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Age of tobacco smoking initiation among Iranian adults based on National and Subnational data from the 2021 STEPS survey

Short title: Tobacco Smoking Onset Age in Iran

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Tobacco smoking is a significant global public health challenge, responsible for 8 million deaths annually. This study aimed to analyze the age of smoking initiation and its sociodemographic determinants among Iranian adults, based on data from the 2021 STEPwise approach to surveillance (STEPS) survey, to inform targeted public health interventions. The analysis of 27,874 adults revealed that the average initiation ages for cigarette and hookah smoking were 22.2 years and 24.9 years, respectively. Men typically began smoking earlier than women, with average ages of 21.9 years for males and 27.7 years for females. No significant differences were observed in smoking initiation ages between rural and urban areas. Education level and marital status were also influential, with the youngest initiators having 7–12 years of education and being single. This study highlights the significant roles of gender, education, and urban-rural differences in smoking initiation in Iran. The findings underscore the need for targeted public health strategies conforming to the WHO's MPOWER initiatives and the Framework Convention on Tobacco Control (FCTC). Increased investment in public health, focusing on education and preventive measures, is crucial to reduce early smoking initiation and its associated health risks, ultimately supporting broader health policy goals.

Keywords Age of onset, Tobacco Smoking, Tobacco Use, Cigarette smoking, Smoking Water pipes, Iran

Abbreviations
NCD   Noncommunicable disease
WHO   World Health Organization
CDC   Centers for Disease Control and Prevention
CI   Confidence interval
OR   Odds ratio
FCTC   Framework Convention on Tobacco Control

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Tobacco smoking, the most significant behavioral risk factor for noncommunicable diseases (NCDs), accounts for approximately 8 million deaths globally each year[1,2]. The widespread prevalence of cigarette smoking, followed by hookah smoking, underscores the urgent need for comprehensive tobacco control measures[3,4]. The age at which individuals begin smoking is critically associated with long-term adverse outcomes, including an increased risk of developing chronic diseases, facing educational challenges, engaging in substance abuse, and encountering psychosocial issues[5]. Moreover, smoking initiation at a young age significantly increases the risk of lung cancer, thereby reducing life expectancy by at least a decade compared to that of nonsmokers[6,7].

Addressing tobacco use requires a multifaceted approach, encompassing global strategies and legal acts such as the World Health Organization's (WHO's) Framework Convention on Tobacco Control (FCTC) and the MPOWER measures[8]. These strategies aim to monitor tobacco use, protect people from tobacco smoke, help people quit tobacco, warn people about the dangers of tobacco, enforce advertising bans, and raise tobacco taxes. They represent a concerted effort to curtail tobacco use through comprehensive policy and public health initiatives[8].

Despite the global push for stringent tobacco control, Iran encounters unique hurdles in mitigating tobacco use among its population. The prevalence of tobacco consumption across all age groups in Iran was approximately 14.01% in 2021, with projections from the WHO suggesting a potential decrease to 12.8% by 2025, contingent upon the persistence of current control strategies[4,9]. This highlights the critical need for an in-depth understanding of smoking behaviors, particularly the age of initiation, as a foundational element for effective public health strategies.

Even slight variations in the age of smoking initiation can significantly impact mortality risk several decades later, highlighting the profound long-term consequences of early tobacco use. Early initiation is notably linked to higher levels of nicotine dependence and an increased likelihood of escalating tobacco consumption, whereas individuals who begin smoking at an older age tend to exhibit lower consumption intensity[10]. The initiation age for smoking may be influenced by the strength and nature of anti-smoking efforts, as well as sociodemographic factors such as education level, employment status, and social environment[11,12]. In Spain, lower socioeconomic status, including factors like lower education levels and unemployment, has been linked to higher smoking rates, underscoring significant socioeconomic disparities in tobacco use[11]. Similarly, in the United States and Canada, social influences, alcohol and drug use, and stress contribute to smoking initiation among young adults, with targeted prevention programs proving effective when focused on counter-marketing and reshaping social norms[13]. Effective policies have the potential to delay or altogether prevent the initiation of smoking[12]. Conversely, in the absence of such interventions, there is a risk that individuals may begin smoking at increasingly younger ages, posing additional challenges for public health in the future[14].

However, there is a notable gap in the literature regarding the specific patterns of smoking initiation within the Iranian context, especially considering the latest data. Previous studies, including the STEPwise approach to chronic disease risk factor surveillance (STEPS) conducted in 2016, have provided valuable insights yet have left crucial questions unanswered about the current state and trends in smoking initiation age[8,15]. This knowledge gap is especially pertinent for informing policymaking and designing targeted interventions aimed at reducing tobacco use among the Iranian populace.

