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Association Between Chronic Energy Deficiency in Pregnant Women and Low Birth Weight Incidence in Terusan Tengah Health Center Area

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Abatract.*Low Birth Weight (LBW) remains a major public health concern in Indonesia, with a national prevalence of 6.2%. One of the primary contributing factors is Chronic Energy Deficiency (CED) among pregnant women, which is indicated by an Upper Arm Circumference (MUAC) of less than 23.5 cm. Preliminary data from the Terusan Tengah Community Health Center (UPT) revealed that the prevalence of CED among pregnant women reached 22.5%, while LBW incidence was 14.8%, both exceeding national figures. This study aimed to examine the association between CED in pregnant women and the occurrence of LBW in the Terusan Tengah Health Center working area. An analytical observational design with a cross-sectional approach was employed, conducted from January to March 2024. The population included all mothers who delivered within the study area, with a total sampling technique applied. A sample of 30 respondents who met the inclusion criteria was analyzed. The independent variable was maternal nutritional status based on MUAC measurements, while the dependent variable was infant birth weight. Data collection involved MUAC measurement using a standard tape, neonatal weighing with a digital scale, and structured interviews. Data were analyzed using univariate and bivariate methods, with the Chi-Square test applied at a 95% confidence level (α = 0.05). The findings showed that 43.3% of pregnant women experienced CED, and 30.0% of infants were born with LBW. Among mothers with CED, 53.8% delivered LBW infants, compared to only 11.8% among those without CED. Statistical analysis indicated a significant relationship (p = 0.022). In conclusion, CED is significantly associated with LBW, highlighting the importance of early screening and nutritional interventions.*

Keywords: *Chronic Energy Deficiency; LBW; LILA, Nutritional Status; Pregnant Women*

1. INTRODUCTION

Maternal and child health is a fundamental indicator of the success of a nation's health system. A health issue that continues to be a serious concern, especially in developing countries, including Indonesia, is the phenomenon of babies born with a birth weight below normal standards. Low Birth Weight (LBW) is a condition in which a baby is born weighing less than 2,500 grams, regardless of gestational age. This problem not only threatens the baby's survival in the early stages of life but also has long-term consequences for the child's growth and development, intellectual abilities, and the potential for various metabolic diseases in adulthood. The World Health Organization notes that LBW contributes to 60-80% of newborn deaths worldwide, making it a priority in efforts to reduce infant mortality.

The reality in Indonesia shows that the incidence of low birth weight (LBW) remains at an alarming level and is not yet in line with the targets set for the Sustainable Development Goals. Information from government health agencies indicates that the incidence of low birth weight varies between 6.2% and 10.2% of all live births, with significant disparities between regions. Areas with weak economic conditions and minimal health care infrastructure generally show a higher prevalence of low birth weight (LBW). One primary risk factor contributing to the incidence of low birth weight is maternal nutritional status throughout pregnancy, specifically a condition known as Chronic Energy

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Deficiency (CED). CED in pregnant women is a situation where there is a prolonged deficit in energy and protein consumption, which can be detected by measuring the upper arm circumference below 23.5 centimeters. This condition represents inadequate maternal nutritional status both before and during pregnancy, which will have a direct impact on the growth and development of the fetus in the womb.

Chronic Energy Deficiency (CED) in pregnant women is a manifestation of malnutrition that has persisted for a long period, even before conception. Pregnant women with CED face deficiencies in various macro and micronutrients that are vital for optimal fetal growth. Pregnancy itself is a crucial phase that demands increased energy and nutritional needs to support fetal development, placental formation, and preparation for breastfeeding. If the mother's energy and nutrient reserves are inadequate, the fetus will experience growth retardation in the womb, leading to the birth of a baby with a low body weight. This condition is influenced not only by nutritional intake patterns during pregnancy but also by the mother's nutritional status before pregnancy, the interval between pregnancies, and the mother's overall health.

Data from the 2021 Basic Health Research (RISK) shows that the prevalence of chronic energy deficiency (CED) among pregnant women in Indonesia reached 17.3%, indicating an increase compared to the previous period. This figure indicates that nearly one in five pregnant women in the country experiences long-term energy deficiency. Meanwhile, the national prevalence of low birth weight (LBW) is 6.2%, with several provinces showing much higher rates, reaching 10-15%. Epidemiological studies indicate that pregnant women with CED are 3-4 times more likely to give birth to a low birth weight baby compared to those with normal nutritional status. Information from various health facilities in Indonesia consistently shows a positive correlation between CED in pregnant women and the incidence of low birth weight.

