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Predictors of tobacco use among pregnant women: a large-scale, retrospective study

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Abstract

Objective To investigate the predictors of smoking among pregnant women in Iran, focusing on health literacy and associated socioeconomic factors.

Methods This retrospective cohort study included 103,042 pregnant women aged 18–45 years who attended healthcare centers affiliated with Mashhad University of Medical Sciences for routine prenatal and postnatal checkups between 2017 and 2020. Data were collected from the Sina Electronic Health Record System (SinaEHR®), which recorded sociodemographic characteristics, medical history, and lifestyle behaviors, including tobacco use.

Results Smoking prevalence was 0.9%. Women with undergraduate or higher education had significantly lower odds of smoking (OR = 0.36; 95% CI = 0.28–0.47) compared to those with primary education or less. Maternal age was marginally associated with increased smoking risk (OR = 1.01; 95% CI = 1.00-1.03). While unemployment showed an increased crude risk for smoking, this was not significant after adjustment (adjusted OR = 1.02; 95% CI = 0.86–1.21). Strong associations were found between tobacco use and alcohol consumption (OR = 46.3; 95% CI = 24.8–83.4) and opium addiction (OR = 23.4; 95% CI = 14.5–36.3). Chronic disease history also increased smoking odds (OR = 1.51; 95% CI = 1.17–1.92).

Conclusion Lower education, substance use, and chronic disease are significant predictors of smoking among pregnant women in Iran. Targeted interventions to improve health literacy and address these factors are essential to reduce tobacco use during pregnancy.

Keywords Pregnant women, Smoking, Tobacco, Iran

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Introduction

Tobacco use is a major health problem that is associated with many diseases and brings preventable premature death worldwide. Smoking during pregnancy is common and poses significant risks to both maternal and fetal health [1]. Pregnant women face different alterations, such as physiological anemia, anxiety, depression, diabetes, hypertension, and infection. Additionally, lifestyle, genetic factors, and maternal health behaviors affect maternal and childhood health; subsequently, parents are responsible for obtaining health information [2–4].

The health behaviors include harmful (such as smoking), promotive (such as diet and workout), and maintenance (such as vaccination). The data from National STEPs Survey 2016 (cross-sectional national research of the Non-Communicable Diseases Research Center) [5] report that the prevalence of daily tobacco smoking is 3.8% (95% CI: 3.5-4.1%) among women in Iran [6]. Moreover, the prevalence of population-based estimates of smoking during pregnancy in low-income and middle-income countries (LMICs) is 2·6% (95% CI: 1·8 − 3·6) (prevalence of low in the African region (2·0%) and high in the Southeast Asian region (5·1%)).

The prevalence of tobacco use is low in low-income and Middle-East countries, while exposure to SHS in pregnant women is 56% of Iranian women [7, 8]. The proportion of smoking among pregnant women is low; however, it is high in some countries [9]. So, its prevalence is globally 1.7% with the highest prevalence in the three countries of Ireland, Uruguay, and Bulgaria (38·4%, 29·7%, and 29·4%; respectively) [10]. Consequently, the medical care expenditures and birth complications of smoking women during pregnancy are much more than for non-smokers [11, 12].

Accordingly, smoking cessation interventions during pregnancy can have vital public health benefits, including maternal and child health as well as familial dissemination outage of smoking [13–15]. Cigarette smoking can lead to pregnancy morbidity, such as ectopic pregnancy, certain congenital defects, placental abruption/praevia, adverse birth results, miscarriage, preterm birth, low birth weight, increased levels of cotinine in the follicular, fluid gestational hypertension, pre-eclampsia, sudden infant death syndrome, stillbirth, infant mortality, decreased cognitive function in childhood, externalizing problem behaviors, and Attention Deficit Hyperactivity Disorder (ADHD) [9, 15–17]. The rate of these pregnancy morbidities extensively varies among high-, middle-, and low-income countries [18].

