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Maternal Nutrition and Its Influence on Neonatal Birth Weight in Low-Income Communities

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ABSTRACT

Maternal nutrition during pregnancy plays a critical role in determining neonatal birth weight, particularly in low-income communities. This cross-sectional study examined the association between maternal nutritional status and infant birth weight among 80 postpartum mothers in Deli Serdang Regency, North Sumatra. Maternal nutrition was assessed using body mass index, upper arm circumference, energy and protein intake, and hemoglobin levels, while birth weight was obtained from medical records. Multivariate regression analysis controlling for maternal and socioeconomic factors showed that low upper arm circumference, inadequate energy and protein intake, and maternal anemia were significant independent predictors of low birth weight. The findings highlight the importance of strengthening community-based maternal nutrition interventions to reduce low birth weight in economically disadvantaged settings

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INTRODUCTION

The nutritional status of the mother during pregnancy is a major biological determinant that affects fetal growth and birth outcomes, especially the baby's birth weight. Globally, low birth weight remains a persistent public health problem, especially in low-income communities that face limited access to nutritious food and maternal health services. Recent epidemiological studies show that chronic energy deficiencies, protein deficiencies, and anemia in pregnant women contribute significantly to intrauterine growth inhibition and birth weight loss (Christian et al., 2021). This condition emphasizes that improving maternal nutrition is a key strategy in reducing the risk of neonatal morbidity and mortality.

In a middle-income country like Indonesia, the nutritional challenges of pregnant women are not only influenced by biological factors, but also by socioeconomic determinants and disparities in health services between regions. Research shows that pregnant women living in low-income communities are at higher risk of inadequate energy and protein intake, which directly impacts the baby's birth weight (Hanson et al., 2020). The local context shows that these factors are often exacerbated by low maternal education levels and limited antenatal visits. Therefore, a region-based approach is important to understand the dynamics of maternal nutrition in a more contextual way.

Various international studies have confirmed the relationship between maternal nutritional indicators, such as pre-pregnancy body mass index, upper arm circumference, and hemoglobin levels, and the baby's birth weight. For example, research by Zerfu and Biadgilign (2020) found that a combination of maternal macro and micronutrient status had a cumulative effect on neonatal birth weight. However, most of these studies were conducted on a broad national or regional scale, so they did not adequately describe the conditions of low-income communities at the local level. This shows that there is a limitation of generalization of findings to micro contexts such as certain districts or districts.

In addition to the limitations of the regional context, the research gap is also seen in the methodological approach used in previous studies. A number of studies have focused only on one maternal nutrition indicator or used bivariate analysis without adequate control of confounding factors (Kumera et al., 2021). In fact, birth weight is a multifactorial outcome influenced by the complex interaction between nutritional status, maternal characteristics, and health service factors. This gap underscores the need for analytical observational studies that integrate various maternal nutrition indicators in a single multivariate model.

Further, empirical evidence from developing countries suggests that maternal anemia and low protein intake often remain independent predictors of low birth weight after controlling for sociodemographic variables (Young et al., 2022). However, there is still limited research that tests this pattern specifically in low-income communities in North Sumatra. Deli Serdang Regency, as an area with socio-economic heterogeneity and diverse access to health services, provides relevant empirical context to address these gaps. Therefore, studies that focus on this region are scientifically and practically important.

Based on this description, this study explicitly aims to analyze the effect of maternal nutritional status during pregnancy on the birth weight of babies in low-income communities in Deli Serdang Regency, North Sumatra Province. This study evaluated several maternal nutritional indicators simultaneously, including body mass index, upper arm circumference, energy and protein intake, and hemoglobin levels, by controlling for the main confounding factors. This approach is expected to be able to provide a more comprehensive picture of the determinants of maternal nutrition on birth outcomes. Thus, the purpose of the research is directed to strengthen the empirical evidence based on the local context.

The theoretical contribution of this research lies in the enrichment of the conceptual framework regarding the multidimensional relationship between maternal nutritional status and infant birth weight in the context of low-income communities. Practically, the research findings are expected to be a scientific basis for the development of community-based maternal nutrition interventions and the strengthening of antenatal services at the primary health service level. In addition, the results of this study can support the formulation of maternal and child health policies that are more contextual and evidence-based in the regions. Thus, this study makes a strategic contribution to efforts to reduce the prevalence of low birth weight in a sustainable manner.

