



Research Article

Relationship Between Multiple Micronutrient Supplement (MMS) Tablet Supplementation and Gestational Weight Gain Among Pregnant Women with Chronic Energy Deficiency (CED) at UPTD Pancakarsa 2 Primary Health Center

Yolipia Muliku ¹, Retno Dewi Prisusanti ^{2*}

^{1,2} Program Studi Sarjana Kebidanan, Institut Teknologi, Sains, dan Kesehatan Rumah Sakit dr. Soepraoen, Indonesia

* Corresponding author: retnodewi@itsk-soepraoen.ac.id

Abstract. Background : Chronic Energy Deficiency (CED) during pregnancy remains a major nutritional problem associated with increased maternal and fetal health risks, including pregnancy complications, low birth weight, and impaired fetal growth. One of the nutritional interventions currently promoted is Multiple Micronutrient Supplementation (MMS), which provides a combination of essential vitamins and minerals to improve maternal nutritional status. However, evidence regarding the relationship between MMS supplementation and gestational weight gain among pregnant women with CED at the primary healthcare level remains limited. This study aimed to determine the association between MMS supplementation and gestational weight gain among pregnant women with CED at UPTD Pancakarsa 2 Primary Health Center. Methods : A quantitative study with an analytical cross-sectional design was conducted involving 60 pregnant women with CED selected through consecutive sampling. Data were collected from maternal and child health records, medical records, structured questionnaires assessing MMS adherence, and body weight measurements using a calibrated digital scale. Statistical analyses included descriptive analysis, Chi-square test, and multiple linear regression with a significance level of $p < 0.05$. Results : The findings showed that 70.0% of participants adhered to MMS supplementation, while 65.0% achieved recommended gestational weight gain. Chi-square analysis demonstrated a significant association between MMS adherence and gestational weight gain ($p = 0.001$). Multiple linear regression identified adherence to MMS supplementation as the strongest factor associated with gestational weight gain ($\beta = 0.58$; $p < 0.001$) after adjustment for maternal age, gestational age, and parity. Conclusion : Adequate adherence to Multiple Micronutrient Supplementation is significantly associated with improved gestational weight gain among pregnant women with Chronic Energy Deficiency. Strengthening nutritional counseling, improving adherence monitoring, and optimizing MMS implementation within antenatal care services may contribute to better maternal nutritional status and improved pregnancy outcomes.

Keywords: Chronic Energy Deficiency; Gestational Weight Gain; Maternal Nutrition; Multiple Micronutrient Supplementation; Pregnancy.

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1. INTRODUCTION

Chronic Energy Deficiency (CED) during pregnancy remains a major nutritional challenge that requires sustained public health attention because of its strong association with adverse maternal and neonatal outcomes. Pregnant women affected by CED possess insufficient energy reserves and inadequate nutrient stores, increasing their susceptibility to complications during pregnancy, childbirth, and the postpartum period. This nutritional condition is associated with impaired fetal growth, maternal anemia, preterm birth, low birth weight (LBW), and elevated rates of maternal and neonatal morbidity and mortality. Consequently, improving maternal nutritional status has become a fundamental priority within maternal healthcare services to promote healthy pregnancies and optimize birth outcomes (World Health Organization, 2024; Ministry of Health of the Republic of Indonesia, 2023).

Pregnancy is characterized by substantially increased requirements for energy, protein, vitamins, and minerals to support fetal growth, placental development, maternal blood volume expansion, and numerous physiological adaptations. Failure to meet these elevated nutritional demands predisposes pregnant women to Chronic Energy Deficiency, commonly identified by a Mid-Upper Arm Circumference (MUAC) of less than 23.5 cm. Inadequate maternal nutritional status during pregnancy not only compromises maternal health but also adversely affects fetal growth and development, with potential consequences extending into later stages of life. Therefore, ensuring adequate nutrient intake throughout pregnancy represents an essential component of comprehensive antenatal care (WHO, 2024; Ministry of Health of the Republic of Indonesia, 2023).

