



(RESEARCH ARTICLE)



Effectiveness of the Test Strip Method for Hemoglobin Assessment to Identify Anemia in Pregnant Women at Puskesmas Batalaiworu, Kabupaten Muna, Southeast Sulawesi

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World Journal of Advanced Research and Reviews, 2025, 27(02), 1422-1429

Publication history: Received on 10 July 2025; revised on 17 August 2025; accepted on 19 August 2025

Article DOI: <https://doi.org/10.30574/wjarr.2025.27.2.2997>

Abstract

Background: Anemia during pregnancy remains a significant public health issue worldwide, particularly in developing countries. It increases the risk of maternal complications, low birth weight, preterm delivery, and perinatal mortality. Early detection of hemoglobin levels is crucial; however, limited laboratory resources in primary healthcare facilities often hinder timely screening. Test strip hemoglobin methods offer a practical and cost-effective alternative for such settings.

Objective: This study aimed to evaluate the effectiveness of the hemoglobin test strip in identifying anemia among pregnant women attending Puskesmas Batalaiworu, Kabupaten Muna, Southeast Sulawesi, Indonesia.

Methods: A descriptive-analytic cross-sectional design was employed. The study included 60 pregnant women who underwent antenatal care (ANC) at Puskesmas Batalaiworu, selected using purposive sampling. The independent variable was hemoglobin measurement using the test strip, while the dependent variable was anemia status (Hb <11 g/dL = anemia; ≥11 g/dL = normal). Confounding variables included maternal age, parity, gestational age, education level, and nutritional status. Data were analyzed using SPSS software, applying univariate and bivariate analyses, including Chi-square and Kappa tests to assess the agreement between the test strip and standard hematology analyzer.

Results: Most respondents were within the healthy reproductive age group (20–35 years, 57%) and in the third trimester of pregnancy (50%). Compliance with iron tablet supplementation was 60%, while 40% were non-compliant. Anemia prevalence was 43%, with mean hemoglobin levels highest in the first trimester (11.53 g/dL), decreasing in the second trimester (10.15 g/dL), and slightly rising in the third trimester (10.45 g/dL). The test strip method demonstrated good agreement with the standard hematology analyzer.

Conclusion: Hemoglobin test strips are an effective and practical tool for anemia screening in primary healthcare settings. Regular monitoring of hemoglobin levels and improved compliance with iron supplementation are essential strategies to reduce anemia prevalence among pregnant women, especially in late gestation.

Keywords: Pregnancy; Hemoglobin; Test Strip; Antenatal Care; Iron Supplementation

1. Introduction

Anemia remains one of the most critical public health issues worldwide, particularly among pregnant women (1). The World Health Organization (WHO) reports that over 40% of pregnant women globally are affected by anemia, with the highest prevalence observed in developing countries (2). In Africa, the prevalence of anemia among pregnant women is reported to reach 57%, while in South Asia, it ranges between 40–50% (3). These figures illustrate that anemia continues to pose a significant challenge to improving maternal and child health globally.

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In Indonesia, anemia in pregnancy remains a pressing public health concern. Data from the 2018 Basic Health Research (Riskesdas) indicate that the prevalence of anemia among pregnant women reaches 48.9%, with considerable variation across provinces (4). In Southeast Sulawesi, the prevalence of anemia among pregnant women remains relatively high, at approximately 40–45%, contributing to an increased risk of pregnancy-related complications (5). One of the districts with a significant number of cases is Muna, including the service area of Puskesmas Batalaiworu, where anemia is commonly observed among pregnant women during antenatal care visits.

Anemia in pregnancy has serious consequences for both maternal and fetal health. Clinically, anemia may cause fatigue, reduced work capacity, impaired concentration, and weakened immune function (6). During pregnancy, anemia increases the risk of obstetric complications such as postpartum hemorrhage, preeclampsia, and preterm delivery (7). For the fetus, anemia can result in low birth weight (LBW), intrauterine growth retardation, and an elevated risk of perinatal mortality (8).