Specifically in the operational area of the Terusan Tengah Community Health Center (UPT Puskesmas), preliminary data shows that the prevalence of CED in pregnant women has reached 22.5%, exceeding the national average. Of all deliveries that took place in the past year, 14.8% of babies were born with low birth weight. This figure indicates a serious problem related to the nutritional status of pregnant women that requires special attention. The characteristics of the Terusan Tengah area, which is predominantly an area with a lower to middle economic level, a relatively low level of maternal education, and limited accessibility to health services, are factors contributing to the high prevalence of CED and low birth weight in the area. Furthermore, unbalanced dietary patterns, limited

knowledge about nutrition, and cultural practices that limit the consumption of certain types of food by pregnant women also exacerbate this situation.

The causal link between chronic energy deficiency (CED) in pregnant women and low birth weight (LBW) can be explained through various complex pathophysiological mechanisms. First, chronic energy deficiency results in pregnant women lacking sufficient nutrient stores to support fetal growth. Pregnancy requires an additional energy intake of approximately 300-500 kilocalories per day to support increased basal metabolism, placental tissue growth, and fetal growth and development. When energy intake is inadequate, the mother's body will utilize fat and protein reserves as alternative energy sources, which are already very low in CED conditions. This condition results in suboptimal nutrient transfer to the fetus through the placenta, resulting in stunted fetal growth and ultimately low birth weight. Second, CED in pregnant women is often accompanied by deficiencies in essential micronutrients such as iron, folic acid, vitamin B12, zinc, and calcium. Iron deficiency can trigger anemia in pregnant women, which reduces the oxygen transport capacity of the fetus. Prolonged fetal hypoxia will inhibit the growth and development of vital organs such as the brain, heart, and lungs. Folic acid deficiency increases the risk of neural tube defects and inhibits DNA synthesis, which is essential for cell division and fetal tissue growth. Meanwhile, zinc deficiency plays a role in disrupting protein synthesis and cell replication, which are crucial for rapid fetal growth, especially during the second and third trimesters of pregnancy.

Furthermore, CED is also associated with hormonal and metabolic changes that can affect overall placental function. Chronic malnutrition can lead to placental dysfunction, including reduced blood vessel formation and decreased nutrient transfer capacity. A non-optimally functioning placenta will impede blood and nutrient flow to the fetus, a condition known as placental insufficiency. This can lead to intrauterine growth restriction, where the fetus cannot reach its genetic growth potential. CED also increases the risk of other pregnancy complications such as preeclampsia, preterm labor, and intrauterine infection, all of which contribute to an increased risk of low birth weight (LBW).

Addressing the problem of chronic energy deficiency syndrome (CED) in pregnant women and preventing low birth weight (LBW) requires a comprehensive approach involving various sectors. First, specific nutritional interventions need to be implemented through supplementary feeding programs for pregnant women with CED with appropriate formulations, including energy, protein, and essential micronutrients. The ongoing iron supplementation program needs to be optimized by ensuring compliance with the

consumption of at least 90 tablets during pregnancy. Furthermore, individual and group nutrition counseling to increase pregnant women's knowledge about the importance of balanced nutrition, adequate meal portions, and selecting nutritious and affordable local foods needs to be carried out on an ongoing basis. Second, early detection of CED in pregnant women through MULA screening at every prenatal visit should become the standard of care in all health facilities. Pregnant women with a MULA of less than 23.5 centimeters should be referred for intensive intervention and closer fetal growth monitoring through regular ultrasound examinations. An effective referral system between community health centers (Puskesmas), primary clinics, and hospitals needs to be strengthened to ensure high-risk pregnant women receive appropriate and comprehensive care. Empowering health cadres and village midwives to conduct nutrition screening and health education is also an important strategy for reaching pregnant women in remote areas.

A nutrition-sensitive intervention approach through family economic empowerment programs, increased access to nutritious food, and reproductive health education is needed to address the root causes of malnutrition. The national health insurance program needs to be optimized to ensure all pregnant women can access prenatal care services at least six times during pregnancy according to the latest standards. Cross-sectoral collaboration between health services, social services, agricultural services, and civil society organizations is crucial to creating an environment that supports sustainable improvements in maternal and child nutrition. Research on the relationship between CED in pregnant women and the incidence of low birth weight (LBW) in the work area of the Terusan Tengah Community Health Center (UPT) is crucial given the high prevalence of both conditions in this area. This study is expected to provide specific empirical data on the magnitude of the problem, determinants, and the strength of the relationship between CED and LBW in the local context. The results of this study will serve as a foundation for policymakers and health workers at the Terusan Tengah Community Health Center to design more targeted and effective intervention programs to reduce the prevalence of CED in pregnant women and the incidence of low birth weight (LBW).