There are some reasons for tobacco use during women pregnancy, including mood control, depression, psychosocial stress, enjoyment, boredom, calm nerves, being single, younger age, simultaneous consumption of alcohol, unplanned pregnancy, having a smoking partner, economic reasons, lower social class, addiction, poor educational attainment, occupational status, and keep weight down [17, 19–21]. In developed countries, smoking during pregnancy is more common among women with poor education and low revenue, so they feel less responsible for their fetal health consequences [19]. Worryingly, supervision data from the Global Tobacco Surveys indicate that the prevalence of smoking among women is increasing, and considering the effects of smoking on reproduction; these data emphasize smoking prevention plans, health promotion strategies, and better availability of smoking suspension programs for pregnant women is an essential need for communities [10, 22].

Despite the well-documented risks of tobacco use during pregnancy, there is a significant gap in understanding the specific factors that drive smoking in pregnant women, particularly in low- and middle-income countries like Iran. Furthermore, there is limited research on the health literacy of pregnant women regarding the dangers of smoking and their awareness of cessation resources. This gap in knowledge hinders the development of targeted interventions and policies to effectively reduce tobacco use among pregnant women. Therefore, the present study aims to examine the factors associated with smoking in pregnant women in Iran and to assess their health literacy related to smoking.

Considering the importance of fetal and maternal health in the context of tobacco use and the quality of pregnancy care in Iran, this study seeks to address these gaps by investigating the reasons for smoking among pregnant women and evaluating their health literacy regarding smoking.

Materials and methods

Study design

This study is a retrospective cohort study designed to investigate the predictors of smoking and health literacy related to smoking among pregnant women in Mashhad, Iran. The cohort consisted of women who were enrolled in the Sina Electronic Health Record System (SinaEHR®) between 2017 and 2020. The study followed participants from the time of their first prenatal visit through postpartum care.

Setting

The study was conducted in healthcare centers affiliated with Mashhad University of Medical Sciences (MUMS), which serve the city of Mashhad and the surrounding Khorasan Razavi province, Iran. Data were collected during routine prenatal and postnatal visits using the SinaEHR® system, an online electronic health record system.

Participants

We included 103,042 pregnant women aged 18–45 years who were referred to healthcare centers for routine checkups during pregnancy and after delivery between 2017 and 2020. The inclusion criteria were all married and pregnant women in all age groups who were recorded their data in the database. The exclusion criteria were incomplete medical or social information of participants.

Variables

The primary outcome variable was tobacco use during pregnancy, which was self-reported by participants and recorded in SinaEHR®. Other variables collected included:

- **Sociodemographic factors**: Age, education level, employment status.
- **Health behaviors**: Alcohol consumption, opium use, and other substance use.
- **Medical history**: Presence of chronic diseases (e.g., diabetes, hypertension), prepregnancy body mass index (BMI), and history of abortion.
- **Pregnancy outcomes**: Gestational diabetes, preeclampsia, premature birth, stillbirth, birth weight, and macrosomia.

Data source

Data were extracted from the SinaEHR® system, which collects self-reported information as well as data from healthcare providers. All anthropometric measurements (e.g., maternal weight and height) were taken according to standard protocols. The SinaEHR® is supervised by MUMS and ensures consistency in data collection across healthcare centers.

Bias and confounding

Potential sources of bias include recall bias due to self-reported smoking status, and selection bias as only women attending healthcare centers were included. To minimize recall bias, we cross-checked self-reported smoking data with medical records where available. Confounding variables, such as maternal age, education, employment status, and substance use, were adjusted for in the multivariate logistic regression model.

Statistical analysis

The statistical analysis was performed using IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA). Continuous variables were reported as means and standard deviations (SD) or medians and interquartile ranges (IQR), while percentages were used to summarize categorical variables. Chi-square tests were conducted to evaluate the association between categorical variables and tobacco use status. For assessing the association between continuous variables and tobacco use, t-tests or Mann-Whitney tests were used depending on the normality of the data. A significance level of $p<0.05$ was used to determine statistical significance.

Logistic regression analysis was conducted to identify predictors of smoking status both in crude and adjusted models. The dependent variable was tobacco use, while the independent variables were selected based on their potential association with tobacco use. The crude model only included independent variables, while the adjusted model also included potential confounders.

Results

Background characteristics

The study included 103,042 pregnant women with a median age of 31.0 years (IQR: 27.0–35.0). Most women had either primary school education or less (29%) or senior high school education (29%), while only 15% had undergraduate education or higher. Employment status revealed that a significant majority (79%) were unemployed.