The primary aim of this study is to examine the age of smoking initiation among Iranian adults and identify key sociodemographic factors associated with smoking behaviors. Utilizing data from the 2021 STEPS survey, we seek to address gaps in the literature and support the development of targeted public health policies aimed at reducing tobacco use in Iran.

Materials and methods
Study overview and design
The STEPS is a standardized and unified monitoring survey established by the WHO to collect, assess, and distribute critical data from participating nations[16,17]. For this study, we utilized data from the 2021 Iranian STEPS study, the eighth round of a national cross-sectional survey on NCD risk factors. The survey collected data through a three-part process: standardized questionnaires, physical measurements, and laboratory tests, following WHO guidelines. Data collectors, trained in survey methods, followed WHO guidelines to ensure uniformity and reliability of self-reported information across participants. The complete report of the protocol for Iran STEPS 2021 is readily accessible, providing comprehensive details of the study[18].

Study population
The study population included Iranian individuals aged 18 and older residing in Iran at the time of data collection. A cluster random selection method was employed to select participants from all 31 Iranian provinces, encompassing both urban and rural areas. To ensure representative coverage of Iranians aged 18 and older across all provinces, a total of 3176 data collection clusters were established. The final data collection involved 28,821 individuals; however, 947 participants declined to participate or were unable to be enrolled.

Variables
Smoking age of onset was evaluated using the STEPS questionnaire, as recommended by the World Health Organization (WHO) for national STEPS surveys. For each type of product, we queried participants about their current use and age at initiation. Participants were asked, 'Have you ever used any tobacco products, such as cigarettes, cigars, hookah, pipes, smokeless tobacco, or electronic cigarettes?' and then they chose the type of tobacco products they used. The STEPS survey collected data on various tobacco products, including cigarettes, hookah, e-cigarettes, and smokeless tobacco; however, due to limited data on less commonly used products, this study primarily focuses on cigarette and hookah use, the most prevalent forms in Iran. Participants were also asked, 'At what age did you first start smoking cigarettes, hookahs, pipes, smokeless tobacco, or electronic

cigarettes?' Sociodemographic variables included age, residential area (urban or rural), educational attainment (0, 1–7, 7–12, and 12 + years), marital status (single, married, divorced/separated, and widowed), employment status (public sector employee, public sector laborer, private sector employee, private sector laborer, self-employed, unpaid work, retired, unemployed due to disability, unemployed seeking job, and unemployed not seeking work). To derive the wealth index, questions regarding the assets of the household of each participant were utilized, and principal component analysis (PCA) was performed to derive the wealth index of each participant and subsequently divided into quantiles.

The tobacco-age of onset variables included different forms of smoking, namely, cigarette smoking and hookah use. Within this study, we calculated the average age at smoking initiation across six age groups—18–24, 25–34, 35–44, 45–54, 55–64, 65–74, and 75+—for all the defined smoking categories.

Statistical analysis

Data weighting was applied to ensure representativeness by addressing non-response rates and demographic disparities through a four-stage procedure. This included adjustments for (1) general non-response, which considered the overall response rate to correct for potential biases from participants who did not complete the survey, (2) phase-specific non-response at each survey step (questionnaires, physical, and lab measurements), accounting for individuals who participated in some parts of the survey but not others, (3) demographic weighting to reflect the distribution of age, sex, and area, and (4) a comprehensive adjustment that combined these factors to optimize the validity of the analysis, ensuring the sample's representativeness of the Iranian population's demographic structure. Additionally, cluster sampling was conducted across 31 provinces to account for population distribution, providing a balanced representation of urban and rural areas in Iran. Detailed weighting equations and methodology specifics are described in the Iran STEPS protocol, offering insight into handling complex survey data across large, diverse populations[18].

Our descriptive analysis focused exclusively on current smokers, excluding individuals who had quit smoking prior to the survey to concentrate on active consumption patterns. We reported the mean age at smoking initiation among current tobacco users along with the corresponding 95% confidence intervals (CIs). The CI was used to compare the data and determine the statistical significance of differences. All essential data analyses and visualizations, including the map in Fig. 1, were performed using the R statistical package (v3.4.3, http://www.r-project.org, RRID: SCR_001905).

