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Links Among Maternal Nutrition, Pregnancy Weight Gain, and Low Birth Weight Risk

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ABSTRACT
Low birth weight (LBW) represents a major contributor to neonatal morbidity and mortality. Factors related to maternal health, including gestational weight gain and nutritional condition, significantly influence fetal development and birth outcomes. This research examines the association between maternal weight gain, nutritional status, and LBW occurrence in mothers. Conducted as an analytical observational study with a case-control approach, it involved 56 participants: 28 mothers delivering LBW infants (case group) and 28 with normal-weight newborns (control group). Data were gathered from medical records and maternal health logs, then evaluated via Chi-Square testing at 95% confidence. Findings revealed a statistically significant link between maternal weight gain and LBW (p=0.016; OR=4.5), alongside maternal nutritional status and LBW (p=0.027; OR=4.231). These results emphasize the need for consistent antenatal monitoring of maternal weight and nutrition, coupled with sustained educational efforts, to reduce LBW prevalence.

Keywords: *Low Birth Weight, Gestational Weight Gain, Maternal Nutrition, Pregnant Women, Chronic Energy Deficiency*

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INTRODUCTION

The Infant Mortality Rate (IMR) remains a key indicator of public health in Indonesia. World Health Organization (WHO) data shows that globally, there are 20 million cases of low birth weight (LBW) babies, approximately 95.6% of which occur in developing countries (World Health Organization (WHO), 2020) . Surviving LBW babies are 2.5 to 3.5 times more likely to experience wasting, stunting, and underweight, as well as delayed and/or reduced neurodevelopment (Syahda et al., 2024) .

Low birth weight (LBW) is an important indicator of maternal and child health, as low birth weight babies are at risk of various health complications, both short-term and long-term (Simamora et al., 2022) . Low birth weight babies are at greater risk of health and developmental problems, including learning difficulties, hearing and vision impairments, chronic respiratory problems such as asthma, and chronic diseases later in life. (Claude et al., 2021) . LBW is a major factor in increasing mortality, morbidity, and disability in neonates, infants, and children, and has long-term impacts on their future lives.

In Indonesia, of all reported neonatal deaths, 72.0% (20,266 deaths) occurred between the ages of 0 and 28 days. In 2020, the leading cause of neonatal death was low birth weight (LBW), at 35.2%. Other causes of death included asphyxia (27.4%), infection, congenital abnormalities (11.4%), neonatal tetanus (0.3%), and others (22.5%) (Ministry of Health of the Republic of Indonesia, 2020) . Data from the National Health Profile recorded a prevalence of 3.3%, while the Survey conducted by SSGI (2022) recorded a higher figure, namely 6.0% (Ministry of Health, Republic of Indonesia, 2023) . Specifically in West Sumatra, the prevalence of LBW in 2017 reached 7.3% (West Sumatra Provincial Health Office, 2017) . Meanwhile in Padang City, in 2024, out of 13,190 newborns, 459 were found to be LBW, this was an increase from the previous year's 143 cases (Padang City Health Office, 2024) . This confirms that LBW is still a public health problem that requires attention.

The occurrence of LBW is determined by various factors, encompassing both internal and external elements. Internal factors comprise conditions associated with the mother, fetus, and placenta, whereas external determinants include social, economic, and environmental aspects (Grbic et al., 2024) and (Akmal, Safitri, & Fitriani, 2024). Among maternal-related factors, weight gain during pregnancy and maternal nutritional status hold particular significance. Inadequate weight gain throughout the gestational period can lead to intrauterine growth restriction, thereby elevating the risk of LBW (Damayanti, F Gunanegara, & Hidayat, 2022).