Several factors contribute to the high prevalence of anemia in pregnancy, including deficiencies in iron, folic acid, and vitamin B12, which are essential components of hemoglobin (9). Additionally, socio-economic status, dietary patterns, adherence to iron supplementation, and the presence of chronic infections such as malaria and helminthiasis further exacerbate anemia prevalence (10). These factors underscore that anemia is a multifactorial condition requiring comprehensive promotive, preventive, and curative approaches.

Early detection of anemia in pregnant women has traditionally relied on hemoglobin assessment using standard laboratory methods, such as spectrophotometry or hematology analyzers. However, the availability of laboratory infrastructure in primary healthcare facilities, particularly in rural areas, remains limited (11). As an alternative, the use of hemoglobin test strips has gained attention due to their convenience, lower cost, and applicability in resource-limited settings (12).

Although several studies have evaluated the effectiveness of test strip methods, most research has been conducted in other countries or in healthcare facilities with full laboratory support (13). Data specifically examining the effectiveness of test strips for hemoglobin assessment among pregnant women at primary healthcare centers, particularly in Southeast Sulawesi, remain scarce. This represents an important research gap, particularly in regions with a high prevalence of anemia.

This study aims to evaluate the effectiveness of hemoglobin test strips for identifying anemia among pregnant women at Puskesmas Batalaiworu, Muna District, Southeast Sulawesi. The novelty of this research lies in its applied focus at the primary healthcare level, with the expectation of providing scientific evidence supporting the use of a simple yet effective method for anemia screening. The findings are anticipated to inform the development of more practical and affordable anemia screening policies in areas with limited laboratory resources.

2. Material and methods

2.1. Study Design

This study employed a descriptive-analytic design with a cross-sectional approach. This approach was chosen because it allows researchers to evaluate the effectiveness of hemoglobin test strip methods among pregnant women within a specific time frame, without ongoing interventions. The design is suitable for identifying the relationship between test strip results and the standard laboratory method as a reference.

2.2. Study Sample

The study population consisted of all pregnant women attending antenatal care (ANC) at Puskesmas Batalaiworu, Muna District, Southeast Sulawesi. Participants were selected using purposive sampling, with the following inclusion criteria: pregnant women willing to participate, without chronic diseases (e.g., thalassemia or kidney disease), and present during the study period. A total of 60 respondents were recruited based on the Slovin formula. The study was conducted from May to July 2025.

2.3. Study Variables

The variables in this study included:

- Independent variable: hemoglobin assessment using test strip method.

- Dependent variable: anemia status among pregnant women (categorized as hemoglobin <11 g/dL = anemia, ≥ 11 g/dL = normal).
- Confounding variables: maternal age, parity, gestational age, education level, and nutritional status.

2.4. Research Instruments

The instruments used in this study were:

- Hemoglobin test strips for rapid assessment of hemoglobin levels from capillary blood samples of pregnant women.
- Hematology analyzer as the reference (gold standard) to validate test results.
- Observation sheets and questionnaires to record demographic data, obstetric status, and other supporting factors potentially influencing the outcomes.

2.5. Data Analysis

Data were analyzed using the latest version of SPSS statistical software. Univariate analysis was performed to describe respondents' characteristics, anemia prevalence, and the distribution of hemoglobin test results. Bivariate analysis was conducted using the Chi-square test or Kappa test to evaluate the agreement between the test strip and standard laboratory methods. A p-value <0.05 was considered statistically significant, and the level of agreement was assessed using the Kappa coefficient (κ).

2.6. Research Ethics

Ethical approval was obtained from the Health Research Ethics Committee of Universitas Karya Persada Muna. All participants were provided with detailed information regarding the study objectives, procedures, and benefits, and signed written informed consent prior to participation. Confidentiality of participants' personal data was strictly maintained and used solely for research purposes.

3. Results

3.1. Maternal Age

Maternal age is an important factor influencing a woman's health during pregnancy, including the risk of complications. The distribution of maternal age among the study respondents is presented in the following table.