Ethical consideration

This study was conducted in accordance with the Declaration of Helsinki, and all methods were performed in line with the guidelines and regulations set forth by the ethical committee of Tehran University of Medical Sciences under ethical code IR.TUMS.NIHR.REC.1398.006. The protection of participants' data was ensured by all authors. The statistical modeling used in the analysis does not involve any individual-level data, and the results are solely derived from statistical models. Participants provided informed consent for the original survey, Iran STEPS 2021.

Results

The study analyzed data from 27,874 participants, comprising 44.77% males and 55.23% females. The baseline characteristics of the sample included in this study are presented in Supplementary Table S1. We observed that the mean age at cigarette smoking initiation was 22.18 years (95% CI: 21.81–22.55), with males initiating smoking earlier (mean age 21.92 years, 95% CI: 21.55–22.29) than females (mean age 27.73 years, 95% CI: 25.57–29.88). Hookah smoking initiation presented a similar gender disparity, commencing on average at 24.89 years (95% CI: 24.23–25.55), with males beginning at 23.95 years (95% CI: 23.08–24.82) and females beginning at 26.06 years (95% CI: 25.07–27.05). Intriguingly, compared with women, men aged 18 to 44 years-initiated hookah smoking at a younger age, which was reversed in participants over 45 years, where women had a lower mean initiation age. (Table 1)

Education level significantly influenced smoking initiation, with individuals holding 7–12 years of schooling starting cigarette smoking at the youngest mean age of 20.96 years (95% CI: 20.41–21.52). Among those who smoked from hookah, those with more than 12 years of education had the lowest mean age, at 22.53 years (95% CI: 21.78–23.28) for both sexes, 23.51 years (22.31–24.71) for females and 22.02 years (21.08–22.97) for males. (Table 1) Marital status further impacted smoking onset, with single individuals beginning at the earliest for both cigarettes (mean age 19.71 years, 95% CI: 19.00- 20.43) and hookah (mean age 19.05 years, 95% CI: 18.48–19.63), contrasting with widows who had the highest initiation ages (30.29 years, 25.76–34.82 for cigarette smokers and 32.19 years; 28.33–36.04 for hookah smokers) (Table 2).

Our analysis demonstrated that the mean age at cigarette smoking initiation did not significantly differ between rural and urban residents, with averages of 21.95 years (21.2–22.69) for both sexes in rural areas and 22.26 years (21.84–22.69) for both sexes in urban areas. Within these groups, rural females started smoking at a mean age of 25.52 years (20.85–30.19), while urban females began smoking at 28.13 years (25.73–30.52). For males, the mean initiation age was 21.84 years (21.09–22.6) in rural settings and 21.95 years (21.53–22.37) in urban settings, indicating that men in urban areas tend to start smoking at a younger age than women. There was no notable difference in the average age of hookah smoking initiation between rural areas (24.53 years; 23.42–25.64) and urban areas (22.26 years; 21.84–22.69) (Table 1).