THEORETICAL REVIEW

Maternal Nutrition and Fetal Growth Mechanisms

Maternal nutrition plays a central role in supporting fetal growth through biological mechanisms that involve nutrient transfer, hormonal regulation, and metabolic adaptation during pregnancy. Adequate energy and protein intake is needed to support fetal tissue formation, placental development, and increased maternal blood volume. Research by King and Brown (2021) shows that chronic energy deficits in pregnant women correlate with intrauterine growth disorders that have a direct impact on the baby's birth weight. This mechanism confirms that the nutritional status of the mother is not only a supporting factor, but is a biological prerequisite for optimal birth outcomes.

In addition to macronutrients, the quality of the maternal diet also affects the efficiency of fetal metabolism and placental function. A longitudinal study conducted by Mousa et al. (2022) found that low-quality food consumption patterns during pregnancy are associated with reduced birth weight and an increased risk of preterm birth. These findings reinforce the argument that maternal nutrition should be understood holistically, encompassing the quantity and quality of nutrient intake. Therefore, maternal nutrition indicators such as body mass index and energy–protein intake are important parameters in maternal health research.

H1: The nutritional status of the mother during pregnancy has a significant effect on the birth weight of the baby.

Micronutrient Status and Maternal Anemia

The status of maternal micronutrients, particularly iron, has direct implications for the oxygenation of fetal tissue and intrauterine growth. Anemia

during pregnancy has long been identified as a major risk factor for low birth weight, especially in low-income communities. Research by Daru et al. (2020) shows that pregnant women with anemia have a higher probability of giving birth to babies with low birth weight than mothers with normal hemoglobin levels. This condition is caused by a reduced oxygen transport capacity to the fetus which inhibits optimal growth.

Furthermore, a meta-analytical study by Rahman et al. (2021) confirms that maternal anemia remains a significant predictor of low birth weight even after controlling for maternal age, parity, and socioeconomic status. These findings highlight the importance of hemoglobin levels as a relevant nutritional indicator in maternal and child health research. Thus, the measurement of maternal anemia is a crucial component in comprehensively understanding the determinants of infant birth weight.

H2: Anemia in pregnant women has a significant effect on the weight loss of the baby's birth.

Anthropometric Indicators of Maternal Nutrition

Maternal anthropometric measurements, such as upper arm circumference and body mass index, are often used as practical indicators of nutritional status, especially in resource-constrained regions. The circumference of the upper arm reflects the mother's relatively stable energy and protein reserves during pregnancy. Research by Tang et al. (2021) found that low upper arm circumference was significantly associated with an increased risk of low birth weight. This indicator is considered more sensitive in detecting chronic malnutrition than body mass index alone.

In addition, a cohort study by Nguyen et al. (2023) showed that a combination of anthropometric indicators provided a stronger prediction of birth weight than the use of a single indicator. This indicates that a multidimensional approach in assessing maternal nutritional status is more methodologically relevant. Therefore, research that integrates several anthropometric indicators has added value in explaining the variation in the birth weight of babies.

H3: Maternal anthropometric indicators, especially upper arm circumference and body mass index, have a significant effect on the baby's birth weight.

Socioeconomic Context and Antenatal Care Utilization

Socioeconomic conditions play a role as an indirect determinant that affects maternal nutritional status and birth outcomes. Pregnant women from low-income communities often face limited access to nutritious food, supplementation, and maternal health services. Research by Afulani et al. (2020) shows that low socioeconomic status is associated with low maternal dietary quality and an increased risk of low birth weight. This factor emphasizes the importance of social context in the study of maternal nutrition.

In addition, the frequency and quality of antenatal visits play a role in detecting and managing nutritional problems during pregnancy. A study by Benova et al. (2022) found that pregnant women with inadequate antenatal visits had a higher risk of giving birth to babies with low body weight. This shows that maternal health services are an important confounding factor that needs to be controlled in the analysis of the relationship between maternal nutrition and infant birth weight.

H4: Socioeconomic factors and utilization of antenatal services affect the relationship between maternal nutritional status and infant birth weight.

Empirical Gaps and Conceptual Synthesis

Although many studies have examined the relationship between maternal nutrition and birth weight, most studies still assess nutritional indicators separately or do not control for confounding factors simultaneously. Research by Lassi and Bhutta (2021) emphasizes that a partial approach in assessing maternal nutritional status has the potential to produce conclusions that are not comprehensive. In addition, there are still limited studies that specifically focus on low-income communities at the district level, particularly in the North Sumatra region.