Tobacco smoking was reported by 0.9% of the women. Other substance use included alcohol consumption (<0.1%) and opium addiction (0.1%). Chronic diseases were present in 5.3% of the participants, with specific conditions such as diabetes mellitus (0.5%), hypertension (0.7%), and anemia (0.4%) noted. Gestational diabetes mellitus was observed in 4.5% of the women, and gestational hypertension in 0.9%.

Regarding reproductive history, 29% of the women had a history of abortion, with a median abortion number of 0.00 (IQR: 0.00–1.00). The median pre-pregnancy BMI was 25.1 (IQR: 22.0-28.5). Delivery methods included cesarean Sect. (40%) and natural vaginal delivery (60%). Hospitalization during pregnancy was common, with 92% of women being hospitalized. Among the newborns, 48% were female and 52% were male, with stillbirths occurring in 1.5% of cases, premature births in 4.1%, low birth weight in 6.8%, and macrosomia in 4.9%. Of all pregnant women, 98%, 1.7%, and 0.4% fed their neonate with mother's milk, a combination of mother's and synthetic milk, and only synthetic milk, respectively. The median OGTT was 102. (IQR: 90–120) (Table 1).

Comparison of Tobacco-exposed and non-exposed

When comparing tobacco-exposed ($n=931$) to non-exposed ($n=102,111$) pregnant women, several significant differences were observed. Tobacco-exposed women were more likely to have lower educational attainment, with 40% having completed only primary school education or less, compared to 29% of non-exposed women ($p<0.001$). Employment status also differed, with 82% of

Table 1 Background characteristics of pregnant females

Characteristic	*N* = 103,042[1]
Education	
Primary school or less	29,776 (29%)
Junior high school	27,675 (27%)
Senior high school	29,833 (29%)
Undergraduate or above	15,758 (15%)
Mother age	
Median (IQR)	31.0 (27.0, 35.0)
Range	18.0, 44.0
Occupation	
Employed	21,880 (21%)
Unemployed	81,162 (79%)
Alcohol consumption	62 (< 0.1%)
Opium addiction	131 (0.1%)
Tobacco smoking	931 (0.9%)
Chronic disease	5,494 (5.3%)
Diabetes mellitus	479 (0.5%)
Hypertension	728 (0.7%)
Anemia	391 (0.4%)
Gestational DM	4,652 (4.5%)
Gestational HTN	934 (0.9%)
History of abortion	30,296 (29%)
Abortion number	
Median (IQR)	0.00 (0.00, 1.00)
Range	0.00, 13.00
History of congenital disorder	845 (0.8%)
Pre pregnancy BMI	
Median (IQR)	25.1 (22.0, 28.5)
Range	15.1, 54.6
Type of delivery	
Cesarean section	41,469 (40%)
Natural vaginal delivery	61,573 (60%)
Preeclampsia postpartum	2,131 (2.1%)
Hospitalization	94,634 (92%)
Blood receives	116 (0.1%)
Sex of the newborn child	
Female	49,669 (48%)
Male	53,373 (52%)
Still birth	1,589 (1.5%)
Premature birth	4,237 (4.1%)
Low birth weight	6,965 (6.8%)
Macrosomia	5,031 (4.9%)

[1]Frequency (%)

BMI: Body mass index.

tobacco-exposed women being unemployed compared to 79% of non-exposed women, though this difference was relatively small but statistically significant ($p=0.035$). Additionally, tobacco-exposed women had markedly higher rates of alcohol consumption (2.7% vs. <0.1%, $p<0.001$) and opium addiction (3.7% vs. <0.1%, $p<0.001$) compared to their non-exposed counterparts (Table 2).

Tobacco-exposed women had higher prevalence of chronic diseases (7.6% vs. 5.3%, $p=0.002$), hypertension (1.7% vs. 0.7%, $p<0.001$), and anemia (1.0% vs. 0.4%, $p=0.008$) (Table 2). They also had a higher history of abortion (34% vs. 29%, $p=0.004$), with a greater mean number of abortions (0.48 vs. 0.41, $p=0.002$). The median pre-pregnancy BMI was higher among tobacco-exposed women (25.7 vs. 25.1, $p<0.001$) (Table 3).

