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# Awareness and practices in preventing maternal iron deficiency among pregnant women living in urban slum areas in Makassar City, Indonesia

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**Abstract:**

**BACKGROUND:** During pregnancy, the body requires more complex nutritional intake. Therefore, problems with fulfilling nutrition during pregnancy occur often. One of the most common nutritional problems in pregnancy is iron deficiency anemia, the most widespread micronutrient problem and the most difficult to overcome worldwide. This study aimed to determine awareness and prevention behavior associated with the incidence of iron deficiency in pregnant women living in urban slum areas.

**MATERIALS AND METHODS:** This was a cross-sectional study. The data collection used KoboToolbox, an Android-based tool. Iron status was examined by serum ferritin level assay using ELISA at the Microbiology Laboratory Unit of Hasanuddin University Hospital.

**RESULTS:** The prevalence of pregnant women who experienced iron deficiency was 78%. The logistic regression analysis showed that poor awareness (AOR = 3.03, CI 95% 1.26-7.29, *P* = 0.013) and practices in taking iron enhancers (AOR = 2.85, CI 95% 1.18–6.92, *P* = 0.020) became the main factors associated with iron deficiency among pregnant women.

**CONCLUSIONS:** Poor awareness and practices regarding consuming iron enhancers increased the risk of iron deficiency among pregnant women living in urban slum areas. Iron deficiency is a major health concern for pregnant women, especially those living in slum settlements, which must be addressed. A more optimal healthcare system for pregnant women may reduce the incidence of iron anemia in pregnancy by improving health promotion and optimizing healthcare services.

**Keywords:**

Awareness and prevention, maternal iron deficiency, serum ferritin level, Urban slum areas

## Introduction

Increasingly complex nutrition is required by the body during pregnancy. Therefore, difficulties in fulfilling these nutrition requirements are common. One of the most common nutritional problems in pregnant women is iron deficiency anemia, the most widespread micronutrient problem and the most difficult to overcome worldwide.[1]

The incidence of anemia is still high, affecting a fairly large proportion of people worldwide. According to World Health Organization (WHO) data, approximately 29.9% of women globally in the 15–49 age group have anemia. This is equivalent to more than half a billion people. The prevalence is 29.6% in non-pregnant women and 36.5% in pregnant women.[2] The incidence of anemia in pregnant women is very high in lower-middle-income countries (LMICs), especially in Southeast Asia and Africa. Based on the World Bank income category, the prevalence of anemia in pregnant women in LMICs is 45%.



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Meanwhile, in high-income countries, the prevalence of anemia in pregnant women is only around 17%.[3]

Anemia in pregnancy is potentially harmful to the mother and child. Therefore, it requires serious attention from all parties involved in health services. Anemia in pregnant women can cause complications such as bleeding, increased risk of birthweight, abortion, and increased risk of mortality for both mother and baby.[4] Low hemoglobin levels in pregnant women can impact fetal growth and development. Hence, pregnant women with a history of anemia are more likely to have infants with low birthweight.[5]

Considering the impact of iron deficiency anemia on pregnant women and the potential future health conditions, preventing anemia during pregnancy is crucial. Poor awareness and prevention restrict efforts to reduce the prevalence of iron deficiency anemia.[6] According to Rogers' theory (1962), commonly known as the AIETA theory, the body undergoes a series of sequential stages while adopting new behaviors: awareness, interest, evaluation, trial, and adoption. If the behavior adoption through this process is built on awareness, the behavior will persist.

Knowledge and awareness can powerfully influence behavior and better habits, such as fulfilling the nutritional needs that the body requires during pregnancy;[7] approximately 95% of iron deficiency anemia is caused by diet.[8] A lack of maternal awareness of iron deficiency anemia causes the condition in most pregnancies.[9] The underlying cause of this high incidence is low education, which affects the level of knowledge and awareness regarding the causes of anemia, its impact, and its prevention. Awareness of iron deficiency anemia greatly determines the mother's behavior during pregnancy. Therefore, awareness of the causes of anemia and preventive behavior toward its risk factors play a significant role in preventing it in pregnancy.

## Materials and Methods

### Study design and setting

This sub-study of the Indonesian Birth Cohort Study was based in the Tallo subdistrict, one of the heavy informal settlements in Makassar City, Indonesia. We performed a cross-sectional study that aimed to describe the iron deficiency awareness and precautions of pregnant women.

### Study participant and sampling

The sample in this study was all pregnant women in the second and third trimesters who were residents in the study site. The data on these women were obtained from three public health center work areas in the Tallo subdistrict.

