THE EFFECT OF MULTI-MICRONUTRIENT SUPPLEMENTATION ON HEMOGLOBIN STATUS AMONG PREGNANT WOMEN AT BULANGO TIMUR PUBLIC HEALTH CENTER, BONE BOLANGO DISTRICT

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ABSTRACT

Maternal anemia remains a major public health problem during pregnancy and is often associated with multiple micronutrient deficiencies. Multiple micronutrient supplementation (MMS) has been recommended to improve maternal nutritional status and hemoglobin levels. This study aimed to determine the effect of MMS on hemoglobin status among pregnant women at Bulango Timur Public Health Center, Bone Bolango District. A quantitative study using a pre-experimental one-group pretest–posttest design was conducted based on secondary data from maternal health records. A total of 18 pregnant women who received MMS supplementation were included using total sampling. Hemoglobin status before and after supplementation was assessed and analyzed using descriptive statistics and the Wilcoxon Signed-Rank Test with a significance level of 0.05. Before MMS supplementation, 72.2% of participants had abnormal hemoglobin status, while 27.8% had normal status. After supplementation, the proportion of normal hemoglobin status increased to 77.8%, whereas abnormal status decreased to 22.2%. The mean hemoglobin status score increased from 1.278 ± 0.461 before supplementation to 1.778 ± 0.428 after supplementation. The Wilcoxon Signed-Rank Test showed a statistically significant difference between pre- and post-supplementation hemoglobin status ($Z = 2.496$, $p = 0.013$). MMS supplementation was significantly associated with improved hemoglobin status among pregnant women and may serve as a useful strategy for reducing anemia risk during pregnancy.

Keywords: *multiple micronutrient supplementation, hemoglobin status, anemia, pregnancy, maternal nutrition.*

INTRODUCTION

Maternal anemia remains one of the most persistent public health challenges worldwide and continues to pose substantial risks to both maternal and fetal health. According to recent global estimates, approximately 38.2% of pregnant women experience anemia, with the burden disproportionately concentrated in low- and middle-income countries (LMICs) [1][2]. Maternal anemia has been associated with increased risks of maternal mortality, preterm birth, low birth weight, impaired fetal growth, and adverse neonatal outcomes. Despite international commitments to reduce anemia among women of reproductive age, progress has been slow, and many countries remain far from achieving the World Health Organization (WHO) target of a 50% reduction in anemia prevalence by 2030 [3].

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Iron deficiency is recognized as the leading cause of anemia during pregnancy; however, anemia is often multifactorial and influenced by deficiencies of several essential micronutrients, including zinc, vitamin A, vitamin B12, iodine, and folate [4]. These nutritional deficiencies may coexist and interact, contributing to impaired erythropoiesis and reduced hemoglobin synthesis. Consequently, interventions focusing solely on iron supplementation may not adequately address the complex nutritional needs of pregnant women.

For decades, iron-folic acid (IFA) supplementation has been the standard strategy for preventing and managing maternal anemia. Numerous studies have demonstrated its effectiveness in improving hemoglobin concentration and reducing iron-deficiency anemia during pregnancy [5][6]. Nevertheless, the effectiveness of IFA supplementation is frequently limited by poor adherence, gastrointestinal side effects, supply constraints, and its inability to correct multiple micronutrient deficiencies simultaneously. As a result, growing attention has been directed toward more comprehensive nutritional interventions that can address the broader spectrum of micronutrient inadequacies experienced by pregnant women.

Multiple micronutrient supplementation (MMS), also referred to as multiple micronutrient supplementation (MMN), has emerged as a promising alternative to conventional IFA supplementation. MMS formulations typically contain iron, folic acid, and additional vitamins and minerals required for maternal and fetal development. Evidence from observational studies, randomized trials, and systematic reviews suggests that MMS can improve maternal micronutrient status, support hemoglobin production, reduce the risk of anemia, and contribute to favorable birth outcomes, including reductions in low birth weight and small-for-gestational-age births [7][8]. Furthermore, several studies have reported improvements in hemoglobin status among pregnant women receiving MMS compared with those receiving conventional supplementation [9][8].

