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Short Communication

Adherence to iron supplementation and associated factors among pregnant women in Cambodia: Insights from the 2021–2022 Demographic and Health Survey

Annas Buanasita[1], Sri Sumarmi[2*], Trias Mahmudiono[2], Soenarnatalina Melaniani[3], Lutfi A. Salim[3], Ma Sokvy[4] and Nur MW. Sari[5]

[1]Doctoral Program in Public Health, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia; [2]Department of Nutrition, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia; [3]Department of Epidemiology, Biostatistics, Population Studies, and Health Promotion, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia; [4]School of Public Health, National Institute of Public Health, Phnom Penh, Cambodia; [5]Department of Health, Population Control and Family Planning, Trenggalek, Indonesia

*Corresponding author: sri_sumarmi@fkm.unair.ac.id

Abstract

Iron deficiency is the leading cause of anemia during pregnancy, a major public health concern in many developing countries. To mitigate anemia, iron supplementation for at least 90 days is recommended for pregnant women. The aim of this study was to evaluate adherence to iron supplementation during pregnancy and to identify its key determinants in Cambodia. A cross-sectional study was conducted using secondary data from the 2021–2022 Cambodia National Demographic and Health Survey. Key variables assessed included maternal age, education level, ethnicity, wealth index, number of pregnancies, age at first pregnancy, prenatal care provider, timing of the first antenatal care (ANC) visit, and frequency of ANC visits. Multivariate logistic regression was employed to evaluate associations between adherence and independent variables. A total of 4,475 women aged 15–49 years who had been pregnant in the past five years were included in the analysis, with 91.2% adhering to iron supplementation for at least 90 days. Multivariate logistic regression showed that those with primary and higher education had greater odds of adherence (odds ratio (OR)=1.38; 95%CI: 1.00–1.90; OR=3.07; 95%CI: 1.39–6.79, respectively) compared to women with no education. There was a positive relationship between education level and adherence. Women who attended four or more ANC visits were more likely to adhere (OR=2.93; 95%CI: 2.27–3.77), and those who initiated ANC in the first trimester had higher adherence compared to those who started later (OR=1.78; 95%CI: 1.35–2.36). This study highlights that education level, frequency, and timing of ANC visits significantly influenced adherence to iron supplementation. Strengthening maternal education and promoting early and regular ANC follow-up should be prioritized to improve adherence and prevent anemia during pregnancy.

Keywords: Cambodia, pregnant women, micronutrient supplementation, iron supplementation, adherence

Introduction

Maternal malnutrition represents a significant global health challenge, with far-reaching consequences for both mothers and their offspring. Pregnant women who are malnourished face an elevated risk of maternal mortality, adverse perinatal outcomes, and long-term developmental impairments in children [1-4]. Insufficient micronutrient intake during pregnancy is associated

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with low birth weight (LBW), preterm birth, fetal malnutrition, coexisting LBW and prematurity small-for-gestational-age infants, stillbirth, growth faltering, and elevated perinatal and neonatal mortality rates [5,6]. Additionally, maternal micronutrient deficiencies can hinder fetal growth and development, leading to neonatal stunting, immune dysfunction, altered cardiometabolic programming, neurodevelopmental disorders, including autism and schizophrenia, and long-term cognitive impairments [7,8]. These deficiencies also adversely affect maternal health, increasing the risk of postpartum hemorrhage, preeclampsia, and the need for blood transfusions [6,9].

Iron and folic acid (IFA) deficiencies are major contributors to pregnancy-related anemia, a condition frequently linked to poor maternal and neonatal outcomes, including labor complications, congenital abnormalities, and adverse birth outcomes [10-12]. Iron supplementation has been prioritized in the National Policy and Guidelines for Micronutrient Supplementation to Prevent and Control Deficiencies in Cambodia [13]. The World Health Organization (WHO) has emphasized the importance of addressing micronutrient deficiencies, recommending multiple micronutrient supplementation (MMS) during pregnancy to improve pregnancy outcomes [14]. This shift prioritizes improving fetal-maternal health outcomes and mitigating risks such as LBW and neonatal mortality. Research has increasingly explored the benefits of MMS over traditional IFA supplementation, particularly in regions with high anemia prevalence [15].

