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Risk factors and awareness of tobacco smoking and second-hand smoke exposure among pregnant women in Taiwan

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Abstract

Objectives: Tobacco smoking during pregnancy is a significant public health concern, posing serious risks to both maternal and fetal health. This study aimed to identify factors associated with smoking, second-hand smoke (SHS) exposure, and knowledge of smoking hazards and cessation counseling services during pregnancy.

Methods: A cross-sectional study was conducted among 3,052 pregnant women receiving prenatal care from 2016 to 2022. Maternal characteristics, smoking status, SHS exposure, and knowledge of smoking risks and cessation services were analyzed using multivariable logistic regression models.

Results: Approximately 5.6 % of participants were current smokers. Smoking was more prevalent among unmarried women, those with low income, multigravida, and women with overweight/obesity ($p<0.05$). SHS exposure was reported by 19.9 % of participants, with higher rates among women with low income and immigrant status ($p<0.05$). While 99.2 % of participants were aware of the risks of smoking to maternal and infant health, awareness was significantly lower among immigrant women ($p<0.05$). Additionally, 96.3 % of participants were aware of smoking cessation counseling services, but lower awareness levels were observed in women aged≥35 years, unmarried women, and immigrant women ($p<0.05$).

Conclusions: Sociodemographic factors such as low income and immigrant status are strongly associated with smoking and SHS exposure during pregnancy. To address these disparities, hospitals should prioritize tailored prenatal education and counseling services. Emphasizing the risks of smoking to maternal and infant health can promote healthier pregnancies, especially in underserved rural areas.

Keywords: smoking; second-hand smoke (SHS); knowledge; awareness; prenatal care; health policy

Introduction

According to the World Health Organization (WHO) in 2023, tobacco use accounts for over 8 million deaths annually, including those caused by second-hand smoke (SHS) exposure [1]. Smoking during pregnancy remains a critical public health concern, significantly contributing to adverse maternal, fetal, and child health outcomes. These outcomes include increased risks of obstetric complications, challenges with assisted reproductive technology, adverse birth outcomes (e.g., stillbirth, preterm birth, low birth weight), sudden infant death syndrome, asthma, obesity, and childhood cancers. Higher levels of smoking are associated with greater risks of these adverse outcomes [2–6]. Several demographic and social-behavioral factors influence the likelihood of smoking during pregnancy, such as age, education level, family income, unplanned pregnancy, alcohol consumption, perceived stress, and depression [7–10].

SHS also poses significant health risks, especially for vulnerable pregnant women. The prevalence of SHS exposure at home among pregnant women ranges from 17 to 73 % across various countries [11]. SHS exposure during pregnancy has been linked to depressive symptoms, cardiovascular diseases, hypertension, respiratory problems, pregnancy complications, and adverse outcomes for infants and children [12–14]. While sustained SHS exposure has decreased in countries like the USA, Japan, and Korea due to stricter smoking regulations, improving knowledge, attitudes, and practices (KAP) remains a critical strategy for reducing exposure globally [13]. Factors influencing SHS-related KAP include age, education level, occupation, sources

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of information, unintended pregnancies, living environment, and ethnicity [11, 13–15].

A 2012 WHO report highlighted that four major non-communicable diseases – cancer, diabetes, cardiovascular diseases, and chronic respiratory diseases – accounted for approximately 68 % of global deaths, a figure that rises to nearly 80 % in Taiwan. Key risk factors for these conditions include smoking, physical inactivity, unhealthy diets, and excessive alcohol consumption [16]. To enhance comprehensive prenatal care, the Taiwan government expanded publicly funded prenatal checkups in July 2021, increasing the number from 10 to 14 [17]. The Taiwan Birth Cohort Study, conducted in 1994 by the National Health Bureau, interviewed 21,248 mothers six months postpartum. The study found that while 7.7 % of mothers smoked before pregnancy, this rate dropped to 3.6 % during pregnancy. However, this still translates to approximately 7,000 pregnant women nationwide continuing to smoke annually, posing significant risks to the next generation [18]. In recent years, societal and cultural changes, such as an increase in marriages between foreign spouses and Chinese nationals, have introduced new challenges. These include life adaptation difficulties related to age, education, and language differences, which may impact perinatal care outcomes [16, 19].

