from Global Youth Tobacco Survey (GYTS) [30]. The other outcome of the current study was the future smoking behavior of studied adolescents who were initially nonsmokers, i.e., the likelihood of them becoming nonsmoking adults (becoming a current smoker throughout the study duration in a sample of nonsmoker adolescents at baseline). Due to the longitudinal nature of the study, smoking status of adolescents was assessed with the appropriate questionnaire according to their age at the time of follow-up throughout the span of the study. Based on the GYTS questionnaire, in participants who were aged < 18 years, a current smoker was defined as a person who has at least smoked a cigarette once in the past 30 days. In participants aged > 18 years, an adult questionnaire was used which meant that a current smoker was defined as a person who smokes cigarette either occasionally or daily.

Statistical Analysis

Two-step cluster analysis was used to assess the simultaneous effect of parental risk factors which affect adolescents' smoking behaviors, i.e., age, smoking, education, employment, and physical activity. Parental education and paternal smoking status were determined to be the most imperative factors. Parental physical activity and mothers' smoking status were not as important in differentiating high/low-risk families and were excluded from cluster analysis. Eventually, families were categorized into low- and high-risk groups. Two-step cluster analysis is a statistical procedure used to identify similar sub-groups or "clusters" of individuals within a data set. The advantages of two-step cluster analysis include the following: (1) the ability to process data of any form of measurement (e.g., binary, Likert, or categorical) simultaneously, (2) being suitable for large data sets, (3) determining the number of clusters automatically, (4) determining the importance of each predictor item and interpreting how it might be significantly different among clusters after analysis [31]. This clustering method assumes that all variables are independent, that continuous variables have a normal distribution, and that both categorical and ordinal variables have a multinomial distribution. If categorical and continuous variables are employed, the log-likelihood algorithm is required, and in a situation where only continuous items need to be analyzed, the Euclidian algorithm can be used. This method gives us the optimum number of clusters based on Schwarz's Bayesian information criterion (BIC). In the current study, as the characteristics of groups are not known prior to starting, the number of clusters was determined automatically using cluster algorithm; based on Bayesian information criteria and log-likelihood as distance measure, optimal parental risk groups were extracted. Subsequently, data on high- and low-risk groups were obtained and parental characteristics were compared between the two risk groups using T test or chi-square test. The survival (Cox PH) method was applied to examine the age of the first smoking experience as a time-to-event variable. In the survival analysis, censoring occurs when a subject leaves the study before an event occurs, or the study ends before the event has

occurred. In the current analysis, data of the adolescents who may not have experienced smoking until the end of the study was included as censored. Using Cox proportional hazard model, the effect of parental risk was evaluated on the first smoking experience and the hazard ratio (HR) of parental risk was calculated on the first smoking experience. The proportional hazard assumption of the Cox model was tested using Shoenfeld residuals and graphical evaluation and was approved. The Cox regression model extends survival analysis methods to simultaneously assess the effects of several risk factors on survival time. The effect estimate of Cox regression is a HR which is the incidence rate of an event in an infinitesimal short time period [32]. Eventually, the association between first smoking experience and future smoking behavior was examined by logistic regression analysis. The effect of adolescent's sex and age as well as parental clusters was adjusted in multiple models. All statistical analysis was done using STATA v13 and IBM SPSS v23.

Results

Identifying the Family Clusters

Figure 1 illustrates the importance of various parental factors in the final clustering model. Using cluster analysis, we assessed the co-occurrence of parental factors that play a role in forming adolescents' smoking (i.e., parental age, education, employment status, smoking, and physical activity). Among parental factors, education level of both parents and fathers' smoking status were the most important predictors in differentiating family risk levels. Parental physical activity and mothers' smoking status were excluded from cluster analysis due to very low level of importance in family differentiation. Eventually, two clusters emerged in terms of level of risk for adolescent smoking which we named high- and low-risk families.