Additionally, cigarette smokers who were unemployed and not seeking work started smoking at the lowest mean age (19.75 years, 17.48–22.03), while those with unpaid work had the highest mean age at cigarette smoking onset (25.54 years, 23.57–27.5). There were no significant differences in the mean age at cigarette smoking initiation across all five wealth indices, with ages ranging from 19.14 years (17.23–21.05) to 22.63 years (21.8–23.46). The job situation reflected those unemployed individuals seeking work had the earliest mean
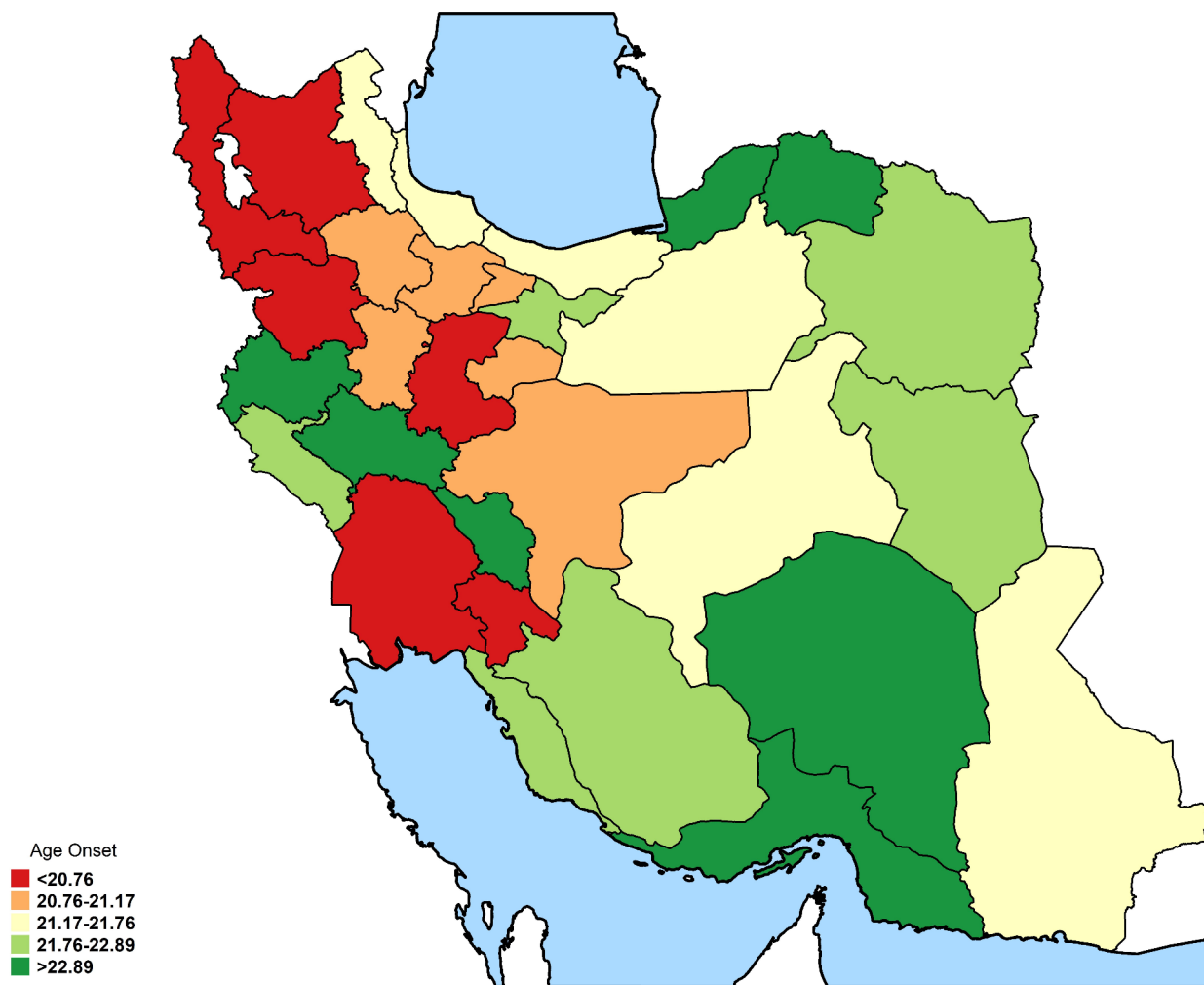
Fig. 1. Geographic distribution of early onset age for cigarette smoking in Iran. Created using the R statistical package (version 3.4.3, http://www.r-project.org).

