

RESEARCH STUDY

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Dominant Factors Associated with Chronic Energy Deficiency in Pregnant Women in Tlogosari, Bondowoso

Faktor Dominan yang Berhubungan dengan Kekurangan Energi Kronis pada Ibu Hamil di Tlogosari, Bondowoso

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Available online at:<https://e-journal.unair.ac.id/AMNT>**Keywords:**Chronic Energy Deficiency,
History of Infectious Diseases,
Nutritional Knowledge,
Pregnant Women**ABSTRACT**

Background: The high prevalence of Chronic Energy Deficiency (CED) in Bondowoso Regency, affecting 16.4% of women of reproductive age and 17.67% of pregnant women in 2023, indicates the need for further analysis of its contributing factors. CED increases the risk of maternal and infant mortality, as well as adverse cases such as low birth weight and stunting.

Objectives: This study aimed to analyze suspected contributing factors and determine the most dominant factor associated with Chronic Energy Deficiency (CED) among pregnant women in the working area of Tlogosari Health Center, Bondowoso Regency, East Java Province, Indonesia.

Methods: This study used a case-control design, involving 96 pregnant women (48 with CED and 48 without CED) in Tlogosari Subdistrict. The analyzed variables included age, education, history of infectious diseases, parity, pregnancy spacing, dietary patterns, nutritional knowledge, and socioeconomic status. Data were collected through questionnaire and analyzed using descriptive statistics, chi-square tests, odds ratios, and logistic regression. The sample was selected using simple random sampling.

Results: The logistic regression test results indicated that nutritional knowledge (OR=7.509; 95%CI=1.948-28.954; p-value=0.003) and history of infectious diseases (OR=0.091; 95%CI=0.023-0.367; p-value=0.001) were significantly associated with Chronic Energy Deficiency (CED) among pregnant women in the working area of Tlogosari Community Health Center.

Conclusions: Poor nutritional knowledge and a history of infectious diseases were significantly associated with CED, with nutritional knowledge emerging as the most dominant factor. Improving personal hygiene practices and enhancing nutritional education during pregnancy are essential to reduce the risk of CED.

INTRODUCTION

Pregnancy is a physiological process that marks the beginning of the next generation's life¹. It is divided into three trimesters, each spanning approximately 13 weeks or three calendar months². Pregnancy leads to an increase in energy metabolism, which corresponds to the increased need for energy and nutrients. These increased energy and nutrient requirements are necessary for fetal growth and development, the enlargement of the uterus, as well as changes in the composition and metabolism of the mother's body³. Inadequate nutrient intake during pregnancy can lead to nutrient and energy deficiencies, impairing fetal growth. Prolonged deficiencies period may result in health problems such as Chronic Energy

Deficiency (CED).

A pregnant woman is classified as having CED if her mid-upper arm circumference (MUAC) measures below 23.5 cm or her pre-pregnancy/early first-trimester (≤ 12 weeks gestation) body mass index (BMI) is less than 18.5 kg/m² (underweight) (1). According to the World Health Organization (WHO), the prevalence of anemia and CED among pregnant women rises substantially during the third trimester, with global estimates ranging from 35% to 75%⁴.

The prevalence of pregnant women with CED indicates the risks for maternal and neonatal outcomes, including during delivery, and postpartum⁵. A survey of nutritional status monitoring (PSG) in 2017 showed that

the percentage of pregnant women with CED was 14.8%, rising to 17.3% in 2018⁶. Based on data on Chronic Energy Deficiency (CED) among women of reproductive age (WRA) in East Java in 2018, the prevalence was higher than the national average, with more than 17.3% of pregnant women and more than 14.5% of non-pregnant women affected. The percentage of pregnant women with CED in East Java decreased to 9.2% in 2021, though it remained above the national average of 8.7%⁷. In Bondowoso Regency, CED prevalence among pregnant women reached 16.4% in 2022, with 1,692 cases of CED reported in the same year⁸. The percentage of CED in Bondowoso remains quite high compared to the national percentage of CED in that year⁹.

Tlogosari Subdistrict in Bondowoso Regency recorder the highest prevalence of pregnant women with CED in 2022, with 19.8% (122 women) of pregnant women affected⁹. According to data from the Tlogosari Health Center, 76 pregnant women had CED from January to September 2023, accounting for 17.67% of pregnancies. Referring to the health program performance indicators, the target percentage for CED in pregnant women in 2024 is 10%¹⁰. Therefore, it can be concluded that the incidence of CED in the working area of Tlogosari Health Center remains a significant public health issue, as it exceeds the health problem cut-off for the community.