Taiwan implemented the Tobacco Hazard Prevention Act to align with the WHO's 2013–2020 goal of reducing tobacco use by 30 %. Since 2002, the country has promoted smoking cessation training for healthcare professionals [20, 21]. Key initiatives include the Tobacco Control Program and the Study of Whole Person Health Promotion and Addiction Prevention. In November 2014, Taiwan launched prenatal health education services for pregnant women through the Maternal Health Handbook and Health Education Handbook [16]. Studies underscore the importance of providing adequate counseling and support services to pregnant women and their spouses to enhance their understanding of smoking hazards and to promote smoking cessation during pregnancy [11, 22, 23]. Despite these efforts, the effectiveness of initiatives such as the 2014 prenatal health education services and the 2021 expansion of publicly funded prenatal checkups remains unclear.

Given the persistent health risks associated with smoking and SHS exposure during pregnancy, it is crucial to monitor current risk factors and levels of knowledge regarding smoking hazards and cessation services. This will enable the development of targeted interventions for this vulnerable population and the implementation of appropriate policies. Therefore, the objectives of this study were: (1) to examine the prevalence of smoking and SHS exposure during pregnancy, (2) to identify risk factors associated with smoking and SHS exposure, and (3) to evaluate risk factors linked to knowledge of smoking hazards related to maternal-infant health and counseling services for smoking cessation among pregnant women.

Materials and methods

Study design and participants

This study utilized cross-sectional data mandated by the Health Promotion Administration (HPA) of the Ministry of Health and Welfare (MOHW) in Taiwan. It included 3,052 pregnant women in their first trimester (mean gestational age: 9.3 weeks) who underwent prenatal examinations at Fooyin University Hospital between 2016 and 2022. Fooyin University Hospital is a specialized teaching hospital with over 70 years of experience in obstetrics and newborn care.

Participant enrollment and data collection took place at the prenatal service center within the obstetrics and gynecology department, staffed by two trained registered nurses. Under the guidance of the HPA, participants completed a structured questionnaire that collected information on maternal characteristics, weight control, medical history, health status, nutrition, vertical infectious diseases, and health behaviors. Data recorded in the questionnaire were verified by trained nurses to ensure accuracy.

A current tobacco smoker is defined as an individual who has smoked at least 100 cigarettes in their lifetime and continues to smoke. Second-hand smoke exposure refers to being in an environment where others are smoking tobacco products. Knowledge of smoking hazards is defined as an awareness of the risks associated with smoking, such as miscarriage, preterm birth, and low birth weight. Counseling services for smoking cessation involve knowing that the hospital provides specialists who can assist pregnant individuals in quitting smoking. The study adhered to the ethical principles outlined in the Declaration of Helsinki and received approval from the Ethics Review Board of Fooyin University Hospital (IRB No: FYH-IRB-112-06-02-A).

Statistical analysis

Maternal characteristics analyzed in this study included age, marital status, financial status, nationality, maternal smoking status, SHS exposure, knowledge of smoking hazards related to maternal-infant health, awareness of counseling services for smoking cessation, and the screening year. The Chi-squared test was used to compare nominal variables, including age group, marital status, income, immigrant status, gravidity, pregnancy BMI, and time period.

Multivariable logistic regression models were utilized to estimate adjusted odds ratios (aORs) and their corresponding 95 % confidence intervals (95 % CIs), enabling an assessment of differences in maternal smoking status, exposure to second-hand smoke, knowledge of smoking-related hazards, and awareness of counseling services for smoking cessation. The goodness-of-fit test following the multivariable logistic model was conducted to assess model fit. The interaction effect between two investigated variables was evaluated for effect modification by incorporating both the main effects and their interaction term into the multivariable logistic model. A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using SPSS statistical software (version. 25.0; IBM, Chicago, IL, USA).

Results

A total of 3,052 pregnant women were enrolled in this study, with their characteristics summarized in Table 1. The average age of the participants was approximately 28 years, 18 % were unmarried, and 8 % had a low income. Additionally, 12.1 % of the women were immigrants, primarily from Vietnam (8.2 %). Only 29.5 % were primigravida, and 54.4 % had a normal BMI (18.5–23.9 kg/m^2).