Variable	Category	Mean age onset of cigarette smoking (95%CI*)			Mean age onset of hookah smoking (95%CI)		
	Sex	Both	Female	Male	Both	Female	Male
Age groups	18–24	17.25 (16.65–17.85)	18.46 (17.78–19.14)	17.2 (16.58–17.82)	17.37 (16.94–17.8)	18.08 (17.06–19.1)	17.11 (16.67–17.55)
	25–34	19.55 (18.99–20.12)	22.93 (17.01–28.84)	19.42 (18.9–19.95)	20.8 (20.3–21.3)	22.15 (21.32–22.98)	19.93 (19.34–20.51)
	35–44	21.94 (21.36–22.53)	27.24 (23.48–31.01)	21.72 (21.14–22.3)	26.08 (25.09–27.06)	26.38 (24.79–27.98)	25.84 (24.61–27.07)
	45–54	22.25 (21.53–22.97)	28.47 (23.28–33.66)	22.01 (21.29–22.72)	31.61 (29.82–33.39)	30.56 (28.22–32.89)	33.02 (30.28–35.76)
	55–64	22.92 (22.05–23.8)	29.9 (25.57–34.22)	22.51 (21.64–23.39)	33.1 (30.04–36.16)	31.1 (27.41–34.79)	36.97 (31.71–42.22)
	65–74	25.24 (23.63–26.84)	27.21 (21.67–32.75)	25.13 (23.47–26.8)	32.2 (26.63–37.77)	29.15 (22.88–35.41)	38.63 (28–49.26)
	75+	28.38 (24.11–32.65)	31.83 (21.91–41.74)	27.98 (23.37–32.58)	36.48 (27.25–45.71)	34.45 (25.7–43.19)	37.6 (24.14–51.05)
Area of residency	rural	21.95 (21.2–22.69)	25.52 (20.85–30.19)	21.84 (21.09–22.6)	24.53 (23.42–25.64)	25.94 (24.16–27.72)	23.34 (22–24.69)
	urban	22.26 (21.84–22.69)	28.13 (25.73–30.52)	21.95 (21.53–22.37)	25.02 (24.21–25.82)	26.1 (24.91–27.3)	24.16 (23.08–25.24)
Years of education	0	23.88 (22.29–25.48)	28.84 (24.87–32.82)	23.13 (21.44–24.83)	27.23 (24.6–29.85)	26.84 (23.87–29.8)	28.69 (23.14–34.24)
	1–7	22.04 (21.27–22.81)	27.51 (22.48–32.54)	21.86 (21.1–22.63)	28.33 (26.61–30.05)	28.08 (26.11–30.06)	28.73 (25.54–31.93)
	7–12	20.96 (20.41–21.52)	26.91 (21.65–32.18)	20.87 (20.31–21.43)	24.84 (23.63–26.05)	26.43 (24.46–28.41)	24.08 (22.56–25.59)
	12+	22.82 (22.23–23.4)	27.21 (23.8–30.63)	22.56 (21.98–23.15)	22.53 (21.78–23.28)	23.51 (22.31–24.71)	22.02 (21.08–22.97)
Total		22.18 (21.81–22.55)	27.73 (25.57–29.88)	21.92 (21.55–22.29)	24.89 (24.23–25.55)	26.06 (25.07–27.05)	23.95 (23.08–24.82)

Table 1. Mean onset age of smoking by age groups, area of residency and years of education. * CI: Confidence interval.

Variable	Category	Mean age onset of cigarette smoking (95%CI*)			Mean age onset of hookah smoking (95%CI)		
	Sex	Both	Female	Male	Both	Female	Male
Marriage status	Single	19.71 (19–20.43)	22.43 (18.23–26.63)	19.55 (18.85–20.26)	19.05 (18.48–19.63)	20.53 (18.9–22.15)	18.64 (18.08–19.21)
	Married	22.27 (21.87–22.67)	28.38 (25.46–31.3)	22.11 (21.71–22.51)	26.18 (25.36–27)	26.06 (24.92–27.2)	26.28 (25.12–27.44)
	Divorced/seprate with partner	25.16 (22.03–28.29)	25.24 (19.03–31.44)	25.14 (21.55–28.73)	26 (22.89–29.11)	26.19 (23.34–29.05)	25.29 (15.33–35.25)
	Widow	26.77 (23.42–30.13)	30.29 (25.76–34.82)	22.34 (18.5–26.18)	32.19 (28.33–36.04)	31.48 (27.49–35.47)	43.92 (38.08–49.75)
Job situation	Public sector employee	22.86 (20.99–24.73)	34.52 (28.28–40.76)	22.55 (20.69–24.4)	23.05 (21.07–25.04)	27.82 (23.16–32.49)	22.22 (20.17–24.27)
	Public sector labor	19.8 (17.75–21.84)	N/A	19.8 (17.75–21.84)	25.59 (21.92–29.26)	24 (24–24)	25.77 (21.71–29.82)
	Private Sector Employee	22.09 (20.69–23.5)	23.02 (21.17–24.86)	22.05 (20.57–23.52)	25.84 (23.33–28.34)	24.23 (21.31–27.15)	26.45 (23.2–29.69)
	Private Sector labor	21.2 (20.06–22.33)	N/A	21.2 (20.06–22.33)	24.16 (21.58–26.73)	24.63 (16.94–32.31)	24.11 (21.38–26.84)
	Freelance job or self-employed	21.75 (21.29–22.22)	27.7 (22.01–33.4)	21.69 (21.23–22.16)	23.4 (22.44–24.36)	24.59 (20.89–28.29)	23.27 (22.29–24.25)
	Unpaid work	25.54 (23.57–27.5)	27.71 (25.19–30.23)	20.65 (18.58–22.72)	25.6 (24.56–26.63)	26.32 (25.21–27.42)	18.48 (17.24–19.72)
	Retired	23.94 (22.74–25.13)	45.71 (17.37–74.06)	23.87 (22.68–25.06)	41.36 (34.43–48.3)	42.74 (31.08–54.39)	41.28 (33.94–48.61)
	Unemployed due to disability	23.47 (20.51–26.43)	N/A	23.47 (20.51–26.43)	29.29 (20.42–38.15)	29.77 (10.39–49.14)	29.09 (19.41–38.76)
	Unemployed seeker job	20.04 (18.91–21.17)	21.52 (16.67–26.37)	20 (18.84–21.15)	19.08 (17.93–20.23)	20.05 (17.21–22.9)	18.94 (17.7–20.18)
	Unemployed Not seeking work	19.75 (17.48–22.03)	N/A	19.75 (17.48–22.03)	24.24 (19.09–29.39)	21.31 (18.69–23.93)	28.07 (17.16–38.97)
	Not Declared	19.14 (17.23–21.05)			31.94 (26.58–37.3)		
Wealth index / National	1	22.47 (21.61–23.32)	28.51 (24.19–32.82)	22.13 (21.27–22.98)	24.53 (23.16–25.91)	26.44 (24.53–28.35)	21.89 (20.14–23.64)
	2	22.03 (21.21–22.85)	26.76 (22.4–31.11)	21.73 (20.91–22.55)	25.2 (23.47–26.94)	26.24 (24.03–28.45)	23.98 (21.29–26.67)
	3	21.99 (21.24–22.75)	28.29 (22.1–34.49)	21.81 (21.06–22.56)	26.48 (24.88–28.07)	26.97 (24.72–29.22)	26.08 (23.86–28.31)
	4	21.89 (20.95–22.82)	29.58 (21.22–37.94)	21.75 (20.82–22.68)	24.4 (23.08–25.72)	26.33 (23.76–28.89)	23.44 (21.96–24.93)
	5	22.63 (21.8–23.46)	27.49 (23.67–31.3)	22.27 (21.45–23.1)	24.36 (22.77–25.95)	24.24 (21.27–27.22)	24.39 (22.52–26.26)