Various nutritional strategies have been introduced to address maternal undernutrition, one of which is the provision of Multiple Micronutrient Supplement (MMS) tablets. MMS formulations contain a broad spectrum of essential vitamins and minerals, including iron, folic acid, vitamins A, D, B-complex, and C, as well as zinc, iodine, selenium, and other micronutrients required during pregnancy. Unlike conventional iron and folic acid supplementation alone, MMS is designed to provide a more comprehensive supply of micronutrients, thereby improving maternal nutritional status while supporting optimal fetal growth and development (WHO, 2020).

Evidence from international studies has demonstrated that MMS supplementation during pregnancy is associated with a reduced risk of low birth weight, preterm delivery, and improvements in maternal nutritional status. Beyond correcting micronutrient deficiencies, MMS is also believed to facilitate maternal weight gain by supporting energy metabolism, protein synthesis, and the growth of maternal and fetal tissues. Nevertheless, the magnitude of these benefits is influenced by several factors, including adherence to supplementation, baseline nutritional status, habitual dietary intake, and the quality of antenatal care services received throughout pregnancy (Keats et al., 2019; WHO, 2020).

Gestational weight gain is widely recognized as an important indicator of maternal nutritional adequacy during pregnancy. Weight gain that falls within recommended ranges reflects sufficient nutritional intake to meet the physiological needs of both mother and fetus, whereas inadequate gestational weight gain has been consistently associated with impaired fetal growth, low birth weight, and other obstetric complications. Consequently, routine monitoring of maternal body weight during antenatal visits constitutes an essential component of early nutritional surveillance, particularly among pregnant women with Chronic Energy Deficiency (Institute of Medicine, 2009).

Previous investigations have consistently reported that MMS supplementation produces greater improvements in maternal micronutrient status than supplementation with iron and folic acid alone. However, the majority of existing studies have focused primarily on outcomes such as maternal anemia, infant birth weight, or preterm birth, whereas evidence regarding the relationship between MMS supplementation and gestational weight gain among pregnant women with Chronic Energy Deficiency remains limited, particularly within primary healthcare settings in Indonesia.

Research conducted by Retno Dewi Priskusanti demonstrated that nutritional interventions integrated with health education and continuous monitoring throughout pregnancy can enhance maternal health behaviors and improve maternal healthcare outcomes. These findings indicate that the effectiveness of nutritional supplementation depends not only on the nutritional composition of the supplements themselves but also on maternal adherence, ongoing support from healthcare providers, and active participation in recommended antenatal care practices.

Despite the documented benefits of MMS supplementation, an important research gap remains regarding its effectiveness among pregnant women with Chronic Energy Deficiency, particularly in relation to maternal weight gain during pregnancy. Most previous studies have examined general populations of pregnant women rather than focusing specifically on high-risk groups, while factors such as adherence to MMS consumption, gestational age, parity, and baseline nutritional status have seldom been evaluated simultaneously. Furthermore, evidence concerning the implementation of MMS programs in primary healthcare facilities, including UPTD Pancakarsa 2 Primary Health Center, remains scarce, highlighting the need for more context-specific investigations.

The novelty of the present study lies in its evaluation of the relationship between Multiple Micronutrient Supplement (MMS) administration and gestational weight gain among pregnant women with Chronic Energy Deficiency within a primary healthcare setting. In addition to assessing MMS as a nutritional intervention, this study examines maternal weight gain as an indicator of maternal nutritional status throughout pregnancy. Moreover, important participant characteristics—including maternal age, gestational age, parity, and adherence to MMS supplementation—are incorporated into the analysis to provide a more comprehensive understanding of the effectiveness of MMS implementation within primary healthcare services.

Based on these considerations, this study aimed to analyze the relationship between Multiple Micronutrient Supplement (MMS) administration and gestational weight gain among pregnant women with Chronic Energy Deficiency (CED) at UPTD Pancakarsa 2 Primary Health Center. The findings are expected to provide scientific evidence supporting the strengthening of maternal nutritional supplementation programs, contribute to the development of evidence-based antenatal care strategies, and serve as a reference for healthcare professionals in improving maternal nutritional status to reduce pregnancy-related complications and enhance maternal and neonatal health outcomes (WHO, 2024; Ministry of Health of the Republic of Indonesia, 2023).