Descriptive statistics of baseline characteristics of both adolescents and their parents in each parental cluster are reported in Table 1; mean age of adolescents was 14.63 ± 2.07 years. Except for maternal smoking habits, all other parental characteristics were significantly different in the high- and low-risk clusters. In the low-risk cluster groups, most mothers (58.9%) and fathers (58.9%) had secondary levels of education. The percentage of unemployed mothers was slightly higher in the high-risk compared with the low-risk cluster (99.0 vs. 81.9%). A greater number of fathers smoked in the high-risk cluster, compared with the low-risk cluster (46.2 vs. 3.3%).

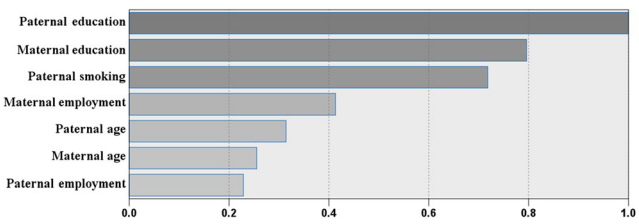

Fig. 1 Factor importance graph in the parental clustering. Both parents' physical activity and mothers' smoking status had non-significant importance in the family classification and were excluded from cluster analysis

Investigating the Age of the First Smoking Experience in Adolescents

The impact of parental cluster on the first smoking experience is displayed in Table 2. In the unadjusted model, the hazard ratio of the first smoking experience was 53% higher in the high-risk families compared with the low-risk ones (HR = 1.53, 95% CI 1.19–1.95; P = 0.001). After adjusting for adolescent's sex and age, the hazard of their first smoking experience was still significantly higher in the high-risk cluster compared with the low-risk (HR = 1.49, 95% CI 1.16–1.92; P = 0.002). In addition, girls were significantly less at risk of having an initial smoking experience compared with boys (HR = 0.17, 95% CI 0.12–0.22; $P < 0.001$).

Figure 2 shows the hazard function of the initial smoking experience in adolescents by parental risk clusters. Based on the adjusted cumulative hazard function, the risk of the smoking experience in adolescents in the high-risk families was higher than that in low-risk ones throughout the whole study period (12 years) ($P = 0.028$). For example, the hazard of having an initial smoking experience up to 21 years of age in the low-risk families is almost 11%, whereas this figure is 17% for high-risk families.

Investigating Future Smoking Behaviors in Adolescents

Table 3 shows the association of adolescents' smoking behavior throughout the 12-year duration of the study with their parental cluster risks (model A) and with the time that their first smoking experience occurred (model B). In the adjusted model, the odds of future smoking in the high-risk cluster was 1.55 times higher than that in the low-risk (OR = 1.55, 95% CI 1.16–2.08; $P = 0.003$). In addition, based on the final adjusted model, 1-year increase in the age of the first smoking experience was related to 25% reduction in the odds of smoking in the future (OR = 0.75, 95% CI 0.66–0.85, $P < 0.001$).

Table 1 Baseline characteristics of adolescents and their parents in the low- and high-risk clusters

