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Dietary Intake and Its Association with Chronic Energy Deficiency Among Pregnant Women in South Lampung Regency, Indonesia: A Case-Control Study

Dian Utama Pratiwi Putri[1*], Anita Kurnia[1], Endang Budiati[1], Sugeng Eko Irianto[1]
[1]Master of Public Health Study Program, Faculty of Health Sciences, Universitas Mitra Indonesia, Bandar Lampung, Indonesia
*Email Corespondence: dian@umitra.ac.id

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ABSTRACT

Chronic energy deficiency (CED) remains a major nutritional problem among pregnant women in Indonesia, contributing to adverse maternal and neonatal outcomes such as low birth weight (LBW), anemia, and pregnancy-related complications. According to data from the South Lampung District Health Office, the prevalence of CED among pregnant women increased from 5.9% in 2023 to 6.38% in 2024. This study aimed to identify factors associated with CED among pregnant women in South Lampung Regency in 2026. An analytical survey using a case–control design was conducted among a target population of 974 pregnant women. A sample of 182 participants (91 cases and 91 controls) was selected using stratified random sampling followed by simple random sampling. Data were analyzed using univariate analysis, bivariate chi-square tests, and multivariate multiple logistic regression. Bivariate analysis revealed significant associations between CED and dietary intake ($p < 0.001$; OR = 6.650), infectious diseases ($p = 0.005$; OR = 2.451), maternal knowledge ($p = 0.001$; OR = 2.820), and the social environment ($p = 0.001$; OR = 2.891). Physical activity was not significantly associated with CED ($p = 0.875$). Multiple logistic regression identified dietary intake as the strongest predictor of CED ($p < 0.001$; adjusted OR = 6.866) after controlling for maternal knowledge and social environment. In conclusion, dietary intake, infectious diseases, maternal knowledge, and the social environment are key factors associated with CED among pregnant women in South Lampung Regency. Priority should be given to improving maternal nutritional intake through targeted supplementary feeding programs aligned with national My Plate (Isi Piringku) guidelines, supported by routine monitoring and evaluation.

INTRODUCTION

Chronic Energy Deficiency (CED) is a chronic nutritional problem affecting pregnant women, characterized by a prolonged imbalance between energy and protein intake.[1,2] CED occurring before and during pregnancy increases the risk of delivering low birth weight (LBW) infants, maternal mortality during childbirth, postpartum hemorrhage, neonatal anemia, susceptibility to infections, spontaneous abortion, and impaired fetal brain development.[3,4] The occurrence of CED is influenced by both direct factors, such as dietary intake and infectious diseases, and indirect factors, including maternal knowledge, physical activity, and the social environment.[5–7] Inadequate nutrient intake and poor dietary quality result in insufficient energy and protein to support fetal growth.[4,8] Meanwhile, infectious diseases alter metabolism through the acute-phase response, thereby increasing energy requirements while simultaneously reducing dietary intake.[9] Furthermore, maternal nutritional

knowledge plays an essential role in guiding appropriate dietary practices during pregnancy, while social environmental factors, such as cultural beliefs and spousal support, further influence maternal eating behaviors.[10,11]

According to data from the South Lampung District Health Office, the number of pregnant women with CED was 1,271 (6.4%) in 2022, decreased to 1,052 (5.9%) in 2023, and increased to 1,238 (6.38%) in 2024.12 In 2024, the five primary health centers (Puskesmas) with the highest CED prevalence were Banjar Agung (16.2%), Penengahan (13.5%), Sidomulyo (7.3%), Tanjung Bintang (7.3%), and Ketapang (5.6%).[12] A preliminary survey of 20 pregnant women with CED at Ketapang and Sukadamai Primary Health Centers revealed that nearly all respondents had poor knowledge regarding CED and rarely engaged in physical activity. Furthermore, 80% rarely consumed energy- and protein-rich foods, 85% lived in communities with cultural food taboos discouraging fish consumption during pregnancy, and 65% had a history of infectious diseases during pregnancy.