Table 2. Mean onset age of smoking by marriage status and wealth index job situation. *CI: Confidence interval. *N/A: Not available data.

onset age for hookah smoking (19.08 years, 17.93–20.23), while retirees started at an older age (41.36 years, CI 34.43–48.3). (Table 2) The analysis showed no substantial variation in smoking initiation across wealth indices, with a relatively narrow range across different quintiles (Table 2).

The distribution of the average age of cigarette smoking initiation in Iran revealed higher rates of early cigarette smoking initiation in the northwest and parts of the southwest and midwest, as illustrated in Fig. 1. Participants from Kurdistan Province had the lowest mean age of cigarette smoking onset (18.68 years; 16.93–20.42), while participants from Golestan Province had the highest (25.71 years; 23.02–28.4). In most provinces, the mean age at cigarette smoking initiation was lower for males than for females. Regarding hookah smoking, participants from Khorasan, South Province, had the lowest average age at hookah smoking initiation (19.26 years, 17.04–21.49), while participants from Khorasan, Razavi Province, had the highest average age (26.04 years, 24.3–27.78). The lowest mean age of onset of hookah smoking in females was 17.77 years (15.23–20.3) in Alborz, and the highest was 34.36 years (23.94–44.78) in Khorasan, North. The lowest mean age at hookah smoking initiation in males was 17.52 years (15.54–19.49) in Gilan, and the highest was 26.05 years (14.12–37.99) in Alborz (Supplementary Table S2).

Discussion

This study investigated the initiation age of smoking products using a national and subnational representative sample in Iran, a low- to middle-income country. The main findings revealed that the mean age of onset for cigarette smoking (22.18 years) was lower than that for hookah smoking (24.89 years), with males generally starting to smoke at a younger age than females (21.92 vs. 27.73 years, respectively). Notably, single individuals exhibited the lowest average age at cigarette smoking initiation. Among hookah smokers, those with more than 12 years of education had the lowest mean initiation age. Furthermore, our analysis revealed nonsignificant differences in the mean initiation age between rural (21.95 years) and urban areas (22.26 years).