	Total ($n = 1487$)	Low risk ($n = 610$)	High risk ($n = 877$)	P value
Adolescents' age	14.63 ± 2.07	14.39 ± 2.04	14.77 ± 2.06	0.001
Adolescents' sex				0.28
Boy	687 (46.2)	271 (44.4)	416 (47.4)	
Girl	800 (53.8)	339 (55.6)	461 (52.6)	
Maternal characteristics				
Age	41.73 ± 6.61	39.54 ± 4.91	43.20 ± 7.19	< 0.001
Education				< 0.001
Primary	630 (42.4)	64 (10.5)	566 (64.5)	
Secondary	586 (39.4)	359 (58.9)	227 (25.9)	
Higher	271 (18.2)	187 (30.7)	84 (9.6)	
Employment				< 0.001
Employed	120 (8.1)	111 (18.2)	9 (1.0)	
Unemployed	1367 (91.9)	499 (81.8)	868 (99.0)	
Smoking status				0.44
Yes	65 (4.4)	23 (3.8)	42 (4.8)	
No	1408 (95.6)	578 (96.2)	830 (95.2)	
Physical activity				0.13
Low	399 (27.2)	149 (24.9)	250 (28.8)	
Moderate	846 (57.7)	364 (60.9)	482 (55.6)	
High	220 (15.0)	85 (14.2)	135 (15.6)	
Paternal characteristics				
Age	47.51 ± 7.73	44.76 ± 5.43	49.41 ± 8.42	< 0.001
Education				< 0.001
Primary	776 (52.2)	160 (26.2)	616 (70.2)	
Secondary	619 (41.6)	359 (58.9)	260 (29.6)	
Higher	92 (6.2)	91 (14.9)	1 (0.1)	
Employment				< 0.001
Employed	1232 (82.9)	589 (96.6)	643 (73.3)	
Unemployed	255 (17.1)	21 (3.4)	234 (26.7)	
Smoking status				< 0.001
Yes	425 (28.6)	20 (3.3)	405 (46.2)	
No	1062 (71.4)	590 (96.7)	472 (53.8)	
Physical activity				0.71
Low	529 (46.3)	229 (47.7)	300 (45.3)	
Moderate	341 (29.9)	141 (29.4)	200 (30.2)	
High	272 (23.8)	110 (22.9)	162 (24.5)	

Discussion

This study prospectively examines the age of the first cigarette smoking experience and future smoking behaviors in adolescents, and at the same time, considers different parental risk clusters. Our results indicate that adolescents living with high-risk parents are more likely not only to experience their first cigarette earlier but also to become a smoker in the future. The present study also shows that when the child's first experience of smoking occurred at a younger age, the likelihood of becoming a smoker in the future was heightened.

This current investigation utilized the most commonly reported family-related predictors of adolescents' smoking in previous studies including age, education, employment, and smoking status of both parents [33] to identify two parental risk clusters (high and low risk). We found impelling evidence that living in high-risk families does have significant detrimental effects on the age of FSE, likelihood of smoking initiation, and the risk of future smoking in adolescents. Parental SES as defined by education level, occupation, and income is reported to be inversely associated with smoking in adolescents [12, 14, 33–36]. In their review article [37], Conrad et al.

Table 2 HR and 95% CI for the effects of parental risk clusters on adolescents' first smoking experience

Models	Predictors	Category	HR (95% CI)	*P* value
Model 1	Cluster	Low risk (Ref.)	1	-
		High risk	1.53 (1.19–1.95)	0.001
Model 2	Cluster	Low risk (Ref.)	1	-
		High risk	1.49 (1.16–1.92)	0.002
	Sex	Male (Ref.)		-
		Female	0.17 (0.12–0.22)	< 0.001
	Age		1.04 (0.98–1.10)	0.21

Model 1: The dependent variable is the time to the first smoking experience occurred. Parental cluster is the only covariate

Model 2: The dependent variable is time to the first smoking experience. Parental cluster and adolescents' sex and age are the covariates

HR hazard ratio, *CI* confidence interval

concluded that 76% of reviewed studies supported the inverse association between SES and adolescent smoking. Ayubi et al. [35] reported that smoking in male Iranian adolescents is strongly related to household economic status, so that more experimental smoking occurs in wealthier adolescents and regular smoking occurs in deprived families. Interestingly, there are studies which demonstrate no significant differences in adolescent smoking by socioeconomic disparity [38, 39]. However, Liu et al. [40] explain that these inconsistencies are results of different stages of tobacco epidemic between developing and developed countries. These findings further emphasize the need for conducting research on parental factors and correlates of adolescent smoking in developing countries, especially when there is limited data available in these regions.