Association of Socioeconomic Factors with Tobacco Smoking

Multivariate analysis revealed that lower educational levels were significantly associated with higher odds of tobacco smoking. Compared to women with primary school education or less, the odds ratios (OR) for smoking were 0.88 (95% CI: 0.75–1.03) for junior high school, 0.53 (95% CI: 0.44–0.63) for senior high school, and 0.36 (95% CI: 0.28–0.47) for undergraduate education or above ($p<0.001$ for trend). Each additional year of age increased the odds of smoking slightly (adjusted OR: 1.01, 95% CI: 1.00-1.03, $p=0.014$) (Table 4).

Unemployment was not significantly associated with smoking after adjustment (adjusted OR: 1.02, 95% CI: 0.86–1.21, $p=0.9$). However, alcohol consumption and opium addiction were strongly associated with higher odds of smoking, with adjusted ORs of 46.3 (95% CI: 24.8–83.4, $p<0.001$) and 23.4 (95% CI: 14.5–36.3, $p<0.001$), respectively. The presence of chronic diseases also increased the odds of smoking (adjusted OR: 1.51, 95% CI: 1.17–1.92, $p=0.002$) Table 4).

Discussion

Parental tobacco uses and exposure during pregnancy have unfavorable effects on the health of the mother and fetus. For this reason, evaluation of tobacco use, exposure to secondhand smoke among pregnant women, and its avoidance strategies are an important part of the pregnancy care plan in governments [23]. This issue has achieved less attention in developing countries. Therefore, we investigated the prevalence, causes, predictors of smoking, and consequences of tobacco use among pregnant women in Mashhad, Iran. The findings of the current study demonstrated that the prevalence of tobacco exposure during pregnancy was 0.9%. Moreover, tobacco use was strongly associated with alcohol and opium consumption (alcohol OR=46.3; opium OR=23.4). Based on the results of this study, there were some predictors of smoking, such as socioeconomic factors, education, mother's age, lifestyle, and chronic disease. The findings indicated that more literacy was associated with less tobacco use (OR=0.40). Moreover, lifestyle was related to smoking behavior, such that the BMI had a protective effect on smoking ($p<0.001$).

We found that the higher mother age (OR=1.01) and chronic disease (OR=1.51) were risk factors after smoking and associated with increased tobacco consumption.

Table 2 Qualitative demographic, socioeconomic, and obstetric complications in tobacco-exposed and non-exposed females

Characteristic	Tobacco smoking		Test Statistic	*p*-value[2]
	No *N* = 102,111[1]	Yes *N* = 931[1]		
Education			103	< 0.001
Primary school or less	29,404 (29%)	372 (40%)		
Junior high school	27,382 (27%)	293 (31%)		
Senior high school	29,641 (29%)	192 (21%)		
Undergraduate or above	15,684 (15%)	74 (7.9%)		
Occupation			4.4	0.035
Employed	21,709 (21%)	171 (18%)		
Unemployed	80,402 (79%)	760 (82%)		
Alcohol consumption	37 (< 0.1%)	25 (2.7%)	1,033	< 0.001[3]
Opium addiction	97 (< 0.1%)	34 (3.7%)	892	< 0.001[3]
Chronic disease	5,423 (5.3%)	71 (7.6%)	9.3	0.002
DM	475 (0.5%)	4 (0.4%)	0.00	0.926 [3]
HTN	712 (0.7%)	16 (1.7%)	12	< 0.001
Anemia	382 (0.4%)	9 (1.0%)	7.1	0.008 [3]
Gestational DM	4,602 (4.5%)	50 (5.4%)	1.4	0.225
Gestational HTN	921 (0.9%)	13 (1.4%)	2.0	0.275
History of abortion	29,982 (29%)	314 (34%)	8.3	0.004
History of congenital disorder	842 (0.8%)	3 (0.3%)	2.3	0.130 [3]
Type of delivery			3.5	0.062
CS	41,066 (40%)	403 (43%)		
NVD	61,045 (60%)	528 (57%)		
Preeclampsia postpartum	2,113 (2.1%)	18 (1.9%)	0.03	0.926
Hospitalization	93,780 (92%)	854 (92%)	0.00	0.923
Blood receives	114 (0.1%)	2 (0.2%)	0.20	0.745 [3]
Sex of the newborn child			0.10	0.878
Female	49,215 (48%)	454 (49%)		
Male	52,896 (52%)	477 (51%)		
Still birth	1,580 (1.5%)	9 (1.0%)	1.7	0.225 [3]
Premature birth	4,185 (4.1%)	52 (5.6%)	4.8	0.028
Low birth weight	6,889 (6.7%)	76 (8.2%)	2.7	0.100
Macrosomia	5,000 (4.9%)	31 (3.3%)	4.5	0.033