Southeast Asia remains a hotspot for anemia among pregnant women, with 48% of cases documented regionally [16]. In Cambodia, anemia prevalence among pregnant women showed only a slight decline, from 56% in 2005 to 53% in 2014, according to data from the Cambodian Demographic and Health Survey (DHS) [17]. Despite some progress, Cambodia continues to have higher anemia rates compared to neighboring Southeast Asian countries during the same period [18]. The Cambodia DHS 2021–2022 report highlights that 88% of Cambodian pregnant women utilized iron supplements for 90–179 days during their pregnancies, predominantly sourced from public health centers (85%) and the private sector (9%) [19]. However, disparities persist, with anemia prevalence strongly associated with socioeconomic factors, geographic location, and gestational trimester [17].

Adherence to IFA supplementation is critical for reducing iron-deficiency anemia (IDA) and its associated maternal and neonatal health risks. Low adherence rates hinder the development of key physiological systems, including immunological and neurological functions [20], while increasing the likelihood of adverse outcomes such as LBW, congenital anomalies, stillbirth, and preterm delivery [21]. A small study in two provinces in Cambodia identified factors such as antenatal care (ANC) access, the number of prenatal visits, and socioeconomic status as key determinants of IFA supplementation adherence [22]. However, the representative study assessing the similar issue in the country is not available. Therefore, the aim of this study was to evaluate adherence to iron supplementation during pregnancy and identify its key determinants using data from Cambodia DHS 2021–2022 to inform strategies for improving maternal nutrition and pregnancy outcomes.

Methods

Study design, setting and sampling

A cross-sectional study was conducted using data from the 2021–2022 Cambodia DHS, with authorization from the DHS program. The Cambodia DHS is a nationally representative survey implemented by the National Institute of Statistics in collaboration with the Ministry of Health. A stratified, two-stage cluster sampling design was employed to ensure proportional representation across all provinces. In the first stage, clusters—defined as enumeration areas (EAs) from the 2019 General Population Census (GPC)—were selected. A total of 709 clusters were included, comprising 241 urban and 468 rural areas. In the second stage, 30 households were systematically sampled from each cluster, yielding a total of 21,270 households. Because the sample size was nearly uniform across provinces, sample weights were calculated and applied to ensure national-level representativeness. Data collection was carried out from September 15,

2021, to February 15, 2022. Ethical protocols—including informed consent and confidentiality safeguards—were strictly followed.

Respondents

This study included women aged 15–49 years who completed the individual survey interview, reported a history of pregnancy, gave birth within five years preceding the survey, and had complete data on iron supplementation. Cases with missing or incomplete information on iron intake during pregnancy were excluded from the study.

Data collection

Fieldwork activities were coordinated and supervised by representatives from the National Institute of Statistics (NIS) and the Ministry of Health (MoH), with virtual technical assistance provided by ICF throughout the data collection period. Fieldwork commenced on September 15, 2021, across all 25 provinces, with each field team assigned to a specific province. Monitoring of field activities was conducted by NIS, MoH, and ICF (virtually), with quality control overseen by five designated field coordinators. Data collection concluded on February 15, 2022.

For the present study analysis, data were extracted from the women's questionnaire section of the 2021–2022 Cambodia DHS. The questionnaire captured self-reported information on iron supplementation during pregnancy, alongside demographic characteristics, socioeconomic status, and healthcare access.

Study variables

The primary outcome variable in this study was adherence to iron supplementation during pregnancy, as measured by self-reported responses to a structured survey questionnaire. A response of "no" indicated non-adherence, which was defined as either not taking iron supplements at all or taking them for fewer than 90 days during the most recent pregnancy. In contrast, a response of "yes" indicated adherence, defined as taking iron supplements for at least 90 days. Based on these responses, participants were classified into two groups: the adherence group, comprising women who reported taking iron supplements for 90 days or more, and the non-adherence group, consisting of those who took them for fewer than 90 days.