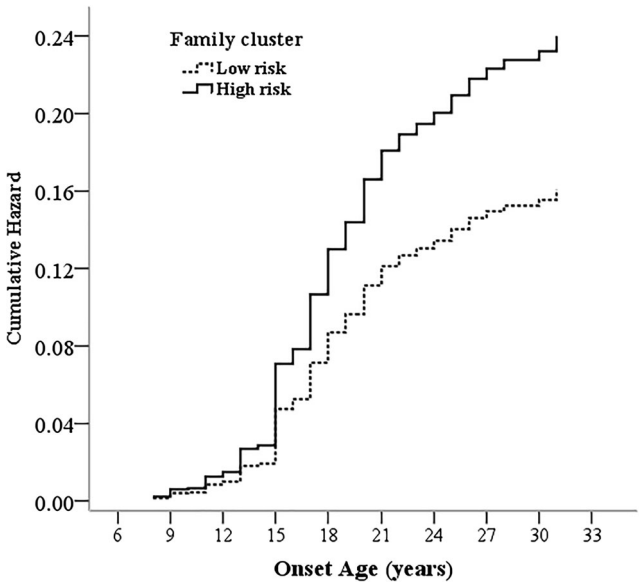

Fig. 2 Cumulative hazard function for the first smoking experience in the adolescents across parental clusters: adjusted cox model

The Iranian families studied in this longitudinal analysis showed a tendency in clustering of socioeconomic indicators (educational and occupational levels) and parental smoking. Essentially, education in both parents and smoking habits just in fathers were the three most important discriminating parameters in family clustering. According to our findings, both parents in low-risk groups were typically more educated as compared with high-risk families, a finding that further embeds the concept that level of education in both parents plays a pivotal role in shaping children's behavior. Several landmark studies have also shown that parental education and adolescents' smoking are directly and inversely correlated [12, 41–45]. In terms of parental employment, our results illustrated that compared with low-risk families, more unemployed parents were in high-risk clusters which usually results in lower household income and lower SES. Although unemployed mothers likely spend more time at home with their children than do employed mothers, they tend to also have lower education levels which may be related to overall health-related knowledge.

We found that a limited number of fathers in the low-risk cluster were smokers, emphasizing the positive impact of a smoke-free family environment on adolescents' behavior towards smoking; findings consistent with those of previous studies that demonstrated children of smoker parents are susceptible to earlier initiation of smoking [11, 15, 21, 43, 46]. In Iran, a recent cross-sectional study revealed that cigarette smoking among fathers increased the risk of current smoking in adolescents [25]. Interestingly, in the current study, mothers' smoking status revealed no meaningful association with parental risk clusters. This could be explained by the sociocultural stigma associated with women smoking in Iran, which may prevent many mothers from honest disclosure of their tobacco use [47].

Based on the current study, boys are more prone to experimental smoking than girls at any age in high-risk families, a gender-specific trend in smoking initiation also seen in a whole host of previous studies. When reviewing 12 studies on 10,831 children and adolescents in nine countries, Okoli et al. [48] concluded that in most regional studies, boys, with the exception of Yemeni and Chinese teenagers, had lower ages of smoking initiation than girls. Regrettably, girls' first smoking experience setting mainly took place at home, while boys tended to smoke their first cigarette at school [48]. In a recent study of Jordanian students [21], a greater percentage of nonsmoker boys initiated smoking in the 8th or 10th grades compared with nonsmoker girls,. Likewise, in Iran, Khosravi et al. [4] showed that the probability of smoking initiation in teenage boys is 8.9-fold higher than that in high school girls. The current study substantiated the results of other studies [49, 50] that also identified a significant association between the age of first smoking experience and future smoking status. Interestingly, when analyzing sex and age, a 1-year delay in

Table 3 Logistic regression: examining the effects of parental cluster and the age of the first smoking experience on future smoking

			OR (95% CI)	*P* value
Model 1A*	Parental clusters	Low risk (Ref.)	1	.
		High risk	1.58 (1.20–2.09)	0.001
Model 1B	Parental clusters	Low risk (Ref.)	1	.
		High risk	1.55 (1.16–2.08)	0.003
	Sex	Male (Ref.)		.
		Female	0.14 (0.10–0.20)	< 0.001
	Age		1.05 (0.98–1.12)	0.19
Model 2A**	Age of the first smoking experience		0.74 (0.66–0.84)	< 0.001
Model 2B	Age of the first smoking experience		0.75 (0.66–0.85)	< 0.001
	Sex	Male (Ref.)		
		Female	0.23 (0.90–0.59)	0.002
	Age		1.18 (0.92–1.53)	0.19

