

The Relationship between Macronutrient Intake, Eating Patterns, and Nutritional Knowledge with the Incidence of CED in Pregnant Women

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ABSTRACT

Background: Chronic Energy Deficiency (CED) during pregnancy remains a significant public health challenge in Indonesia, as it increases the risk of maternal morbidity and adverse neonatal outcomes, such as low birth weight and stunting. In the working area of the North Galesong Public Health Centre, many pregnant women continue to experience CED. However, the specific contributions of dietary composition and behavioural factors remain unclear. This study aimed to analyse factors associated with CED incidence among pregnant women, focusing on macronutrient intake, eating patterns, and nutritional knowledge. **Methods:** A cross-sectional study was conducted involving 63 pregnant women. Data were collected through dietary assessments and interviews and analysed using the Chi-Square test. **Results:** Protein intake ($p=0.000$), carbohydrate intake ($p=0.002$), eating patterns ($p=0.0001$), and nutritional knowledge levels ($p=0.001$) were statistically significantly associated with CED incidence. Conversely, total energy intake ($p=0.962$) and fat intake ($p=0.695$) showed no significant correlation. **Conclusion:** The nutritional status of expectant mothers in this region is primarily determined by the quality of their intake, specifically protein and carbohydrates, alongside healthy eating habits and health literacy, rather than total caloric volume alone. Therefore, maternal health programs should prioritise intensive nutritional counselling and education on balanced dietary patterns to reduce the prevalence of CED effectively.

Highlights:

- Protein and carbohydrate intake are the primary predictors of Chronic Energy Deficiency (CED) and show a highly significant relationship with the nutritional status of pregnant women.
- Total energy and fat intake do not significantly correlate with CED, indicating that the specific composition and quality of the diet are more critical than total caloric volume alone.
- Suboptimal eating patterns and low nutritional knowledge are major contributors to maternal malnutrition, with all CED cases in the study being linked to deficient eating habits.
- High nutritional literacy and consistent, adequate eating patterns serve as the strongest protective factors against the development of CED during pregnancy.
- Effective strategies to reduce CED prevalence should focus on intensive education regarding protein-rich diets and meal frequency rather than a general increase in caloric intake.

INTRODUCTION

Pregnancy is a vital period in a woman's life cycle, marked by numerous physiological and psychological changes that require support for her health and optimal nutrition (1-3). A high-risk pregnancy is a condition that poses a threat to maternal and infant mortality and has the potential to cause disabilities or pregnancy complications. One of the primary complicating factors is Chronic Energy Deficiency (CED), a state of malnutrition resulting from a long-term (chronic) deficit in calorie and protein intake. This condition leads to serious health issues for Women of Reproductive Age (WRA) as well as pregnant women (4-6).

The Maternal Mortality Rate (MMR) is a crucial indicator in measuring a community's health status. MMR reflects the number of women who die from causes related to complications during pregnancy, which remains a significant challenge in Indonesia. According to the Indonesian Demographic and Health Survey (IDHS), the MMR in Indonesia was 228 per 100,000 live births (7,8). Pregnant women with CED are prone to risks of complications such as infection, anemia, difficult and prolonged labor, premature birth, and postpartum hemorrhage. For the fetus, CED can hinder intrauterine development, lead to labor failure, asphyxia, and Low Birth Weight (LBW). CED and anemia are the primary causes of hemorrhage in pregnant women (2,9,10).

Factors influencing the occurrence of CED include food intake, age, workload, infectious diseases, nutritional knowledge, and family income. Rural populations are often associated with low economic status. These socioeconomic factors correlate with poverty and low educational attainment, which, in turn, affect low food consumption, poor hygiene and sanitation, and increased health disorders (11-14). Nutritional knowledge is crucial, as it influences daily consumption behavior and the understanding of

nutritional needs in line with the Recommended Dietary Allowances (RDA). Good knowledge is expected to enable appropriate food choices, whereas a lack of knowledge often leads to less prudent nutritional selections. This is supported by previous research, which demonstrates a significant relationship between energy and protein consumption and the incidence of CED (13,15).