Several independent variables were included to assess factors influencing adherence to iron supplementation. Maternal age was categorized into seven groups: 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, and 45–49 years. Place of residence was classified as either rural or urban. Socioeconomic status was represented by the wealth index, categorized as poor, middle, or rich, and detailed have been published elsewhere [23]. The wealth index was derived based on household ownership of selected consumer goods (e.g., television, bicycle, and car) and housing characteristics such as the source of drinking water, sanitation facilities, and flooring materials. Educational attainment was categorized as no education, primary, secondary, or higher. Age at first pregnancy was grouped into three ranges: less than 20 years, 20–35 years, and greater than 35 years. Healthcare-related variables included the location of ANC visits, categorized as home, hospital, health center, clinic, or other healthcare facilities. The frequency of ANC visits was classified as fewer than four visits or at least four visits, with four or more considered a key indicator in the Global Strategy for Women's, Children's and Adolescents' Health (2016–2030) Monitoring Framework [24]. The timing of the first ANC visit was grouped into three categories: "do not know," first trimester, and second or third trimester. These variables were selected to comprehensively capture demographic, socioeconomic, and healthcare-related characteristics associated with adherence to iron supplementation during pregnancy.

Statistical analysis

Descriptive statistics were utilized to summarize the socio-demographic and prenatal characteristics of the study subjects, expressed as frequencies and percentages. The chi-squared test was applied to assess differences in the distribution of independent variables between adherence and non-adherence groups. For multivariate analysis, binary logistic regression was employed to evaluate the relationship between a dichotomous dependent variable and multiple independent variables measured on a nominal scale. A 95% confidence level (α=0.05) was set to determine statistical significance. Odds ratios (ORs) and their corresponding 95% confidence

intervals (95%CIs) were calculated to quantify the strength and direction of associations between the variables. All statistical analysis was performed using SPSS software version 25 (IBM, New York, USA). Statistical significance was considered at $p<0.05$.

Results

Selection of respondents

A total of 19,496 women aged 15–49 participated in the 2021–22 Cambodia DHS survey. Among them, 5,622 had never been pregnant, leaving 13,874 respondents with a reported pregnancy history. Of these, 4,475 women (32.25%) who had been pregnant within the last five years and had complete data on iron supplementation were included in the final analysis (**Figure 1**).

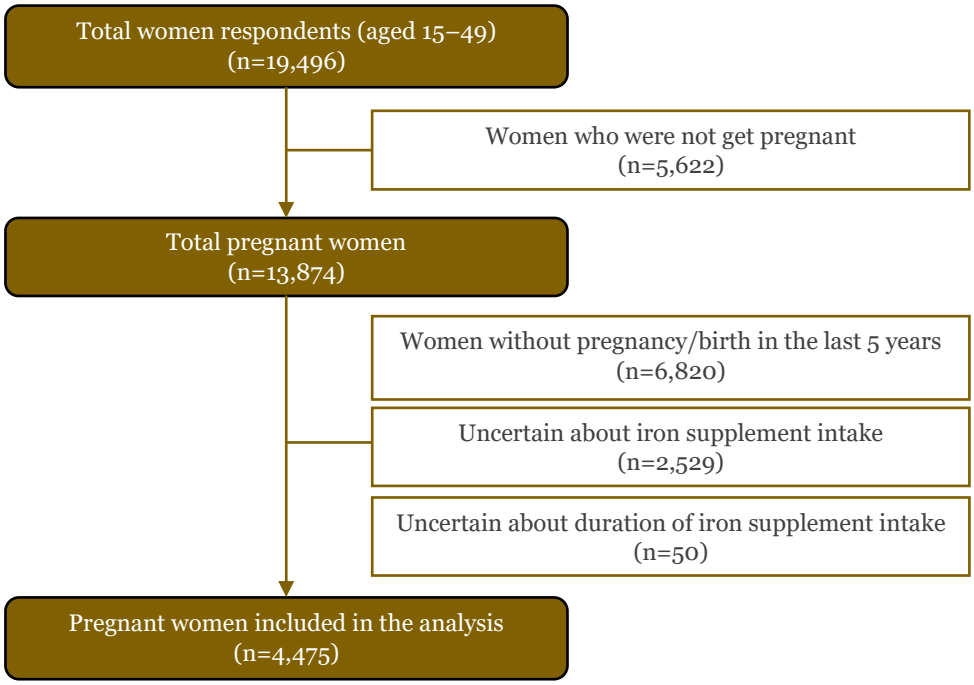

Figure 1. Flowchart showing the selection process of respondents included in the final analysis.