Model 1A: Parental cluster is the only covariate

Model 1B: Parental cluster and adolescents' sex and age are the covariates

Model 2A: The age of the first smoking experience is the only covariate

Model 2B: The age of the first smoking experience and adolescents' sex and age are the covariates

*$n = 1475$: the number of nonsmoker adolescents with complete parental information at baseline

**$n = 288$: the number of adolescents who had experienced smoking for the first time at any time

smoking initiation results in 25% reduced likelihood of future smoking in adolescents. As no previous information or study on Iranians was available vis-à-vis smoking, these findings are of great significance for future gender- and age-targeted interventions and health policies.

This study adds to our limited knowledge about smoking initiation during adolescence in Eastern Mediterranean/countries and is the first from Iran. Moreover, it also highlights the relationships between family types and adolescent smoking behavior using cluster analyses for the first time; as well as examining the effects of parental factors simultaneously on adolescent smoking initiation. The large sample size and the longitudinal design are the other significant strengths of our study, which advanced our knowledge on smoking initiation in the transition period of adolescence to adulthood in the sociocultural context of an urban Iranian population. The current study, however, does have its limitations which are worth considering. Firstly, this analysis employed self-reported data which naturally may be subject to under reporting and recall bias. Secondly, as a part of TLGS, the current study was conducted on urban families; therefore, the results may not be generalized to suburban and rural populations within Iran that may be considerably heterogeneous. Thirdly, our findings infer association between the age of the FSE in adolescents and their parental risk clusters, not their cause and effect relationship. Finally, as a family-based cohort study, we were not able to examine school- and peer-related factors (environment in Tehran) as potential correlates of smoking in adolescents that need to be considered in future researches. Essentially, taking up a smoking habit is considered a part of the development of independence and identity in the critical and vulnerable period between childhood and adulthood, that is, adolescence. Social and psychological models have been used to describe the transition from initiation to becoming a true smoker with a dynamic perspective [51]. Consequently, future qualitative and quantitative sociological and culture-based research is required to further explicate how, when, and why adolescents initiate and continue smoking in Iranian society and developing nations at large. There is clearly a need to examine smoking habit trajectories as a dynamic concept and to evaluate the interactive roles of parents, peers, and the adolescents' own perceptions in this regard.

In conclusion, we can affirm that the present study reveals the synergistic effect of parental factors on the first smoking experience in adolescents. Our findings indicate that adolescents in the high-risk cluster are more likely to experience smoking as well as to become smokers in future. This analysis facilitates the identification of at-risk populations as well as development of strategies to reach out to them with targeted prevention programs. Our findings highlight the necessity of future smoking prevention programs within the family structure that should be tailored specific to gender and culture in relation to smoking initiation in the youth.

Acknowledgments The authors are grateful to all families who participated in the current study. They would also like to acknowledge Ms. Niloofar Shiva for critical editing of English grammar and syntax of the manuscript.

Compliance with Ethical Standards This study was approved by the research ethics committee of the Research Institute for Endocrine Sciences (RIES), Shahid Beheshti University of Medical Sciences. All procedures were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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

Informed Consent Informed consent was obtained from all individual participants included in the study. Prior to data collection, both children and parents were informed about the study procedure and its aims and if the child and parent agreed to participate in the study, parents were asked to sign a written consent form.

Welfare of Animals This article does not contain any studies with animals performed by any of the authors.