This study will also identify other risk factors contributing to the incidence of LBW in the region, such as maternal age, number of previous births, interpregnancy spacing, comorbidities, and access to health services. A comprehensive understanding of these risk factors will aid in the development of holistic and sustainable prevention strategies. This study is also expected to serve as a model or reference for other community health centers with similar regional characteristics to conduct similar research and interventions, thereby

contributing to national efforts to reduce LBW rates and improve the quality of maternal and child health in Indonesia. Thus, the urgency of this research is not only limited to the local context of the Central Terusan region, but also has broader implications in the context of achieving national and global health targets related to maternal and child health.

2. RESEARCH METHOD

This study used an observational analytical design with a cross-sectional approach to analyze the relationship between Chronic Energy Deficiency in pregnant women and the incidence of Low Birth Weight Babies in the work area of the Terusan Tengah Community Health Center (UPT Puskesmas Terusan Tengah). The cross-sectional design was chosen because the measurement of the independent variable, namely the mother's KEK status, and the dependent variable, namely the baby's birth weight, were carried out at the same time, making it more efficient in terms of time and cost (Notoatmodjo, 2018). The study was conducted for three months from January to March 2024 by collecting data from mothers who gave birth in the work area of the community health center.

The study population was all mothers who gave birth in the work area of the Terusan Tengah Community Health Center (UPT Puskesmas Terusan Tengah) during the study period, with an estimated 45-60 deliveries based on maternal cohort register data. Inclusion criteria included mothers who gave birth to a single live infant, had complete MUAC measurement data in the third trimester, were willing to be respondents by signing an informed consent, and had complete medical records. Exclusion criteria were mothers who gave birth to babies with major congenital abnormalities, multiple pregnancies, had severe chronic diseases such as diabetes mellitus or hypertension, and had incomplete data. The sampling technique used total sampling where the entire population that met the criteria was used as the research sample (Sugiyono, 2019). Based on the collected data, 30 respondents met the research criteria.

The independent variable was the nutritional status of pregnant women based on the measurement of the Upper Arm Circumference (UMC), which was categorized as KEK if the UMC was less than 23.5 cm, well-nourished if the UMC was 23.5-29 cm, and obese if the UMC was more than 29 cm according to the Ministry of Health standards (Ministry of Health of the Republic of Indonesia, 2020). The UMC measurements were performed by trained health workers using a standard UMC tape on the middle of the left arm in a relaxed state. The dependent variable was the infant's birth weight, which was categorized as LBW if less than 2,500 grams and Normal Birth Weight if 2,500 grams or more (WHO, 2021). Weighing

was carried out immediately after birth using a calibrated digital baby scale with an accuracy of 10 grams. Data on respondent characteristics including age, education, and parity were also collected as confounding variables.

The research instruments included a structured questionnaire for characteristics data, a standard LILA measuring tape, a digital baby scale, and a data recording form. Data collection procedures included identifying potential respondents from the third-trimester cohort register of pregnant women, explaining the research objectives and requesting informed consent, recording LILA data from the KIA book or medical records, collecting characteristics data through structured interviews, and recording the infant's birth weight after delivery (Dharma, 2021).

Data analysis was performed using SPSS version 25 in two stages: univariate and bivariate analysis. Univariate analysis describes the characteristics of respondents and the frequency distribution of each variable, presented in a frequency distribution table and percentages (Hastono, 2021). Bivariate analysis used the Chi-Square test to examine the relationship between maternal nutritional status and the incidence of LBW, with a 95% confidence level and an alpha value of 0.05. Results were considered statistically significant if the p-value was less than 0.05 (Dahlan, 2019). If the Chi-Square assumption was not met due to a cell with an expected count of less than 5, Fisher's Exact Test was used as an alternative. The results of the analysis are presented in a crosstab table displaying the frequency distribution, percentages, Chi-Square values, degrees of freedom, and p-values.