In addition , Additionally, nutritional status during pregnancy also affects the baby's birth weight, which can be monitored thru the mother's weight gain and upper arm circumference (UAC) measurement. Mothers with chronic energy deficiency (CED), indicated by an upper arm circumference (MUAC) <23.5 cm, are at a higher risk of delivering a low birth weight (LBW) baby (Akmal et al., 2024). Adequate macro and micronutrient intake during pregnancy is necessary for fetal growth and maternal health, so nutrient deficiencies can result in stunted fetal growth (Nasriyah & Ediyono, 2023). The impact of a pregnant woman with chronic energy deficiency (CED) includes reduced muscle strength that aids in the birthing process, which can lead to prolonged

labor, postpartum hemorrhage, and even the risk of maternal death. This condition also increases the risk to the unborn baby, including fetal death (miscarriage), prematurity, birth defects, low birth weight (LBW), and infant mortality. During pregnancy, it can disrupt fetal development, including physical growth (reduced size), brain development, and metabolism, which can lead to non-communicable diseases later in life (Wahyuni et al., 2022).

Given the high prevalence of LBW observed in community health centers and the significant influence of maternal health factors, this study aims to investigate the relationship between weight gain during pregnancy and maternal nutritional status with the incidence of LBW. These findings are expected to provide evidence for developing promotive and preventive strategies to reduce the prevalence of low birth weight in Indonesia.

METHODS

This study employed an observational analytic design using a case-control approach. The population included all mothers giving birth within the Pauh Health Center catchment area in Padang City from January 2017 to August 2018. In total, 56 participants took part, split evenly into 28 mothers with low birth weight (LBW) infants (case group) and 28 mothers with normal birth weight infants (control group). Cases were chosen via total sampling, whereas controls were selected through purposive sampling. The independent variables assessed were maternal gestational weight gain (classified as normal or low) and maternal nutritional status (based on chronic energy deficiency [CED] status: non-CED or CED). The dependent variable was LBW incidence. Data were sourced primarily from medical records and maternal-child health (MCH) books. Analysis involved univariate and bivariate techniques, applying the Chi-Square test at a 95% confidence level ($\alpha = 0.05$).

RESULTS

1. The Correlation Between Maternal Weight Gain and the Incidence of Low Birth Weight (LBW)

Among the 26 mothers in table 1 who demonstrated inadequate weight gain throughout their pregnancy, 64.3% were observed to have given birth to infants with low birth weight (LBW). Conversely, mothers who attained appropriate weight gain showed a lower proportion, with only 35.7% delivering LBW infants. The Chi-Square analysis revealed a statistically significant relationship between maternal weight gain and LBW incidence, demonstrated by a p-value of 0.016 ($p < 0.05$) and an odds ratio (OR) of 4.5 with a 95% confidence interval (CI: 1.45–13.882).

Table 1. Association between Maternal Weight Gain during Pregnancy and the Incidence of Low Birth Weight

Maternal Weight Gain During Pregnancy	The incidence of low birth weight levels							
	Case		Control		Total		p-value	OR
a. Risk	18	64.3%	8	28.6%	26	46.4%	0.016	4.5
b. No risk	10	35.7%	20	71.4%	30	53.6%		

								(CI: 1.45–13.882)
Total	28	100%	28	100%	56	100		

2. The Correlation Between Nutritional Status of Pregnant Women and the Incidence of Low Birth Weight

Within the group of 21 mothers in table 2 identified as having chronic energy deficiency (CED), 53.6% were found to deliver low birth weight (LBW) infants. By contrast, mothers with sufficient nutritional status showed a considerably lower rate, with only 21.4% giving birth to LBW babies. The Chi-Square statistical analysis confirmed a significant relationship between maternal nutritional status and the occurrence of LBW, as indicated by a p-value of 0.027 ($p < 0.05$) and an odds ratio (OR) of 4.231 with a 95% confidence interval (CI: 1.314–13.617).

Table 2. Association between Maternal Nutritional Status and the Incidence of Low Birth Weight

Nutritional Status	The Incidence of Low Birth Weight Levels							
	Case		Control		Total		p-value	OR
a. CED	15	53.6%	6	21.4%	21	37.5%	0.027	4.231
b. No CED	13	46.4%	22	78.6%	35	62.5%		CI: 1.314–13.617
Total	28	100%	28	100%	56	100		

DISCUSSION

1. The Relationship Between Maternal Weight Gain and the Incidence of Low Birth Weight (LBW)

The study findings demonstrate a statistically significant relationship between maternal weight gain throughout pregnancy and the likelihood of delivering a low birth weight (LBW) infant ($p = 0.016$). This result is the same with research by Gyimah et al., 2021, which found a significant association between weight gain during pregnancy and the risk of LBW. Mothers with a weight gain of <10 kg had a 3.9-fold higher risk of delivering a LBW infant. Research in Sri Lanka (Pathirathna et al., 2025) corroborates this finding, finding significant weight gain in the risk of LBW, particularly in mothers with a low pre-pregnancy BMI, while the association weakened or was non-significant in those with a normal/higher BMI. This implies that recommendations for nutritional interventions and monitoring of weight gain should ideally be personalized based on initial BMI. This study emphasizes the importance of weight monitoring as an indicator of maternal nutrition.

