

Household Food Security and Risk of Chronic Energy Deficiency among Pregnant Women: A Cross-Sectional Study

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ABSTRACT

Background: Household food insecurity may limit pregnant women's access to sufficient and nutritious food. This study examined the association between household food security and the risk of chronic energy deficiency (CED) among pregnant women in Badiri District, Central Tapanuli Regency, Indonesia.

Methods: A cross-sectional study was conducted in March 2025 involving 50 pregnant women recruited through total sampling. Household food security was assessed using a questionnaire, and CED risk was classified as a mid-upper arm circumference <23.5 cm. Associations were examined using Pearson's chi-square test. The unadjusted prevalence ratio (PR) and its 95% confidence interval (CI) were calculated from the contingency table.

Results: Twenty-two participants (44.0%) lived in food-insecure households, and 15 (30.0%) were classified as at risk of CED. The proportion at risk of CED was 50.0% in food-insecure households and 14.3% in food-secure households. Food insecurity was associated with a higher prevalence of CED risk (PR = 3.50; 95% CI: 1.29–9.50; $\chi^2 = 7.483$; $p = 0.006$).

Conclusion: Household food insecurity was associated with CED risk among pregnant women in the study population. Integrating food-security screening, nutritional assessment, and support for food access into antenatal care should be considered. The cross-sectional design and lack of adjustment for confounders limits causal interpretation and generalizability.

BACKGROUND

Adequate nutrition before and during pregnancy is crucial for maternal health and fetal development. Poor nutritional status and inadequate weight gain during pregnancy are associated with unfavorable perinatal outcomes. Therefore, attention to maternal nutrition needs to encompass dietary quality and conditions that enable mothers to obtain nutritious food sustainably (Marshall et al., 2022). Maternal malnutrition is also linked to social inequalities and access to health services, therefore addressing it requires cross-sectoral support (Victora et al., 2021).

In Indonesian healthcare, a mid-upper arm circumference (MUAC) of <23.5 cm is used to identify pregnant women at risk of chronic energy deficiency (CED). This classification is an anthropometric screening indicator and does not, by itself, prove the duration or cause of an individual's nutritional deficiencies. Identification of this risk serves as the basis for further nutritional assessment and interventions tailored to the mother's needs (Ministry of Health of the Republic of Indonesia [Kemenkes RI], 2023). A study in Banyumas showed that CED risk is associated with several maternal characteristics, utilization of antenatal care, and nutrient intake; these findings confirm the multifactorial nature of the problem (Wati et al., 2024).

Food security encompasses the ability to obtain adequate and nutritious food sustainably. Affordability of a healthy diet and access to resources are distinct issues beyond the mere availability of food in a given area (Food and Agriculture Organization of the United Nations [FAO] et al., 2024). The conceptual framework for maternal and child nutrition places food, caregiving practices, and services as interconnected in determining diet quality and nutritional status (United Nations Children's Fund [UNICEF], 2021). Women facing economic constraints and limited access to nutritious food require special attention in nutrition improvement efforts (UNICEF, 2023).

International evidence supports the link between food insecurity and malnutrition during pregnancy. A meta-analysis in Ethiopia reported associations between household food insecurity and low dietary diversity with maternal malnutrition during pregnancy (Zewude et al., 2024). Research in Konso also identified food security and dietary diversity as factors associated with maternal nutritional status (Gelebo et al., 2021). A study published in February 2025 found an association between food security and maternal minimum dietary diversity during pregnancy, although these outcomes differed by CED risk classification (Lemi et al., 2025).

In the context of North Sumatra, a descriptive study of food-insecure pregnant women in Bagan Serdang showed that inadequate energy and protein intakes were still prevalent (Nurhayati et al., 2023). However, this study did not provide a direct comparison with food-secure households. Research on dietary restrictions and dietary diversity in rural Indonesia also demonstrates the need to consider local context when assessing maternal nutrition (Angkasa et al., 2024). Therefore, evidence from local populations is needed to understand the distribution of risk and design appropriate services.