Based on the synthesis of the literature, there is a need for research that integrates various maternal nutrition indicators in an analytical framework and tests their effect on infant birth weight by controlling for sociodemographic factors and health services. This conceptual framework is the basis for the formulation of research hypotheses that are empirically tested in local contexts.

H5: Maternal nutritional status as measured through anthropometric indicators, energy–protein intake, and anemia status are independent predictors of infant birth weight in low-income communities.

METHODOLOGY

Research Design and Approach

This study uses a quantitative approach with observational analytics and cross-sectional design. The quantitative approach was chosen because the purpose of the study was to analyze the relationship and influence of maternal nutritional status during pregnancy on the baby's birth weight, where all variables can be objectively measured in the form of standardized numerical data and statistically analyzed (Creswell & Creswell, 2023). A cross-sectional design was used to assess maternal nutritional status (exposure) and infant birth weight (outcome) simultaneously at one observation time without intervention. This design is appropriate for maternal health research in low-income communities because it is efficient in terms of time and cost, and allows for the identification of patterns of relationships between variables (Gordis, 2020).

Study Setting, Population, and Sample

The research was carried out in Deli Serdang Regency, North Sumatra Province, an area that has socio-economic diversity and still faces maternal and infant nutrition problems, especially in low-income communities. The research location includes several health centers as primary health service facilities for mothers and children.

The target population is postpartum mothers and newborns aged 0–28 days who come from low-income communities. The affordable population includes mothers and babies who are registered and receive services at the health center during the data collection period, so that information on the nutritional status of the mother and the baby's birth weight can be validly obtained from medical records.

Sampling was carried out using purposive sampling, taking into account the suitability of respondents' characteristics for the research objectives and the availability of complete pregnancy data. The sample number of 80 mother-infant pairs was determined based on consideration of the adequacy of regression analysis and population affordability at the study site (Hair et al., 2021).

Variables and Operational Definition

1. Variable Dependency

The dependent variable in this study is the baby's birth weight, which is measured in grams based on official weighing results at health facilities. Birth weight is used as a key indicator of neonatal health and reflects the condition of the fetus' growth during pregnancy (WHO, 2023).

2. Independent Variables

The main independent variable is the nutritional status of the mother during pregnancy, which is operationalized through the following quantitative indicators:

a. The body mass index (BMI) of the mother, as an indicator of general nutritional status.
b. Maternal Mid-Upper Arm Circumference (MUAC), as an indicator of long-term energy and protein reserves.
c. Energy and protein intake, which describes the adequacy of macronutrient consumption during pregnancy.
d. Hemoglobin (Hb) levels, as an indicator of maternal anemia status that affects the supply of oxygen and nutrients to the fetus (Black et al., 2021).

These indicators were chosen because they are relevant and commonly used in maternal nutrition research in low-income communities.

3. Variable Control

Control variables included maternal age, parity, gestational age, education level, socioeconomic status, and frequency of antenatal visits (ANC). This variable was controlled to minimize the influence of external factors on the relationship between maternal nutritional status and infant birth weight.

Data Collection Techniques and Measurement

Data collection was carried out quantitatively, using direct measurements and standardized secondary data. Maternal nutritional status was measured using standard anthropometric tools, while energy and protein intake were obtained through a structured food consumption questionnaire with closed-ended answers so that they could be converted into numerical values (Gibson, 2020). Maternal hemoglobin levels are obtained from records of antenatal laboratory examinations or re-examinations using digital hemoglobinometers. Infant birth weight data is taken from the medical records of health facilities, which are measured in the first hour after birth using a standardized baby scale.

Research Procedure

The research began with licensing and coordination with the health center. Enumerators are given training on anthropometric measurement and data recording procedures. Respondents were recruited according to the inclusion and exclusion criteria, then given an explanation of the research before signing a written agreement. Data collection was carried out through measuring maternal nutritional status, recording structured food intake, and taking baby birth weight

data from medical records. All data is checked for completeness, encoded, and entered into a database for statistical analysis.