CED in pregnancy increases the risk of muscle weakness that may affect the childbirth process, as well as potential complications such as miscarriage, premature birth, birth defects, low birth weight (LBW), and even an increased risk of infant mortality. Additionally, CED during pregnancy can impair fetal growth and development, including physical growth (stunting), brain development, and metabolism, potentially contributing to the emergence of infectious diseases in adulthood⁵. Various factors cause the condition of CED in pregnant women. Previous studies have identified multiple factors contribute to CED in pregnant women, including dietary habits, nutritional knowledge, socioeconomic status, and maternal age.

Maternal and fetal health are closely linked to nutritional intake during pregnancy. Insufficient nutrient consumption depletes maternal reserves, as nutrients are diverted to meet fetal demands, potentially reducing muscle mass and precipitating CED¹¹. Adequate nutritional knowledge significantly impacts dietary patterns in pregnant women. During pregnancy, adequate knowledge of nutrition is crucial to ensure that the pregnant woman receives the appropriate nutrients to meet the demands of pregnancy and address any issues that arise in each trimester. A lack of nutritional knowledge can result in insufficient nutrient intake during pregnancy¹².

Socioeconomic status further influences dietary patterns, as limited household income restricts access to diverse and nutritious foods. A small family with low income may face difficulties in selecting diverse and nutritious foods according to their needs¹³.

Experiencing childbirth at a very young or very old age may result in lower-quality outcomes for the baby and pose risks to maternal health. Additionally, infections can trigger malnutrition due to decreased appetite,

impaired nutrient absorption in the digestive tract, or increased nutritional requirements due to illness. High-risk pregnancies can also lead to complications related to parity and the spacing of pregnancies¹⁴.

Research by Fajaryanti in 2018 demonstrated an association between energy, protein, and carbohydrate intake and CED among adolescent mothers in Tlogosari Subdistrict¹⁵. Another study by Ardi in 2021 found a connection between maternal age and dietary patterns with the occurrence of CED in women of reproductive age¹⁶. However, these findings contrast with Sutrisno in 2022, who found no correlation between age and CED in pregnant women¹⁴.

CED contributes to negative health impacts for both the mother and the baby. One of the major negative effects is the increase in Maternal Mortality Rate (MMR) and Infant Mortality Rate (IMR). The MMR significantly decreased in 2022 to 17 cases, compared to 43 cases the previous year. The IMR, however, was 103 cases, with the leading cause of death being LBW (67 cases). LBW cases in 2022 reached 7.8% (813 cases), which, although lower than previous years, remains relatively high (Health Office of Bondowoso Regency, 2022). Data from Tlogosari Health Center shows 46 cases of LBW in 2022 and 29 cases from January to September 2023. In addition to LBW, there were 194 cases of stunting (7.5%) in 2022, rising to 236 cases (10.2%) from January to September 2023 in Tlogosari Subdistrict. Bondowoso has the second-highest stunting prevalence in East Java, reaching 32% in 2022 double the provincial average of 15.8%¹⁷.

Based on the findings above, this study aims to analyze potential contributing factors to CED, including maternal characteristics such as age, education, nutrition knowledge, and socioeconomic status, as well as dietary patterns, history of infectious diseases, parity, and pregnancy spacing. It also aims to identify the most dominant factor associated with the incidence of Chronic Energy Deficiency (CED) among pregnant women in the working area of Tlogosari Health Center, Bondowoso Regency, East Java Province, Indonesia. The findings of this study are expected to support the Desa Emas (Elimination of Stunting) program as part of broader efforts to reduce stunting prevalence in Bondowoso, a region facing high rates of CED and stunting, low education levels, poverty, and various public health challenges.

METHODS

This observational study was conducted in the working area of Tlogosari Community Health Center from September to December 2023, employing a case-control design. The case-control approach enables the investigation of potential causal relationships between risk factors and disease outcomes by comparing exposed (case) and unexposed (control) groups (18). In this study, the case group consisted of pregnant women diagnosed with Chronic Energy Deficiency (CED), while the control group comprised pregnant women without CED¹⁸.