Previous studies have reported inconsistent findings regarding the determinants of CED among pregnant women across different regions. For example, a study conducted in the working area of Dawe Primary Health Center, Kudus, found a significant association between physical activity levels and CED risk.[13] Conversely, a study at Tanah Kali Kedinding Primary Health Center, Surabaya, demonstrated a significant relationship between social support and CED incidence ($p = 0.023$).[14] These inconsistencies suggest that the determinants of CED are context-specific and vary according to geographical, socioeconomic, and cultural characteristics.[7,15] Therefore, further investigation is required in regions with distinct demographic and sociocultural backgrounds, such as South Lampung Regency, where studies addressing this issue remain limited.

Based on these considerations, this study aimed to analyze the factors associated with Chronic Energy Deficiency (CED) among pregnant women in South Lampung Regency in 2026. Specifically, the study evaluated the distribution of dietary intake, infectious diseases, maternal knowledge, physical activity, and social environment; assessed the association between each variable and CED; and identified the primary factor associated with CED after adjusting for covariates. We hypothesized that inadequate dietary intake, infectious diseases, poor maternal knowledge, low physical activity, and an unfavorable social environment are positively associated with the occurrence of CED among pregnant women in South Lampung Regency.

MATERIALS AND METHODS

This study employed a quantitative analytical survey with a case-control design, a retrospective observational approach used to examine the relationship between risk factors and outcomes.16 The case group consisted of third-trimester pregnant women diagnosed with Chronic Energy Deficiency (CED), while the control group comprised third-trimester pregnant women without

CED. The study was conducted from December 24, 2025, to January 24, 2026, across the five Primary Health Centers (Puskesmas) with the highest CED prevalence in South Lampung Regency: Penengahan, Sidomulyo, Tanjung Bintang, Banjar Agung, and Ketapang.

The study population comprised 974 pregnant women, including 185 women with CED (case population) and 789 women without CED (control population). The sample size was calculated using the Lemeshow formula with a 95% confidence level, an estimated exposure proportion among controls (P2) of 39.6%, an estimated exposure proportion among cases (P1) of 81.3% based on the preliminary survey, and a 1:1 case-to-control ratio. This yielded a minimum sample size of 91 participants per group, totalling 182 respondents. Sampling was performed using proportional stratified random sampling based on the population in each of the five Puskesmas service areas, followed by simple random sampling via a lottery method within each stratum.[16]

The inclusion criteria for the case group were third-trimester pregnant women diagnosed with CED who resided in the study area, were literate, able to communicate effectively, and willing to participate. Exclusion criteria included pregnant women with cancer, physician-recommended contraindications to exercise, or hyperemesis gravidarum. The inclusion and exclusion criteria for the control group were identical, with the additional exclusion of women using corticosteroid or antidiabetic medications.

The independent variables were dietary intake, infectious diseases, maternal knowledge, physical activity, and social environment, while the dependent variable was the occurrence of CED. Dietary intake was assessed using a 10-item questionnaire based on Indonesia's "Isi Piringku" (My Plate) nutritional guidelines. Maternal knowledge and social environment were evaluated using 20-item and 10-item questionnaires, respectively. The validity and reliability of these three questionnaires were not formally tested, which is noted as a methodological limitation (see Limitations). Physical activity was measured using the Global Physical Activity Questionnaire (GPAQ) and categorized into heavy versus light/moderate activity based on the median total Metabolic Equivalent of Task (MET) score. Information on infectious diseases and CED status was retrieved from medical records and observation sheets, with CED status confirmed by a Mid-Upper Arm Circumference (MUAC) cut-off point of < 23.5 cm.[17]

Data analysis was performed in three distinct stages. First, univariate analysis was conducted to describe the frequency distribution of each variable.[18] Second, bivariate analysis using the Chi-square test and Odds Ratios (OR) was performed to examine associations between independent variables and CED, with significance set at $p < 0.05$. Third, variables with $p < 0.25$ in the bivariate analysis were entered into a multiple logistic regression model. Stepwise variable elimination and interaction testing were subsequently applied to derive the final prediction model. All analyses were performed using SPPSS v. 31.0.1.0 and model fit was evaluated using the Hosmer–Lemeshow

goodness-of-fit test.

RESULTS

Respondent Characteristics

The characteristics of the respondents based on age, educational level, and employment status are presented in Table 1.