[1]Frequency (%)

[2]Pearson's Chi-squared test

[3] Fisher's Exact Test

DM: Diabetes mellitus; HTN: Hypertension; CS: Cesarean section; NVD: Natural vaginal delivery

Tobacco use in pregnant women led to a significant increase in the rate of macrosomia ($P=0.033$) and premature birth ($P=0.028$) in the tobacco exposed group. Although existing evidence supports the correlation between smoking and IUGR [24], it is important to note that other inappropriate lifestyle factors, such as high body mass index (BMI), may contribute to higher rates of complications, including macrosomia, in pregnant tobacco users [25, 26].

Among 1745 pregnant women in Nigeria, the prevalence of tobacco exposure during pregnancy was 64, which represented 3.7% of the total. Moreover, according to the indicators of age, education, BMI, abortion history, and alcohol consumption; only alcohol consumption (OR = 2.60) was significantly associated with tobacco exposure based on regression results [27]. In comparison, the prevalence of tobacco exposure during pregnancy was lower (0.9%) in our study, which may be related to the social stigma that could affect the reported status of tobacco use among participants. The opposite results regarding probable predictors of tobacco use can be explained by the cultural levels of the society. It seems that smoking behavior has a reverse relation with the state of development of society due to smoking behavior is more common in people with high socioeconomic status in developed countries, while it is a prevalent behavior in low socioeconomic status in developing countries [28]. In a study looking back at predictors of drug use during pregnancy, it was found that 16.2% (out of 25,734) of women used tobacco. Moreover, data indicated that

Table 3 Quantitative demographic, socioeconomic, and obstetric complications in tobacco-exposed and non-exposed females

Characteristic	Tobacco smoking		*p*-value[1]
	No *N* = 102,111	Yes *N* = 931	
Mother age			0.007
Median (IQR)	31.0 (27.0, 35.0)	31.0 (27.0, 36.0)	
Mean (SD)	31.0 (5.7)	31.6 (5.7)	
Abortion number			0.002
Median (IQR)	0.00 (0.00, 1.00)	0.00 (0.00, 1.00)	
Mean (SD)	0.41 (0.76)	0.48 (0.81)	
pregnancy BMI			< 0.001
Median (IQR)	25.1 (22.0, 28.5)	25.7 (22.2, 29.8)	
Mean (SD)	25.6 (4.8)	26.3 (5.4)	

[1]Mann-Whitney U test

BMI: Body mass index

maternal age (OR = 0.9), low educational level (OR = 1.02), depression (OR = 1.70), and anxiety (OR = 1.39) were predictors of tobacco use based on logistic regression [16]. The prevalence of waterpipe smoking among female adolescents in western Iran is significant 20.4% according to the regional reports [29].