Table 2 presents factors associated with the smoking status of pregnant women. Approximately 5.6 % of pregnant women were current smokers. Women under the age of 25, unmarried, low-income, local Taiwanese, multigravida, and those with overweight/obesity exhibited significantly higher rates of smoking compared to their respective counterparts (p<0.05). Regarding SHS exposure, 19.9 % of pregnant women reported exposure. Women under 25 years of age, unmarried, low-income, and immigrants experienced higher levels of SHS exposure than their counterparts (p<0.05). Table 2 also details participants' knowledge of smoking hazards and counseling services for smoking cessation. Most participants (99.2 %) were aware of the risks of smoking to maternal and infant health. However, immigrant and primigravida women had significantly lower awareness compared to their counterparts (p<0.05). Similarly, 96.3 % of participants were aware of available counseling services for smoking cessation, but unmarried women, immigrants, primigravida women, and those surveyed during earlier time periods showed lower awareness than their counterparts (p<0.05). For the time period, smoking prevalence began at 5.6 % in 2016–2017, increased to 6.9 % in 2018–2019, and then declined to 4.7 % in 2020–2022. Similarly, SHS exposure decreased from 21.5 % in 2016–2017 to 19.4 % in 2018–2019 and further to 19.0 % in 2020–2022.

Table 1: Demographic characteristics of pregnant women (n=3,052).

Variable	n (%)	Mean (SD)
Age, years		28.3 (5.9)
Age group, year		
14–19	169 (5.5)	
20–24	778 (25.5)	
25–29	902 (29.6)	
30–34	728 (23.9)	
35–39	398 (13.0)	
≥ 40	77 (2.5)	
Marital status-unmarried	549 (18.0)	
Financial low income[a]	244 (8.0)	
Country of birth		
Taiwanese	2,684 (87.9)	
Immigrant	368 (12.1)	
Vietnam	250 (8.2)	
Indonesia	52 (1.7)	
Mainland China	46 (1.5)	
Philippine	12 (0.4)	
Malaysia	4 (0.1)	
Thailand	2 (0.1)	
Cambodia	1 (0.0)	
Gravidity[b]		
Primigravidae	832 (29.5)	
Multigravidae	1,989 (70.5)	
Pregnancy BMI[c], kg/m^2		
<18.5	337 (11.5)	
18.5–23.9	1,591 (54.4)	
24.0–26.9	501 (17.1)	
≥27.0	497 (17.0)	
Investigation year		
2016–2017	935 (30.6)	
2018–2019	902 (29.5)	
2020–2022	1,215 (39.9)	

[a]A low-income family is defined as having an average income per member below US$410 during the study period in Pingtung. [b]231 women missed gravidity data (n=2,821). [c]126 women missed BMI, data (n=2,926).

We also analyzed the likelihood of smoking-related behaviors and knowledge among pregnant women, presenting adjusted odds ratios (aORs) relative to reference groups, as shown in Table 3. Unmarried women (aOR=3.16; 95 % CI: 2.16–4.63), low income women (aOR=2.64; 95 % CI: 1.71–4.08), multigravida women (aOR=1.98; 95 % CI: 1.27–3.07), and women with overweight/obesity (aOR=1.44; 95 % CI: 1.02–2.05) were more likely to smoke. In contrast, immigrant women (aOR=0.14; 95 % CI: 0.03–0.57) had a lower likelihood of smoking than the reference group.

For SHS exposure, low-income (aOR=2.14; 95 % CI: 1.58–2.90) and immigrant women (aOR=1.55; 95 % CI: 1.16–2.06) were more likely to be exposed. However, women aged 25–34 years (aOR=0.74; 95 % CI: 0.59–0.92) had significantly lower exposure than the reference group. Immigrant women (aOR=0.30; 95 % CI: 0.10–0.95) also had lower

Table 2: Factors associated with smoking, second-hand smoke, knowledge of smoking hazards related to maternal-infant health, and knowledge of smoking cessation counselling (n=3,052).