This study aims to analyze the relationship between household food security and the risk of CED among pregnant women in Badiri District, Central Tapanuli Regency, in March 2025. The study focused on differences in the prevalence of CED risk between food-insecure and food-secure households. The findings are expected to provide initial input for antenatal care and nutritional support programs in the study population.

METHOD

Design and location. This cross-sectional, analytical observational study was conducted in Badiri District, Central Tapanuli Regency, North Sumatra, in March 2025. Exposure and outcome variables were measured during the same study period. The reporting structure was aligned with the relevant points of the STROBE guidelines for observational studies (von Elm et al., 2007).

Population and sample. The population reported in the source text was 50 pregnant women in the study area. All were included through total sampling, resulting in a total sample size of 50 respondents. The inclusion criteria were pregnant women who were willing to be respondents. Potential respondents who could not be interviewed due to illness were excluded, and refusal or withdrawal of consent was grounds for termination of participation.

Variables and operational definitions. Exposure was household food security, categorized into food insecurity and food security based on the research questionnaire. The outcome was the risk of CED, classified as at risk if the MULA was <23.5 cm and not at risk if the MULA was ≥ 23.5 cm. These limits align with national guidelines (Ministry of Health, 2023).

Respondent characteristics reported included age (<20 , 20–35, and >35 years), education (primary, secondary, and higher), occupation (working and unemployed/housewife), and trimester of pregnancy (I, II, and III). Data collection used a questionnaire.

Statistical analysis. Data are presented as frequencies and percentages. Bivariate analysis used the Pearson chi-square test with a significance level of 0.05. The source text mentions the use of SPSS; Recalculation based on aggregate frequencies in the contingency table yielded expected frequencies of 6.6; 15.4; 8.4; and 19.6, resulting in all cells meeting expected frequencies ≥ 5 . The primary results are reported as Pearson chi-square without continuity correction. To clarify the magnitude of the association, unadjusted prevalence ratios (PRs) were calculated by comparing the prevalence of CED risk in food insecure and food secure groups. The 95% CI was calculated using the logarithmic/Katz approach. RPs were chosen because outcomes were measured as prevalence in cross-sectional studies (Barros & Hiraakata, 2003). Sensitivity analysis using a two-sided Fisher exact test was performed on the same table. Multivariate analysis was not performed because individual data for adjustment for confounding factors were not available in the revised materials.

RESULTS

Respondent characteristics. A total of 50 pregnant women were included in the analysis. Most were aged 20–35 years (80.0%), had secondary education (58.0%), and were unemployed/housewives (62.0%). The largest proportion were in the second trimester (48.0%). A total of 22 respondents (44.0%) were in food-insecure households, and 15 respondents (30.0%) were classified as at risk of CED. The complete distribution is presented in Table 1.

Relationship between food security and CED risk. In the food insecure group, 11 of 22 pregnant women (50.0%) were at risk of CED. In the food secure group, 4 of 28 pregnant women (14.3%) were at risk of CED. Pearson's chi-square test showed a relationship between the two variables ($\chi^2 = 7.483$; $df = 1$; $p = 0.006$). The prevalence of CED risk in the food insecure group was 3.50 times the prevalence in the food secure group (unadjusted RP = 3.50; 95% CI: 1.29–9.50). The difference in absolute prevalence was 35.7 percentage points. Sensitivity analysis using a two-tailed Fisher's exact test yielded $p = 0.012$. Distribution by group is shown in Table 2.