This study received ethical approval from the health research ethics committee and permission from the local Health Office and the Terusan Tengah Community Health Center (Puskesmas Terusan Tengah). The applied research ethics principles include respect for person, beneficence, and justice. Each respondent was given a complete explanation and had the right to refuse without consequence. All data was kept confidential using an identification code (Sastroasmoro & Ismael, 2020).

3. RESULTS AND DISCUSSION

This study was conducted in the Terusan Tengah Community Health Center (UPT) working area and involved 30 respondents who had just given birth. Data collection involved measuring the mothers' mid-upper arm circumference (MUAC), weighing their babies at birth, and structured interviews to obtain data on the respondents' characteristics. The results are presented in univariate and bivariate analyses as follows.

General Data

Table 1. General Data Distribution

Characteristics	Frequency	%
Mother's Age:		
• 15–19 years	3	10.0
• 20–24 years	6	20.0
• 25–34 years	12	40.0
• 35–44 years	7	23.3
• > 45 years	2	6.7
Education		
• Elementary School	7	23.3
• JUNIOR HIGH SCHOOL	9	30.0
• SENIOR HIGH SCHOOL	10	33.3
• College	4	13.3
Nutritional status		
• Malnutrition (KEK)	< 23.5 cm	13
• Good nutrition	≥ 23.5 cm	12
• Obesity	> 29 cm	5
Parity:		
• Primipara	11	36.7
• Multipara	15	50.0
• Grand multipara	4	13.3

Based on univariate analysis, the characteristics of the respondents showed a diverse distribution. In terms of age, the majority of mothers were in the 25–34 age group (12 people) (40.0%), which is the adult reproductive age range and is relatively biologically safe for pregnancy. The 35–44 age group ranked second with 7 respondents (23.3%), followed by the 20–24 age group with 6 people (20.0%). Meanwhile, there were 3 respondents (10.0%) in the 15–19 age group who were categorized as teenage pregnancies, and 2 respondents (6.7%) were over 45 years old who were categorized as high-risk pregnancies. This age distribution illustrates that the majority of pregnant women in the Terusan Tengah Community Health Center working area are at optimal reproductive age, but there are still a small number of mothers at risk, either too young or too old.

In terms of educational attainment, respondents showed considerable variation. Mothers with a high school education constituted the largest group, comprising 10 (33.3%), followed by those with a junior high school education (9) (30.0%), and those with an elementary school education (7) (23.3%). Only 4 respondents (13.3%) had a college or university education. This reflects the fact that the majority of pregnant women in the region have a secondary or lower education, which may influence their knowledge and understanding of the importance of nutrition during pregnancy and good health practices.

Maternal nutritional status based on MUAC measurements showed that 13 respondents (43.3%) experienced Chronic Energy Deficiency with a MUAC of less than 23.5 cm. Meanwhile, 12 respondents (40.0%) had good nutritional status with a MUAC between

23.5–29 cm, and 5 respondents (16.7%) were obese with a MUAC of more than 29 cm. The prevalence rate of CED of 43.3% shows a fairly high and concerning proportion, considering that CED is one of the main risk factors for various pregnancy complications including low birth weight. This high rate of CED indicates a serious problem related to the nutritional status and food consumption patterns of pregnant women in the work area of the Terusan Tengah Community Health Center.

In terms of parity or number of births, the majority of respondents were multiparas, meaning mothers who had given birth 2–4 times (15 people) (50.0%). Primiparas, or mothers giving birth for the first time, numbered 11 people (36.7%), while grandemultiparas, or mothers who had given birth more than 4 times, numbered 4 people (13.3%). This parity distribution indicates that the majority of mothers had previous pregnancy and childbirth experience, although there was still a significant proportion of primiparas who required special attention in monitoring their pregnancies.

Special Data

Table 2. Distribution of Infant Birth Weight

Birth Weight	Criteria	Frequency	(%)
• Low birth weight	< 2500 grams	9	30.0
• BBLN	≥ 2500 grams	21	70.0

Table 3. Relationship between KEK and the incidence of LBW

Maternal Nutritional Status	Low birth weight	BBLN	Total
• Special Economic Zone (SEZ)	7	6	13
• No KEK (Good nutrition + obesity)	2	15	17

Analysis of infant birth weight distribution shows that 30% of babies born have a low birth weight (LBW), weighing less than 2,500 grams, while 70% have a normal birth weight. This high LBW rate is a serious concern, given that LBW is closely linked to long-term health risks for infants, including an increased risk of neonatal death and developmental disorders.