Characteristics of the respondents

Characteristics of the pregnant woman respondents included in the final analysis are presented in **Table 1**. The majority were aged 25–34 years (52.7%), followed by 15–24 years (26.9%) and 35–49 years (20.4%), indicating most participants were of reproductive age, with a substantial proportion in younger age groups. A large proportion (66.7%) resided in rural areas, while 33.3% lived in urban areas, reflecting a predominance of rural representation that may affect healthcare access. In terms of wealth, 48.4% were classified as poor, 17.7% as middle-income, and 33.9% as rich, illustrating economic disparities. Most respondents had primary (42.0%) or secondary education (40.4%), while 11.8% had no education and 5.8% had higher education, indicating limited access to higher education. Regarding age at first pregnancy, 70.9% experienced it between 20–35 years, 27.9% before 20, and 1.2% after 35, raising concerns about adolescent pregnancy and related health risks. Most ANC visits occurred at health centers (80.9%), followed by hospitals (9.5%) and clinics (8.2%), suggesting health centers are the primary ANC providers due to accessibility. The majority (83.4%) attended at least four ANC visits, while 16.6% had fewer. Most (87.7%) initiated ANC in the first trimester, 11.5% in the second or third trimesters, and 0.8% were unsure of the timing.

Table 1. Characteristics of the pregnant woman respondents (n=4,475)

Characteristics	Frequency	Percentage
Age (years)		
15–24	1,202	26.9

Characteristics	Frequency	Percentage
25–34	2,358	52.7
35–49	915	20.4
Type of residence	4,475	
Urban	1,489	33.3
Rural	2,986	66.7
Wealth index		
Poor	2,168	48.4
Middle	791	17.7
Rich	1,516	33.9
Level of education		
No education	528	11.8
Primary	1,878	42.0
Secondary	1,810	40.4
Higher	259	5.8
Age at first pregnancy (year)		
<20	1,250	27.9
20–35	3,172	70.9
>35	53	1.2
Place of antenatal care (ANC) visit		
Home and other health care	64	1.4
Hospital	420	9.5
Health center	3,594	80.9
Clinic	363	8.2
Frequency of ANC visit		
<4 ANC visits	741	16.6
≥4 ANC visits	3,732	83.4
Time of the first ANC visit		
Do not know	34	0.8
First trimester	3,925	87.7
Second and third trimester	516	11.5

Univariate analysis of factors associated with adherence to iron supplementation

Adherence to iron supplementation during pregnancy was significantly influenced by several demographic, socioeconomic, and healthcare-related factors (**Table 2**). Higher adherence was observed among women aged 25–34 years, while younger women aged 15–24 years were more likely to be non-adherent ($p<0.001$). Women from wealthier households demonstrated higher adherence compared to those from poorer households ($p=0.034$). Educational attainment was also associated with adherence, with women who had no education showing higher non-adherence compared to those with secondary or higher education levels ($p<0.001$). First pregnancies before the age of 20 were linked to lower adherence compared to those occurring between 20 and 35 years ($p<0.001$). Healthcare utilization played a critical role; adherence was significantly higher among women who attended at least four ANC visits ($p<0.001$), and those who initiated ANC during the first trimester were more likely to adhere than those who began later ($p<0.001$). However, place of residence and the location of ANC services were not found to be significantly associated with adherence ($p>0.05$).