2. LITERATURE REVIEW

Chronic Energy Deficiency (CED) during pregnancy is a prolonged state of inadequate energy and nutrient intake that adversely affects maternal health and fetal development. In Indonesia, CED among pregnant women is commonly identified using a Mid-Upper Arm Circumference (MUAC) measurement of less than 23.5 cm. This condition is associated with an increased risk of maternal anemia, fetal growth restriction, low birth weight (LBW), preterm delivery, and higher maternal and neonatal morbidity and mortality. Accordingly, improving maternal nutritional status constitutes a fundamental component of antenatal care aimed at ensuring healthy pregnancies and favorable birth outcomes (World Health Organization, 2024).

Pregnancy substantially increases the physiological demand for energy, protein, vitamins, and minerals to support fetal development, placental formation, maternal blood volume expansion, and metabolic adaptations. When these nutritional requirements are not adequately fulfilled, pregnant women become more susceptible to insufficient gestational weight gain and deterioration of nutritional status. Maternal weight gain throughout pregnancy is widely recognized as an important indicator of nutritional adequacy because it reflects the balance between maternal nutritional intake and fetal growth requirements. Gestational weight gain that falls outside the recommended range has consistently been associated with adverse pregnancy outcomes and impaired fetal development (Institute of Medicine, 2009).

Multiple Micronutrient Supplementation (MMS) consists of a comprehensive combination of essential vitamins and minerals, including iron, folic acid, vitamins A, D, C, E, B-complex vitamins, zinc, selenium, copper, and iodine. Compared with conventional iron and folic acid supplementation, MMS is formulated to provide a broader spectrum of micronutrients required during pregnancy. These nutrients contribute to energy metabolism, protein synthesis, erythropoiesis, immune function, and the growth of both maternal and fetal tissues. Consequently, MMS supplementation is expected to improve maternal nutritional status, thereby supporting appropriate gestational weight gain in accordance with recommended guidelines (WHO, 2020).

This study is grounded in the Nutrition Care Process (NCP), which conceptualizes nutritional management as a systematic sequence of nutritional assessment, nutrition diagnosis, intervention, monitoring, and evaluation. Within this framework, MMS supplementation represents a nutritional intervention designed to correct micronutrient deficiencies and optimize metabolic processes. Improved micronutrient status is anticipated to enhance the efficiency of energy utilization and nutrient metabolism, thereby facilitating healthier weight gain among pregnant women affected by Chronic Energy Deficiency.

The study is further supported by the Health Behavior Theory proposed by Soekidjo Notoatmodjo, which emphasizes that the effectiveness of health interventions is influenced by an individual's knowledge, attitudes, and behavioral practices. In the context of MMS supplementation, adherence to the prescribed supplementation regimen is a critical determinant of intervention success. Adequate health education regarding the benefits of MMS is expected to strengthen maternal motivation to consume the supplements consistently, thereby maximizing their intended biological effects (Notoatmodjo, 2018).

Previous studies have consistently demonstrated that MMS supplementation during pregnancy offers greater benefits than iron and folic acid supplementation alone, particularly in reducing the incidence of low birth weight, improving infant birth weight, and enhancing maternal micronutrient status. Several investigations have also reported a tendency toward greater maternal weight gain among women receiving MMS. However, the magnitude of these improvements varies according to baseline nutritional status, adherence to supplementation, gestational age, and habitual dietary intake. These findings indicate that the effectiveness of MMS is determined by multiple interrelated maternal and environmental factors.

A study conducted by Retno Dewi Prisusanti reported that nutritional interventions combined with health education and continuous maternal support throughout pregnancy significantly improved maternal health behaviors and maternal healthcare outcomes. These findings suggest that the success of supplementation programs depends not only on the nutritional composition of the supplements but also on maternal adherence and the quality of guidance provided by healthcare professionals. This concept provides an important theoretical foundation for the present investigation of MMS supplementation among pregnant women with Chronic Energy Deficiency.