A population-based study in India on 356,853 women aged 20–35 years reported that the risk of uncontrolled hypertension was 10% higher for smokers than non-smokers [30]. In line with the previous study, our data revealed hypertension and the odds of chronic disease (51%) were significantly higher in smokers. Our results showed that the rate of gestational hypertension and postpartum preeclampsia was not related to tobacco use. While a previous study indicated that smoking has a protective effect against preeclampsia (OR for light and heavy smokers was 0.66 and 0.51, respectively) and gestational hypertension (OR for light and heavy smokers was 0.65 and 0.49, respectively). The authors suggest that the protective effect is probably not mediated by nicotine but rather by some ingredient(s) in the combustion products of cigarette smoke. They highlight that carbon monoxide, a major component in combustion, might play a role in this protective effect. Carbon monoxide has been shown to diminish the release of soluble fms-like tyrosine kinase 1 (sFlt1) from cultured endothelial cells, which is implicated in the pathophysiology of preeclampsia. In contrast, nicotine does not influence the production of sFlt1 from cultured placental cells [31]. Our results demonstrated that lifestyle can be related to smoking behavior; as BMI was higher in tobacco exposed than nonexposed group, as well as tobacco use was strongly associated with alcohol and opium consumption (alcohol OR = 46.3; opium OR = 23.4). A study has found that pregnant women who smoke tobacco have a 1.47 times higher chance of experiencing stillbirth compared to non-smoking pregnant women [32]; while in our study there was no relation between tobacco use and the rate of stillbirth. However, the abortion rate was higher in smokers in our study population. In accordance with our data, it has been documented that the likelihood of preterm birth among smokers is 1.08 [33].

Although this study was conducted with a large, population-based sample, it relied on self-reported data recorded in the electronic health system, which may have

Table 4 Association of the socioeconomic factors with smoking

Characteristic	Crude			Adjusted		
	OR[1]	95% CI[1]	*p*-value	OR[1]	95% CI[2]	*p*-value
Education			**< 0.001**			**< 0.001**
Primary school or less	1.00	Ref.		1.00	Ref.	
Junior high school	0.85	0.72–0.99		0.88	0.75–1.03	
Senior high school	0.51	0.43–0.61		0.53	0.44–0.63	
Undergraduate or above	0.37	0.29–0.48		0.36	0.28–0.47	
Mother age	1.02	1.01–1.03	**0.004**	1.01	1.00-1.03	**0.014**
Occupation			**0.029**			0.900
Employed	1.00	Ref.		1.00	Ref.	
Unemployed	1.20	1.02–1.42		1.02	0.86–1.21	
Alcohol consumption			**< 0.001**			**< 0.001**
No	1.00	Ref.		1.00	Ref.	
Yes	76.1	45.1–126		46.3	24.8–83.4	
Opium addiction			**< 0.001**			**< 0.001**
No	1.00	Ref.		1.00	Ref.	
Yes	39.9	26.5–58.6		23.4	14.5–36.3	
Medical history			**0.003**			**0.002**
No	1.00	Ref.		1.00	Ref.	
Yes	1.47	1.14–1.86		1.51	1.17–1.92	

[1]OR = Odds Ratio; [2]CI = Confidence Interval

introduced bias, particularly due to underreporting. Participants may have underreported sensitive behaviors such as smoking, alcohol consumption, and opium use due to social desirability bias or fear of judgment. This potential underreporting could affect the accuracy of the findings, particularly in estimating the prevalence of these behaviors. Furthermore, due to the retrospective nature of the study, it was not possible to capture the quantity or frequency of smoking during pregnancy, which limits the ability to assess dose-response relationships.

Despite these limitations, the study's large sample size and use of multivariate regression models allowed for a comprehensive analysis of the socioeconomic, demographic, and health factors associated with tobacco use. Future research should aim to validate these findings using more objective measures of smoking, alcohol, and opium use, as well as explore the potential dose-response relationship between tobacco exposure at different stages of pregnancy and its effects on postnatal outcomes.

Conclusions

In summary, we found that although tobacco use during pregnancy is not prevalent; it can be associated with adverse outcomes, such as preterm birth and macrosomia. Tobacco use increases the risk of abortion and is related to chronic diseases, such as anemia and hypertension. Socioeconomic status, addiction to opium, and alcohol are predictors of smoking in pregnant women.