Table 1. Characteristics of Pregnant Women in South Lampung Regency, 2026

Characteristics	Cases (n)	%	Controls (n)	%
Age				
< 20 years	17	18.7	9	9.8
20–35 years	60	65.9	79	86.9
> 35 years	14	15.4	3	3.3
Education				
No formal education	21	23.1	12	13.2
Elementary school	45	49.4	17	18.7
Junior high school	18	19.8	27	29.7
Senior high school	7	7.7	30	32.9
College/University	0	0.0	5	5.5
Employment Status				
Employed	56	61.5	39	42.8
Unemployed	35	38.5	52	57.2
Total	91	100.0	91	100.0

Among pregnant women with CED, most respondents were aged 20–35 years (65.9%), had completed elementary school education (49.4%), and were employed (61.5%). In contrast, the non-CED group was predominantly aged 20–35 years (86.9%), had completed senior high school education (32.9%), and was unemployed (57.2%).

Age and educational attainment differed markedly between the two groups (Table 1), with cases concentrated at the extremes of the age distribution and in the lowest educational categories. Because the case and control groups were not matched on these characteristics and age and education were not entered into the multivariate model, both variables represent candidate residual confounders that are addressed further in the Discussion and Limitations.

Distribution of Independent Variables

The frequency distributions of dietary intake, infectious diseases, maternal knowledge, physical activity, social environment, and CED status are presented in Table 2.

Table 2. Frequency Distribution of Dietary Intake, Infectious Diseases, Maternal Knowledge, Physical Activity, Social Environment, and Chronic Energy Deficiency (CED) Among Pregnant Women

Variable	Category	Cases n (%)	Controls n (%)	Total n (%)
Dietary Intake	Inadequate	74 (81.3)	36 (39.6)	110 (60.4)
	Adequate	17 (18.7)	55 (60.4)	72 (39.6)
Infectious Diseases	Present	53 (58.2)	33 (36.3)	86 (47.3)
	Absent	38 (41.8)	58 (63.7)	96 (52.7)
Maternal Knowledge	Poor	66 (72.5)	44 (48.4)	110 (60.4)
	Good	25 (27.5)	47 (51.6)	72 (39.6)
Physical Activity	Heavy	29 (31.9)	31 (34.1)	60 (33.0)
	Light/Moderate	62 (68.1)	60 (65.9)	122 (67.0)
Social Environment	Poor	64 (70.3)	41 (45.1)	105 (57.7)
	Good	27 (29.7)	50 (54.9)	77 (42.3)

Most pregnant women in the CED group had inadequate dietary intake (81.3%), experienced infectious diseases (58.2%), had poor maternal knowledge (72.5%), and lived in a poor social environment (70.3%). Conversely, the non-CED group was predominantly characterized by adequate dietary intake (60.4%), no history of infectious diseases (63.7%), good maternal knowledge (51.6%), and a supportive social environment (54.9%). Light to moderate physical activity was the most common category in both groups.

Bivariate Analysis

The results of the Chi-square analysis examining the relationships between independent variables and CED are presented in Table 3.

Table 3. Association Between Dietary Intake, Infectious Diseases, Maternal Knowledge, Physical Activity, Social Environment, and Chronic Energy Deficiency (CED) Among Pregnant Women in South Lampung Regency, 2026

Variable	Category	CED n (%)	Non-CED n (%)	p-value	OR (95% CI)
Dietary Intake	Inadequate	74 (81.3)	36 (39.6)	<0.001	6.650 (3.389–13.050)
	Adequate	17 (18.7)	55 (60.4)		
Infectious Diseases	Present	53 (58.2)	33 (36.3)	0.005	2.451 (1.350–4.453)
	Absent	38 (41.8)	58 (63.7)		
Maternal Knowledge	Poor	66 (72.5)	44 (48.4)	0.001	2.820 (1.521–5.227)
	Good	25 (27.5)	47 (51.6)		
Physical Activity	Heavy	29 (31.9)	31 (34.1)	0.875	–

Variable	Category	CED n (%)	Non-CED n (%)	p-value	OR (95% CI)
	Light/Moderate	62 (68.1)	60 (65.9)		
Social Environment	Poor	64 (70.3)	41 (45.1)	0.001	2.891 (1.570–5.323)
	Good	27 (29.7)	50 (54.9)		

The Chi-square analysis revealed significant associations between dietary intake (p = <0.001; OR = 6.650), infectious diseases (p = 0.005; OR = 2.451), maternal knowledge (p = 0.001; OR = 2.820), and social environment (p = 0.001; OR = 2.891) with the occurrence of Chronic Energy Deficiency among pregnant women. However, physical activity was not significantly associated with CED (p = 0.875).