A review of the available literature reveals an important research gap regarding the relationship between MMS supplementation and gestational weight gain among pregnant women with Chronic Energy Deficiency receiving care at primary healthcare facilities. Most previous investigations have primarily focused on neonatal outcomes or maternal hemoglobin status, whereas maternal weight gain as an indicator of improved nutritional status has received comparatively little attention. Moreover, evidence evaluating the implementation of MMS programs within primary healthcare centers while simultaneously considering maternal adherence and participant characteristics remains limited.

Conceptually, this study assumes that regular consumption of Multiple Micronutrient Supplement tablets enhances the intake of essential micronutrients involved in energy metabolism, tissue development, and nutrient utilization throughout pregnancy. When maternal micronutrient requirements are adequately fulfilled through consistent supplementation, improvements in nutritional status are expected to promote more appropriate gestational weight gain. Therefore, this study aims to provide empirical evidence regarding the relationship between MMS supplementation and maternal weight gain among pregnant women with Chronic Energy Deficiency, thereby contributing to the development of evidence-based nutritional intervention policies within primary healthcare antenatal services.

3. RESEARCH METHODS

This study employed a quantitative approach using an analytical observational design with a cross-sectional methodology. This design was selected to examine the relationship between Multiple Micronutrient Supplement (MMS) administration and gestational weight gain among pregnant women with Chronic Energy Deficiency (CED). Both the independent and dependent variables were assessed during the same observation period, allowing the association between the variables to be analyzed based on participants' conditions at the time of data collection (Creswell & Creswell, 2018; Polit & Beck, 2021).

The study was conducted at UPTD Pancakarsa 2 Primary Health Center, Pohuwato Regency, Gorontalo Province, Indonesia, between May and August 2026. The study population comprised all pregnant women diagnosed with Chronic Energy Deficiency who received antenatal care within the health center's service area during the study period. A total of 60 participants were recruited using a consecutive sampling technique, whereby all eligible

pregnant women with CED were enrolled sequentially until the predetermined sample size was achieved.

Eligible participants were pregnant women in the second or third trimester of pregnancy with a Mid-Upper Arm Circumference (MUAC) of less than 23.5 cm who had received Multiple Micronutrient Supplement (MMS) tablets for at least one month, agreed to participate in the study, and provided written informed consent. Women with severe obstetric complications, chronic diseases affecting nutritional status, multiple pregnancies, or incomplete clinical records were excluded from the final analysis.

The independent variable (X) was Multiple Micronutrient Supplement (MMS) administration, which was evaluated according to participants' adherence to MMS consumption based on standard antenatal care recommendations. The dependent variable (Y) was gestational weight gain among pregnant women with Chronic Energy Deficiency, determined by calculating the difference between maternal body weight at the initiation of MMS supplementation and body weight at the time of data collection. In addition to these primary variables, information regarding maternal age, gestational age, parity, educational attainment, occupation, pre-pregnancy body mass index (BMI), and adherence to antenatal care visits was collected as potential covariates that could influence the study outcomes.

Data were collected using participant characteristic forms, MMS adherence monitoring records, Maternal and Child Health (MCH) handbooks, medical records, and standardized maternal weight observation forms. Maternal body weight was measured using a calibrated digital weighing scale with a precision of 0.1 kg. Information regarding MMS administration was obtained from antenatal care records and verified directly with participants through a structured questionnaire.

The research instruments underwent content validity assessment conducted by experts in midwifery, nutrition, and research methodology. Expert evaluation confirmed that all instrument components were appropriate for the objectives of the study. Reliability testing yielded a Cronbach's Alpha coefficient of 0.91, indicating excellent internal consistency and confirming the suitability of the instruments for data collection.

Statistical analyses were performed using statistical software. Descriptive (univariate) analysis was used to summarize participant characteristics as means, standard deviations, frequencies, and percentages. The association between MMS administration and gestational weight gain was analyzed using the Chi-square test when variables were categorized or Pearson's correlation test when continuous variables met the assumptions of normality. Subsequently, multiple linear regression analysis was performed to identify the factors most strongly associated with maternal weight gain after adjusting for potential confounding variables. Statistical significance was established at $\alpha = 0.05$ (Field, 2018).