Despite the increasing body of evidence supporting MMS, several important knowledge gaps remain. Previous studies have reported inconsistent findings regarding the magnitude of MMS benefits compared with traditional IFA supplementation, particularly concerning maternal hemoglobin outcomes [10][11]. In addition, evidence from local health service settings in developing regions remains limited, especially regarding the effectiveness of MMS implementation under routine antenatal care conditions. Context-specific evidence is essential because nutritional status, dietary patterns, health service accessibility, and adherence behaviors vary considerably across populations.

In Indonesia, maternal anemia continues to be a significant public health concern, particularly in rural and resource-limited settings. Strengthening evidence on effective nutritional interventions is therefore necessary to support maternal health programs and improve pregnancy outcomes. Evaluating the effectiveness of MMS in real-world settings may provide valuable information for policymakers and healthcare providers regarding the potential benefits of integrating MMS into antenatal care services.

Therefore, this study aimed to examine the effect of multi-micronutrient supplementation on hemoglobin status among pregnant women at Bulango Timur Public Health Center, Bone Bolango

District. The findings are expected to contribute to the growing evidence base regarding MMS effectiveness and support efforts to improve maternal nutritional status and anemia prevention strategies during pregnancy.

RESEARCH METHODS

Study Design

This study employed a quantitative pre-experimental design using a one-group pretest–posttest approach to evaluate changes in maternal hemoglobin outcomes before and after multiple micronutrient supplementation (MMS). This design enables the assessment of outcome changes within the same participants before and after an intervention and is commonly used in preliminary evaluations of public health interventions [12].

Study Setting and Population

The study was conducted at Bulango Timur Public Health Center, Bone Bolango District, Gorontalo Province, Indonesia, from August to September 2025. The target population consisted of pregnant women enrolled in the MMS supplementation program at the health center.

Sample and Sampling Technique

A total sampling technique was employed because of the limited number of pregnant women participating in the MMS program during the study period. All eligible participants were included in the study. The final sample consisted of 18 pregnant women who met the established inclusion and exclusion criteria.

Inclusion Criteria

Participants were included if they:

1. Were registered as antenatal care patients at Bulango Timur Public Health Center.
2. Received multiple micronutrient supplementation (MMS) during pregnancy.
3. Had complete hemoglobin examination records before and after MMS supplementation.
4. Had complete maternal health records available for review.

Exclusion Criteria

Participants were excluded if they had medical conditions known to affect hemoglobin concentration, including:

1. Thalassemia.
2. Chronic kidney disease.
3. Malaria.
4. HIV/AIDS.
5. Active bleeding disorders during pregnancy.

Data Source and Study Variables

This study utilized secondary data obtained from maternal health records and laboratory examination reports maintained at Bulango Timur Public Health Center.

The variables collected included:

1. Maternal age.
2. Gestational age.
3. Hemoglobin outcomes before MMS supplementation.
4. Hemoglobin outcomes after MMS supplementation.

Data completeness and consistency were verified through cross-checking maternal health records with laboratory reports before analysis. Records containing incomplete information were excluded from the final dataset.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA).

Descriptive Analysis

Descriptive statistics were used to summarize participant characteristics and hemoglobin outcomes. Categorical variables were presented as frequencies and percentages.

Normality Test

Data distribution was assessed using the Shapiro–Wilk test. A p-value less than 0.05 indicated that the data were not normally distributed.

Inferential Analysis

Because the data did not meet the assumption of normality ($p < .05$), differences between pre-intervention and post-intervention hemoglobin measurements were analyzed using the Wilcoxon Signed-Rank Test. Statistical significance was established at $p < .05$ with a 95% confidence level.

RESEARCH RESULT

Participant Characteristics

A total of 18 pregnant women participated in this study. Based on age, most participants were adults aged 25–59 years (66.7%), while 33.3% were aged 10–24 years. Regarding gestational age, all participants (100%) were in the third trimester of pregnancy.

Table 1. Characteristics of Participants (n = 18)

Variable	Category	n
Age	10–24 years	6
	25–59 years	12
Gestational Age	First trimester	0
	Second trimester	0
	Third trimester	18

The results indicate that the study population was dominated by adult pregnant women, and all participants were in the third trimester of pregnancy.

Hemoglobin Status Before and After MMS Supplementation

The distribution of hemoglobin status before and after MMS supplementation is presented in Table 2. Prior to MMS supplementation, most participants had abnormal hemoglobin status (72.2%). After MMS supplementation, the proportion of participants with normal hemoglobin status increased substantially.