Data were collected using an online questionnaire administered via Google Forms, which the researcher assistance provided to participants as needed. The questionnaire consists of respondent characteristic sheets, socioeconomic status questionnaires, and

nutrition knowledge questionnaires that have been tested for validity and reliability. Only the respondents' nutritional knowledge instrument was tested for validity and reliability, as had been modified with additional questions from the researcher, while other tests used standard instruments. Validity was assessed using Pearson's Product-Moment correlation, and reliability was tested with Cronbach's Alpha, where an instrument is considered reliable if Cronbach's Alpha > 0.6. The test was conducted on 30 pregnant women with characteristics similar to the study sample in the Puskesmas Tlogosari work area, Bondowoso Regency. Of the 20 questions, 19 were valid ($r > 0.361$), while one was not. Reliability testing showed a Cronbach's Alpha of 0.875 (> 0.6), indicating that the instrument is reliable.

The study proposal was approved by the Surabaya City Bakesbangpol and the Ethics Committee of FKM Unair with the ethical number 1183/HRECC.FODM/X/2023 on October 16, 2023. Prior to participation, all subjects provided informed consent, obtained either in written or verbal form following a comprehensive explanation of the study's purpose and procedures. Throughout the research process, strict

confidentiality measures were implemented to protect participants' personal identities and data.

The research population consisted of 430 pregnant women registered at Tlogosari Public Health Center between March and September 2023. The sample for this study consisted of pregnant women in Bondowoso Regency who met specific inclusion and exclusion criteria. The inclusion criteria required pregnancies to be registered at the Tlogosari Public Health Center, Bondowoso Regency, within the last six months during the period from March to September 2023, and the participants needed to demonstrate the ability to communicate effectively. Meanwhile, the exclusion criteria eliminated pregnant women who required complete bed rest due to illness or those who were nearing their expected delivery date (EDD). These criteria ensured a well-defined and appropriate sample for the study. The sample size was determined using the Lemeshow formula, assisted by the SSIZE (Sample Size) software and data from previous studies¹⁹. The determination of P1 and P2 values was conducted by reviewing previous studies, as shown in the following table:

Table 1. Reference for minimum sample size determination

Variable	P1	P2	n
Consumptions Patterns ²⁰	0.762	0.333	23
History of Infectious Diseases ²¹	0.286	0.050	24
Social Economy Status ²²	0.556	0.241	31
Education Level ²³	0.52	0.48	44
Nutritional Knowledge ²⁴	0.783	0.565	19
Age ²⁵	0.360	0.153	52
Parity ²⁶	0.372	0.176	65
Pregnancy Interval ²⁷	0.726	0.333	11

Based on Table 1, the minimum required sample size is as follows. The sample size was determined using hypothesis testing to compare two proportions, P1 and P2, with the SSIZE (Sample Size) software. With a significance level (alpha) of 0.05 and a power of 80%, a minimum of 48 respondents is required for both the case and control groups, including a 10% increase to account for potential refusals. Thus, the total sample size is 96 respondents. The sampling method used in this research is simple random sampling.

The variables analyzed included CED status as the dependent variable, and age, education, nutritional knowledge, socioeconomic status, consumption patterns, history of infectious diseases, parity, and interpregnancy interval as independent variables. In this study, data were analyzed directly by the researcher to ensure consistency and accuracy. Data were systematically stored in digital format using spreadsheets or databases, while physical copies were kept in protected folders. To maintain confidentiality, data were encrypted and accessible only to authorized researchers.

All data for the research variables were obtained through direct interviews with respondents. A set of variables was identified, including age, education, history of infectious diseases, parity, interpregnancy interval, and CED status. These variables were determined using a respondent characteristic questionnaire filled out according to the respondents' circumstances. The

diagnosis of CED (Chronic Energy Deficiency) was determined by measuring the Mid-Upper Arm Circumference (MUAC) of pregnant women. The measurement was conducted by the researcher using a MUAC measuring tape. The socioeconomic status variable was obtained using a 34-item Social Economy Status questionnaire with scoring categories of 0-16=Very Low; 17-32=Low; 22-48=Medium; and 49-66=High²⁸. The variable of nutritional knowledge was obtained using a multiple-choice nutritional knowledge questionnaire consisting of 19 questions, with scoring determined as good if greater than the median, and otherwise categorized as poor. The dietary consumption pattern variable encompasses carbohydrate consumption patterns, animal protein consumption patterns, plant protein consumption patterns, and oil or fat consumption, measured using the SQ-FFQ questionnaire, where scores for each nutrient are totaled and compared to daily requirements. In the event that the nutrient consumption score falls below the established daily requirement, it is categorized as inadequate. The development of the SQ-FFQ questionnaire has been tailored to the types of foods consumed in the area where the research is conducted. In order to mitigate the impact of recall bias in pregnant women during the SQ-FFQ interview method, probing is done by ensuring the respondent accurately recalls the foods they have consumed and stimulating their memory

by prompting them to recollect specific events that may deviate from their usual eating habits, such as weddings, religious holidays, and other notable occasions.