Conceptual Framework

Independent Variable (X)

Multiple Micronutrient Supplement (MMS) Administration

1. Adherence to MMS consumption
2. Duration of supplementation
3. Compliance with the prescribed dosage

↓

Dependent Variable (Y)

Gestational Weight Gain Among Pregnant Women with Chronic Energy Deficiency (CED)

Controlled Variables

1. Maternal age
2. Gestational age
3. Parity

4. Educational level
5. Pre-pregnancy body mass index (BMI)
6. Adherence to antenatal care (ANC) visits

Conceptual Framework Description: The independent variable in this study was Multiple Micronutrient Supplement (MMS) administration, evaluated according to adherence to supplementation, duration of use, and compliance with the recommended dosage throughout pregnancy. The dependent variable was gestational weight gain among pregnant women with Chronic Energy Deficiency, assessed by measuring changes in maternal body weight during the monitoring period. The relationship between these variables was analyzed while controlling for several potential confounding factors, including maternal age, gestational age, parity, educational level, pre-pregnancy body mass index, and adherence to antenatal care, all of which may influence maternal nutritional status during pregnancy.

4. RESULTS AND DISCUSSION

Data Collection Process

This study was conducted at UPTD Pancakarsa 2 Primary Health Center, Pohuwato Regency, Gorontalo Province, Indonesia, between May and August 2026. Prior to data collection, ethical approval was obtained from the Health Research Ethics Committee, research permission was granted by the Pohuwato Regency Health Office, and institutional approval was received from the Head of UPTD Pancakarsa 2 Primary Health Center. Before enrollment, all eligible participants received detailed information regarding the study objectives, procedures, potential benefits, and their rights as research participants. Written informed consent was obtained from every respondent before participation.

A total of 60 pregnant women diagnosed with Chronic Energy Deficiency (CED) were enrolled using a consecutive sampling technique based on the predefined inclusion and exclusion criteria. Information regarding adherence to Multiple Micronutrient Supplement (MMS) consumption was collected from the Maternal and Child Health (MCH) handbook, medical records, and structured participant interviews. Maternal body weight was measured using a calibrated digital weighing scale with a measurement precision of 0.1 kg. Following data collection, all records underwent editing, coding, data entry, and data cleaning before statistical analysis was performed.

Participant Characteristics

Table 1. Participant Characteristics (n = 60).

Characteristics	n	(%)
Maternal Age		
<20 years	5	8.3
20–35 years	46	76.7
>35 years	9	15.0
Gestational Age		
Second trimester	38	63.3
Third trimester	22	36.7
Adherence to MMS Supplementation		
Adherent	42	70.0
Non-adherent	18	30.0

Source: Research data, 2026.

As presented in Table 1, most participants were within the optimal reproductive age group of 20–35 years (76.7%). The majority were in the second trimester of pregnancy (63.3%), while 70.0% demonstrated good adherence to Multiple Micronutrient Supplement (MMS) consumption in accordance with recommendations provided by healthcare professionals.

Distribution of Gestational Weight Gain

Table 2. Distribution of Gestational Weight Gain Among Pregnant Women with Chronic Energy Deficiency.

Gestational Weight Gain	n	(%)
Within recommended range	39	65.0
Below recommended range	21	35.0

Source: Research data, 2026.

According to **Table 2**, 65.0% of participants achieved gestational weight gain within the recommended range, whereas 35.0% did not attain the expected level of weight gain during pregnancy. These findings indicate that a substantial proportion of pregnant women with Chronic Energy Deficiency continue to require intensified nutritional support and monitoring.

Association Between MMS Supplementation and Gestational Weight Gain

Table 3. Association Between Adherence to MMS Supplementation and Gestational Weight Gain.

MMS Adherence	Recommended Weight Gain	Inadequate Weight Gain	Total
Adherent	33 (78.6%)	9 (21.4%)	42
Non-adherent	6 (33.3%)	12 (66.7%)	18

Chi-square test: $\chi^2 = 11.87$; $p = 0.001$

Source: Research data, 2026.

The analysis presented in **Table 3** revealed a statistically significant association between adherence to Multiple Micronutrient Supplement (MMS) consumption and gestational weight gain among pregnant women with Chronic Energy Deficiency ($p = 0.001$). Participants who adhered to MMS supplementation were considerably more likely to achieve recommended gestational weight gain (78.6%) than those who were non-adherent (33.3%).