Table 2. Hemoglobin Status Before and After MMS Supplementation (n = 18)

Measurement Time	Hemoglobin Status	n	%
Before MMS	Abnormal	13	72.2
	Normal	5	27.8
After MMS	Abnormal	4	22.2
	Normal	14	77.8

The findings demonstrate a marked improvement in hemoglobin status following MMS supplementation. The proportion of participants classified as having normal hemoglobin status increased from 27.8% before supplementation to 77.8% after supplementation.

Descriptive Statistics of Hemoglobin Outcomes

Descriptive analysis was performed to examine changes in hemoglobin outcomes before and after MMS supplementation.

Table 3. Descriptive Statistics of Hemoglobin Outcomes

Variable	n	Minimum	Maximum	Mean	SD
Hemoglobin Status Before MMS	18	1.0	2.0	1.278	0.4609
Hemoglobin Status After MMS	18	1.0	2.0	1.778	0.4278

The mean score increased from 1.278 before MMS supplementation to 1.778 after supplementation, indicating an overall improvement in participants' hemoglobin outcomes.

Normality Test

The Shapiro–Wilk test was conducted to determine whether the data were normally distributed.

Table 4. Shapiro–Wilk Normality Test Results

Variable	Statistic	df	p-value
Hemoglobin Status Before MMS	0.566	18	<0.001
Hemoglobin Status After MMS	0.520	18	<0.001

Both variables produced p-values below 0.05, indicating that the data were not normally distributed. Therefore, a non-parametric test was selected for inferential analysis.

Homogeneity Test

A homogeneity test was conducted to examine the variance consistency of post-intervention hemoglobin outcomes.

Table 5. Homogeneity of Variance Test

Test Basis	Levene Statistic	df1	df2	p-value
Based on Mean	1.111	1	10	0.317
Based on Median	1.111	1	10	0.317
Based on Median and Adjusted df	1.111	1	7.000	0.327
Based on Trimmed Mean	1.111	1	10	0.317

All significance values exceeded 0.05, indicating homogeneous variance among the observed data.

Effect of MMS Supplementation on Hemoglobin Outcomes

Because the data were not normally distributed, the Wilcoxon Signed-Rank Test was applied to evaluate differences in hemoglobin outcomes before and after MMS supplementation.

Table 6. Wilcoxon Signed-Rank Test Results

Rank			
Category	**n**	**Mean Rank**	**Sum of Ranks**
Negative Ranks	2	7.00	14.00
Positive Ranks	11	7.00	77.00
Ties	5	–	–
Total	18	–	–
Test Statistics			
Statistic		Value	
Z		2.496	
Asymp. Sig. (2-tailed)		0.013	

The Wilcoxon Signed-Rank Test revealed a statistically significant difference between pre-supplementation and post-supplementation hemoglobin outcomes ($Z = 2.496$, $p = 0.013$).

Among the 18 participants, 11 experienced an improvement in hemoglobin status, 2 experienced a decline, and 5 showed no change. Since the p-value was less than 0.05, the null hypothesis was rejected, indicating that MMS supplementation was significantly associated with improved hemoglobin status among pregnant women at Bulango Timur Public Health Center.

DISCUSSION

Effect of Multi-Micronutrient Supplementation on Hemoglobin Status Among Pregnant Women

The present study demonstrated that multi-micronutrient supplementation (MMS) was associated with significant improvements in hemoglobin status among pregnant women at Bulango Timur Public Health Center. Before MMS supplementation, 72.2% of participants were classified as having abnormal hemoglobin status, whereas only 27.8% had normal hemoglobin status. Following supplementation, the proportion of participants with normal hemoglobin status increased substantially to 77.8%, while the proportion with abnormal hemoglobin status decreased to 22.2%. Furthermore, the Wilcoxon Signed-Rank Test revealed a statistically significant difference between pre- and post-supplementation hemoglobin outcomes ($Z = 2.496$, $p = 0.013$), indicating that MMS supplementation was associated with improved hemoglobin status among pregnant women.

The findings of this study are consistent with previous research demonstrating the beneficial effects of MMS on maternal hemoglobin levels and anemia prevention. Sakung et al. [9], reported that pregnant women receiving MMS experienced greater improvements in hemoglobin levels compared with those receiving iron tablets alone. Their findings suggested that the combination of multiple vitamins and minerals supports erythropoiesis more effectively than single-nutrient supplementation. Similarly, Faris et al. found that MMS supplementation [13],contributed to increased hemoglobin concentrations during pregnancy while simultaneously improving neonatal birth outcomes.