Meanwhile, research (Agaba, Azupogo, & Brouwer, 2022) shows that maternal weight gain is not correlated with the risk of LBW, as maternal body composition during pregnancy is more closely related to appropriate size. Factors significantly associated with low birth weight are preterm birth and lower maternal fat-free mass in the third trimester. Additionally, research (Imran Al Mu'min Khomeny, 2025) indicates that inadequate maternal weight gain is directly associated with

the birth of low birth weight (LBW) babies, which poses a risk to the baby's long-term health. This research can encourage medical personnel to be more proactive in providing education on the importance of monitoring the weight of pregnant women and delivering timely interventions, such as nutritional counselling and monitoring adequate calorie intake, to prevent low birth weight and other complications.

Weight gain during pregnancy reflects not only the mother's nutritional condition but also the effectiveness of nutrient transfer to the developing fetus. When maternal weight gain falls short of recommended levels, placental nutrient supply becomes compromised, leading to restricted fetal growth and heightened risk of LBW (Noviyanti, 2020). Consequently, the nutritional status of expectant mothers emerges as a critical factor influencing newborn birth weight. Proper nutrition during pregnancy manifests through appropriate and sufficient weight gain, whereas failure to achieve recommended weight gain levels significantly elevates the risk of LBW occurrence. Therefore, ensuring optimal maternal weight increase during gestation is vital for preventing low birth weight (Mulyatun et al., 2023). The inadequate maternal weight gain observed among study participants is likely attributable to insufficient consumption of energy and protein throughout pregnancy.

BMI is a consistent indicator. Weight gain during pregnancy in Indonesia is generally low (<10 kg), even though this weight gain is an important indicator of fetal growth. Recommendations for maternal weight gain during pregnancy are based on the mother's nutritional status, namely the mother's pre-pregnancy Body Mass Index (BMI). Mothers with a low BMI (less than 19.8) need a weight gain of 12.5-18 kg. Mothers with a normal BMI (19.8-26) need a weight gain of 11.5-16 kg, mothers with a BMI above (26-29) need a weight gain of 7-11.5 kg, while obese mothers (BMI above 29) only need a weight gain of 6 kg (Lestari, Maulidia, & Firdaus, 2024).

Overall, this study shows that the nutritional status of pregnant women can be assessed by monitoring weight gain during pregnancy. A weight appropriate for gestational age indicates adequate nutritional reserves in the mother's body, which play a crucial role in fetal development. A lack of these nutritional reserves can disrupt the supply of nutrients to the fetus, increasing the risk of low birth weight (LBW). Body Mass Index (BMI) serves as a reference in determining appropriate weight gain targets during pregnancy and evaluating the mother's nutritional status before pregnancy. Two important clinical indicators in estimating a baby's birth weight are initial weight at the start of pregnancy and weight change during pregnancy. Therefore, mothers with low birth weight or those who do not experience adequate weight gain during pregnancy are at risk of delivering babies in less than optimal condition. Maternal nutritional deficiencies can increase the likelihood of malnutrition in babies, as healthy mothers tend to give birth to healthy babies. Researchers assume that low maternal weight gain in the study area may be influenced by inadequate energy and protein intake during pregnancy. It is hoped that this can be implemented to achieve a 30% reduction in the incidence of Low Birth Weight.