Globally, 2018 World Health Organization (WHO) data recorded the prevalence of CED during pregnancy ranging from 35% to 75%, with 40% of maternal deaths in developing countries linked to this condition. In Indonesia, the 2018 Basic Health Research (Riskesdas) showed a CED prevalence of 17.3% among pregnant women. Meanwhile, the latest 2023 Indonesian Health Survey (SKI) indicates that the risk of CED in South Sulawesi Province reached 19.7%, higher than the national average of 13.6% (16).

Takalar Regency is among the regions with a high risk of CED in South Sulawesi, with a prevalence of 20.3%, exceeding that of several other areas such as Makassar, Gowa, and Maros (16). Preliminary study results at the North Galesong Public Health Center in 2023 showed that 94 pregnant women (19.5%) out of a total of 480 individuals experienced CED based on Mid-Upper Arm Circumference (MUAC) measurements of <23.5 cm. This percentage increased during the period from January to April 2024, when 25 pregnant women (21.9%) out of 114 were identified with CED.

Besides intake and knowledge, maternal characteristics such as age and pregnancy spacing also play a vital role. Pregnant women under 20 years of age have a higher risk of malnutrition due to nutritional competition between the mother's growth and the fetus (17-19). Previous research also confirms a significant relationship between nutritional knowledge and the incidence of CED in pregnant women. The study aimed to determine the relationships between food

intake, nutritional knowledge, and maternal characteristics and the incidence of Chronic Energy Deficiency (CED) among pregnant women at the North Galesong Public Health Center.

METHODS

Research Design and Setting

This study used a quantitative, cross-sectional design to investigate the relationships among the independent variables (knowledge, food intake, and maternal characteristics) and the dependent variable, Chronic Energy Deficiency (CED), among pregnant women at the North Galesong Public Health Centre. The research was conducted within the North Galesong Public Health Centre area from August 5 to 14, 2024.

Participants and Sampling

The population for this study included all first-trimester pregnant women at the North Galesong Public Health Centre in Takalar Regency, totalling 75 individuals. Based on sample size calculations, a minimum sample of 63 pregnant women was determined. The sampling process utilised a purposive sampling technique, wherein participants were selected according to specific criteria established by the researcher. The inclusion criteria for this study include being in the first trimester of pregnancy, aged 15-35 years, and residing within the working area of the North Galesong Public Health Centre in Takalar Regency. The exclusion criterion for this study is any pregnant woman who is unwilling to participate as a respondent.

Materials and Equipment

The materials and equipment used in this study were carefully selected to measure the research variables accurately. The primary tools included a Mid-Upper Arm Circumference (MUAC) tape (Pita LILA) for identifying the incidence of CED and a

calibrated weighing scale and stadiometer for anthropometric measurements. Data collection instruments included a validated questionnaire to assess respondents' nutritional knowledge and 24-hour Food Recall forms to record daily dietary intake.

Data Collection and Analysis

Data for this study were obtained from both primary and secondary sources. Primary data were collected directly from respondents through anthropometric measurements and structured interviews. The incidence of Chronic Energy Deficiency (CED) was determined by measuring the respondents' Mid-Upper Arm Circumference (MUAC) using a MUAC tape. Additionally, a structured questionnaire was administered to assess nutritional knowledge and maternal characteristics, while a 24-hour Food Recall method was used to gather detailed information regarding dietary intake. Secondary data were retrieved from the medical records and official reports of the North Galesong Public Health Centre to support the demographic profile and population data.

The collected data underwent a systematic processing phase, including editing, coding, entry, and cleaning. The analysis was conducted using statistical software and was divided into two stages: (1) Univariate Analysis: This was performed to describe the frequency distribution and percentage of each variable, including the independent variables (nutritional knowledge, food intake, and maternal characteristics) and the dependent variable (incidence of CED); (2) Bivariate Analysis: This was carried out to determine the relationship between the independent and dependent variables. Given the categorical nature of the data, a Chi-Square test was utilized with a significance level of $p < 0.05$. This analysis helps to establish whether there is a statistically significant correlation between food intake, knowledge, and

maternal characteristics with the occurrence of CED in pregnant women.