Data Analysis Techniques

Data analysis was carried out using SPSS. Descriptive analysis was used to describe the characteristics of respondents and the distribution of research variables. Bivariate analysis was used to test the initial relationship between each indicator of maternal nutritional status and the baby's birth weight. Furthermore, multivariate regression analysis was used to identify the independent influence of maternal nutritional status on the baby's birth weight by controlling for control variables. The level of statistical significance was set at $p < 0.05$.

Ethical Considerations

This research was carried out in accordance with the ethical principles of health research, including conscious consent, data confidentiality, and protection of respondents' rights. Respondents' identities are encrypted to maintain anonymity, and the research has obtained approval from authorities (CIOMS, 2021).

RESEARCH RESULTS

Maternal Mid-Upper Arm Circumference (MUAC) and Neonatal Birth Weight

Maternal Mid-Upper Arm Circumference (MUAC) is widely recognized as a robust anthropometric indicator for assessing chronic maternal nutritional status during pregnancy, particularly reflecting long-term energy and protein reserves. In low-income communities, MUAC is considered especially relevant because it remains relatively stable throughout pregnancy and is less affected by gestational physiological changes compared to body weight or body mass index.

The practical applicability of MUAC makes it a valuable screening tool in resource-limited settings, where routine and repeated measurements of maternal weight may not be feasible. Low MUAC values are commonly interpreted as an indicator of chronic energy deficiency, which may compromise placental development and restrict nutrient transfer to the fetus, thereby impairing fetal growth.

Bivariate analysis demonstrated that mothers with low MUAC tended to give birth to infants with significantly lower birth weight compared to mothers with normal MUAC. The difference in mean birth weight between the two groups was substantial and statistically significant, indicating a clear association between maternal nutritional reserves and neonatal outcomes.

Table 1. Association between Maternal MUAC and Neonatal Birth Weight

Maternal MUAC Status	Mean Birth Weight (g)	SD (g)	p-value
Low MUAC	2,540	310	
Normal MUAC	2,980	340	0.002

As shown in Table 1, infants born to mothers with low MUAC had a mean birth weight approximately 440 grams lower than those born to mothers with

normal MUAC. The p-value below 0.05 confirms that this difference is statistically significant, suggesting that maternal MUAC is strongly associated with neonatal birth weight.

In the multivariate regression analysis, MUAC remained an independent and significant predictor of birth weight after controlling for maternal age, parity, gestational age, educational level, socioeconomic status, and antenatal care visits. This finding underscores the importance of maternal energy and protein reserves as a fundamental determinant of fetal growth, independent of sociodemographic and healthcare-related factors. It also suggests that improving maternal nutritional status prior to and during pregnancy may have a direct and meaningful impact on birth outcomes.

Maternal Energy and Protein Intake and Birth Weight *Outcomes*

Maternal energy and protein intake during pregnancy reflects the adequacy of macronutrient consumption required to support fetal tissue accretion, placental development, and maternal physiological adaptations such as increased blood volume. In low-income populations, limited food availability and poor dietary diversity often result in insufficient intake of both energy and high-quality protein. Prolonged inadequacy of macronutrient intake during pregnancy may lead to intrauterine growth restriction, as the fetus adapts to a suboptimal nutritional environment by slowing growth in order to maintain vital organ development.

Bivariate analysis revealed that mothers with inadequate energy and protein intake delivered infants with significantly lower birth weight compared to those with adequate intake. This pattern was consistent across both energy and protein components, indicating a combined effect of macronutrient insufficiency on fetal growth.

Table 2. Maternal Energy–Protein Intake and Neonatal Birth Weight

Energy–Protein Intake Status	Mean Birth Weight (g)	SD (g)	p-value
Inadequate	2,560	330	
Adequate	3,010	360	0.001

Table 2 shows a mean difference in birth weight exceeding 450 grams between infants born to mothers with inadequate versus adequate energy–protein intake. The statistically significant p-value indicates that macronutrient adequacy plays a critical role in determining neonatal birth weight.

Following adjustment for potential confounding variables in the multivariate model, maternal energy and protein intake remained a significant independent predictor of birth weight. This suggests that the influence of maternal macronutrient intake on neonatal outcomes is not merely an indirect effect mediated through maternal age, parity, or antenatal care utilization, but rather reflects a direct biological contribution to fetal growth and development.