Over time, the age of smoking initiation in Iran has shown variability, which reflects shifts in social norms and the impact of public health interventions. A 2007 survey on NCD risk factors reported an average initiation age of 20.5 years, with men starting at 20.4 years and women at 24.2 years[19]. Subsequent data from the STEPS surveys between 2000 and 2011 also demonstrated fluctuations in initiation ages, culminating in higher reported ages in 2016 of 23.3 years overall, 21.9 for men, and 25.5 for women[20,21]. Despite these year-to-year variations, the overall trend across the historical data from previous STEPS surveys suggests a stabilization in the age at which individuals begin smoking, indicating that changes, while present, do not significantly alter the general onset age over time. Additionally, a regional study by Hamzeh et al., conducted between 2014 and 2017 in western Iran, revealed a mean age of 20.3 years for men and 25.19 years for women[5], which aligns with our findings, particularly in terms of gender disparities. Moving beyond regional comparisons, our results also differ significantly from European patterns. For instance, a study conducted in Europe in 2012 reported an average initiation age of 17.6 years for smokers, with men starting slightly younger than women[22]. Furthermore, a 2008 study highlighted that over 80% of European women began smoking at the age of 20, averaging an initiation age

of 18.2 years[23]. These figures are substantially lower than those observed in our Iranian cohort, where the mean age at which smokers started smoking cigarettes was notably greater.

Initiating smoking at a young age has been consistently associated with a greater risk of subsequent regular and heavy smoking later in life[24]. Influential factors for initiating smoking include the influence of friends (79%), parental smoking (21%), and a liking for the taste or smell of tobacco (19%)[22]. Although smoking traditionally carries a stigma, especially among Iranian women, this trend is shifting as smoking becomes a symbol of gender equality and personal freedom[25]. This shift contributes to the greater propensity of men to start smoking at an earlier age than women, which significantly impacts the prevalence of smoking-related diseases, such as lung cancer[6].

Furthermore, it is commonly believed that individuals with lower incomes are more responsive to changes in tobacco prices, which could influence their smoking behaviors[26]. Contrary to this expectation, our study revealed that the mean age at cigarette smoking initiation was consistent across all wealth indices. This consistency suggests that economic status does not significantly impact the onset of smoking, possibly due to the relative affordability and widespread availability of cigarettes in Iran, which makes them accessible irrespective of economic status, indicating a nonlinear relationship between wealth and smoking[27,28]. Additionally, Meysamie et al. observed no significant differences in smoking initiation between urban and rural areas[19], consistent with our findings. However, contrasting studies from other regions suggest that urban residents are more likely to be smokers, a trend attributed to the stressful environments and greater social acceptance found in urban settings[29]. For instance, a study from Germany demonstrated that urban dwellers (both men and women) tend to start smoking at younger ages and are more likely to be heavy smokers than their rural counterparts, highlighting the need for targeted public health strategies in urban areas[30].

This study revealed that the mean age of smoking initiation in Iran and its western provinces (Ilam, Kermanshah, and Khuzestan) was generally greater than that in our neighboring country, Iraq, where the average initiation age is 19.1 years, except for the province of Kurdistan[31]. This discrepancy warrants further investigation, especially with respect to Iraqi Kurdistan, due to its close geographical proximity. In contrast, Turkey reported a lower average initiation age of 18.1 years, suggesting earlier exposure to smoking than Iran and its adjacent province, West Azerbaijan[32]. Similarly, to the east, Afghanistan has a mean smoking initiation age of 18.8 years, which is lower than that in Iran and its eastern provinces, such as Khorasan Razavi, Khorasan South, Sistan and Baluchistan[33]. However, Pakistan has a mean age of smoking initiation comparable to that of Iran and its provinces Sistan and Baluchistan, likely reflecting shared cultural and socioeconomic characteristics[34]. Moving north, Armenia, Azerbaijan, and Turkmenistan reported lower mean ages of smoking initiation (18.1 years, 18.7 years, and 21.3 years, respectively) than Iran and its neighboring provinces[35–37]. Interestingly, according to Heydari's analysis of WHO reports, Iran was ranked first in implementing the MPOWER package in the Eastern Mediterranean region between 2011 and 2019[38]. This robust implementation might help explain why the smoking initiation age in Iran is greater than that in most neighboring countries.

The age of hookah smoking initiation varied based on the study's age range; for example, in Syria, there was a significant difference in the initiation age between university students (mean age 22) and café smokers (mean age 30)[3]. In our study, hookah smoking initiation was found to occur at a later age than cigarette smoking, consistent with the trends observed in the STEPS 2016 data[39]. It has been found that hookah smoking is associated with a greater than twofold increase in the likelihood of subsequent cigarette smoking[40]. In Iran, women mostly use hookah as a form of entertainment, socializing, and forming intimate relationships[41]. Sighaldeh et al.'s study indicated that the average age of onset of hookah smoking among female hookah smokers in Tehran, Iran, was 16.5 years[41]. This age is considerably younger than what was observed in our study. These divergent results emphasize the importance of considering different study populations and contexts when examining tobacco initiation patterns. As a result of incorrect perceptions about hookah smoking, such as being less harmful than cigarettes and being easier to stop, hookah smoking is likely to become more prevalent among adolescents, especially those in high school[20]. As education level plays a key role in predicting smoking, the smoking rate decreases with higher education levels[39]. Baheiraeia et al.'s study[42] reported that hookah smoking is most prevalent among Iranian women with university educations. Our study also revealed that women with the highest level of education had the lowest average age at hookah smoking initiation. This suggests a potential association between educational attainment and hookah smoking initiation age, especially among women.