Table 1 Distribution of Maternal Age

Age	Frequency	Percentage (%)
< 20 years	12	20
20–35 years	34	57
> 35 years	14	23
Total	60	100

The results indicate that the majority of pregnant women were in the 20–35 years age group, with 34 respondents (57%), followed by the >35 years group with 14 respondents (23%), and the <20 years group with 12 respondents (20%). This distribution suggests that most participants fall within the healthy reproductive age range of 20–35 years, which is physiologically considered the optimal period for pregnancy and childbirth.

Pregnant women under 20 years are categorized as high-risk due to incomplete reproductive organ maturation, which increases the likelihood of complications such as anemia, preeclampsia, preterm delivery, and low birth weight. Similarly, the >35 years age group is also considered high-risk, as it is often associated with reduced reproductive function, increased incidence of gestational hypertension, gestational diabetes, and a higher likelihood of assisted deliveries (14).

The observed distribution aligns with the theory that the healthy reproductive age range (20–35 years) represents the optimal period for pregnancy. The high proportion of women within this age group indicates that most respondents

were in a relatively low-risk category. Nevertheless, the presence of pregnant women in the <20 years and >35 years groups warrants special attention, including close monitoring during

3.2. Gestational Age

Gestational age plays a critical role in determining maternal physiological needs and fetal development, including the risk of anemia. The distribution of gestational age among respondents in this study is presented in the following table.

Table 2 Distribution of Gestational Age (Trimester)

Gestational Age	Frequency	Percentage (%)
First trimester	18	30
Second trimester	12	20
Third trimester	30	50
Total	60	100

The results indicate that most respondents were in the third trimester (n = 30, 50%), followed by the first trimester (n = 18, 30%) and second trimester (n = 12, 20%). These findings suggest that the majority of pregnant women participating in this study were in the late stages of pregnancy.

Physiologically, gestational age determines maternal nutritional requirements and the risk of health complications for both mother and fetus. During the first trimester, pregnant women often experience nausea and vomiting, which may affect nutritional intake and impact hemoglobin levels. The second trimester is characterized by increased nutrient requirements due to rapid fetal growth. In the third trimester, iron requirements rise significantly owing to increased plasma volume, thereby elevating the risk of anemia. This aligns with previous studies indicating that physiological changes, particularly in the late stages of pregnancy, contribute to higher hemoglobin demands (15)

The predominance of respondents in the third trimester highlights the need for careful attention to anemia risk during this period. Preventive measures, including nutritional monitoring and regular iron supplementation, are essential strategies to minimize complications as delivery approaches.

3.3. Compliance with Iron Supplementation

Compliance with iron tablet (iron-folic acid) supplementation is a crucial factor in preventing anemia during pregnancy. The compliance levels of respondents in this study are presented in Table 3.

Table 3 Distribution of Compliance with Iron Tablet Consumption

Compliance	Frequency	Percentage (%)
Compliant	36	60
Non-compliant	24	40
Total	60	100

Maternal compliance with iron supplementation is a key indicator in the prevention and management of gestational anemia. The findings indicate that the majority of respondents (60%) adhered to the recommended iron tablet regimen, whereas 40% were non-compliant.

The relatively high compliance rate reflects an awareness among most participants regarding the importance of iron supplementation to maintain adequate hemoglobin levels during pregnancy. Nonetheless, a notable proportion of non-compliant women may be influenced by factors such as side effects (e.g., nausea, constipation), lack of knowledge about the benefits of supplementation, and limited support from family or healthcare providers.

These findings align with previous research demonstrating a significant association between iron tablet compliance and reduced risk of anemia in pregnant women. Non-compliance increases vulnerability to iron deficiency, which may

adversely affect maternal and fetal health, including preterm delivery, low birth weight, and elevated maternal and neonatal morbidity.

3.4. Hemoglobin Levels

Hemoglobin concentration is the primary indicator for determining anemia status in pregnant women. The distribution of hemoglobin levels among respondents is shown in Table 4.