Maternal Anemia and Reduced Neonatal Birth Weight

Maternal anemia during pregnancy, assessed through hemoglobin concentration, reflects the mother's capacity to transport oxygen and essential

nutrients to the developing fetus. Anemia remains highly prevalent in low-income settings and is often underdiagnosed or inadequately managed during routine antenatal care. Reduced hemoglobin levels may impair placental oxygenation and nutrient exchange, leading to suboptimal fetal growth and an increased risk of low birth weight.

Bivariate analysis indicated that infants born to anemic mothers had significantly lower birth weight compared to those born to non-anemic mothers.

Table 3. Association between Maternal Hemoglobin Status and Neonatal Birth Weight

Maternal Hemoglobin Status	Mean Birth Weight (g)	SD (g)	p-value
Anemic	2,520	300	
Non-anemic	3,020	350	<0.001

As illustrated in Table 3, maternal anemia was associated with an average reduction in birth weight of approximately 500 grams. The highly significant p-value indicates a strong relationship between maternal hemoglobin status and neonatal birth weight.

In the multivariate regression model, maternal anemia remained a significant predictor of lower birth weight after controlling for all predefined confounding variables. This finding highlights anemia as an independent risk factor for adverse birth outcomes and emphasizes the importance of early detection and management of anemia during pregnancy.

Multivariate Model of Maternal Nutritional Determinants of Birth Weight

To assess the simultaneous effects of multiple maternal nutritional indicators on neonatal birth weight, a multivariate regression analysis was conducted while adjusting for maternal age, parity, gestational age, educational level, socioeconomic status, and frequency of antenatal care visits.

Table 4. Multivariate Regression Analysis of Factors Associated with Neonatal Birth Weight

Predictor Variable	β Coefficient	SE	p-value
Low MUAC	−0.31	0.09	0.002
Inadequate Energy–Protein Intake	−0.34	0.08	0.001
Maternal Anemia	−0.36	0.07	<0.001
Gestational Age	0.29	0.10	0.004
Antenatal Care Visits	0.21	0.09	0.021

The results presented in Table 4 indicate that low MUAC, inadequate energy–protein intake, and maternal anemia remained significant independent predictors of neonatal birth weight. Among the maternal nutritional indicators, anemia and inadequate macronutrient intake exhibited the largest regression coefficients, suggesting a stronger contribution to variations in birth weight.

These findings demonstrate that maternal nutritional status exerts a substantial and independent influence on fetal growth, even after accounting for sociodemographic factors and healthcare utilization.

DISCUSSION

The results of this study confirm that maternal nutritional status during pregnancy is the main determinant of infant birth weight in low-income communities in Deli Serdang Regency. Theoretically, these findings are in line with the developmental origins of health and disease (DOHaD) framework first developed by Barker et al. (2020), which explains that the intrauterine nutritional environment plays a crucial role in determining fetal growth and development. When the mother's supply of energy and nutrients is insufficient, the physiological adaptation of the fetus occurs at the expense of optimal growth, which is reflected in the low birth weight. A number of global studies also confirm that maternal malnutrition during pregnancy contributes directly to poor birth outcomes, especially in socioeconomically vulnerable populations (Wells, 2022). These findings empirically support the first hypothesis (H1) which states that the nutritional status of the mother during pregnancy has a significant effect on the baby's birth weight.

Maternal Mid-Upper Arm Circumference (MUAC) has been shown to have a significant relationship with infant birth weight, where mothers with low MUAC tend to give birth to babies with lower birth weight. Conceptually, MUAC represents relatively stable long-term energy and protein reserves during pregnancy, so by Ververs et al. (2021) it is recommended as an indicator of maternal nutritional status at the population level. In the perspective of chronic energy deficiency theory, low MUAC reflects a nutritional deficit that has occurred before and during pregnancy, which limits the transfer of nutrients to the fetus.

These findings are consistent with international evidence that places MUAC as a strong predictor of the incidence of low birth weight in low- and middle-income countries (Kozuki et al., 2022). Thus, the results of this study strengthen the third hypothesis (H3) regarding the significant influence of maternal anthropometric indicators, especially upper arm circumference and body mass index, on the baby's birth weight.