References

1. Organization WH. WHO global report on trends in prevalence of tobacco smoking 2000-2025: World Health Organization. p. 2018.
2. Organization WH. WHO report on the global tobacco epidemic, 2019: offer help to quit tobacco use: executive summary: executive summary. 2019.
3. WHO. Global Youth Tobacco Survey-Islamic Republic of Iran. 2018.
4. Khosravi A, Mansournia MA, Mahmoodi M, Pouyan AA, Holakouie-Naieni K. Estimating the transitional probabilities of smoking stages with cross-sectional data and 10-year projection for smoking behavior in Iranian adolescents. Int J Prev Med. 2016;7:101. https://doi.org/10.4103/2008-7802.188602.
5. Parizadeh D, Momenan AA, Amouzegar A, Azizi F, Hadaegh F. Tobacco Smoking: findings from 20 years of the Tehran Lipid and Glucose Study. Int J Endocrinol Metab. 2018;16(4 (Suppl)): e84738. https://doi.org/10.5812/ijem.84738.
6. Harrell JS, Bangdiwala SI, Deng S, Webb JP, Bradley C. Smoking initiation in youth: the roles of gender, race, socioeconomics, and developmental status. J Adolesc Health. 1998;23(5):271–9.
7. Banzer R, Haring C, Buchheim A, Oehler S, Carli V, Wasserman C, et al. Factors associated with different smoking status in European adolescents: results of the SEYLE study. Eur Child Adolesc Psychiatry. 2017;26(11):1319–29. https://doi.org/10.1007/s00787-017-0980-4.
8. World Health Organization. WHO report on the global tobacco epidemic ohtqtuesWHO. 2019.
9. O'Loughlin J, Karp I, Koulis T, Paradis G, Difranza J. Determinants of first puff and daily cigarette smoking in adolescents. Am J Epidemiol. 2009;170(5):585–97. https://doi.org/10.1093/aje/kwp179.
10. Peltzer K. Early smoking initiation and associated factors among in-school male and female adolescents in seven African countries. Afr Health Sci. 2011;11(3):320–8.
11. Chang HY, Wu WC, Wu CC, Cheng JY, Hurng BS, Yen LL. The incidence of experimental smoking in school children: an 8-year follow-up of the child and adolescent behaviors in long-term evolution (CABLE) study. BMC Public Health. 2011;11:844. https://doi.org/10.1186/1471-2458-11-844.
12. Goldade K, Choi K, Bernat DH, Klein EG, Okuyemi KS, Forster J. Multilevel predictors of smoking initiation among adolescents: findings from the Minnesota Adolescent Community Cohort (MACC) study. Prev Med. 2012;54(3–4):242–6. https://doi.org/10.1016/j.ypmed.2011.12.029.
13. Wellman RJ, Dugas EN, Dutczak H, O'Loughlin EK, Datta GD, Lauzon B, et al. Predictors of the onset of cigarette smoking: a systematic review of longitudinal population-based studies in youth. Am J Prev Med. 2016;51(5):767–78. https://doi.org/10.1016/j.amepre.2016.04.003.
14. Tjora T, Hetland J, Aaro LE, Overland S. Distal and proximal family predictors of adolescents' smoking initiation and development: a longitudinal latent curve model analysis. BMC Public Health. 2011;11:911. https://doi.org/10.1186/1471-2458-11-911.
15. Zhao X, White KM, Young RM. Future smoking intentions at critical ages among students in two Chinese high schools. Int J Behav Med. 2019;26(1):91–7. https://doi.org/10.1007/s12529-018-09759-y.