Multiple Linear Regression Analysis

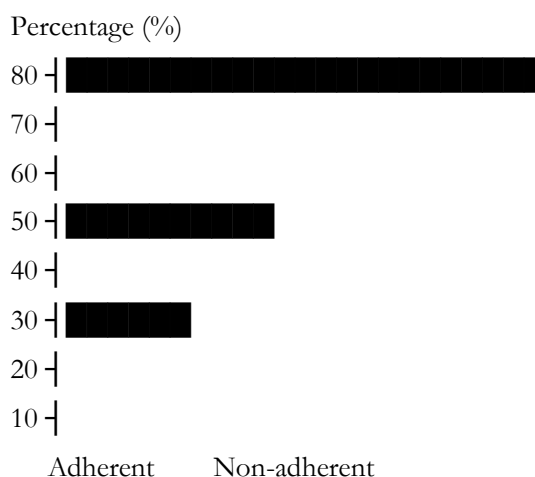
Table 4. Factors Associated with Gestational Weight Gain.

Variable	β	t	p-value
Adherence to MMS supplementation	0.58	5.74	<0.001
Maternal age	0.07	0.69	0.492
Gestational age	0.16	1.48	0.144
Parity	0.11	1.03	0.307

$R^2 = 0.47$

Source: Research data, 2026.

Multiple linear regression analysis identified adherence to Multiple Micronutrient Supplement (MMS) consumption as the strongest factor associated with gestational weight gain ($\beta = 0.58$; $p < 0.001$). The coefficient of determination ($R^2 = 0.47$) indicates that the regression model explained 47% of the variation in gestational weight gain among pregnant women with Chronic Energy Deficiency.



Recommended Recommended
Weight Gain Weight Gain

Figure 1. Percentage of Recommended Gestational Weight Gain According to Adherence to MMS Supplementation.

Source: Research data, 2026.

Figure 1 illustrates that pregnant women who consistently adhered to Multiple Micronutrient Supplement (MMS) consumption achieved the recommended gestational weight gain more frequently than those with poor adherence. This graphical presentation supports the statistical findings demonstrating a significant association between MMS adherence and improved maternal nutritional status.

Interpretation of the Findings

The findings indicate that adherence to Multiple Micronutrient Supplement (MMS) consumption is significantly associated with gestational weight gain among pregnant women with Chronic Energy Deficiency. Women who consumed MMS consistently were more likely to achieve gestational weight gain within the recommended range than those who did not adhere to the supplementation regimen. These findings are consistent with the principles of the Nutrition Care Process, which emphasizes that structured nutritional interventions accompanied by continuous monitoring can improve nutritional status by optimizing nutrient utilization.

From a physiological perspective, Multiple Micronutrient Supplements provide a broad spectrum of vitamins and minerals that support energy metabolism, protein synthesis, tissue development, and numerous enzymatic processes essential during pregnancy. Improvements in maternal micronutrient status enhance metabolic efficiency, allowing maternal and fetal nutritional requirements to be met more effectively. Consequently, these physiological improvements contribute to healthier gestational weight gain, which serves as an important indicator of improved maternal nutritional status.

The present findings are consistent with previous studies demonstrating that Multiple Micronutrient Supplementation provides greater nutritional benefits than iron and folic acid supplementation alone in improving maternal nutritional status during pregnancy. However, this study contributes additional evidence by specifically evaluating the relationship between MMS supplementation and gestational weight gain among pregnant women with Chronic Energy Deficiency within a primary healthcare setting, thereby providing context-specific evidence regarding the implementation of MMS programs at community health centers.

Study Implications

From a theoretical perspective, these findings reinforce the concept that adequate micronutrient intake plays a critical role in improving the nutritional status of pregnant women affected by Chronic Energy Deficiency. The study also provides additional evidence supporting the contribution of Multiple Micronutrient Supplementation to energy metabolism and maternal tissue growth throughout pregnancy.