Statistical analysis involved a range of methods, including chi-square tests, odds ratio estimation, and logistic regression, to investigate the associations between variables and to evaluate the risk of chronic energy deficiency (CED). All analyses were performed using SPSS software, with a significance threshold set at $p\text{-value} < 0.05$. The objective of this method was to identify potential risk factors contributing to CED among pregnant women in the Tlogosari area.

RESULTS AND DISCUSSIONS

The majority of respondents in this study were of non-risk age (78.1%), had a basic education level (97.9%), and belonged to the middle socioeconomic group (76%). In terms of health and nutrition, the majority exhibited poor nutritional knowledge (51%), no history of infectious diseases (53.1%), and demonstrated favorable consumption patterns for carbohydrates (93.8%), animal protein (79.2%), and plant protein (100%). However, a significant portion demonstrated poor fat consumption habits (67.7%) despite having ideal parity (79.2%) and pregnancy intervals (80.2%).

Table 2. Distribution of Respondent Characteristics

Variable	Frequency	Percentage (%)
Age		
High Risk (<20 years and >35 years)	21	21.9
Not at Risk (20-35 years)	75	78.1
Total	96	100
Education Level		
Low	94	97.9
High	2	2.1
Total	96	100
Social Economy Status		
Low	20	20.8
Middle	73	76.0
High	3	3.1
Total	96	100
Nutritional Knowledge		
Poor (score <64; median)	49	51
Good (score ≥ 64 ; median)	47	49
Total	96	100
History of Infectious Diseases		
Yes	45	46.9
No	51	53.1
Total	96	100
Consumptions Patterns		
Carbohydrate		
Poor	6	6.3
Good	90	93.8
Total	96	100
Animal-Based Protein		
Poor	20	20.8
Good	76	79.2
Total	96	100
Plant-Based Protein		
Poor	0	0
Good	96	100
Total	96	100
Fat		
Poor	65	67.7
Good	31	32.3
Total	96	100
Parity		
Not Ideal	20	20.8
Ideal	76	79.2
Total	96	100
Pregnancy Interval		
Not Ideal	19	19.8
Ideal	77	80.2
Total	96	100

The results indicated that 78.1% of the participants were aged 20 to 35 years, an age range that is considered to be within the safe or non-risk category for maternal age. Most respondents had completed high school (50%), which is classified as basic education, and demonstrated poor nutritional knowledge, with 51% scoring below the median. Additionally, 76% of respondents were categorized as having a middle socioeconomic status. With respect to the prevalence of, 53.1% of the subject reported an absence of any history of infections in the past three months, including tuberculosis, measles, respiratory infections (ARI), hepatitis, or diarrhea.

The study also examined dietary patterns, revealing that the majority of respondents had adequate consumption of carbohydrates (93.8%), animal proteins (79.2%), and plant proteins (100%). However, a significant proportion, amounting to 67.7%, exhibited poor consumption patterns for fats. Among the various carbohydrate sources, rice was the most frequently consumed, with 76% of respondents reporting daily intake. In contrast, tubers were the least consumed, with only 5.2% of respondents reporting consumption 1-3

times per month. For animal proteins, salted fish was the most common source, consumed daily by 31.3%, while beef was the least frequently consumed source of animal proteins, with only 6.3% of respondents reporting its consumption 1-3 times per month. Among plant proteins, tofu and tempeh were the most commonly consumed, with 72.9% of respondents reporting daily intake. Conversely, soy sauce was the least consumed, with only 9.4% of respondents reporting intake 1-3 times per month. For fats, palm oil (cooking oil) emerged as the most prevalent source, with 50% of the population reporting its daily use. Conversely, margarine exhibited the least frequent consumption, with only 27.1% of individuals reporting its use 1-3 times per month.

The study also highlighted parity and pregnancy intervals. The data indicates that 52.1% of the respondents were nulliparous and experiencing their first pregnancy. Among respondents who had been pregnant before, 57.7% reported having an ideal pregnancy interval. These findings provide a comprehensive overview of the dietary habits, socioeconomic status, and reproductive health characteristics of pregnant women in the Tlogosari Community Health Center area.