Multivariate Analysis

The final multiple logistic regression model is presented in Table 4.

Table 4. Final Multivariate Logistic Regression Model of Factors Associated with Chronic Energy Deficiency (CED) Among Pregnant Women

Variable	p-value	Adjusted OR (Exp(B))
Dietary Intake	<0.001	6.866
Maternal Knowledge	0.001	3.184
Social Environment	0.003	2.827

Note: Table 4 reports the adjusted odds ratio [Exp(B)] for each retained variable. The regression coefficient (B), standard error (SE), and 95% confidence interval for each adjusted OR, together with the Hosmer–Lemeshow goodness-of-fit statistic, should be added from the original statistical output before submission.

Following bivariate screening, stepwise logistic regression, and interaction testing, infectious diseases and the interaction between dietary intake and maternal knowledge were excluded from the final model because their p-values exceeded 0.05. The final model identified dietary intake as the factor most strongly associated with Chronic Energy Deficiency among pregnant women after adjustment for maternal knowledge and social environment, as indicated by the smallest p-value (<0.001) and the highest adjusted odds ratio (OR = 6.866).

DISCUSSION

The present study found that pregnant women with inadequate dietary intake were 6.650 times more likely to experience Chronic Energy Deficiency (CED) than those with adequate dietary intake. Nutritional requirements increase substantially during pregnancy to support the development of the breasts, uterus, blood volume, placenta, amniotic fluid, and fetal growth.[8,19] Consequently, insufficient energy and protein intake becomes a direct risk factor for CED. These findings are consistent with previous studies conducted in several primary health center service areas, including Puskesmas Warung Jambu, Bogor, which also reported a significant association between dietary patterns and the occurrence of CED among pregnant women.[20,21]

Infectious diseases were also found to be significantly associated with CED (OR = 2.451). Infectious diseases may alter the body's metabolism by increasing energy requirements while simultaneously reducing appetite, thereby accelerating the development of chronic energy deficiency among pregnant women.[9] This finding highlights the importance of early detection and appropriate management of infectious diseases during antenatal care as an integral component of CED prevention programs, particularly since poorer nutritional and health status, including CED, has been shown to influence how early pregnant women initiate antenatal care in Indonesia.[22]

Poor maternal knowledge was significantly associated with the occurrence of CED (OR = 2.820). Adequate nutritional knowledge enables pregnant women to select appropriate types and quantities of food that meet the increased nutritional demands of pregnancy.[10] Therefore, improving maternal knowledge through nutrition education and counseling should be considered an essential strategy for preventing CED. These findings are consistent with a previous study conducted at the Tanah Kali Kedinding Primary Health Center, Surabaya, which also reported significant associations between maternal knowledge, social support, and the occurrence of CED among pregnant women.[14] Maternal education level, which strongly shapes access to and comprehension of nutritional knowledge, has similarly been found to be significantly related to the occurrence of CED among pregnant women in Jambi.[23]

In contrast, physical activity was not significantly associated with CED in this study ($p = 0.875$), which differs from findings reported in the Dawe Primary Health Center, Kudus.[13] This discrepancy may be explained by differences in occupational characteristics and daily activity patterns among pregnant women in the present study. Most participants in both the case and control groups engaged predominantly in light to moderate physical activity, resulting in limited variability in physical activity levels and reducing its ability to distinguish CED risk between the two groups.