16. Saint Onge JM, Krueger PM. Health lifestyle behaviors among US adults. SSM-population health. 2017;3:89–98.https://doi.org/10.1016/j.ssmph.2016.12.009.
17. Baumrind D. The influence of parenting style on adolescent competence and substance use. J Early Adolesc. 1991;11(1):56–95. https://doi.org/10.1177/0272431691111004.
18. Fearnow M, Chassin L, Presson CC, Sherman SJ. Determinants of parental attempts to deter their children's cigarette smoking. J Appl Dev Psychol. 1998;19(3):453–68.
19. Chassin L, Presson CC, Rose J, Sherman SJ, Davis MJ, Gonzalez JL. Parenting style and smoking-specific parenting practices as predictors of adolescent smoking onset. J Pediatr Psychol. 2005;30(4): 333–44. https://doi.org/10.1093/jpepsy/jsi028.
20. Huang HL, Hsu CC, Peng WD, Yen YY, Chen T, Hu CY, et al. Analysis of influential factors associated with the smoking behavior of aboriginal schoolchildren in remote Taiwanese mountainous areas. J Sch Health. 2012;82(7):318–27. https://doi.org/10.1111/j.1746-1561.2012.00705.x.
21. McKelvey K, Attonito J, Madhivanan P, Yi Q, Mzayek F, Maziak W. Determinants of cigarette smoking initiation in Jordanian schoolchildren: longitudinal analysis. Nicotine Tob Res. 2015;17(5):552–8. https://doi.org/10.1093/ntr/ntu165.
22. Kelishadi R, Mokhtari MR, Tavasoli AA, et al. Determinants of tobacco use among youths in Isfahan, Iran. Int J Public Health. 2007;52(3):173–9.
23. Kelishadi R, Shahsanai A, Qorbani M, Esmaeil Motlagh M, Jari M, Ardalan G, et al. Tobacco use and influencing factors among Iranian children and adolescents at national and subnational levels, according to socioeconomic status: the Caspian-IV Study. Iran Red Crescent Med J. 2016;18(5):e21858. https://doi.org/10.5812/ircmj.21858.
24. Baheiraei A, Soltani F, Ebadi A, Cheraghi MA, Rahimi FA. Family and peer risk factors as predictors of lifetime tobacco use among Iranian adolescents: gender similarities and differences. Global J Health Sci. 2014;6(4):63–75. https://doi.org/10.5539/gjhs.v6n4p63.
25. Kelishadi R, Heshmat R, Shahsanai A, Djalalinia S, Motlagh ME, Keikha M, et al. Determinants of tobacco and hookah smoking in a nationally representative sample of Iranian children and adolescents: the CASPIAN-IV Study. Iran Red Crescent Med J. 2016;18(8):e31099. https://doi.org/10.5812/ircmj.31099.
26. Azizi F. Tehran lipid and glucose study. CVD Prev. 2000;3:242–7.
27. Azizi F, Ghanbarian A, Momenan AA, et al. Prevention of non-communicable disease in a population in nutrition transition: Tehran Lipid and GlucoseStudy phase II. Trials. 2009;10:5. https://doi.org/10.1186/1745-6215-10-5.
28. Kriska AM, Knowler WC, LaPorte RE, et al. Development of questionnaire to examine relationship of physical activity and diabetes in Pima Indians. Diabetes Care. 1990;13(4):401–11.
29. Delshad M, Ghanbarian A, Ghaleh N, Amirshekari G, Askari S, Azizi F. Reliability and validity of the modifiable activity questionnaire for an Iranian urban adolescent population. Int J Prev Med. 2015;6(1):3. https://doi.org/10.4103/2008-7802.151433.