Table 3. Result of Chi-Square Test and Odds Ratio

Variable	CED Status				Total		p-value	OR (95%CI)
	Case		Control		n	%		
	n	%	n	%				
Age								
High Risk	16	33.3	5	10.4	21	21.9	0.007*	4.3 (1.426-12.964)
Not at Risk	32	66.7	43	89.6	75	78.1	Ref	
Total	48	100	48	100	96	100		
Education Level								
Low	48	100	46	95.8	94	97.9	0.495	-
High	0	0	2	4.2	2	2.1	Ref	
Total	48	100	48	100	96	100		
Social Economy Status								
Low	18	37.5	2	4.2	20	20.8	0.044*	8.694 (2.419-30.923)
Middle	29	60.4	44	91.6	73	76	0.825	1.318 (0.114-15.212)
High	1	2.1	2	4.2	3	3.2	Ref	
Total	48	100	48	100	96	100		
Nutritional Knowledge								
Poor	41	85.4	8	16.7	49	51	<0.001*	29.286 (9.710-88.327)
Good	7	14.6	40	83.3	47	49	Ref	
Total	48	100	48	100	96	100		
History of Infectious Diseases								
Yes	8	16.7	43	89.6	51	53.1	<0.001*	0.023 (0.007-0.077)
No	40	83.3	5	10.4	45	46.9	Ref	
Total	48	100	48	100	96	100		
Consumptions Patterns								
Carbohydrate								
Poor	4	8.3	2	4.2	6	6.2	0.677	2.091 (0.364-11.996)
Good	44	91.7	46	95.8	90	93.8	Ref	
Total	48	100	48	100	96	100		
Animal-Based Protein								
Poor	15	31.2	5	10.4	20	20.8	0.012*	3.909 (1.289-11.851)
Good	33	68.8	43	89.6	76	79.2	Ref	
Total	48	100	48	100	96	100		
Plant-Based Protein								
Good	48	100	48	100	96	100	-	-
Total	48	100	48	100	96	100		
Fat								
Poor	34	70.8	31	64.6	65	67.7	0.513	1.332 (0.564-3.143)

Variable	CED Status				Total		p-value	OR (95%CI)
	Case		Control		n	%		
	n	%	n	%				
Good	14	29.2	17	35.4	31	32.3	Ref	
Total	48	50	48	50	96	100		
Parity								
Not Ideal	13	27.1	7	14.6	20	20.8	0.132	0.460 (0.165-1.279)
Ideal	35	72.9	41	85.4	76	79.2	Ref	
Total	48	100	48	100	96	100		
Pregnancy Interval								
Not Ideal	9	18.8	10	20.8	19	19.8	0.798	1.140 (0.417-3.116)
Ideal	39	81.2	38	79.2	77	80.2	Ref	
Total	48	100	48	100	96	100		

Note: (*) indicates variables with p-values < 0.05, showing a statistically significant association.

This present study identified age as a pivotal factor influencing the incidence of Chronic Energy Deficiency (CED) among pregnant women. The statistical analysis, employing the chi-square test produced a p-value of 0.007, which is below the significance level of $\alpha=0.05$, thereby confirming a meaningful association. The odds ratio (OR) for maternal age was 4.3, with a 95% confidence interval ranging from 1.426 to 12.964. This indicates that women under 20 or over 35 years old are 4.3 times more likely to experience CED than those aged 20-35 years. The present findings underscore the significant of age as a predictor of risk for CED in pregnancy.

Contrary to the findings related to age, the results of the study indicated that maternal education level was not significantly associated with the incidence of CED. The Chi-square test produced a p-value of 0.495, which exceeds the α level of 0.05. This finding suggests that there is no statistically significant relationship between educational attainment and CED risk. Additionally, the odds ratio could not be determined due to a zero frequency in one of the cells of the 2x2 contingency table. These results suggest that, unlike age, maternal education does not appear to be a determining factor in the development of CED.

On the other hand, maternal knowledge emerged as a pivotal predictor of the occurrence of CED. The Chi-square analysis yielded a highly significant p-value of <0.001, thereby confirming a strong association between a mother's level of knowledge and her risk of experiencing CED. The calculated odds ratio was 29.286, with a 95% confidence interval ranging from 9.710 to 88.327. This indicates that women with limited understanding of nutrition and health are over 29 times more likely to suffer from CED than those who are well-informed. The present findings emphasize the critical role of knowledge and awareness in mitigating the risk of CED during pregnancy.