Author contributions

Seyyed Pouria Tafti: Conceptualization, Methodology, Writing - Original Draft Preparation, Supervision. Dr. Tafti led the conception and design of the study, developed the methodology, drafted the initial manuscript, and supervised the project. Adele Azarshab: Data Curation, Writing - Review & Editing. Dr. Azarshab was responsible for the collection and management of research data, and critically reviewed and edited the manuscript for important intellectual content. Reihaneh Alsadat Mahmoudian: Investigation, Visualization. Dr. Mahmoudian conducted the experiments/investigations and was responsible for data visualization and interpretation. Reza Khayami: Software, Validation. Dr. Khayami developed and maintained the software used for data analysis, and validated the analytical methods and results. Reza Nejad Shahrokh Abadi: Formal Analysis, Resources. Dr. Abadi performed the formal analysis of the data and provided essential research materials and tools. Saeideh Ahmadi-Simab: Funding Acquisition, Project Administration. Dr. Ahmadi-Simab acquired the funding that supported the project and administered the project activities. Soodabeh Shahidsales: Supervision, Writing - Review & Editing. Dr. Shahidsales supervised the research activities and critically reviewed and edited the manuscript for important intellectual content. Mohammad Moein Vakilzadeh: Conceptualization, Methodology, Writing - Review & Editing. Dr. Vakilzadeh contributed to the conception and design of the study, developed the methodology, and critically reviewed and edited the manuscript for important intellectual content.

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Data availability

Data are available on reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate

The study protocol adhered to the ethical standards of the Declaration of Helsinki and was approved by the ethics committee of Mashhad University of Medical Sciences (MUMS), Mashhad, Iran (ethical code: IR.MUMS.MEDICAL.REC.1401.539). Privacy was maintained for all collected data, and informed consent was obtained from all participants. Furthermore, study outcomes were communicated to the participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Mahmoodabad SSM, Karimiankakolaki Z, Kazemi A, Mohammadi NK, Fallahzadeh H. Exposure to secondhand smoke in Iranian pregnant women at home and the related factors. Volume 5. Tobacco Prevention & Cessation; 2019.
2. Soma-Pillay P, Nelson-Piercy C, Tolppanen H, Mebazaa A. Physiological changes in pregnancy: review articles. Cardiovasc J Afr. 2016;27(2):89–94.
3. Tavassoli A, Abedi M, Gharejedaghi SM. Cultural Capital and Tobacco-Related Health Literacy in pregnant women and the relationship with fetal smoke exposure. Int J High Risk Behav Addict. 2022;11(1).
4. Nawabi F, Krebs F, Vennedey V, Shukri A, Lorenz L, Stock S. Health literacy in pregnant women: a systematic review. Int J Environ Res Public Health. 2021;18(7):3847.
5. Djalalinia S, Modirian M, Sheidaei A, Yoosefi M, Zokaiee H, Damirchilu B, et al. Protocol design for large–scale cross–sectional studies of surveillance of risk factors of non–communicable diseases in Iran: STEPs 2016. Arch Iran Med. 2017;20(9):–.
6. Varmaghani M, Sharifi F, Mehdipour P, Sheidaei A, Djalalinia S, Gohari K, et al. Prevalence of smoking among Iranian adults: findings of the national STEPs survey 2016. Arch Iran Med. 2020;23(6):369–77.
7. Sarraf-Zadegan N, Boshtam M, Shahrokhi S, Naderi GA, Asgary S, Shahparian M, et al. Tobacco use among Iranian men, women and adolescents. Eur J Public Health. 2004;14(1):76–8.
8. Bahiraii A, Rad SF, Mirmohammadali M, Nezhad AK. Predictors of home smoking ban in households in pregnant women. Payesh (Health Monitor). 2012;11(4):511–7.
9. Fazel N, Kundi M, Kazemzadeh A, Esmaily H, Akbarzadeh R, Ahmadi R. Environmental tobacco smoke exposure during pregnancy affects complications and birth outcomes in women with and without asthma. BMC Pregnancy Childbirth. 2020;20(1):1–8.
10. Lange S, Probst C, Rehm J, Popova S. National, regional, and global prevalence of smoking during pregnancy in the general population: a systematic review and meta-analysis. Lancet Global Health. 2018;6(7):e769–76.
11. Adams EK, Melvin CL, Raskind-Hood C, Joski PJ, Galactionova E. Infant delivery costs related to maternal smoking: an update. Nicotine Tob Res. 2011;13(8):627–37.
12. Kathleen Adams E, Miller VP, Ernst C, Nishimura BK, Melvin C, Merritt R. Neonatal health care costs related to smoking during pregnancy. Health Econ. 2002;11(3):193–206.
13. Havard A, Chandran JJ, Oei JL. Tobacco use during pregnancy. Addiction. 2022;117(6):1801–10.
14. Crume T. Tobacco use during pregnancy. Clin Obstet Gynecol. 2019;62(1):128–41.
15. Caleyachetty R, Tait CA, Kengne AP, Corvalan C, Uauy R, Echouffo-Tcheugui JB. Tobacco use in pregnant women: analysis of data from demographic and health surveys from 54 low-income and middle-income countries. Lancet Global Health. 2014;2(9):e513–20.
16. Brown R, Dakkak H, Gilliland J, Seabrook JA. Predictors of drug use during pregnancy: the relative effects of socioeconomic, demographic, and mental health risk factors. J neonatal-perinatal Med. 2019;12(2):179–87.