A total of 205 pregnant women were assessed for their eligibility to participate in the study. Of these, 32 were excluded because they were <16 or >45 years old, had an infectious disease, were carrying two fetuses, or were unwilling to give blood samples. As shown in Figure 1, 173 pregnant women were eligible to participate.

### Data collection and tool

Interview procedures and blood sample collections were conducted during pregnancy care visits at the primary health center or the participant's residence during a home visit. The researchers took around 15–30 minutes to conduct the interviews and collect blood specimens for each participant. All interviews were recorded using the Android-based KoboToolbox platform.

### Ethical consideration

This study was approved by the Hasanuddin University Health Research Ethics Committee, with ethical approval recommendation number 13974/UN4.14.1/TP.01.02/2022 before the commencement. Written informed consent was obtained from all the study participants, and confidentiality was maintained. Patient identifiers were removed, and privacy was ensured.

### Variable measurements

#### *Consumption of iron enhancers and inhibitors*

Each question to measure pregnant women's awareness of iron deficiency originated from previous studies.[10-13] Ten items were used to measure the awareness of pregnant women about iron deficiency anemia. These were found valid and reliable, with a Cronbach's alpha value of >0.7. A score of 1 was given for each correct answer, and an incorrect answer was given a 0. The maximum score that could be obtained was 10. Participants who scored 0–4 were categorized as low awareness, and those scoring 5–10 were categorized as high awareness. This cutoff point was obtained from the mean value of the answers.

The variable of adherence to the consumption of iron tablets was categorized as adherent if pregnant women

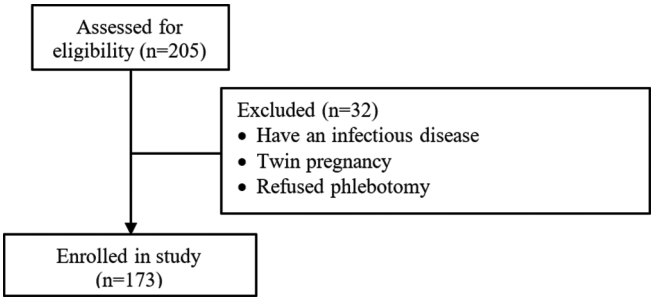


**Figure 1:** Flow diagram of participants

consumed ≥90 tablets during the pregnancy and as non-adherent if they consumed <90 tablets during the pregnancy, following Indonesian Ministry of Health recommendations.

The variables of the eating habits of pregnant women included consumption habits of iron enhancer and inhibitor food sources. Consumption habits were measured using a modified food frequency questionnaire with iron enhancer food ingredients and items, including oranges, tomatoes, mangoes, papayas, guavas, chilies, lemons and limes, and spinach. Food sources of iron inhibitors include tea, coffee, milk, cheese, yogurt, and ice cream. The frequency of consumption was given a score of 50 if consumed once a day, 25 if consumed 4–6 times a week, 15 if consumed three times a week, 10 if consumed 1–2 times a week, 1 if consumed less than once per week, and 0 if never consumed. Each participant's score was totaled and divided by the number of food ingredients. The average score obtained was then categorized as "frequent" if the average score was 15–50, "sometimes" if the average score was 10–14.9, and "never" if the average score was 0–9.9.

### *Laboratory assay*

A trained phlebotomist carried out the blood specimen collection for iron status assays. Blood was collected using a 0.9-mm needle and a 3-cc vacutainer. Serum samples were obtained by centrifugation at 3,500 × g for 30 minutes at 4°C, then transferred to a polypropylene tube. Serial ferritin levels were examined at the Microbiology Laboratory unit at Hasanuddin University Hospital using the ELISA method (Ferritin ELISA Kit, DBC-Diagnostics Biochem Canada Inc). Compared with the RIA kit, the standard kit was used as a control, with an R2 value of 0.97. Pregnant women were classified as having adequate iron reserves in the body if the serum ferritin level was 25–283 ng/mL. They were classified as experiencing iron deficiency if the serum ferritin was <25 ng/mL, based on the ELISA kit procedure. The ELISA reader used a Thermo Scientific-Multiskan FC with a 96-well plate type. The examination results were read using a standard curve in SkanIt 3.1 software.

## Statistical data analysis

Data were analyzed using Stata version 14 software. The relationships between all variables were analyzed using Chi-square test analysis. Univariate and multivariate analyses were performed using logistic regression analysis to determine the risk factors for maternal iron deficiency in pregnant women, tested with predictor variables with a confidence level of 95% ($\alpha$ =0.05).