From a practical standpoint, the results suggest that healthcare professionals should strengthen strategies for monitoring adherence to Multiple Micronutrient Supplement consumption through continuous nutrition education, individualized counseling, and regular antenatal care visits. Such approaches may enhance gestational weight gain in accordance with recommended guidelines, improve maternal nutritional status, and contribute to reducing the risk of pregnancy complications and low birth weight.

DISCUSSION

The findings of this study demonstrated a statistically significant association between the use of Multiple Micronutrient Supplement (MMS) tablets and gestational weight gain among pregnant women with Chronic Energy Deficiency (CED) at UPTD Pancakarsa 2 Primary Health Center. Most participants who consistently consumed MMS achieved gestational weight gain within the recommended range, whereas those with poor adherence were less likely to reach the expected weight gain. The Chi-square analysis yielded a p-value of 0.001, indicating a significant relationship between MMS adherence and maternal weight gain. These findings suggest that adequate micronutrient intake during pregnancy contributes

substantially to improving the nutritional status of pregnant women, particularly those affected by CED. According to the researchers, adherence to MMS supplementation represents a key component of maternal nutrition programs because it supports metabolic balance throughout pregnancy (World Health Organization, 2020).

From a physiological perspective, these findings can be explained by the essential role of micronutrients in energy metabolism and tissue development. Multiple Micronutrient Supplement tablets contain iron, folic acid, zinc, vitamins A, D, C, and B-complex, together with several other essential minerals that function as cofactors in numerous biochemical reactions. Adequate availability of these micronutrients promotes protein synthesis, erythropoiesis, and the development of both maternal and fetal tissues, thereby contributing to appropriate maternal weight gain during pregnancy. Maternal nutrition theory further explains that optimal micronutrient status enhances the efficient utilization of macronutrients, enabling pregnant women to meet their increased physiological nutritional requirements (Gibson, 2021).

The present findings are also consistent with the principles of the Nutrition Care Process (NCP), which conceptualizes nutritional management as a systematic sequence consisting of nutritional assessment, diagnosis, intervention, monitoring, and evaluation. Within this framework, MMS supplementation represents a nutritional intervention designed to correct micronutrient deficiencies among pregnant women. In this study, women who adhered to MMS supplementation tended to experience more favorable gestational weight gain than those with lower adherence. According to the researchers, these findings indicate that the effectiveness of nutritional interventions depends not only on supplement availability but also on sustained compliance and continuous monitoring provided by healthcare professionals during antenatal care.

The multiple linear regression analysis further identified adherence to MMS supplementation as the strongest determinant of gestational weight gain among pregnant women with CED ($\beta = 0.58$; $p < 0.001$). In contrast, maternal age, gestational age, and parity were not significantly associated with weight gain after adjustment for potential confounding variables. This finding suggests that adequate micronutrient intake contributes more substantially to improvements in maternal nutritional status than demographic characteristics. According to the researchers, these results emphasize that efforts to optimize MMS supplementation programs should be accompanied by strategies aimed at improving maternal adherence to maximize the benefits of nutritional interventions.

The results of this study are consistent with previous investigations reporting that MMS supplementation during pregnancy provides greater benefits than iron and folic acid supplementation alone in improving maternal nutritional status and pregnancy outcomes. Several studies have demonstrated that pregnant women receiving MMS have a lower risk of delivering low birth weight infants, experiencing impaired fetal growth, or developing micronutrient deficiencies. Nevertheless, most previous research has primarily focused on neonatal outcomes, whereas the present study contributes additional evidence regarding the relationship between MMS supplementation and gestational weight gain among pregnant women with CED as an indicator of improved maternal nutritional status (Keats et al., 2019; WHO, 2020).

Research conducted by Retno Dewi Prisusanti also reported that successful nutritional interventions in maternal healthcare are influenced by the combined effects of nutritional supplementation, health education, and continuous follow-up. These findings indicate that maternal adherence to healthcare recommendations plays an essential role in enhancing the effectiveness of maternal health programs. The present study supports this concept, as most women who consistently consumed MMS experienced more appropriate gestational weight gain than those with poor adherence. According to the researchers, continuous education regarding the benefits of MMS should become an integral component of antenatal care to encourage sustained compliance with supplementation.