Socioeconomic status was also found to be significantly associated with the risk of CED. The Chi-square test yielded a p-value of <0.001, indicating a statistically meaningful relationship between economic standing and the likelihood of developing CED. The odds ratio was calculated at 8.694, with a 95% confidence interval of 2.419 to 30.923, showing that pregnant women from lower socioeconomic backgrounds are approximately 8.7 times more likely to experience CED than those with better economic conditions. The findings

of this study underscore the imperative for mitigating socioeconomic inequalities as a pivotal component of comprehensive strategies aimed at enhancing maternal nutritional health.

No significant association was observed with CED regarding parity (the number of previous pregnancies) and pregnancy interval. The P-values for both variables were 0.132 and 0.798, respectively, both of which are greater than $\alpha=0.05$. The odds ratios for both variables suggested no significant protective or risk factor effects. Thus, the study concludes that neither parity nor pregnancy interval exerts a significant influence on the probability of developing CED.

A history of infectious diseases was another critical factor influencing the occurrence of CED. The Chi-square test revealed a P-value of <0.001, and the OR was 0.023, with a confidence interval of 0.007-0.077, indicating that women without a history of infectious diseases had a significantly lower risk of developing CED. This suggests that preventing infections during pregnancy may play a protective role in reducing the likelihood of CED.

Dietary patterns were also examined in relation to CED risk. The analysis revealed that carbohydrate consumption was not significantly associated with CED, as the Chi-square test produced a P-value of 0.677, and the OR was 2.091, with a confidence interval of 0.364-11.996, suggesting that the consumption of carbohydrates does not have a meaningful statistical impact on CED. However, the consumption of animal protein was found to be a significant risk factor. The Chi-square test yielded a p-value of 0.012, and the OR was 3.909, with a confidence interval of 1.289-11.851. This indicates that women with inadequate consumption of animal protein are 3.9 times more likely to develop CED. This highlights the importance of ensuring adequate intake of animal protein during pregnancy.

An analysis of the data revealed that there was no variability observed in the intake of plant protein between the case and control groups. This finding indicates that the consumption of plant-based proteins, such as tofu and tempeh, was reported in sufficient amounts by all respondents. Consequently, statistical analysis for this variable was not feasible. Conversely, the consumption of fats was not found to be significantly associated with CED. The chi-square test yielded a p-value of 0.513, and the odds ratio (OR) was 1.332, with a confidence interval of 0.564-3.143. These findings

indicate that poor fat consumption did not have a statistically significant impact on the likelihood of

developing CED.

Table 4. Summary of Chi-Square Test and Odds Ratio

Variable	p-value	OR (95%CI)
Age	0.007	4.3 (1.426-12.964)
Nutritional Knowledge	<0.001	29.286 (9.710-88.327)
Social Economy Status	0.044	8.694 (2.419-30.923)
History of Infectious Diseases	<0.001	0.023 (0.007-0.077)
Consumption Pattern (Animal-Based Protein)	0.012	3.909 (1.289-11.996)

In summary, the study identifies several key factors that significantly influence the risk of CED in pregnant women. A comprehensive review of the extant literature reveals a compelling correlation between the occurrence of CED and several factors, including age, maternal knowledge, socioeconomic status, and a history of infectious diseases. Specifically, the study identified

several factors that were found to increase the risk of CED, including younger or older age, poor maternal knowledge, lower socioeconomic status, and a history of infectious diseases. On the other hand, educational level, parity, pregnancy interval, carbohydrate consumption, plant protein consumption, and fat intake exhibited no statistically significant correlation with CED.

Table 5. Result of Final Logistic Regression Model Test

Variable	B	p-value	Odds Ratio	95%CI
Nutritional Knowledge (Poor vs. Good)	2.016	0.003	7.509	1.948-28.954
History of Infectious Disease (No vs. Yes)	-2.394	0.001	0.091	0.023-0.367
Constant	-5.860	0.006	-	-

Based on the calculated B values above, the formed equation model was $\ln P/1-P = -5.860 + 2.016\text{Knowledge} - 2.394$. This model was considered valid. The constant value of -5.860 represented the log odds of experiencing CED when both knowledge and infectious disease history were absent (coded as 0). Since the constant was negative, it indicated a low baseline risk. Individuals with limited

understanding of nutrition were 7.51 times more at risk of suffering from CED than those who possessed good nutritional awareness. Regarding the variable of infectious disease history, the reference group consisted of individuals who have experienced infections. Individuals without a history of infectious disease had significantly lower odds of experiencing CED (OR=0.091), which suggested a strong protective effect.