# Results

Of the participants, 131 (75.7%) were 20–35 years old, and 119 (68.8%) had completed secondary education. The majority (148; 85.6%) were housewives. At the beginning of the pregnancy, the participants were measured for mid-upper arm circumference (MUAC) and body mass index (BMI). As shown in Table 1, 133 (76.9%) had a MUAC of ≥23.5 cm, and 170 (98.3%) had a BMI of ≥18.5 kg/m$^2$.

Table 2 shows that 67.0% of participants had heard of anemia in pregnancy, and 56.6% could define anemia correctly. However, under half (49.1%) could identify the symptoms of anemia. Nearly half (42.2%) correctly identified the cause of anemia. Only a small proportion of participants believed that anemia in pregnancy was dangerous (41.0%) and agreed that anemia was a health problem (40.5%) and could cause serious problems for both mother and fetus (16.8%). More than half of the participants thought that they might have anemia (56.6%), knew how to prevent and treat anemia (55.5%), and were willing to take iron tablets if prescribed to prevent and treat anemia (59.1%).

**Table 1: Descriptive characteristics of participants**

| Characteristic | Mean±SD or *n* (%) | |
|---|---|---|
| Age, years | | |
| <20 | 23 | 13.3 |
| 20–35 | 131 | 75.7 |
| >35 | 19 | 11.0 |
| Education | | |
| Completed primary | 36 | 20.8 |
| Completed secondary | 119 | 68.8 |
| Completed tertiary | 18 | 10.4 |
| Occupation | | |
| Housewife | 148 | 85.6 |
| Employee | 5 | 2.9 |
| Business | 17 | 9.8 |
| Laborer | 3 | 1.7 |
| MUAC | | |
| <23.5 cm | 40 | 23.1 |
| ≥23.5 cm | 133 | 76.9 |
| BMI | | |
| <18.5 kg/m$^2$ | 3 | 1.7 |
| ≥18.5 kg/m$^2$ | 170 | 98.3 |
| Gestational age | | |
| Second trimester | 77 | 44.5 |
| Third trimester | 96 | 55.5 |
| Gravida | | |
| Primigravida | 48 | 27.7 |
| Multigravida | 125 | 72.3 |
| Parity | | |
| Nulliparous | 110 | 63.6 |
| Multiparous | 63 | 36.4 |
| Abortus | | |
| Yes | 31 | 17.9 |
| No | 142 | 82.1 |
| Pregnancy spacing, years | | |
| <2 | 91 | 52.6 |
| ≥2 | 82 | 47.4 |
| Age at first marriage | 20.4 | 0.3 |

Table 3 shows that more than half of the participants (57.2%) attended less than four antenatal care (ANC) visits; pregnant women are recommended to attend at least four during pregnancy. Most of the participants (74.4%) were not compliant with consuming iron tablets. Over half (55.5%) never took iron inhibitors. This figure contrasts with the number of participants who consumed iron enhancers (69.4%). For three of these four variables, the majority of participants reported no behavior to prevent iron deficiency in pregnancy.

Table 4 shows the relationship between awareness and some variables that may be related to the incidence of iron deficiency in pregnancy. Most participants who did not experience iron deficiency had good awareness (78.9%, $P = 0.017$). Most participants who experienced iron deficiency were not compliant in consuming iron tablets (78.5%, $P = 0.024$). Most participants who did not experience iron deficiency regularly consumed food sources rich in ascorbic acid (vitamin C; 47.4%, $P = 0.040$). Among those who experienced iron deficiency, the interval between previous pregnancies was under two years (57.0%, $P = 0.028$).

**Table 2: Awareness of iron deficiency anemia in pregnancy**

| Item | *n* | % |
|---|---|---|
| Ever heard about anemia in pregnancy | 116 | 67.0 |
| Know what anemia is | 98 | 56.6 |
| Know the signs/symptoms of anemia | 85 | 49.1 |
| Know the causes of anemia in pregnancy | 73 | 42.2 |
| Knowing whether anemia is dangerous | 71 | 41.0 |
| Believe that anemia is a health problem in pregnant women | 70 | 40.5 |
| Thinking that they could be anemic | 98 | 56.6 |
| Thinking that anemia can cause serious health problems for the mother and baby | 29 | 16.8 |
| Know the prevention and treatment of iron deficiency anemia | 96 | 55.5 |
| Willing to take iron tablets if prescribed to prevent and treat anemia | 101 | 59.1 |