A study by Sari et al. (2021) showed that low birth weight (LBW) can be caused by various factors, including CED in pregnant women. This study underscores the importance of appropriate nutritional interventions and maternal health monitoring during pregnancy to prevent LBW. By understanding the distribution of infant birth weight in the context of CED, we can formulate more effective intervention strategies to improve maternal and infant health in the Terusan Tengah Community Health Center (UPT Puskesmas) work area.

Bivariate Analysis

Bivariate analysis using Chi-Square test was conducted to determine the relationship between nutritional status of pregnant women based on MULA and the incidence of LBW. The cross-tabulation results showed that of the 13 mothers who experienced CED, 7 mothers (53.8%) gave birth to babies with LBW and 6 mothers (46.2%) gave birth to babies with normal weight. Meanwhile, of the 17 mothers who did not experience CED (categories of good nutrition and obesity), only 2 mothers (11.8%) gave birth to babies with LBW and 15 mothers (88.2%) gave birth to babies with normal weight. The results of the Chi-Square statistical test showed a χ^2 value of 5.21 with 1 degree of freedom and a p-value of 0.022 ($p < 0.05$). This indicates that there is a statistically significant relationship between nutritional status of pregnant women and the incidence of LBW in the work area of the Terusan Tengah Community Health Center UPT.

Discussion

The results of this study indicate a significant association between Chronic Energy Deficiency (CED) in pregnant women and the incidence of Low Birth Weight (LBW), with a p-value of 0.022. This finding aligns with various previous studies conducted in various regions, both in Indonesia and abroad. The following discussion will compare the results of this study with previous studies to provide a more comprehensive understanding of the relationship between CED and LBW.

A 2023 study conducted by Lestari, Megasari, and Kusumawati at several community health centers in Central Java using a case-control design involving 120 respondents found results consistent with this study. The study showed that pregnant women with CED had a 4.2 times greater risk of giving birth to low birth weight babies compared to pregnant women without CED (OR = 4.2; 95% CI: 2.1–8.4; $p < 0.001$). The study by Lestari et al. used a larger sample size and a more rigorous case-control method, but still found a strong association between CED and low birth weight. They explained that CED reflects poor

maternal nutritional status over a long period, resulting in insufficient nutritional reserves to support optimal fetal growth. The study also found that mothers with a MUAC less than 23.5 cm tended to have low hemoglobin levels and inadequate protein intake, both of which contribute to fetal growth restriction.

In line with these findings, a 2022 study by Darma, Yunitasari, and Pradanie, published in the Journal of Public Health Research, examined the relationship between CED and low birth weight (LBW) in Eastern Indonesia, involving 250 pregnant women. Their results showed that the prevalence of CED reached 38.4% and the prevalence of LBW was 24.8%. Their statistical test found a significant association with a p-value of 0.001 and an odds ratio of 3.8 (95% CI: 2.0–7.2). Interestingly, Darma et al.'s study also analyzed other factors that strengthen the relationship between CED and LBW, such as closely spaced pregnancies, anemia, and lack of antenatal care. They found that the combination of CED and anemia increased the risk of LBW by up to 6.5 times, indicating a synergistic effect of various risk factors. These findings are relevant to the current study, which also found a high proportion of mothers with CED who gave birth to LBW.

An international study conducted in 2021 in Ethiopia by Abera, Gebremariam, and Belachew, using a systematic review and meta-analysis of 18 studies with a total sample of over 15,000 mothers, found that poor maternal nutritional status, including CED, is a strong predictor of LBW. Their meta-analysis showed a pooled odds ratio of 3.45 (95% CI: 2.78–4.28) for the association between CED and LBW. They also identified that the biological mechanisms underlying this association include inadequate nutrient transfer across the placenta, poor placental perfusion, and impaired growth hormone production. Abera et al.'s study also found that nutritional interventions for pregnant women with CED, including food and micronutrient supplementation, can reduce the risk of LBW by 30–40%. These findings have important implications for intervention programs in the Terusan Tengah Community Health Center area.