Although this study identified a significant association, gestational weight gain is influenced by multiple factors beyond MMS supplementation alone. Daily energy and protein intake, dietary patterns, physical activity, underlying medical conditions, socioeconomic circumstances, educational attainment, family support, and adherence to

antenatal care visits may also affect maternal weight gain during pregnancy. Furthermore, the cross-sectional design does not permit the establishment of a direct causal relationship between MMS supplementation and gestational weight gain. Therefore, the findings should be interpreted with caution, taking into consideration the possibility of residual confounding factors that could not be fully controlled.

Overall, the findings suggest that MMS supplementation programs should be strengthened as an integral component of antenatal care, particularly for pregnant women with CED. Enhancing nutrition education, regularly monitoring supplement adherence, providing counseling on balanced dietary practices, and conducting periodic nutritional assessments are recommended strategies to improve the effectiveness of nutritional interventions. From an academic perspective, this study expands the existing evidence regarding the relationship between micronutrient supplementation and maternal nutritional status. Nevertheless, future investigations employing prospective cohort studies or randomized controlled trials, larger sample sizes, and follow-up through delivery are required to comprehensively evaluate the effects of MMS supplementation on gestational weight gain, maternal micronutrient status, and both maternal and neonatal outcomes (Creswell & Creswell, 2018; Polit & Beck, 2021).

5. CONCLUSION, RECOMMENDATIONS, AND ACKNOWLEDGMENTS

Conclusion and Recommendations

The findings of this study demonstrated a significant association between Multiple Micronutrient Supplement (MMS) use and gestational weight gain among pregnant women with Chronic Energy Deficiency (CED) at UPTD Pancakarsa 2 Primary Health Center. Pregnant women who consistently adhered to MMS supplementation were more likely to achieve gestational weight gain within the recommended range than those with lower adherence. Statistical analysis confirmed that this relationship was significant, while multivariate analysis identified adherence to MMS consumption as the strongest predictor of gestational weight gain after adjusting for maternal characteristics, including age, gestational age, and parity. Therefore, the objective of this study—to examine the relationship between MMS supplementation and gestational weight gain among pregnant women with CED—was successfully achieved based on the empirical evidence obtained.

Nevertheless, these findings should be interpreted with appropriate caution because gestational weight gain is influenced by numerous interacting factors. In addition to MMS supplementation, daily energy and protein intake, dietary quality, physical activity, maternal health status, socioeconomic conditions, family support, compliance with antenatal care visits, and other biological factors may contribute to changes in maternal body weight during pregnancy. Consequently, the results of this study cannot be generalized directly to all pregnant women without considering differences in individual characteristics and variations in healthcare service settings.

Based on the study findings, the implementation of MMS supplementation should continue to be strengthened as an integral component of antenatal care, particularly for pregnant women affected by CED. Healthcare professionals are encouraged to enhance education regarding the benefits of MMS, conduct regular monitoring of supplementation adherence, and integrate nutritional counseling with routine assessment of gestational weight gain during every antenatal visit. Such strategies are expected to improve maternal nutritional status, support optimal fetal growth and development, and reduce pregnancy complications associated with chronic energy deficiency.

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design only allows the assessment of associations at a single point in time and therefore cannot establish causal relationships. Second, the relatively small sample size and the implementation of the study at a single primary healthcare center limit the generalizability of the findings. In addition, several variables that may influence gestational weight gain, including daily energy intake, protein consumption, physical activity, underlying medical conditions, and socioeconomic status, were not comprehensively evaluated.

Future studies are recommended to employ prospective cohort or randomized controlled trial designs with larger sample sizes and involve multiple healthcare facilities to improve external validity. Further research should also include more objective measurements of MMS adherence, comprehensive assessments of nutritional and micronutrient status, and evaluations of the effects of MMS supplementation on pregnancy outcomes, including birth weight, gestational age at delivery, the incidence of low birth weight, and postpartum maternal health. Such investigations will provide stronger scientific evidence regarding the effectiveness of MMS implementation among pregnant women with CED and support the development of evidence-based maternal healthcare policies.

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