**Table 3: Practices for preventing iron deficiency in pregnancy**

| Variables | *n* | % |
|---|---|---|
| Antenatal care visits | | |
| <4 | 99 | 57.2 |
| ≥4 | 74 | 42.8 |
| Compliance with consumption of iron tablets | | |
| No | 128 | 74.4 |
| Yes | 44 | 25.6 |
| Taking iron enhancers | | |
| Never | 53 | 30.6 |
| Sometimes | 67 | 38.8 |
| Often | 53 | 30.6 |
| Taking iron inhibitors | | |
| Never | 96 | 55.5 |
| Sometimes | 61 | 35.3 |
| Often | 16 | 9.2 |

Table 5 shows the results of the univariate and multivariate logistic regression analysis. In the multivariate model, the significant relationship variable was that pregnant women with poor awareness were 3.03 times more at risk of experiencing iron deficiency than those with good awareness. Pregnant women who did not often consume iron enhancers were 2.8 times more at risk of iron deficiency than those who often consumed iron enhancers. These findings are associated with a significantly increased likelihood of depletion of iron stores in the body. Other factors analyzed but unrelated to iron deficiency in pregnancy include age, education, ANC visits, gestation interval, and parity.

## Discussion

This study found that the prevalence of iron deficiency during pregnancy in the slums of Makassar City was 78.0%. This figure is large compared to a community-based study in East Ethiopia that found only around 52.9%.[14] Another study conducted in Austria reported that around 65% of pregnant women experienced iron deficiency.[15] This finding shows that the incidence of iron deficiency in slums in Makassar City is very high compared to other regions studied.

This study found a significant relationship between awareness and the incidence of iron deficiency in pregnant women. According to prior research, a correlation exists between awareness and the incidence of anemia in pregnant women.[16] Other studies have also reported a significant relationship between knowledge and the occurrence of anemia in pregnant women.[17,18] According to multiple studies, pregnant women's awareness influences their behavior during pregnancy. A lack of understanding among pregnant women has an adverse effect on their behavior to prevent anemia.[11,19] Pregnant women with good knowledge are more adherent to iron deficiency prevention practices than pregnant women with poor knowledge.[20] This association is an indication that the level of knowledge significantly contributed to the level of adherence. What it means is that non-adherence occurs as a result of ignorance and inadequate knowledge a pregnant woman has about anemia.[21] Poor awareness and knowledge have also been evident in Ethiopian pregnant women, resulting in improper food consumption behavior.[22] Pregnant women with a high level of knowledge and awareness can choose foods that will increase the quality of their pregnancy, specifically if they regularly adhere to consuming iron supplements.[23] However, unlike these results, a study conducted in India found no correlation between knowledge and the occurrence of anemia.[24]

**Table 4: Factors related to iron deficiency in pregnancy**

| Variable | Iron deficiency *n*=135 (78%) | Normal *n*=38 (22%) | Total | Unadjusted OR (95% CI) | *P*[a] |
|---|---|---|---|---|---|
| Awareness | | | | | |
| Poor | 42.2 | 21.1 | 37.6 | 2.74 (1.16–6.42) | 0.017 |
| Good | 57.8 | 78.9 | 62.4 | 1 | |
| ANC visits | | | | | |
| <4 | 57.1 | 57.9 | 57.2 | 0.96 (0.46–2.00) | 0.925 |
| ≥4 | 42.9 | 42.1 | 42.8 | 1 | |
| Compliance with consumption of iron tablets | | | | | |
| No | 78.5 | 60.5 | 74.6 | 2.38 (1.10–5.14) | 0.024 |
| Yes | 21.5 | 39.5 | 25.4 | 1 | |
| Taking iron enhancers | | | | | |
| Never | 32.6 | 23.7 | 30.6 | 2.51 (1.00–6.27) | 0.040 |
| Sometimes | 41.5 | 28.9 | 38.8 | 2.61 (1.10–6.19) | |
| Often | 25.9 | 47.4 | 30.6 | 1 | |
| Taking iron inhibitors | | | | | |
| Never | 52.6 | 65.8 | 55.5 | 1 | 0.238 |
| Sometimes | 38.5 | 23.7 | 35.3 | 2.03 (0.87–4.72) | |
| Often | 8.9 | 10.5 | 9.2 | 1.05 (0.31–3.57) | |
| Age, years | | | | | |
| <20 | 14.8 | 7.9 | 13.3 | 1 | 0.058 |
| 20–35 | 77.0 | 71.1 | 75.7 | 0.57 (0.15–2.08) | |
| >35 | 8.2 | 21.0 | 11.0 | 0.20 (0.04–0.94) | |
| Education | | | | | |
| Completed primary | 20.0 | 23.7 | 20.8 | 0.37 (0.09–1.96) | 0.480 |
| Completed secondary | 68.1 | 71.0 | 68.8 | 0.42 (0.07–1.95) | |
| Completed tertiary | 11.9 | 5.3 | 10.4 | 1 | |
| Pregnancy spacing, years | | | | | |
| <2 | 57.0 | 36.8 | 52.6 | 2.27 (1.08–4.77) | 0.028 |
| ≥2 | 43.0 | 63.2 | 47.4 | 1 | |
| Parity | | | | | |
| Nulliparous | 65.2 | 57.9 | 63.6 | 1 | 0.409 |
| Multiparous | 34.8 | 42.1 | 36.4 | 0.73 (0.35–1.53) | |