RESULTS

Characteristics of respondents

Based on the data presented in Table 1, the maternal characteristics of the respondents indicate that the majority fall into the 21–35 years age group, totalling 41 individuals (65.1%), which is generally considered a low-risk age for pregnancy; however, a significant 34.9% of the respondents are aged between 15 and 20 years.

Table 1. Frequency distribution based on maternal characteristics

Characteristics	n (63)	(%)
Maternal Age		
15–20 years	22	34.9
21–35 years	41	65.1
Gestational Age		
1 month	18	28.6
2 months	22	34.9
3 months	23	36.5
Pregnancy Spacing		
First pregnancy	29	46.0
< 2 years	4	6.3
2 years	6	9.5
> 2 years	24	38.1
Educational Level		
Elementary School	8	12.7
Junior High School	21	33.3
Senior High School	25	39.7
Higher Education	9	14.3

Regarding gestational age, the highest proportion of respondents is in the third month of pregnancy (36.5%), followed by the second (34.9%) and first (28.6%) months. Regarding pregnancy spacing, a large percentage of respondents (46.0%) are experiencing their first pregnancy. In contrast, among those with previous pregnancies, the majority reported a birth spacing of more than 2 years (38.1%).

Furthermore, the educational distribution shows that the largest group of respondents is senior high school graduates (39.7%), whereas those with a higher education background represent the smallest segment (14.3%).

Relationship between Macronutrient Intake, Eating Pattern, and Knowledge with The Incidence of CED

Based on the bivariate analysis in Table 2, it was found that only protein intake ($p=0.000$) and carbohydrate intake ($p=0.002$) were statistically significantly associated with the incidence of Chronic Energy Deficiency (CED) among pregnant women at the North Galesong Public Health Centre. Protein intake showed a significant association: 13 of 14 respondents with deficient protein intake (92.8%) were identified with CED. Conversely, energy intake ($p=0.962$) and fat intake ($p=0.695$) did not show a significant relationship ($p > 0.05$), indicating that the nutritional status of pregnant women in this study is more closely linked to the quality of specific macronutrient composition, especially protein, rather than total caloric or fat consumption.

Table 3 presents the bivariate analysis results on the relationship between eating patterns and nutritional knowledge levels and the incidence of Chronic Energy Deficiency (CED) among pregnant women at the North Galesong Public Health Centre. The analysis of eating patterns revealed that of 24 respondents (38.1%) with a deficient eating pattern, 17 (27.0%) were identified as having CED, while only 7 (11.1%) remained in the non-CED group. In contrast, among the 39 respondents (61.9%) who maintained an adequate eating pattern, none (0.0%) experienced CED; all 39 individuals (61.9%) were categorized as non-CED. Statistical testing using the Chi-Square method yielded a p -value of 0.001, which is significantly lower than the standard significance level. This indicates a highly significant association

between eating patterns and CED incidence, suggesting that a deficient eating pattern is a major risk factor for malnutrition in the study population.

Regarding nutritional knowledge, the data show that respondents with low levels faced the highest risk. Out of 20 respondents (31.7%) with low knowledge, 14 individuals (22.2%) suffered from CED. Among those with moderate knowledge (46.1%), only 3 individuals (4.8%) were identified as having CED, while the remaining 26 individuals (41.3%) were categorized as non-CED. Notably, in the group with good knowledge (22.2%), none (0.0%) of the respondents experienced CED.

The statistical analysis yielded a p-value of 0.001, indicating a statistically significant relationship between nutritional knowledge and CED incidence. These findings suggest that higher levels of nutritional knowledge serve as a protective factor against Chronic Energy Deficiency during pregnancy.

DISCUSSION

The results of this study indicate that energy intake is not statistically significantly associated with the incidence of Chronic Energy Deficiency (CED) among pregnant women at the North Galesong Public Health Centre.