Variable	Smoking, n (%)	Second-hand smoke, n (%)	Knowledge of smoking hazards, n (%)	Knowledge of smoking cessation counselling, n (%)
Age group				
<25 years (947)	69 (7.3)[e]	213 (22.5)[d]	940 (99.3)	913 (96.4)
25–34 years (1,630)	71 (4.4)	295 (18.1)	1,617 (99.2)	1,577 (96.7)
≥35 years (475)	31 (6.5)	99 (20.8)	472 (99.4)	450 (94.7)
Marital status				
Married (2,503)	101 (4.0)[f]	481 (19.2)[d]	2,486 (99.3)	2,420 (96.7)[d]
Unmarried (549)	70 (12.8)	126 (23.0)	543 (98.9)	520 (94.7)
Income group				
Middle/high income (2,808)	135 (4.8)[f]	527 (18.8)[f]	2,785 (99.2)	2,705 (96.3)
Lowcincome[a] (244)	36 (14.8)	80 (32.8)	244 (100.0)	235 (96.3)
Immigrant status				
Taiwanese (2,684)	169 (6.3)[f]	518 (19.3)[d]	2,670 (99.5)[f]	2,600 (96.9)[f]
Immigrant (368)	2 (0.5)	89 (24.2)	359 (97.6)	340 (92.4)
Gravidity[b]				
Primigravidae (832)	34 (4.1)[d]	158 (19.0)	820 (98.6)[e]	788 (94.7)[e]
Multigravidae (1,989)	127 (6.4)	404 (20.3)	1,980 (99.5)	1,929 (97.0)
Pregnancy BMI[c]				
Low/normal weight (1,928)	87 (4.5)[e]	374 (19.4)	1,913 (99.2)	1,859 (96.4)
Over weight/ Obesity (998)	70 (7.0)	204 (20.4)	993 (99.5)	965 (96.7)
Time period				
2016-2017 (935)	52 (5.6)	201 (21.5)	925 (98.9)	883 (94.4)[f]
2018-2019 (902)	62 (6.9)	175 (19.4)	897 (99.4)	869 (96.3)
2020-2022 (1,215)	57 (4.7)	231 (19.0)	1,207 (99.3)	1,188 (97.8)
Total	171 (5.6)	607 (19.9)	3,029 (99.2)	2,940 (96.3)

[a]A low-income family is defined as having an average income per member below US$410 during the study period in Pingtung. [b]231 women missed gravidity data (n=2,821). [c]126 women missed BMI, data (n=2,926). [d]0.01<p <0.05; [e]0.001<p <0.01; [f]p<0.001.

awareness of smoking hazards compared to the reference group. Finally, women aged≥35 years (aOR=0.51; 95 % CI: 0.27–0.77), unmarried women (aOR=0.51; 95 % CI: 0.31–0.87), and immigrant women (aOR=0.45; 95 % CI: 0.26–0.77) demonstrated lower knowledge of counseling services for smoking cessation. In contrast, multigravida women (aOR=1.98; 95 % CI: 1.27–3.07) and those surveyed in recent years (aOR=1.76; 95 % CI: 1.08–2.89 for 2018–2019; aOR=2.67; 95 % CI: 1.61–4.45 for 2020–2022) were more likely to be aware of these services.

The p-values for the model fit of the multivariate logistic regressions for 'Smoking', 'Second-hand smoke', 'Knowledge of smoking hazards', and 'Knowledge of smoking cessation counselling', as presented in Table 3, are 0.405, 0.349, 0.100, and 0.004, respectively. All models, except for the last outcome, demonstrate a good fit. After removing the non-significant variables related to 'Knowledge of smoking cessation counselling,' the p-value for model fit improved to 0.486, indicating a good model fit.

We also analyzed the interaction effects of significant factors on all study outcomes. Marital status and income group exhibited a significant interaction on smoking among pregnant women (Supplementary Table 1). Compared to married women with middle-to-high income, unmarried women with middle-to-high income had a 4.10-fold higher likelihood of smoking (95 % CI: 2.71–6.21); however, this likelihood increased to 5.18-fold (95 % CI: 2.59–10.33) among unmarried women with low income (p for interaction=0.005).

Discussion

Maternal smoking rates have shown significant fluctuations worldwide, and our study highlights notable changes in Taiwan from 2016 to 2022. Smoking prevalence declined from 5.6 % in 2016–2017 to 4.7 % in 2020–2022. These trends align with findings by Dias-Damé and Cesar (2015), who reported a decrease in smoking during pregnancy from 22 % in 2007 to 18 % in 2013 [9]. The decline is likely linked to the implementation of Taiwan's Tobacco Hazard Prevention Act, which aligns with the WHO's 2013–2020 goal of reducing tobacco use by 30 %. Similarly, SHS exposure among pregnant women decreased from 21.5 % in 2016–2017 to 19.4 % in 2018–2019 and 19.0 % in 2020–2022. The decline may be attributed to stricter regulations and the introduction of publicly funded prenatal checkups in 2021, which included education on SHS hazards.

Our study identified several key risk factors for smoking during pregnancy, including age below 25, unmarried status, low income, multigravida, and overweight/obesity. These findings are consistent with previous research [7, 9, 10, 24], supporting the notion that various social, economic, and demographic factors contribute to smoking behaviors

Table 3: Multiple logistic regression of factors associated with smoking related events among pregnant women (n=3,052).