Table 1. Respondent characteristics, food security, and SEZ risks (N = 50)

Variables	Category	n	%
Age	<20 years	4	8.0
	20–35 years	40	80.0
	>35 years	6	12.0
Education	Base	13	26.0
	Intermediate	29	58.0
	Tall	8	16.0
Work	Not working/housewife	31	62.0
	Work	19	38.0
Trimester	I	8	16.0
	II	24	48.0
	III	18	36.0
Food security	Food insecurity	22	44.0
	Food security	28	56.0
SEZ Risks	At risk (LILA <23.5 cm)	15	30.0
	No risk (LILA $\geq$ 23.5 cm)	35	70.0

Note. Percentages are calculated from all respondents. CED = chronic energy deficiency; MUAC = mid-upper arm circumference.

Table 2. CED risk according to household food security (N = 50)

Food security	CED risk, n (%)	No risk of CED, n (%)	Total, n
Food insecurity	11 (50.0)	11 (50.0)	22
Food security	4 (14.3)	24 (85.7)	28
Total	15 (30.0)	35 (70.0)	50

Note. Percentages in each row. Pearson's chi-square without continuity correction: $\chi^2(1) = 7.483$; $p = 0.006$. Unadjusted RP = 3.50 (95% CI: 1.29–9.50), with the food-secure group as the comparison.

Two-tailed Fisher's exact test: $p = 0.012$.

DISCUSSION

This study found that household food insecurity was associated with a higher prevalence of CED risk among pregnant women in Badiri District. The difference in proportions of 50.0% compared to 14.3%, accompanied by an unadjusted RP of 3.50, suggests that the magnitude of the association requires attention, in addition to the p-value. However, the relatively wide 95% CI indicates limited estimation precision. The p-value and confidence interval should be interpreted in conjunction with the study design, sample size, and potential bias; statistical significance does not prove causality (Greenland et al., 2016).

The direction of this association is consistent with a meta-analysis linking food insecurity and low dietary diversity to maternal malnutrition in Ethiopia (Zewude et al., 2024). Studies in Konso also support the association between food security, dietary diversity, and maternal nutritional status (Gelebo et al., 2021). The consistent direction of the findings helps position the Badiri results within the broader literature, but

the magnitude of the associations cannot be directly compared. Differences in MUAC thresholds, food security instruments, population characteristics, and adjustment for confounding factors may influence the results across studies.

The relationship found can be conceptually explained by limited access to adequate and diverse food. Research in Fiche demonstrated a relationship between household food security and the minimum dietary diversity of pregnant women (Lemi et al., 2025). Descriptive research in Bagan Serdang reported inadequate energy and protein intake in a group of pregnant women experiencing food insecurity (Nurhayati et al., 2023). Both sources support the possibility of a dietary pathway, but the Badiri study did not measure food consumption or nutrient adequacy. Therefore, reduced intake as a mediator of the relationship among the respondents in this study remains an explanation that needs to be tested.

Dietary diversity, energy adequacy, and CED risk are related constructs, but they are not interchangeable. The MDD-W guidelines use food group diversity as a proxy for micronutrient adequacy at the population level, not as a direct measure of energy adequacy or diagnosis of CED (FAO, 2021). Prospective research in Tanzania suggests that dietary diversity and diet quality have different patterns of association with birth outcomes (Madzorera et al., 2020). A systematic review also found variations in the association of maternal diet with preterm birth and low birth weight (Gete et al., 2020). The Badiri study did not follow pregnancies through to delivery and therefore cannot draw conclusions about the effect of food security on birth weight, prematurity, or child growth.

Evidence from Indonesia suggests that factors associated with CED may vary by context. Wati et al. (2024) found associations with maternal age, education, pregnancy spacing, antenatal visits, and protein intake. Meanwhile, Wiyono et al. (2020) found no significant differences in CED across several dietary intake categories, education, and occupation in their sample. A study by Angkasa et al. (2024) also found no statistically significant association between dietary restrictions and CED. These results did not examine the exact same exposures as the present study, but they do suggest that not all determinants produce a uniform association.