[a]*P:* the value of the difference between groups obtained from the Chi-square test

Based on our survey, only a small proportion of participants believed that anemia during pregnancy was a harmful health problem that might result in severe complications for the mother and fetus. This certainly has an impact on the actions of the mother during her pregnancy. Awareness is strongly related to health behavior in preventing and maintaining oneself to avoid disease.[17] Also, pregnant women with good awareness are more attentive to the symptoms they experience and can act to reduce the severity of iron deficiency anemia.[25] An understanding and awareness of anemia during pregnancy contribute to the practice of iron consumption during this time.[26]

In general, pregnant women in slums are less concerned with education. They are typically more attentive to dietary needs. Their lack of interest in education leads to low health status awareness. Formal education also affects health knowledge and awareness.[27] Several studies have stated that when a woman's education level increases, awareness of anemia also increases.[28]

This study also found a significant relationship between the preventive measure of consuming iron enhancers and the incidence of iron deficiency in pregnant women. Behavior in consuming daily food is an external factor related to the ongoing absorption of iron in the body. This study is in line with others finding a relationship between vitamin C intake and the incidence of anemia.[29] In contrast, another study found no correlation between the use of iron enhancers and the incidence of anemia in the third trimester of pregnancy, thus contradicting our study's findings.[30]

Several interaction factors between the foods consumed influence iron absorption in the body. The increase in iron absorption is dominated by the effect of ascorbic acid (vitamin C) and has an impact on preventing iron deficiency.[31] Ascorbic acid performs as a good regulator of iron absorption from food and can contribute to the defense against phytic acid and tannins, which interrupt iron absorption.[32] Ascorbic acid is required for iron absorption since iron is

**Table 5: Logistic regression analysis of factors associated with the incidence of iron deficiency in pregnancy**

| Variable | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|
| | Adjusted OR | 95% CI | *P* | Adjusted OR | 95% CI | *P* |
| Awareness | | | | | | |
| Poor | 2.71 | 1.03–7.18 | 0.043* | 3.03 | 1.26–7.29 | 0.013** |
| Good | 1 | | | 1 | | |
| ANC visits | | | | | | |
| <4 | 0.73 | 0.31–1.70 | 0.469 | | | |
| ≥4 | 1 | | | | | |
| Compliance with iron supplementation | | | | | | |
| No | 2.76 | 1.10–6.86 | 0.029* | | | |
| Yes | 1 | | | | | |
| Taking iron enhancers | | | | | | |
| Never | 4.31 | 1.48–12.56 | 0.005* | 2.83 | 1.10–7.26 | 0.030** |
| Sometimes | 4.41 | 1.57–12.39 | 0.007* | 2.85 | 1.18–6.92 | 0.020** |
| Often | 1 | | | 1 | | |
| Taking iron inhibitors | | | | | | |
| Never | 1 | | | | | |
| Sometimes | 2.84 | 1.07–7.53 | 0.036* | | | |
| Often | 1.21 | 0.30–4.84 | 0.780 | | | |
| Age, years | | | | | | |
| <20 | 1 | | | | | |
| 20–35 | 0.99 | 0.22–4.50 | 0.998 | | | |
| >35 | 0.29 | 0.04–2.15 | 0.230 | | | |
| Education | | | | | | |
| Completed primary | 0.17 | 0.02–1.33 | 0.093 | | | |
| Completed secondary | 0.27 | 0.04–1.57 | 0.147 | | | |
| Completed tertiary | 1 | | | | | |
| Pregnancy spacing, years | | | | | | |
| <2 | 1.85 | 0.75–4.55 | 0.176 | | | |
| ≥2 | 1 | | | | | |
| Parity | | | | | | |
| Nulliparous | 1 | | | | | |
| Multiparous | 1.78 | 0.64–4.99 | 0.268 | | | |

more effectively and efficiently absorbed in an acidic environment.[33]

These study findings suggest focused awareness and education strategies designed to improve nutritional habits by encouraging the consumption of iron enhancers and rich sources of iron to make positive health contributions to avert iron deficiency.

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## Conflicts of interest

There are no conflicts of interest.

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