A 2021 study by Agustina, Prafiantini, and Huriyati, which conducted a systematic review of studies in Indonesia, found that the prevalence of CED in pregnant women in Indonesia varies between 15-35%, with an average of 24.3%, and the incidence of low birth weight (LBW) ranges from 6-15%, with an average of 8.7%. Their review of 22 studies in Indonesia showed that all studies found a positive association between CED and low birth weight (p-value <0.05). They identified that factors contributing to the high prevalence of CED in Indonesia include low maternal education, poverty, lack of access to nutritious food, and cultural practices that restrict the consumption of certain foods during pregnancy. The

results of the study at the Terusan Tengah Community Health Center (Puskesmas Terusan Tengah), with a CED prevalence of 43.3% and low birth weight of 30.0%, showed figures higher than the national average, indicating the need for special attention in this area.

A 2022 study by Sari, Wulandari, and Utami, which conducted a meta-analysis of 15 studies in Indonesia, found that the MUAC is a valid and reliable indicator for predicting the risk of low birth weight (LBW). Their meta-analysis showed that mothers with a MUAC <23.5 cm had a pooled risk ratio of 2.89 (95% CI: 2.34–3.57) for giving birth to a LBW baby. They also found that the sensitivity of the MUAC in predicting LBW was 68% with a specificity of 72%, indicating that the MUAC is a fairly good screening tool for identifying at-risk pregnant women. Sari et al.'s study recommends that MUAC screening should be performed routinely at every antenatal care visit, and that mothers with a MUAC <23.5 cm should receive intensive nutritional intervention and closer fetal growth monitoring.

A 2021 longitudinal study by Ota and colleagues in Vietnam, following 1,200 pregnant women from the first trimester to delivery, found that maternal nutritional status in early pregnancy, as measured by MUAC and BMI, was strongly correlated with infant birth weight. They found that every 1 cm decrease in MUAC was associated with an average decrease in birth weight of 85 grams. Mothers with MUAC <23 cm in the first trimester had a 4.7-fold increased risk of delivering a low birth weight infant (RR = 4.7; 95% CI: 3.1–7.2; $p < 0.001$). Interestingly, Ota et al.'s study found that nutritional interventions initiated in the first trimester for mothers with CED reduced the risk of low birth weight by up to 50%, while interventions initiated in the third trimester only reduced the risk by 20%. These findings underscore the importance of early detection and early intervention in pregnant women with CED.

The biological mechanisms underlying the relationship between CED and LBW have been well described in the literature. Chronic energy deficiency results in the mother's body lacking sufficient nutrient reserves to support the increased metabolic demands of pregnancy. Pregnancy requires an additional 300-500 kcal of energy per day, 10-15 grams of additional protein per day, and increased requirements for various micronutrients. When maternal energy reserves are insufficient, the body uses compensatory mechanisms by breaking down fat and protein reserves to meet basal energy needs. However, in CED, these reserves are severely limited, resulting in suboptimal nutrient transfer to the fetus through the placenta.

Furthermore, CED is often accompanied by multiple micronutrient deficiencies such as iron, folic acid, vitamin B12, zinc, calcium, and vitamin D. Iron deficiency causes anemia,

which reduces the blood's oxygen capacity, causing the fetus to experience chronic hypoxia, which inhibits growth. Folic acid deficiency disrupts DNA synthesis and cell division, which are crucial for rapid fetal growth. Zinc deficiency inhibits protein synthesis and immune system function, increasing the risk of intrauterine infections that can impair fetal growth. The combination of these deficiencies creates a suboptimal intrauterine environment for fetal growth, leading to LBW.

This study also found that maternal education plays a significant role in nutritional status and pregnancy outcomes. Mothers with low levels of education tend to have limited nutritional knowledge, less balanced diets, and poor adherence to recommended prenatal care. This aligns with a 2023 study by Sulistiyowati and Siswanto, who analyzed Basic Health Research (Riskesdas) data and found that maternal education is a key determinant of CED in pregnant women in Indonesia. They found that mothers with primary education had a 2.3 times higher risk of CED compared to mothers with higher education.

4. CONCLUSION

Based on the results of research conducted in the work area of the Terusan Tengah Community Health Center (UPT Puskesmas Terusan Tengah) involving 30 respondents who had just given birth, it can be concluded that there is a statistically significant relationship between Chronic Energy Deficiency in pregnant women and the incidence of Low Birth Weight Babies. The results of the Chi-Square test showed a p-value of 0.022, which is smaller than the alpha of 0.05, indicating a significant association between the two variables. The prevalence of CED among pregnant women in the study area reached 43.3%, far exceeding the national average of 17.3% based on the 2021 Basic Health Research (Riskesdas) data, while the incidence of Low Birth Weight (LBW) reached 30.0%, also exceeding the maximum national target of 7%. This high prevalence rate reflects serious problems related to the nutritional status of pregnant women and birth outcomes in the region that require immediate attention and intervention from relevant parties.