30. Group GYTSC. Global Youth Tobacco Survey (GYTS): Core Questionnaire with Optional Questions, Version 1.2. Atlanta, GA: Centers for Disease Control and Prevention, 2014. 2014.
31. Norušis M. IBM SPSS statistics 19 advanced statistical procedures. New York: Pearson; 2011.
32. Kleinbaum DG, Klein M. Survival analysis: Springer; 2010.
33. Soteriades ES, DiFranza JR. Parent's socioeconomic status, adolescents' disposable income, and adolescents' smoking status in Massachusetts. Am J Public Health. 2003;93(7):1155–60.
34. Mathur C, Erickson DJ, Stigler MH, Forster JL, Finnegan JR Jr. Individual and neighborhood socioeconomic status effects on adolescent smoking: a multilevel cohort-sequential latent growth analysis. Am J Public Health. 2013;103(3):543–8. https://doi.org/10.2105/ajph.2012.300830.
35. Ayubi E, Sani M, Safiri S, Khedmati Morasae E, Almasi-Hashiani A, Nazarzadeh M. Socioeconomic determinants of inequality in smoking stages: a distributive analysis on a sample of male high school students. Am J Mens Health. 2017;11(4):1162–8. https://doi.org/10.1177/1557988315585822.
36. Hanson MD, Chen E. Socioeconomic status and health behaviors in adolescence: a review of the literature. J Behav Med. 2007;30(3):263–85. https://doi.org/10.1007/s10865-007-9098-3.
37. Conrad KM, Flay BR, Hill D. Why children start smoking cigarettes: predictors of onset. Br J Addict. 1992;87(12):1711–24.
38. Paavola M, Vartiainen E, Haukkala A. Smoking from adolescence to adulthood: the effects of parental and own socioeconomic status. Eur J Pub Health. 2004;14(4):417–21. https://doi.org/10.1093/eurpub/14.4.417.
39. Richter M, Leppin A. Trends in socio-economic differences in tobacco smoking among German schoolchildren, 1994-2002. Eur J Pub Health. 2007;17(6):565–71. https://doi.org/10.1093/eurpub/ckm010.
40. Liu Y, Wang M, Tynjälä J, Villberg J, Lv Y, Kannas L. Socioeconomic differences in adolescents' smoking: a comparison between Finland and Beijing, China. BMC Public Health. 2016;16(1):805.
41. Yanez AM, Leiva A, Estela A, Cukic I. The associations of personality traits and parental education with smoking behaviour among adolescents. PLoS One. 2017;12(3):e0174211. https://doi.org/10.1371/journal.pone.0174211.
42. Mahabee-Gittens EM, Xiao Y, Gordon JS, Khoury JC. The dynamic role of parental influences in preventing adolescent smoking initiation. Addict Behav. 2013;38(4):1905–11. https://doi.org/10.1016/j.addbeh.2013.01.002.
43. Kelishadi R, Shahsanai A, Qorbani M, Ardalan G, Poursafa P, Heshmat R, et al. Exposure to hookah and cigarette smoke in children and adolescents according to their socio-economic status: the CASPIAN-IV Study. Iran J Pediatr. 2016;26(4):e3036. https://doi.org/10.5812/ijp.3036.
44. Barrera DJ. Gender differences in the transmission of smoking from Filipino parents to their offspring: the role of parenting, school climate, and negative emotions. Subst Use Misuse. 2017;52(11):1439–48. https://doi.org/10.1080/10826084.2017.1284237.
45. Fida HR, Abdelmoneim I. Prevalence of smoking among male secondary school students in Jeddah, Saudi Arabia. J Fam Community Med. 2013;20(3):168–72.
46. Okoli CT, Kodet J. A systematic review of secondhand tobacco smoke exposure and smoking behaviors: smoking status, susceptibility, initiation, dependence, and cessation. Addict Behav. 2015;47:22–32. https://doi.org/10.1016/j.addbeh.2015.03.018.
47. Amiri P, Mohammadzadeh-Naziri K, Abbasi B, Cheraghi L, Jalali-Farahani S, Momenan AA, et al. Smoking habits and incidence of cardiovascular diseases in men and women: findings of a 12 year follow up among an urban Eastern-Mediterranean population. BMC Public Health. 2019;19(1):1042. https://doi.org/10.1186/s12889-019-7390-0.
48. Okoli C, Greaves L, Fagyas V. Sex differences in smoking initiation among children and adolescents. Public Health. 2013;127(1):3–10. https://doi.org/10.1016/j.puhe.2012.09.015.
49. Azagba S, Baskerville NB, Minaker L. A comparison of adolescent smoking initiation measures on predicting future smoking behavior. Prev Med Rep. 2015;2:174–7. https://doi.org/10.1016/j.pmedr.2015.02.015.
50. Reidpath DD, Davey TM, Kadirvelu A, Soyiri IN, Allotey P. Does one cigarette make an adolescent smoker, and is it influenced by age and age of smoking initiation? Evidence of association from the U.S. Youth Risk Behavior Surveillance System (2011). Prev Med. 2014;59:37–41. https://doi.org/10.1016/j.ypmed.2013.11.011.
51. Davey G, Zhao X. Turning points to becoming a tobacco smoker: smoking initiation and identity change among Chinese youth. Symb Interact. 2019. https://doi.org/10.1002/symb.442.