Table 2. Characteristics of the pregnant woman respondents based on iron supplementation adherence

Variables	Non-adherence group (n=395)		Adherence group (n=4,080)		*p*-value
	n	Percentage	n	Percentage	
Age (years)					<0.001
15–24	139	35.2	1,063	26.1	
25–34	175	44.3	2,183	53.5	
35–49	81	20.5	834	20.4	
Type of residence					0.743
Urban	128	32.4	1,361	33.4	
Rural	267	67.6	2,719	66.6	
Wealth index					0.034
Poor	216	54.7	1,952	47.8	
Middle	62	15.7	729	17.9	
Rich	117	29.6	1,399	34.3	
Level of education					<0.001

Variables	Non-adherence group (n=395)		Adherence group (n=4,080)		*p*-value
	n	Percentage	n	Percentage	
No education	68	17.2	460	11.3	
Primary	169	42.8	1,709	41.9	
Secondary	150	38.0	1,660	40.7	
Higher	8	2.0	251	6.2	
Age at first pregnancy (year)					<0.001
<20	150	38.0	1,100	27.0	
20–35	243	61.5	2,929	71.8	
>35	2	0.5	51	1.2	
Place of antenatal care (ANC) visit					0.299
Home and other health care	10	2.6	54	1.3	
Hospital	36	9.2	384	9.5	
Health center	313	80.3	3,281	81.0	
Clinic	31	7.9	332	8.2	
Frequency of ANC visit					<0.001
<4 ANC visits	152	38.5	589	14.4	
≥4 ANC visits	243	61.5	3,489	85.6	
Time of the first ANC visit					<0.001
Do not know	5	1.3	29	0.7	
First trimester	289	73.2	3,636	89.1	
Second and third trimester	101	25.6	415	10.2	

Multivariate analysis of factors associated with adherence to iron supplementation

The factors influencing pregnant women's adherence to iron supplementation are presented in **Table 3**. Education level, frequency of ANC visits, and timing of the first ANC visit were significantly associated with adherence. Education level was identified as a significant determinant. Women with primary education were more likely to adhere compared to those with no education (OR=1.38; 95%CI: 1.00–1.90; p=0.046), while those with higher education had more than threefold increased odds of adherence (OR=3.07; 95%CI: 1.39–6.79; p=0.006). Although the association with secondary education was not statistically significant (OR=1.34; p=0.104), the overall trend indicated a positive relationship between education level and adherence. It was suggested that educated women may have had a better understanding of the importance of supplementation and may have engaged more actively in healthcare services. The frequency of ANC visits was significantly associated with adherence (p<0.001). Women who attended four or more ANC visits were more likely to adhere to iron supplementation (OR=2.93; 95%CI: 2.27–3.77), suggesting that frequent ANC visits increased adherence. The timing of the first ANC visit was also significantly associated with adherence (p<0.001). Women who initiated ANC in the first trimester were 44% more likely to adhere compared to those who began in the second or third trimester (OR=1.78; 95%CI: 1.35–2.36) (**Table 3**).

Table 3. Multivaite logistic regression showing factors associated with pregnant women's adherence to iron supplementation

Variables	Odds ratio (OR)	95% confidence interval (CI)		*p*-value
		Lower	Upper	
Age				
15–24 *(Reference group (R))*				
25–34	0.77	0.55	1.08	0.136
35–49	1.05	0.78	1.42	0.724
Type of residence				
Urban *(R)*				
Rural	1.23	0.95	1.59	0.115
Wealth index				
Poor *(R)*				
Middle	1.08	0.81	1.45	0.599
Rich	1.24	0.88	1.75	0.218
Level of education				
No education *(R)*				
Primary	1.38	1.005	1.904	0.046
Secondary	1.33	0.941	1.900	0.104
Higher	3.06	1.385	6.792	0.006

Variables	Odds ratio (OR)	95% confidence interval (CI)		*p*-value
		Lower	Upper	
Age at first pregnancy				
<20 years *(R)*				
20–35 years	0.42	0.09	1.83	0.251
>35 years	0.52	0.12	2.23	0.382
Place of antenatal care (ANC) visit				
Home and other health care *(R)*				
Hospital	0.61	0.30	1.26	0.185
Health Centre	0.99	0.67	1.49	0.997
Clinic	0.99	0.69	1.45	0.996
Frequency of ANC visit				
<4 ANC visit *(R)*				
≥4 ANC visit	2.92	2.27	3.77	<0.001
Time of the first ANC visit				
First trimester	1.78	1.35	2.37	<0.001
Second and third trimester *(R)*				

Discussion

This study assessed 4,475 women aged 15 to 49 years who had been pregnant within the preceding five years. Among them, 91.2% adhered to the recommended iron supplementation. The majority of the participating pregnant women were between 25 and 34 years old, an age range commonly associated with reproductive years. Previous studies found that older pregnant women had a higher risk of anemia compared to their younger counterparts [25-27]. However, this study found that the majority of non-adherent pregnant women (44.3%) were between the ages of 25 and 34 years. This suggests that adherence to iron supplementation is inconsistent across all age groups. These variations may be attributed to challenges faced by each age group, which potentially affect their ability to take iron (Fe) supplements regularly. These findings underscore the need for targeted interventions that address the specific challenges faced by different age groups to ensure optimal maternal health outcomes.