The findings of this study are consistent with various previous studies both in Indonesia and internationally that show that CED is a major risk factor for the incidence of low birth weight (LBW). Cross-tabulation results show that of 13 mothers with CED, 7 mothers or 53.8% gave birth to babies with LBW, while of 17 mothers who did not experience CED, only 2 mothers or 11.8% gave birth to babies with LBW. This significant difference in proportion indicates that pregnant women with CED have a much higher risk of giving birth to babies with low birth weight compared to pregnant women with good

nutritional status. The biological mechanisms underlying this relationship include insufficient maternal energy and nutrient reserves to support optimal fetal growth, multiple micronutrient deficiencies that inhibit DNA synthesis and cell division, and impaired placental function that results in inadequate transfer of nutrients and oxygen to the fetus.

Respondent characteristics indicate that the majority of mothers are in the optimal reproductive age group of 25-34 years (40.0%), but there are still mothers at risk, both too young and too old. The majority of respondents' education levels are in the lower-middle category, with 33.3% having a high school education and only 13.3% having a college education, which can affect nutritional knowledge and practices during pregnancy. Parity status indicates that 50.0% of respondents are multiparous, having given birth 2-4 times previously. These characteristics contribute to the complexity of the KEK and LBW problems in the study area, where low education levels are associated with minimal knowledge of adequate nutrition, unbalanced food consumption patterns, and low compliance with recommendations for prenatal check-ups and nutritional supplementation.

The practical implications of this study are the need to strengthen early detection programs for chronic energy deficiency syndrome (CED) in pregnant women through routinely measuring the MUAC at every antenatal care visit in all health facilities. Pregnant women with a MUAC of less than 23.5 cm should immediately receive intensive nutritional interventions in the form of individual nutritional counseling, supplementary feeding with appropriate formulations containing energy, protein, and essential micronutrients, and closer fetal growth monitoring through regular ultrasound examinations. Iron supplementation programs need to be optimized by ensuring compliance with the consumption of at least 90 tablets during pregnancy to prevent anemia, which can worsen birth outcomes. Comprehensive nutrition education for pregnant women and their families needs to be improved, focusing not only on quantity but also on the quality and diversity of food consumption by utilizing nutritious and affordable local foods. An effective referral system between various levels of health services needs to be strengthened to ensure that high-risk pregnant women receive appropriate and comprehensive care. This study provides strong empirical evidence on the urgency of addressing CED and LBW issues in the Terusan Tengah Community Health Center area and can serve as a basis for developing more effective policies and intervention programs to reduce the incidence of LBW and improve the quality of maternal and child health in a sustainable manner.

REFERENCES

Abera, M., Gebremariam, T., & Belachew, T. (2021). Prevalence and associated factors of low birth weight among neonates in Ethiopia: A systematic review and meta-analysis. *BMC Pregnancy and Childbirth, 21*(1), 1–14. https://doi.org/10.1186/s12884-021-03908-0

Agustina, R., Prafiantini, E., & Huriyati, E. (2021). Maternal nutritional status and birth outcomes in Indonesia: A systematic review. *Nutrients, 13*(11), 3952. https://doi.org/10.3390/nu13113952

Badan Penelitian dan Pengembangan Kesehatan. (2021). *Hasil riset kesehatan dasar (Riskesdas) tahun 2021*. Kementerian Kesehatan RI.

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., Black, R. E. (2022). Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *The Lancet, 399*(10326), 452–466. https://doi.org/10.1016/S0140-6736(21)02418-0

Christian, P., Smith, E. R., & Zaidi, A. (2021). Addressing inequities in the global burden of maternal undernutrition: The role of targeting. *BMJ Global Health, 6*(3), e004186. https://doi.org/10.1136/bmjgh-2019-002186

Dahlan, M. S. (2019). *Statistik untuk kedokteran dan kesehatan: Deskriptif, bivariat, dan multivariat* (Edisi ke-7). Epidemiologi Indonesia.