Table 6. Multivariate Analysis Results, Model Fit Test Results

Statistics	Value
-2 Log Likelihood	66.827
Cox and Snell R ²	0.499
Nagelkerke R ²	0.665

The model explained 66.5% of the variation in the occurrence of CED among pregnant mothers in the working area of Tlogosari Public Health Center. Based on a p-value of 0.001 and OR=0.091 (OR<1), it can be inferred that a protective factor the history of infectious diseases was highly related. Pregnant women with no history of infectious infections were therefore much less likely to develop CED (OR=0.091; p-value=0.001), suggesting a strong protective impact. In contrast, poor nutritional knowledge emerged as a significant risk factor, with an odds ratio of 7.509 (p-value=0.003), indicating that mothers with poor knowledge were over seven times more likely to experience CED.

According to the research findings, two of the eight variables under investigation the history of infectious diseases and the dietary awareness of expectant mothers showed a consistent link. Field observations about the favorable settings for mother health and knowledge further corroborate these findings. Most expectant mothers did not know much about nutrition. The results acquired after filling out the questionnaire were referred to as the weak knowledge category. The majority only completed primary school,

which was consistent with these findings. Research data also showed that most mothers do not use the Internet or medical facilities to look up health information. Studies on the variable of history of infectious diseases, on the other hand, showed that diarrhea and ARI (acute respiratory infections, which included fever, cold, and cough) were the most common. The majority of people in the Tlogosari Sub-District self-clean in the river streams and did not use appropriate toilets, which was consistent with the research findings.

A history of infectious diseases was one of the direct factors causing public health issues, such as CED in pregnant women. In this study, the history of infectious diseases refers to infections experienced by pregnant women within the last three months, including diarrhea, measles, respiratory infections (ARI), pulmonary tuberculosis, and hepatitis. The results showed that 46.9% of respondents had a history of infectious diseases, with diarrhea and ARI (cough, cold, and fever) being the most common. These findings aligned with field observations, which indicated that a significant portion of the Tlogosari community did not yet use proper latrines. The primary healthcare facility accessed by all pregnant

women in the Tlogosari Community Health Center area was the health center itself. Logistic regression analysis revealed that a history of infectious diseases was statistically significant as a protective factor. This suggested that pregnant women without a history of infectious diseases have a reduced risk of experiencing Chronic Energy Deficiency (CED). According to HL Blum's theory, the degree of health was determined by environmental, behavioral, healthcare service, and genetic factors. Environmental factors contributed the most to determining the degree of health, accounting for 40%²⁹. This confirmed the research's conclusions that the habitats where viruses that cause infectious diseases arise are influenced by factors such as population density, clean water, adequate nutrition, physical activity, and others^{30,31}. Another study found that a history of infectious diseases was a statistically significant risk factor with an OR of 3.7. This means that pregnant women with a history of infectious diseases have a 3.7 times higher risk of experiencing CED³². The significant results indicated that there were obstacles in the process of nutrient absorption during infectious diseases that affected the incidence of CED in pregnant mothers.

Knowledge is the result obtained after an individual perceives a particular object. Knowledge plays a role as one of the factors determining behavior³³. Poor knowledge was determined based on respondents' scores from a nutrition knowledge questionnaire. Pregnant women scoring below the median (<64) were categorized as having poor knowledge, while those scoring at or above the median (≥64) were categorized as having good knowledge. According to Lawrance Green's Theory (2014), behavior is formed by 3 factors, one of which is predisposing factors consisting of knowledge, attitudes, and so on³⁴. The research findings suggesting the behavior of choosing foods during pregnancy is dependent on a number of factors, including knowledge, are supported by this idea. This result is consistent with the educational background of the respondents, the majority of whom only completed elementary school, mostly high school. Additionally, a sizable percentage of expectant mothers did not actively look for health information online or at medical facilities, according to the research. Logistic regression analysis revealed that nutritional knowledge had a significant association and was identified as a risk factor for Chronic Energy Deficiency (CED) in pregnant women.

These findings aligned with a previous study by Bustan et al. (2021), which found a significant association between nutritional knowledge and the incidence of CED in pregnant women at the Sudiang Health Center, Makassar (p-value 0.000<0.005). The study involved pregnant women whose education levels ranged from elementary (1.9%) to higher education (36.5%), with most having basic to intermediate education (elementary to senior high school). This educational background may contribute to limited nutritional knowledge, thereby influencing the risk of CED³⁵.