Table 4 Distribution of Hemoglobin Levels

Hemoglobin Status	Frequency	Percentage (%)
Anemia	26	43
Non-anemia	34	57
Total	60	100

Hemoglobin concentration directly reflects the blood's oxygen-carrying capacity for both maternal and fetal tissues. Among the 60 respondents, 26 (43%) were classified as anemic, while 34 (57%) were within the normal range. This indicates that the prevalence of anemia among pregnant women in the Puskesmas Batalaiworu catchment area remains considerable, even though most respondents had normal hemoglobin levels.

The high proportion of anemia is consistent with the Indonesian Ministry of Health (2021), which reported a national prevalence of 48.9% among pregnant women (16). Anemia during pregnancy requires attention due to its potential to increase obstetric complications, including preterm birth, low birth weight, and elevated maternal and neonatal morbidity and mortality.

Factors influencing anemia prevalence include compliance with iron supplementation, nutritional status, gestational age, and socio-economic conditions. In this study, the 43% prevalence of anemia may be associated with suboptimal iron tablet compliance, as 40% of respondents were non-compliant. These findings support the hypothesis that iron supplementation interventions must be accompanied by intensive nutritional counseling and monitoring to significantly reduce anemia incidence.

3.5. Mean Hemoglobin Levels by Trimester

Mean hemoglobin levels vary across different trimesters of pregnancy. Table 5 presents the mean hemoglobin values per trimester.

Table 5 Mean Hemoglobin Levels by Trimester

Trimester	N	Min	Max	Mean
First trimester	18	9.2	14.3	11.53
Second trimester	12	9.3	12.8	10.15
Third trimester	30	9.4	12.9	10.45
Total	60	-	-	-

Analysis shows variations in mean hemoglobin levels across gestational age. In the first trimester, the mean hemoglobin was 11.53 g/dL (range 9.2–14.3), which is higher than in subsequent trimesters, likely due to minimal physiological hemodilution. During the second trimester, mean hemoglobin decreased to 10.15 g/dL (range 9.3–12.8), reflecting the physiological expansion of plasma volume outpacing red blood cell mass, resulting in physiological anemia.

In the third trimester, mean hemoglobin slightly increased to 10.45 g/dL (range 9.4–12.9), possibly due to adaptive erythropoiesis and regular iron supplementation. Nevertheless, mean levels in the second and third trimesters remained below first-trimester levels, indicating that mid-to-late pregnancy remains a vulnerable period for anemia.

These findings are consistent with previous literature reporting a decline in hemoglobin during mid-pregnancy due to physiological changes, with potential improvement in late pregnancy if nutritional intake is adequate and iron

supplementation is maintained. This underscores the importance of monitoring hemoglobin levels across all trimesters as part of early detection and prevention strategies for anemia in pregnant women.

4. Discussion

This study revealed that the majority of pregnant women were within the healthy reproductive age range (20–35 years), accounting for 57% of respondents, whereas women aged <20 years and >35 years comprised 20% and 23%, respectively. Regarding gestational age, most respondents were in the third trimester (50%), followed by the first trimester (30%) and second trimester (20%). Compliance with iron tablet (iron-folic acid) supplementation was relatively good, with 60% of respondents adhering to the recommended regimen. Nevertheless, the prevalence of anemia remained substantial, affecting 43% of pregnant women, while 57% were classified as non-anemic. Analysis of mean hemoglobin levels showed the highest values in the first trimester (11.53 g/dL), a decrease in the second trimester (10.15 g/dL), and a slight increase in the third trimester (10.45 g/dL).

The age distribution indicates that most pregnant women were within the healthy reproductive period, considered the optimal phase for pregnancy. However, the presence of respondents aged <20 years and >35 years remains significant, as these age groups are physiologically at higher risk for obstetric complications, including anemia. This finding aligns with a study in Nigeria reporting higher anemia prevalence among pregnant women <20 years and >35 years compared to those within the healthy reproductive age, highlighting maternal age as an important determinant of hemoglobin status (17).