2. The Relationship Between Nutritional Status of Pregnant Women and the Incidence of Low Birth Weight

The results of the study also showed a significant relationship between the nutritional status of pregnant women (measured by MUAC) and the incidence of LBW (p = 0.027). Mothers with CED are at 4.231 times greater risk of giving birth to LBW babies compared to mothers with good nutritional status. Research (Intan Angriani Ananda Nasution, 2023) also found a significant relationship between MUAC <23.5 cm, a higher risk of giving birth to a baby, maternal weight gain during pregnancy, and newborn weight with a calculated p value of 0.001 (p < 0.05). However, research (Mira Miraturrofi'ah, 2025) found no significant relationship between CED and LBW. This study also shows that CED is often related to socio-economic factors, access to health services, and education.

The theory states that KEK reduces the mother's energy reserves and reduces the supply of nutrients to the fetus, thus causing intrauterine growth disorders (Diana et al., 2024) . Pregnant women who experience KEK will affect fetal growth such as miscarriage, abortion, stillbirth, neonatal death, congenital defects, anemia, and low birth weight . The implementation of a healthy lifestyle is also recommended for pregnant women by consuming a balanced diet that is beneficial for themselves and the fetus they are carrying to stay healthy and avoid problems that exist during pregnancy, childbirth or after childbirth (Nabila Mar'atush Sholihah, 2023) .

Mothers with an upper arm circumference <23.5 cm indicate chronic or long-term energy deficiency. This chronic energy deficiency results in the mother not having sufficient nutritional and energy reserves to support the pregnancy process, resulting in reduced nutrient supply to the fetus and a higher risk of being born with low birth weight (Desmiati et al., 2020) . According to fetal programming theory, maternal nutritional status during pregnancy significantly affects fetal growth and development. Maternal malnutrition, reflected in low MUAC measurements, can cause intrauterine growth restriction (IUGR) and increase the risk of low birth weight (Pratiwy, 2025) .

A mother's nutritional status before and during pregnancy can affect her nutritional status. A history of chronic energy deficiency during pregnancy can hinder fetal growth, increasing the risk of giving birth to a low birth weight baby and having a child with stunting by 4.154 times. Furthermore, children with a history of low birth weight (LBW) will experience slower linear growth compared to children born with a history of LBW.

In Indonesia, the threshold for a fetal head circumference (MUAC) with a risk of CED is 23.5 cm. This means that pregnant women at risk of CED are expected to give birth to a low birth weight (LBW) baby. A baby born with LBW will have a risk of death, malnutrition, growth disorders, and impaired child development. To prevent the risk of CED in pregnant women, women of childbearing age must have good nutrition before pregnancy, for example with a MUAC of at least 23.5 cm. If the mother's MUAC before pregnancy is less than this figure, pregnancy should be postponed to avoid the risk of giving birth to a low birth weight (LBW). Pregnant women who experience CED tend to have energy and protein intake below physiological needs, which has an impact on limited nutrient supply to the fetus.

Research (Nabila Mar'atush Sholihah, 2023) indicates that 65% of mothers with anemia and CED experience fetal metabolic disorders. This indicates a synergistic relationship between poor nutritional status and iron deficiency and low birth weight (LBW). Interventions such as iron and folic acid supplementation, and increased consumption of animal protein sources have been shown to reduce the risk of low birth weight by up to 25%.

In policy, the WHO's 2025 target of reducing low birth weight (LBW) by 30% places maternal nutrition improvement as a strategic pivot. This emphasizes that the combination of MUAC screening, nutrition education, and supplementation is a feasible and cost-effective intervention in primary care. The researcher assumed that measurements were taken using a LILA tape; if the measurement result was 23.5 cm, the pregnant woman was classified as CED. The condition of a mother with KEK pregnancy causes a direct relationship between the mother and fetus that is not fulfilled because mothers who experience KEK are more easily tired and weak, which can affect the active movement of the weak fetus and if not immediately treated will result in the birth of a LBW baby. KEK cases in respondents are most likely caused by economic limitations and nutritional knowledge, which have implications for unbalanced eating patterns during pregnancy.

CONCLUSIONS

Maternal gestational weight gain and nutritional condition show a strong correlation with low birth weight (LBW) occurrence. Mothers experiencing insufficient weight gain or chronic energy deficiency (CED) have approximately four times higher odds of giving birth to LBW infants. Enhancing antenatal nutrition counseling and consistent weight monitoring during pregnancy are crucial for optimizing birth outcomes.

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