The strength of this study lies in its ability to illustrate the risk factors associated with Chronic Energy Deficiency (CED) in pregnant women by examining the relationships between various factors in women with and without CED. This was achieved through a case-control

design with a 1:1 ratio, ensuring a balanced comparison. Consequently, the findings of this study can serve as a valuable reference for policy development in targeted promotional and preventive measures against CED in pregnant women. Furthermore, the data were analyzed using three statistical methods univariate, bivariate, and multivariate analyses allowing for a comprehensive examination and consistency in identifying the relationships between independent and dependent variables. Additionally, data collection was conducted through interviews supplemented by probing techniques, with questionnaires completed by the researchers. This approach minimized the likelihood of inaccurate responses and enhanced the validity of the collected data.

However, this study has certain limitations. It was conducted exclusively in Tlogosari District, making the findings representative only of pregnant women with characteristics specific to this region. Another limitation was the potential recall bias among respondents when reporting the type and frequency of food consumed, as data collection relied on the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). This was addressed by using probing approaches to validate and elucidate the respondents' food recollection. For instance, questions on specific events were asked of respondents, such as whether they attended religious festivities, weddings, or other events that would have changed their typical eating habits. There may still be some recollection bias in spite of these attempts. These restrictions, however, emphasize areas that require more investigation and development in subsequent studies rather than lessening the study's contribution to our understanding of CED risk factors.

Effective policy solutions must address CED in pregnant women in light of these findings. Through sustainable maternal health programs, policies should concentrate on expanding access to and adherence to nutritional supplements, especially those that provide numerous micronutrients and a balanced protein-energy consumption. Additionally, strengthening nutrition education through a community-based approach is crucial to ensure that pregnant women understand the importance of adequate nutrition and actively utilize healthcare services for early detection and management of CED³⁶. Moreover, food fortification and supplementary food based on locally sourced ingredients should be optimized to improve maternal nutritional status, particularly in regions with high CED prevalence³⁷. To ensure the long-term effectiveness of these efforts, a multisectoral approach involving the health, education, and food security sectors is essential for the sustainability of programs and the overall reduction in CED rates.

These advantages and disadvantages showed how well the study was designed as well as where more research may be conducted to increase the findings' accuracy and generalizability. Hence, treating CED in expectant mothers necessitates an all-encompassing, research-based strategy that incorporates food fortification, community-based education, nutritional supplements, and multispectral cooperation. Sustainable policies and targeted interventions are critical not only for reducing the prevalence of CED but also for improving

maternal and infant health outcomes, thereby ensuring long-term public health benefits. Future research and continuous evaluation of implemented policies will be crucial in refining strategies to achieve optimal maternal nutrition and well-being.

CONCLUSIONS

Chronic Energy Deficiency (CED) in pregnant women is a significant public health issue that needs to be addressed, particularly in the working area of Tlogosari Community Health Center, Bondowoso Regency. This study found that low nutritional knowledge and a history of infectious diseases, such as diarrhea and acute respiratory infections, were significantly associated with CED. Poor nutritional knowledge emerged as the most dominant factor. Therefore, improving nutritional education through culturally appropriate counseling and promoting good hygiene practices, including regular handwashing and proper latrine use, are essential strategies to prevent CED. Strengthening primary healthcare services by training health workers in effective nutritional counseling and early detection of infections is also crucial. In addition, community-based initiatives, such as involving health cadres and establishing discussion groups for pregnant women, can enhance awareness and prevention efforts. Regular monitoring and evaluation of interventions are necessary to ensure their effectiveness in reducing the prevalence of CED among pregnant women.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

None of the authors involved in this manuscript have any conflicts of interest to declare, whether in the form of financial ties, professional relationships, or institutional affiliations that could influence the content or subject discussed in the article.

AUTHOR CONTRIBUTIONS

WSA: Took the lead in designing the research framework, coordinating and conducting data collection, defining the research questions, and ensuring the integrity of the study's scientific content. Also responsible for data analysis, interpretation, manuscript drafting, and overseeing all stages of revision. SIP: Acted as a mentor in the stages of data analysis and interpretation, and offered valuable critiques, insights, and suggestions to enhance the quality and clarity of the manuscript. JDES: Provided academic supervision throughout the analytical process, contributed expert guidance on interpreting findings, and gave constructive input to improve the writing of the article. BB: Involved in the data gathering process and participated in refining the manuscript

through critical evaluation, feedback, and assistance during revision.

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