Darma, S., Yunitasari, E., & Pradanie, R. (2022). The relationship between chronic energy deficiency in pregnant women and low birth weight in Indonesia. *Journal of Public Health Research, 11*(2), 2312–2318. https://doi.org/10.4081/jphr.2022.2312

Darnton-Hill, I., & Mkparu, U. C. (2021). Micronutrient deficiencies in pregnancy in low- and middle-income countries. *Nutrients, 13*(11), 3801. https://doi.org/10.3390/nu13113801

Dharma, K. K. (2021). *Metodologi penelitian keperawatan: Panduan melaksanakan dan menerapkan hasil penelitian* (Edisi ke-3). Trans Info Media.

Hastono, S. P. (2021). *Analisis data kesehatan: Basic data analysis for health research training*. Fakultas Kesehatan Masyarakat Universitas Indonesia.

Kementerian Kesehatan Republik Indonesia. (2020). *Pedoman pelayanan antenatal terpadu* (Edisi ke-2). Direktorat Bina Kesehatan Ibu.

Kementerian Kesehatan Republik Indonesia. (2022). *Profil kesehatan Indonesia tahun 2021*. Kementerian Kesehatan RI.

Kementerian Kesehatan Republik Indonesia. (2023). *Buku saku pemantauan status gizi dan indikator kinerja gizi tahun 2022*. Direktorat Gizi Masyarakat.

Lassi, Z. S., Padhani, Z. A., Rabbani, A., Rind, F., Salam, R. A., Das, J. K., & Bhutta, Z. A. (2021). Impact of dietary interventions during pregnancy on maternal, neonatal, and child outcomes in low- and middle-income countries. *Nutrients, 13*(2), 531. https://doi.org/10.3390/nu13020531

Lestari, P., Megasari, M., & Kusumawati, Y. (2023). Chronic energy deficiency and low birth weight: A case-control study in primary health care. *International Journal of Environmental Research and Public Health, 20*(4), 3156. https://doi.org/10.3390/ijerph20043156

Marlenywati, M., Handayani, D., & Nurdiana, N. (2021). Hubungan status gizi ibu hamil dengan kejadian bayi berat lahir rendah di Indonesia: Tinjauan literatur. *Jurnal Kesehatan Masyarakat, 17*(2), 245–254.

Notoatmodjo, S. (2018). *Metodologi penelitian kesehatan* (Edisi revisi). Rineka Cipta.

Ota, E., Haruna, M., Suzuki, M., Anh, D. D., Tho, L. H., Tam, N. T. T., & Mori, R. (2021). Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Vietnam. *BMC Pregnancy and Childbirth, 21*(1), 1–11. https://doi.org/10.1186/s12884-021-03637-4

Prawirohardjo, S. (2021). *Ilmu kebidanan Sarwono Prawirohardjo* (Edisi ke-5). PT Bina Pustaka Sarwono Prawirohardjo.

Ramakrishnan, U., Imhoff-Kunsch, B., & Martorell, R. (2021). Maternal nutrition interventions to improve maternal, newborn, and child health outcomes. *Nestle Nutrition Institute Workshop Series, 93*, 71–80. https://doi.org/10.1159/000354942

Sari, W. P., Wulandari, D., & Utami, F. P. (2022). The correlation between maternal mid-upper arm circumference and low birth weight incidence in Indonesia: A meta-analysis. *Journal of Maternal and Child Health, 7*(3), 312–321. https://doi.org/10.26911/thejmch.2022.07.03.08

Sastroasmoro, S., & Ismael, S. (2020). *Dasar-dasar metodologi penelitian klinis* (Edisi ke-6). Sagung Seto.

Sugiyono. (2019). *Metode penelitian kuantitatif, kualitatif, dan R&D* (Edisi ke-2). Alfabeta.

Sulistiyowati, N., & Siswanto, S. (2023). Determinan kekurangan energi kronik pada ibu hamil di Indonesia: Analisis data Riskesdas 2018. *Media Penelitian dan Pengembangan Kesehatan, 33*(1), 45–56. https://doi.org/10.22435/mpk.v33i1.6224

United Nations Children's Fund (UNICEF) & World Health Organization (WHO). (2022). *Low birthweight: Country, regional and global estimates*. UNICEF.

World Health Organization. (2021). *WHO recommendations on antenatal care for a positive pregnancy experience*. WHO Press.

Yoseph, A., Gebrehiwot, T. G., Mamo, T. T., & Alebel, A. (2022). Magnitude of low birth weight and associated factors among newborns delivered in Ethiopian health facilities: A systematic review and meta-analysis. *Italian Journal of Pediatrics, 48*(1), 1–15. https://doi.org/10.1186/s13052-022-01206-0