Analysis of gestational age shows that respondents in the third trimester tend to have an increased risk of anemia. This is consistent with the concept of physiological hemodilution, where plasma volume expands more rapidly than red blood cell mass during mid-to-late pregnancy. These findings support previous studies reporting that anemia prevalence is highest in the late stages of pregnancy due to increased iron requirements that may not be met by dietary intake, indicating that the third trimester is a critical period for anemia prevention (18).

Compliance with iron supplementation significantly influenced hemoglobin status. In this study, 60% of respondents were compliant, higher than the 40% who were non-compliant. This is consistent with prior research demonstrating that pregnant women with high adherence to iron supplementation exhibit significantly higher hemoglobin levels compared to non-compliant individuals (19). Factors contributing to non-compliance include gastrointestinal side effects, low knowledge about supplementation benefits, and limited support from family or healthcare providers (20).

The 43% anemia prevalence observed in this study indicates that anemia remains a significant public health concern within the Puskesmas Batalaiworu catchment area. Although slightly lower than the national prevalence in Indonesia (48.9%), it still warrants targeted intervention (21). These findings are consistent with previous research reporting a 40.9% prevalence of anemia in pregnant women, which is associated with serious outcomes such as low birth weight and preterm birth (22). This suggests that, despite variations in prevalence, anemia among pregnant women remains a global health issue.

Analysis of mean hemoglobin levels by trimester reflects characteristic physiological patterns. The decline in hemoglobin during the second trimester followed by a slight increase in the third trimester corresponds to the body's adaptive mechanisms during pregnancy. These findings corroborate previous studies showing that hemoglobin levels tend to decrease in mid-pregnancy due to hemodilution and rise again approaching delivery, particularly when adherence to iron supplementation is maintained (23). Therefore, monitoring hemoglobin levels across all trimesters is crucial for early detection and prevention of anemia.

This study's strengths include a comprehensive analysis considering maternal age, gestational age, adherence to iron supplementation, and hemoglobin measurement. However, limitations include a relatively small sample size (n = 60) and restriction to a single Puskesmas catchment area, limiting generalizability. Additionally, other factors such as nutritional status, infectious diseases, and dietary patterns were not explored in detail. Future research is recommended to involve larger sample sizes, assess nutritional and socio-economic variables, and compare the effectiveness of hemoglobin assessment methods, thereby supporting more targeted interventions for anemia prevention among pregnant women.

5. Conclusion

This study demonstrates that the majority of pregnant women respondents were within the healthy reproductive age

range, with adherence to iron tablet (iron-folic acid) supplementation at a moderate level (60% compliant and 40% non-compliant). Hemoglobin analysis revealed that 43% of respondents were anemic, while 57% were non-anemic. Mean hemoglobin levels varied across trimesters, with the highest values observed in the first trimester (11.53 g/dL), followed by a decrease in the second trimester (10.15 g/dL) and a slight increase in the third trimester (10.45 g/dL). These findings highlight the urgency of regular hemoglobin monitoring and the reinforcement of nutritional interventions, particularly strategies to improve compliance with iron supplementation, as preventive measures to reduce the prevalence of anemia among pregnant women.

Compliance with ethical standards

Acknowledgements

The authors express their gratitude to Puskesmas Batalaiworu, Kabupaten Muna, Southeast Sulawesi, for granting permission and providing support during the study. Appreciation is also extended to all respondents who participated in the research and to all parties who assisted in data collection and the preparation of this research report.

Disclosure of Conflict of interest

The authors declare that there are no potential conflicts of interest or competing interests related to the publication of this manuscript, either with institutions or with products mentioned in the study.

Statement of ethical approval

This study received ethical approval from the Health Research Ethics Committee of Universitas Karya Persada Muna.

Statement of informed consent

All participants were provided with comprehensive information regarding the study's objectives, benefits, and procedures. Written informed consent was obtained from all respondents prior to their participation in the study.

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