Variable	Smoking		Second-hand smoke		Knowledge of smoking hazards		Knowledge of smoking cessation counselling	
	Adjusted OR[d] (95 % CI)	p-Value	Adjusted OR[d] (95 % CI)	p-Value	Adjusted OR[d] (95 % CI)	p-Value	Adjusted OR[d] (95 % CI)	p-Value
Age group								
<25 (947)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
25–34 (1,630)	0.76 (0.51–1.12)	0.422	0.74 (0.59–0.92)	0.007	1.06 (0.36–3.10)	0.915	0.97 (0.59–1.61)	0.914
≥35 (745)	1.09 (0.64–1.86)	0.104	0.79 (0.58–1.08)	0.139	0.69 (0.16–2.98)	0.616	0.51 (0.27–0.77)	0.034
Marital status								
Married (2,503)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Unmarried (549)	3.16 (2.16–4.63)	<0.001	1.14 (0.88–1.48)	0.316	0.38 (0.12–1.14)	0.085	0.51 (0.31–0.87)	0.012
Income group								
Middle/high income (2,808)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Low income[a] (244)	2.64 (1.71–4.08)	<0.001	2.14 (1.58–2.90)	<0.001	1.00 (0.00–999)	0.995	1.12 (0.48–2.18)	0.957
Immigrant status								
Taiwanese (2,684)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Immigrant (368)	0.14 (0.03–0.57)	0.006	1.55 (1.16–2.06)	0.003	0.30 (0.10–0.95)	0.040	0.45 (0.26–0.77)	0.004
Gravidity[b]								
Primigravidae (832)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Multigravidae (1,989)	1.98 (1.27–3.07)	0.002	1.07 (0.86–1.34)	0.545	2.53 (0.94–6.84)	0.066	1.70 (1.08–2.68)	0.022
Pregnancy BMI[c]								
Low/normal weight (1,928)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Over weight/Obesity (998)	1.44 (1.02–2.05)	0.039	1.07 (0.87–1.31)	0.523	1.25 (0.40–3.92)	0.706	0.83 (0.53–1.30)	0.411
Time period								
2016–2017 (935)	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
2018–2019 (902)	1.03 (0.67–1.59)	0.885	0.80 (0.62–1.02)	0.797	2.22 (0.66–7.44)	0.197	1.76 (1.08–2.89)	0.024
2020–2022 (1,215)	0.82 (0.54–1.26)	0.366	0.81 (0.65–1.03)	0.814	1.88 (0.64–5.54)	0.250	2.67 (1.61–4.45)	<0.001
P Value for model fit		0.405		0.349		0.100		0.004

[a]A low-income family is defined as having an average income per member below US$410 during the study period in Pingtung. [b]231 women missed gravidity data (n=2,821); [c]126 women missed BMI, data (n=2,926). [d]Adjusted ORs, were mutually adjusted for marital status, income group, age group, immigrant status, time period, pregnancy BMI, and gravidity.

among pregnant women. However, unlike previous studies that have predominantly emphasized maternal age as a primary predictor, our study highlights the significance of other factors, such as marital status, income, parity, and BMI. This nuanced understanding of risk factors provides deeper insights into the underlying reasons women continue to smoke during pregnancy and emphasizes the need for targeted interventions. The relationship between marital status and smoking during pregnancy is particularly noteworthy. Specifically, our study supports previous research findings that women without spouses or partners, those with low income, and multigravida women are more likely to smoke during pregnancy [25, 26]. Unmarried pregnant women may face additional stressors compared to their married counterparts, including social stigma, limited social support, and financial strain. These factors could increase the likelihood of smoking as a coping mechanism. The absence of a partner may also result in a sense of isolation, further exacerbating emotional distress, which in turn could encourage smoking [27]. Low income exacerbates financial stress, potentially triggering smoking as a coping mechanism [28]. First-pregnancy women are less likely than multigravida women to smoke, which might be due to heightened concern about the well-being of their baby and the desire to meet social expectations of a healthy pregnancy [29]. BMI also plays a crucial role in smoking behaviors during pregnancy, as our study suggests. Overweight and obese women may face challenges quitting smoking due to the metabolic effects of nicotine, such as appetite suppression and weight loss [30–32]. These women might perceive smoking as a way to control their weight, which could create a barrier to smoking cessation efforts during pregnancy. It is important for health interventions to address both weight management and smoking cessation in these women, emphasizing the

health benefits of quitting smoking not just for the baby but for the mother's long-term well-being. Interestingly, our study uncovered a cultural difference in smoking prevalence between local Taiwanese women and immigrant women. Local Taiwanese women were found to smoke more frequently than their immigrant counterparts, a trend that mirrors findings from Salinas-Vilca et al. [7], who observed higher smoking rates among native Spanish women compared to immigrant women in Spain. This suggests that cultural attitudes towards smoking may play a significant role in shaping smoking behaviors. In Taiwan, smoking may be more accepted in certain groups, potentially contributing to higher smoking rates during pregnancy. Conversely, immigrant women might face cultural barriers or stricter health-related expectations that could reduce smoking prevalence. These findings underscore the importance of considering cultural and social contexts when developing smoking cessation programs, as culturally tailored cessation programs are essential for effective interventions.