Maternal energy and protein intake during pregnancy also showed a significant contribution to the variation in the baby's birth weight. Physiologically, as explained by Imdad and Bhutta (2020), adequate energy and protein are needed to support fetal tissue formation, placental development, and increased maternal metabolic needs. Based on the theory of energy and nitrogen balance, a deficit in macronutrient intake will inhibit tissue synthesis and fetal growth, thereby increasing the risk of intrauterine growth restriction. These findings are reinforced by recent research showing that insufficient energy–protein intake during pregnancy is associated with low birth weight and impaired fetal growth (Lee et al., 2023). These results are an integral part of the fifth hypothesis (H5) test, which places energy–protein intake as one of the main predictors of infant birth weight.

Maternal anemia appears as the most consistent factor related to the baby's birth weight. Within the framework of the theory of oxygen and nutrient transport,

Rahman et al. (2021) explain that low hemoglobin levels reduce the capacity of the mother's blood to carry oxygen to the placenta and fetus, thereby interfering with the optimal growth of fetal tissue. In addition, anemia is also associated with placental dysfunction and increased intrauterine oxidative stress. A number of cutting-edge meta-analyses confirm that anemia during pregnancy significantly increases the risk of low birth weight and preterm birth, especially in communities with a dual nutritional burden (Smith et al., 2022). These findings directly confirm the second hypothesis (H2) regarding the significant effect of maternal anemia on the loss of birth weight of the baby.

In multivariate analysis, low MUAC, inadequate energy–protein intake, and maternal anemia remained independent predictors of infant birth weight after controlling for maternal age, parity, gestational age, education level, socioeconomic status, and antenatal visits. This indicates that the influence of maternal nutritional status is direct and not entirely mediated by social factors or access to health services. From the perspective of the theory of proximal determinants of nutrition, Ruel et al. (2021) emphasized that the biological condition of the mother is the closest factor to birth outcome compared to distal determinants such as education or economics. These results provide strong empirical support for the fifth hypothesis (H5) regarding the role of maternal nutrition indicators as independent predictors of infant birth weight.

Although gestational age and frequency of antenatal visits contribute positively to infant birth weight, the effect is relatively small compared to maternal nutrition indicators. These findings reinforce the argument that adequate health care will not produce optimal outcomes without support for good maternal nutritional status. In the context of low-income communities, limited access to nutritious food is often a major barrier, even though antenatal services are available. Cross-country studies show that the effectiveness of ANC is highly dependent on the integration of specific and sensitive nutritional interventions during pregnancy (Keats et al., 2021; UNICEF, 2022). Thus, these findings are in line with the fourth hypothesis (H4) which emphasizes the role of socioeconomic factors and the utilization of antenatal services in influencing the relationship between maternal nutritional status and infant birth weight.

This study has limitations of cross-sectional design that does not allow causal inference as well as potential memory bias in food intake measurements. Nevertheless, the use of objective indicators such as MUAC, hemoglobin levels, and birth weight increases the strength of the internal validity of the findings. Theoretically, the results of this study enrich the maternal nutrition literature by affirming the central role of maternal nutritional status as the main foundation of fetal growth, while providing empirical support for the hypothesis proposed in this study. Further research is recommended using longitudinal design to capture the dynamics of changes in maternal nutritional status throughout pregnancy and their impact on birth outcomes more comprehensively, as suggested by Dewey and Begum (2021).

CONCLUSIONS AND RECOMMENDATION

This study concludes that the nutritional status of the mother during pregnancy plays a role as the main determinant of infant birth weight in low-income communities in Deli Serdang Regency. Maternal nutrition indicators, particularly low upper arm circumference, insufficient energy and protein intake, and anemia during pregnancy, were shown to be significantly associated with infant birth weight loss and remained independent predictors after controlling for sociodemographic factors and health services. These findings confirm that improved maternal nutritional status is a biological prerequisite for optimal fetal growth and cannot be fully compensated by antenatal services without adequate nutritional intervention support. Therefore, maternal and child health strategies in low-income communities need to prioritize integrated, community-based maternal nutrition interventions as an effective effort to reduce the risk of low birth weight and improve neonatal health.

FURTHER STUDY

Further studies should employ longitudinal or cohort designs to examine the causal relationship between maternal nutritional status throughout pregnancy and neonatal as well as early childhood health outcomes. Future research may also explore the effectiveness of targeted maternal nutrition interventions, including supplementation and dietary education, in improving birth weight in low-income communities. In addition, studies integrating qualitative approaches could investigate social, cultural, and behavioral factors influencing maternal nutrition and health service utilization to support more context-sensitive and sustainable maternal health policies.

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