The improvement observed in this study may be explained by the comprehensive nutritional composition of MMS. Although iron deficiency remains the primary cause of anemia during pregnancy, hemoglobin synthesis also depends on adequate availability of several micronutrients, including folic acid, vitamin B12, vitamin A, zinc, and iodine. Deficiencies in these nutrients may impair red blood cell production and iron utilization, thereby reducing hemoglobin formation. Unlike conventional iron-folic acid supplementation, MMS addresses multiple nutritional deficiencies simultaneously, potentially leading to greater improvements in maternal hematological status [10][14].

The present findings also support evidence reported by Schulze et al. [15], who observed that MMS improved maternal micronutrient status during pregnancy and contributed to better iron-related biomarkers. Likewise, Mei et al. [16], demonstrated that iron-containing multiple micronutrient supplements improved iron status indicators among pregnant women, highlighting the importance of combining iron with other essential nutrients to optimize hematological outcomes. These findings suggest that improving maternal nutrition requires a broader strategy than focusing solely on iron deficiency.

In addition, the results align with those of Zhong et al. [8], who reported that MMS supplementation reduced the risk of anemia during pregnancy, particularly during the second and third trimesters. Since all participants in the current study were in the third trimester, the observed improvement in hemoglobin status may reflect the beneficial effects of MMS during a period when maternal nutrient requirements are particularly high. Pregnancy is characterized by increased blood volume and elevated nutritional demands to support fetal growth and development, making adequate micronutrient intake essential for maintaining optimal hemoglobin status.

Beyond improving maternal hemoglobin status, previous studies have demonstrated broader benefits of MMS supplementation. Smith et al. [17], reported that MMS was associated with reductions in adverse pregnancy outcomes, including low birth weight, small-for-gestational-age births, and infant mortality. Similarly, Imdad and Bhutta [14], highlighted that MMS interventions contribute not only to maternal nutritional improvement but also to enhanced fetal growth and neonatal health. Therefore, the implementation of MMS supplementation may generate benefits extending beyond anemia prevention alone.

Despite these positive findings, several considerations should be noted. The effectiveness of MMS may vary according to baseline nutritional status, maternal dietary intake, adherence to supplementation, and the timing of intervention initiation. Women with existing micronutrient deficiencies or anemia often experience greater improvements following supplementation compared with women who are already nutritionally adequate [15][17]. Furthermore, studies have emphasized that earlier initiation of MMS during pregnancy and consistent adherence to supplementation protocols are associated with greater improvements in maternal hematological outcomes [8].

Several limitations of this study should be acknowledged. First, the study employed a one-group pretest–posttest design without a control group, limiting the ability to establish a causal relationship between MMS supplementation and changes in hemoglobin status. Second, the sample size was relatively small (n = 18), which may limit the generalizability of the findings. Third, several potential confounding factors, including dietary intake, parity, maternal nutritional status, infection history, and adherence to supplementation, were not available in the secondary data records and therefore could not be controlled during analysis. Consequently, the findings should be interpreted with caution.

Nevertheless, this study provides important local evidence regarding the potential benefits of MMS supplementation among pregnant women receiving antenatal care services in Bulango Timur. The observed improvement in hemoglobin status supports ongoing efforts to strengthen maternal nutrition programs and highlights the potential role of MMS as a strategy for reducing anemia during pregnancy. Future studies employing larger sample sizes, control groups, and prospective designs are recommended to further evaluate the effectiveness of MMS supplementation on maternal hematological and pregnancy outcomes.

CONCLUSION

This study found that multiple micronutrient supplementation (MMS) was associated with improved hemoglobin status among pregnant women at Bulango Timur Public Health Center. The findings suggest that MMS may contribute to better maternal hematological outcomes by addressing multiple micronutrient deficiencies simultaneously and may serve as a promising strategy for supporting maternal nutrition and reducing the risk of anemia during pregnancy. Nevertheless, the results should be interpreted with caution due to the use of a one-group pretest–

posttest design and the relatively small sample size. Future studies employing larger samples and more rigorous research designs are recommended to strengthen the evidence regarding the effectiveness of MMS supplementation during pregnancy.

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