A poor social environment, including food taboos during pregnancy and limited support from husbands, was significantly associated with the occurrence of CED (OR = 2.891). Cultural beliefs that

prohibit the consumption of certain nutritious foods during pregnancy may reduce dietary diversity and nutritional adequacy. Furthermore, emotional, financial, and practical support provided by husbands has been shown to influence maternal health behaviors and nutritional status. This is consistent with studies in other Indonesian settings showing that family income is significantly related to the occurrence of CED among pregnant women,[24] and that family income and household food availability are among the strongest correlates of CED, alongside nutritional status and adherence to iron-folic acid supplementation.[25] The multivariate analysis further confirmed that dietary intake was most strongly associated with CED after controlling for maternal knowledge and social environment. Therefore, interventions aimed at improving maternal dietary intake through the implementation of the Indonesian "Isi Piringku" (My Plate) nutritional guideline[1] may be considered an important public health priority for reducing the risk of Chronic Energy Deficiency among pregnant women in South Lampung Regency, although the effectiveness of such interventions was not directly evaluated in this study.

Two estimates of the dietary intake–CED association are reported in this study: an unadjusted bivariate odds ratio (OR = 6.650) and an adjusted odds ratio from the final multivariate model (OR = 6.866). The adjusted estimate, which accounts for maternal knowledge and social environment, should be regarded as the primary reference for interpreting the strength of this association, while the bivariate estimate is presented mainly for comparability with earlier studies. Neither estimate, however, was adjusted for maternal age or educational attainment, which differed substantially between cases and controls (Table 1). Because lower education and extreme maternal age are also plausible determinants of poor dietary intake, part of the large OR attributed to dietary intake may reflect residual confounding by these unmeasured or unadjusted characteristics rather than a purely independent effect. The possibility of reverse causation should also be considered: pregnant women who are already nutritionally compromised may reduce their food intake or alter reported dietary patterns as a consequence of illness, rather than inadequate intake being solely a cause of CED. Similarly, infectious diseases were significantly associated with CED in the bivariate analysis but were excluded from the final multivariate model because their contribution was no longer statistically significant after adjustment for dietary intake, maternal knowledge, and social environment; this should not be interpreted as evidence that infection plays no role, but rather that its association with CED was substantially attenuated once these other factors were accounted for. Consequently, the designation of dietary intake as the factor most strongly associated with CED should be understood as conditional on the covariates included in this model rather than as a definitive causal ranking.

Limitations

This study has several limitations. First, the retrospective case-control design is subject to

recall bias, as dietary intake and physical activity were assessed based on respondents' self-reports. Second, the maternal knowledge and social environment questionnaires used in this study have not been reported with published validity and reliability testing, which may affect measurement accuracy. Third, maternal age and educational attainment differed substantially between cases and controls but, together with other potential confounding variables such as parity, gestational age, household income, and pregnancy history, were not statistically controlled for in the analytic model; residual confounding by these characteristics cannot be excluded and may have inflated the observed associations, particularly for dietary intake. Finally, because CED status and exposure were measured at a single point in time, the temporal sequence between exposures and CED cannot be firmly established. These limitations should be considered when interpreting the findings, and they highlight the need for prospective studies with validated instruments and broader control of confounding factors.

CONCLUSION

This study concludes that dietary intake, infectious diseases, maternal knowledge, and the social environment are significantly associated with the occurrence of Chronic Energy Deficiency (CED) among pregnant women in South Lampung Regency. In contrast, physical activity was not found to have a significant association with CED. Among all variables examined, dietary intake was the factor most strongly associated with CED after controlling for maternal knowledge and the social environment, although this association was not adjusted for maternal age and educational attainment and should therefore be interpreted with caution rather than as a firmly established causal ranking. These findings emphasize the importance of improving maternal nutritional intake as an important public health priority for reducing the risk of Chronic Energy Deficiency during pregnancy.

Health authorities and Primary Health Centers (Puskesmas) are recommended to strengthen supplementary feeding programs for pregnant women based on the Indonesian "Isi Piringku" (My Plate) nutritional guideline. These interventions should be supported by regular monitoring and evaluation, as well as field supervision, to ensure that pregnant women receive adequate nutritional intake and sufficient energy to support healthy pregnancy outcomes. As this study used an observational case-control design, the findings reflect associations rather than causal relationships, and residual confounding cannot be ruled out. Future research is recommended to evaluate the effectiveness of supplementary feeding programs in preventing Chronic Energy Deficiency among pregnant women in South Lampung Regency.

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