In terms of geographical differences, the adherence rate among women in rural areas (66.6%) was slightly higher than that of urban counterparts. This disparity may be attributed to the presence of stronger community networks in rural areas, which may facilitate better communication and support for health practices, including supplement intake. On the other hand, urban residents may face challenges such as busier lifestyles, increased distractions, and a lack of tailored health messaging, leading to lower adherence rates. These findings underscore the importance of considering distinct social and environmental factors between rural and urban areas when designing public health strategies to improve supplement adherence among pregnant women. A previous study highlights the role of community health programs in improving supplement adherence in rural areas [28], while a study of 25 countries in sub-Saharan Africa showed the challenges by urban populations in maintaining consistent health practices due to lifestyle demands [29].

A significant disparity in adherence to iron supplementation was observed among pregnant women based on their family welfare index. Pregnant women from lower socioeconomic backgrounds exhibited significantly lower adherence compared to those from wealthier families. This significant difference underscores the critical need for targeted interventions that address the specific barriers faced by low-income pregnant women, ensuring that they receive the necessary support to improve their adherence to essential prenatal supplements. This gap may be attributed to financial constraints, limited access to healthcare services, and lower health literacy among women from lower socioeconomic groups, which hinders their understanding of the importance of supplementation and their ability to prioritize it. In contrast, wealthier families usually have better access to healthcare services and information, such as interpersonal communication strategies, to bridge the knowledge gap and improve adherence among disadvantaged populations [37].

Furthermore, a significant difference in adherence to iron supplementation was observed across different levels of education. The findings indicate that higher levels of education were associated with greater compliance with consuming Fe tablets. The discrepancy may be attributed

to various factors associated with lower socioeconomic status, such as limited access to healthcare services, lower health literacy, and financial constraints that may hinder the consistent purchase or use of supplements [20].

Pregnant women aged 20–35 years, particularly those experiencing their first pregnancy, demonstrated higher adherence to Fe tablet consumption. Additionally, more frequent ANC visits were associated with increased adherence. This age group is often more health-conscious and more likely to receive guidance from healthcare providers, particularly during their first pregnancy. First-time pregnancies tend to heighten a woman's motivation to follow health advice closely, including adherence to supplementation. This trend could also reflect a greater sense of responsibility or fear of complications, prompting them to be more proactive in their prenatal care. A study on iron-folic acid supplementation among pregnant women in Africa found that younger mothers, particularly those aged 20–35 years, exhibited higher adherence to Fe supplementation [24]. The study highlights that this age group, especially first-time mothers, is often more motivated to follow health recommendations as they more likely to perceive their pregnancy as a critical period for ensuring their own health and that of their baby [24].

Adherence to Fe supplementation also affected by educational levels. Women with primary education had 1.38 times higher of adhering to iron supplements compared to those with no education level and the most substantial association was observed among women with a higher education level. These women were over three times more likely to adhere to iron supplementation compared to those with no education. This strong and statistically significant association highlight the potential role of higher education in fostering greater health awareness, autonomy in decision-making, and acess to health services. Education has been identified as one of the key factors influencing adherence to iron supplementation among pregnant women [29-32]. However, this study found that the number of ANC visits and the timing of the first ANC visit significantly influenced adherence, consistent with recent findings from the Philippines [30]. Higher education levels can motivate pregnant women to initiate ANC visits earlier and attend them more frequently. This underscores the importance of informal educational support during ANC visits to increase maternal knowledge and improve adherence to iron supplementation. Informal education may take the form of counseling or behavior change communication strategies that focus on the importance of adherence to iron supplementation. A study comparing women exposed to interpersonal communication campaign promoting IFA tablet consumption and iron-rich foods found that those who participated in the campaign demonstrated greater knowledge of IFA, along with improved attitudes and intentions toward its use [33]. During prenatal care visits, the integration of interpersonal communication and health promotion materials could assist pregnant women in understanding the benefits and usage of IFA supplements [34].