Table 2. Relationship between Macronutrient Intake and the Incidence of CED

Macronutrient Intake	Status of CED				P-value
	CED	%	Non-CED	%	
Energy					
Deficiency	7	11.1	20	31.7	0.962
Adequate	9	14.3	24	38.1	
Excessive	1	1.6	2	3.2	
Protein					
Deficiency	13	20.6	1	1.6	0.000*
Adequate	0	0.0	4	6.4	
Excessive	4	6.4	41	65.0	
Fat					
Deficiency	1	1.6	1	1.6	0.695
Adequate	4	6.4	9	14.3	
Excessive	12	19.0	36	57.1	
Carbohydrate					
Deficiency	7	11.1	20	31.7	0.002*
Adequate	9	14.3	24	38.1	
Excessive	1	1.6	2	3.2	

Table 3. Relationship between Eating Patterns and the Incidence of CED

Variables	Status of CED						P-value
	CED	%	Non-CED	%	Total	%	
Eating Pattern							
Deficiency	17	27.0	7	11.1	24	38.1	0.0001
Adequate	0	0.0	39	61.9	39	61.9	
Knowledge Level							
Low	14	22.2	6	9.5	20	31.7	0.001
Moderate	3	4.8	26	41.3	29	46.1	
Good	0	0.0	14	22.2	14	22.2	

This finding suggests that nutritional adequacy during pregnancy is not solely determined by total calorie intake, but rather by the quality and balance of nutrients. This aligns with previous research, which argues that even if total energy requirements are met, an imbalance in macronutrient composition can still lead to a deficit in nutritional status (20). Although an additional caloric intake is recommended during the first trimester to support fetal growth, the source of these calories plays a more critical role than the quantity alone. In contrast, protein intake was found to be a highly significant factor in the occurrence of CED. The data show a strong correlation: almost all respondents with deficient protein levels were identified as having CED. Physiologically, protein is essential for building body tissues, developing the placenta, and increasing maternal blood volume. When protein intake is insufficient, the body may lack the building blocks needed for these critical pregnancy developments, even if other calorie sources are available (21-23). These findings are consistent with previous research, emphasising that protein deficiency is a direct predictor of poor nutritional outcomes in expectant mothers, potentially leading to metabolic disorders if left untreated (13,23).

Similarly, fat intake did not demonstrate a significant relationship with CED. Observations during the study revealed that many respondents frequently consumed unvaried diets high in saturated fats, such as fried foods. While fat is a concentrated source of energy, excessive consumption of low-quality fats does not necessarily protect a mother from chronic energy deficiency (2,15,24). An overreliance on fats without adequate variety in other nutrients can even lead to abnormal fetal weight gain without improving the mother's overall nutritional health.

Carbohydrate intake, however, showed a significant relationship with the incidence

of CED, acting as the primary fuel source for both the mother and the developing fetus. Proper carbohydrate consumption supports healthy weight gain and provides a "protein-sparing" effect, allowing protein to be used for tissue growth rather than energy. An imbalance or lack of complex carbohydrates directly increases the risk of malnutrition, as the mother may lack the sustained energy needed to meet the physiological demands of pregnancy (6,25,26).

Beyond specific nutrients, the study highlights that broader behavioural factors, such as eating patterns and nutritional knowledge, are fundamental to the mother's health. The significant relationship found between eating patterns and CED suggests that irregular or poor dietary habits are major risk factors. These habits are often influenced by cultural factors, such as food taboos or local beliefs, which can lead mothers to avoid essential food groups. The level of nutritional knowledge further compounds this. Mothers with a better understanding of prenatal nutrition are more likely to adopt diverse, balanced diets. Conversely, a lack of information often leads to dietary choices that fail to meet medical recommendations, ultimately triggering adverse changes in nutrient metabolism and increasing the prevalence of CED (19,27).

CONCLUSION

In conclusion, this study demonstrates that the incidence of Chronic Energy Deficiency (CED) among pregnant women at the North Galesong Public Health Centre is significantly influenced by protein and carbohydrate intake, as well as behavioural factors such as eating patterns and nutritional knowledge. Conversely, total energy and fat intake showed no significant statistical correlation with CED, suggesting that the nutritional status of expectant mothers in this region is determined more by the specific quality and composition of their diet than by total caloric volume alone. These findings

highlight that a lack of protein, irregular eating habits, and low health literacy are the primary drivers of malnourishment in the study population. Therefore, effective intervention strategies should prioritise intensive nutritional education and the promotion of protein-rich, balanced diets to mitigate the risk of CED during pregnancy.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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