These findings underscore the need for robust tobacco control strategies tailored to address the nuances of tobacco use across different regions and populations within Iran. Since the ratification of the global tobacco control convention on October 6, 2005, Iran has actively implemented MPOWER strategies such as promoting tobacco-free zones, enforcing advertising restrictions, and elevating tobacco taxes[43]. These initiatives align with the FCTC, which advocates for comprehensive measures to protect the population from tobacco smoke, offer cessation programs, and educate people on tobacco dangers[44]. Despite these efforts, challenges persist in the form of high smoking rates among youth, the prevalence of smuggled and foreign cigarettes, inadequate public awareness, and limited enforcement of existing tobacco control policies[45]. Addressing these challenges will require enhanced educational programs that accurately convey the risks of smoking and the benefits of cessation, tailored to diverse demographic needs. Moreover, it is crucial for the government to prioritize funding for public health initiatives aimed at further reducing smoking prevalence.

Looking ahead, Iran's commitment to the Universal Health Coverage (UHC), Sustainable Development Goals (SDGs), and WHO's health objectives is pivotal[46]. The latest results from the STEPS 2021 survey indicate some progress; however, to achieve these international health targets, Iran must intensify its efforts to fully implement both MPOWER strategy and FCTC legal framework. Increasing tobacco taxes and integrating tobacco cessation programs into broader health coverage frameworks are essential steps toward this goal[44,46].

Strengths and limitations

This study's primary strength is its large, representative sample achieved through weighted cluster sampling, enhancing the generalizability and statistical robustness of the findings. Our adherence to the WHO's standardized STEPS survey protocols further ensure the reliability of our data. However, the study's cross-sectional design limits causality inference between smoking initiation age and health outcomes. Potential recall bias due to the self-reported nature of the data collection and the omission of newer tobacco products such as vapes and e-cigarettes are notable limitations. Additionally, regional variations in cultural and socioeconomic factors that may affect smoking behaviors have not been extensively explored. Future studies should investigate additional sociodemographic factors and alternative tobacco products, like e-cigarettes, to better understand emerging trends in smoking. Longitudinal research is also recommended to evaluate the long-term effects of current anti-smoking policies and interventions on smoking initiation and cessation in Iran.

Conclusion

In conclusion, this study underscores early smoking initiation in Iran, particularly among men, unemployed individuals, and educated individuals. The findings highlight the necessity for targeted tobacco control strategies. Despite these advancements, current trends suggest that Iran might not meet the UHC and SDG targets related to noncommunicable diseases without intensified efforts. Adhering to the WHO's MPOWER initiatives and the FCTC could enhance these strategies. Tailored educational programs and increased tobacco taxes are recommended to reduce smoking rates effectively. Prioritizing these interventions is crucial for Iran to progress toward achieving its health-related SDGs.

Data availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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Author contributions

APL: Writing - original draft/Conceptualization/Formal analysis/Visualization, YF: Formal Analysis/Methodology/Data curation, GA: Formal Analysis/Methodology, ZSV: Supervision/Writing - original draft, MAK, NGR: Conceptualization/Review & editing, AG, NR, EG, SA, MN, MMR: Methodology/Data curation, AK, MY, EFM, RH, SSM: Methodology APL, ZSV, YF, ZSV, MAK, NGR, AG, AH, SMF, MM, AMR, MA, FF: Review & editing. FF, NGR, NR: Investigation/Resources/Project administration. All the authors have read and approved the final manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Ethical approval

The study methodology adhered to the Helsinki Declaration standards as revised in 1989. The Ethical Committee approved the study of the National Institute for Health Research under reference number IR.TUMS.NIHR.REC.1398.006. Prior to participating in the study, all participants provided written informed consent. In addition, the study did not include any identifiable personal information about the participants, and the results and data were kept confidential.

Consent for publication

Not applicable.

Additional information

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