17. Gillies PA, Madeley RJ, Power FL. Why do pregnant women smoke? Public Health. 1989;103(5):337–43.
18. Marufu TC, Ahankari A, Coleman T, Lewis S. Maternal smoking and the risk of still birth: systematic review and meta-analysis. BMC Public Health. 2015;15(1):1–15.
19. Ebert LM, Fahy K. Why do women continue to smoke in pregnancy? Women Birth. 2007;20(4):161–8.
20. Da Pilma Lekettey J, Dako-Gyeke P, Agyemang SA, Aikins M. Alcohol consumption among pregnant women in James town community, Accra, Ghana. Reproductive Health. 2017;14(1):1–8.
21. Tsakiridis I, Mamopoulos A, Papazisis G, Petousis S, Liozidou A, Athanasiadis A, et al. Prevalence of smoking during pregnancy and associated risk factors: a cross-sectional study in Northern Greece. Eur J Public Health. 2018;28(2):321–5.
22. Warren CW, Jones NR, Asma S. Global youth tobacco surveillance, 2000–2007. 2008.
23. Goel P, Radotra A, Singh I, Aggarwal A, Dua D. Effects of passive smoking on outcome in pregnancy. J Postgrad Med. 2004;50(1):12.
24. Kansara V, Pateliya PA, Karia J, Kadakar K. An obstetric outcome in pregnant women with consumption of tobacco. Int J Reprod Contracept Obstet Gynecol. 2022;11(1):120–5.
25. Cui D, Yang W, Shao P, Li J, Wang P, Leng J, et al. Interactions between prepregnancy overweight and passive smoking for macrosomia and large for gestational age in Chinese pregnant women. Obes Facts. 2021;14(5):520–30.
26. Wahabi HA, Mandil AA, Alzeidan RA, Bahnassy AA, Fayed AA. The independent effects of second hand smoke exposure and maternal body mass index on the anthropometric measurements of the newborn. BMC Public Health. 2013;13:1–6.
27. Adeoye IA. Alcohol consumption and tobacco exposure among pregnant women in Ibadan, Nigeria. BMC Psychiatry. 2022;22(1):1–13.
28. Hiscock R, Bauld L, Amos A, Fidler JA, Munafò M. Socioeconomic status and smoking: a review. Ann N Y Acad Sci. 2012;1248(1):107–23.
29. Bashirian S, Barati M, Karami M, Hamzeh B, Ezati E. Prevalence of water pipe smoking and associated risk factors among female adolescents. J Educ Health Promotion. 2021;10.
30. Datta BK, Husain MJ. Uncontrolled hypertension among tobacco-users: women of prime childbearing age at risk in India. BMC Womens Health. 2021;21(1):146.
31. Wikström A-K, Stephansson O, Cnattingius S. Tobacco use during pregnancy and preeclampsia risk: effects of cigarette smoking and snuff. Hypertension. 2010;55(5):1254–9.
32. Marufu TC, Ahankari A, Coleman T, Lewis S. Maternal smoking and the risk of still birth: systematic review and meta-analysis. BMC Public Health. 2015;15(1):239.
33. Philips EM, Santos S, Trasande L, Aurrekoetxea JJ, Barros H, von Berg A, et al. Changes in parental smoking during pregnancy and risks of adverse birth outcomes and childhood overweight in Europe and North America: an individual participant data meta-analysis of 229,000 singleton births. PLoS Med. 2020;17(8):e1003182.

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