Furthermore, we revealed that women below 25 years of age, unmarried, low-income, and immigrant women experienced higher rates of SHS exposure compared to their corresponding groups. For the age factor, it aligns with previous research [13]. This study also supports that unmarried and low-income women are more likely to experience exposure to SHS [33]. These women often reside in environments where spouses, family members, or neighbors smoke, due to financial and social stressors [34, 35]. Notably, our study found that local Taiwanese women had a higher smoking rate than immigrant women, whereas immigrant women experienced higher SHS exposure. This may be attributed to cultural attitudes or a lack of empowerment to prevent exposure within their living environments. For example, Arab women have been reported to have less confidence in preventing SHS exposure due to societal norms and exposure from multiple male family members [15]. A study in Sweden also suggested that consideration of a woman's and her partner's ethnic background and life stage at migration may help understand smoking-related patterns of immigrant women [36]. Immigrant women in Taiwan may similarly lack confidence in advocating for themselves. Our findings also revealed that immigrant women had significantly lower knowledge of both the hazards of smoking and the availability of counseling services for smoking cessation during pregnancy. This knowledge gap may partially explain their higher rates of SHS exposure. Pregnancy smoking-prevention and cessation programs should incorporate partners, family members, and culturally appropriate approaches for ethnically diverse couples to enhance effectiveness.

Additionally, we observed lower knowledge of smoking hazards and cessation counseling among immigrant, unmarried, first-pregnancy, and earlier time-period women. Immigrant women, in particular, may lack familiarity with available maternal resources or face cultural and linguistic barriers to accessing care. Women from earlier time periods may have been impacted by the insufficient tobacco control training provided to physicians and midwives prior to 2021. It aligns with previous research [37] recommending that education and training in both medical professionals and the educational system can improve prenatal care and collaboration in the care of vulnerable pregnancy women. Furthermore, interventions based on the Health Belief Model, by altering women's health beliefs, effectively reduced SHS exposure. Previous studies also highlighted education as a crucial factor in promoting smoking cessation during pregnancy [9, 38, 39]. Our findings emphasize the need for culturally appropriate and accessible health education programs tailored to the specific needs of diverse populations. Addressing these disparities through targeted public health initiatives and policies can contribute to further reductions in smoking and SHS exposure among pregnant women in Taiwan.

Strengths and limitations

This study has some limitations. First, smoking status was based on self-reported questionnaires verified by trained nurses but not confirmed by biological markers. Nonetheless, the prevalence rates align with national data. Second, data collection was limited to a single regional hospital. However, Taiwan's free and universal prenatal care system minimizes inter-hospital discrepancies and reduces selection bias. A major strength of this study is its status as the longest-running investigation, spanning six years, into smoking and SHS exposure among pregnant women in rural Taiwan.

Conclusions

Our findings indicate relatively low rates of maternal smoking and SHS exposure, which may reflect increased awareness of smoking-related hazards and improved access to smoking cessation counseling services. However, targeted education and intervention strategies remain essential for populations with higher smoking rates, including single, low-income, and multigravida women, as well as those experiencing disproportionately high SHS exposure, particularly younger, low-income, and immigrant women. Efforts

should focus on providing comprehensive education about the risks associated with all forms of smoking and promoting smoking cessation interventions, particularly during the first trimester, to address the needs of this at-risk population. For immigrant women, healthcare professionals should emphasize culturally sensitive care and actively advocate for healthier living environments by encouraging smoking cessation or facilitating referrals to appropriate cessation programs.

Research ethics: The Institutional Review Board of Fooyin University Hospital approved this study (IRB No: FYH-IRB-112-06-02-A). 2023-07-03.

Informed consent: Not applicable.

Author contributions: Chang and Lin were the principal investigators and drafted the article. Kuo and Lin formulated the study. Kuo collected and interpreted the data. Chang, Wang, and Lin wrote the manuscript and critically revised the article. All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

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