Nutritional knowledge and practices can influence food choices during pregnancy. A systematic review by Bayked et al. (2024) emphasized the interrelationship between maternal dietary knowledge, attitudes, and practices, while a study by Gebremichael et al. (2022) identified dietary diversity, antenatal care utilization, and mental health factors as variables associated with undernutrition. These factors were not assessed as mediators or confounders in the Badiri analysis. Therefore, explanations such as stress, family food sharing, or dietary restrictions should not be considered as proven mechanisms in the participants of this study.

The interpretation of food security also depends on the instrument used. A review by Augusto et al. (2020) demonstrated the heterogeneity of food insecurity assessment tools in pregnancy and neonatal research. The HFIAS, for example, assesses households' experiences of food access difficulties through structured questionnaires (Coates et al., 2007). This reference serves as a basis for the importance of reporting the instrument; Badiri's source text does not specify whether the HFIAS or another instrument was used. The scale name, reference period, grouping rules, and validity evidence should be explained to enable readers to assess the risk of misclassification and accurately compare results.

These findings justify considering food security screening as a complement to nutritional assessment in antenatal care. Antenatal care can be an entry point for nutritional food counseling, anthropometric assessment, and referral for appropriate support to meet the mother's needs (World Health Organization [WHO], 2016). In its implementation, limited access to healthy diets and inequalities experienced by women need to be considered, in line with the maternal and child nutrition framework (FAO et al., 2024; UNICEF, 2021, 2023). The availability of food resources in a region, including coastal areas, cannot be assumed to guarantee adequate access or consumption without supporting data.

Supplementary feeding programs based on local foods remain relevant as part of maternal nutrition management, as per national guidelines (Ministry of Health, 2023). Intervention evidence supports combining specific nutrition approaches with support that addresses broader determinants (Keats et al., 2021). A qualitative evaluation in Padangsidempuan highlighted the importance of monitoring consumption and program implementation, noting that food distribution alone is insufficient to demonstrate successful implementation (Feprina et al., 2024). These findings do not prove the failure of the entire PMT program and cannot be used to determine the effectiveness of the intervention in Badiri, as this study did not evaluate that program.

A review of interventions for pregnant and postpartum women indicates a diversity of approaches, but evidence for long-term evaluation is limited (McKay et al., 2022). Another review of health service-based interventions also indicated the potential benefits of supporting food access, with limitations in the number of studies and the quality of evidence (Merchant et al., 2023). Therefore, screening and referral for food support proposed for Badiri should be accompanied by an assessment of feasibility, local needs, and outcome evaluation. Available observational data do not establish any particular intervention as the most effective option.

Strengths and limitations. The study included all 50 pregnant women in the reported population and provided a direct comparison between the two food security categories. However, the cross-sectional design does not ensure a chronological sequence between food insecurity and SEZ risk. The small sample size, implementation in a single region and period, and wide CI limit precision and generalizability. Total sampling does not eliminate the possibility of bias if the population list is incomplete. The food security instrument and the MUAC measurement procedure, which were not documented in the source text, also limit the validity of the results.

The analysis did not adjust for income, parity, pregnancy spacing, gestational age, dietary intake, comorbidities, or antenatal care utilization. These factors may influence the observed associations. MUAC provides anthropometric screening information, but does not measure the duration of energy deficiency and does not replace a comprehensive nutritional assessment. The results should be treated as unadjusted associations within the local population. Further research with larger samples, standardized instruments, food consumption data, and prospective follow-up is needed to assess time sequence, confounding factors, and pregnancy outcomes.

CONCLUSION

Household food insecurity was associated with a higher prevalence of CED risk among pregnant women in Badiri District in March 2025. The proportion of CED risk was 50.0% in the food insecure group and 14.3% in the food secure group (unadjusted RP = 3.50; 95% CI: 1.29–9.50; $p = 0.006$). Food security screening can be considered as a complement to nutritional assessment and food access support in antenatal care. These findings indicate an association and do not confirm a causal relationship or a relationship independent of confounding factors.

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