The findings of this study revealed that 91.17% of Cambodian pregnant women complied with the recommendation of taking iron supplements for 90 days or more. This percentage is higher than that reported in the previous study using CDHS 2014 data, which found an adherence rate of 75.9% among Cambodian pregnant women [35]. Analyzing the factors contributing to this low adherence, the study discovered that the frequency of ANC visits and educational attainment were associated with higher adherence rates. To the best of our knowledge, this is the first study to use data from a recent nationally representative survey (2021–2022) to evaluate Cambodian pregnant women's compliance with the recommendation of iron supplementation.

The findings of this study are consistent with a study conducted in 2011 on iron/folate supplementation among pregnant women in Cambodian provinces, which found that adherence was influenced by the quantity of supplements taken, the frequency of prenatal visits, and the availability of ANC services [31]. Moreover, these results are consistent with previous studies which demonstrated that maternal age and frequency of ANC visits are factors influencing pregnant women's adherence to Fe supplementation [36,37].

The findings of this study highlight the critical role of prenatal care in pregnant women's adherence to iron supplementation. Recent research across Asian countries has demonstrated that adherence to WHO-recommended IFA regimen in Cambodia is significantly associated with factors such as place of residence, wealth index, number of children, and receiving at least four ANC visits [35]. Similarly, a study conducted in Indonesia, another Southeast Asian country,

demonstrated that pregnant women's adherence to iron and folic acid consumption is strongly influenced by their knowledge, employment status, educational attainment, place of residence, husband's support, health workers' support, ANC visits, and personal intention [37]. Other studies have also shown that ANC is a significant and unavoidable factor influencing pregnant women's adherence to iron supplementation [38-40].

Improving education and ensuring that ANC visits meet the recommended frequency and timing should be key strategies for improving adherence to iron supplementation among Cambodian pregnant women. Future interventions should focus on improving pregnant women's knowledge during ANC visits, with the ultimate goal of increasing adherence to iron supplementation. Given the benefits of iron supplementation in preventing small for gestational age (SGA) births [41,42], Cambodia held a workshop in 2021, during which stakeholders, with support from the Vitamin Angel Alliance, conducted an analysis of the antenatal MMS landscape. This initiative aimed to explore the transition from IFA to MMS as per WHO guidelines on antenatal MMS [14,15,43] and to integrate it into Cambodia's national ANC policy. In order to evaluate acceptability and adherence to MMS in comparison to IFA, as well as to investigate variables influencing MMS use as part of routine ANC services, a study protocol has been released in April 2024 [44].

Conclusion

Education level, frequency of ANC visits, and timing of the first ANC visit were the key factors significantly influencing iron supplementation adherence among pregnant women in Cambodia. To improve adherence, healthcare programs should focus on enhancing maternal education and promoting regular ANC visits. Strengthening prenatal care availability and monitoring systems is crucial for effective anemia prevention strategies.

Ethics approval

Secondary data from the 2021–2022 Cambodia DHS was utilized in this investigation. The information gathered by the survey does not include the respondents identify. When using any technique, we abide by all relevant laws and guidelines. Written informed permission was given by each enrolment participant and their legal guardian to complete the questionnaire. For this study, the author obtained permission to utilize data from the website https://dhsprogram.com. The 2021–22 IDHS received ethical clearance from the ICF Institutional Review Board. Permission to analyze additional datasets for this work was obtained from the Demographic and Health Survey Program.

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Conflict of Interest

The authors declared that there is no conflict of interest. We certify that all members of our research team adequately participated in conceptualizing, designing, analyzing, writing, and revising the manuscript. In addition, we certify that the material used in this study or similar material has not been previously submitted or publishedin any other publication.

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Data Availability

Derived data supporting the findings of this study are available from the corresponding author on reques.

Declaration of artificial intelligence use

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript

preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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