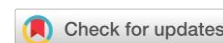


The Relationship between Food Consumption Diversity and the Nutritional Status of Pregnant Women as an Effort to Prevent Chronic Energy Deficiency

Jenni Susi Sihite*, Oktaviani Putri Zega, Mei Yati Simatupang

STIKes Nauli Husada, North Sumatra, Indonesia

*Correspondent Author: Jenni Susi Sihite (jennisusi605@gmail.com)



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ABSTRACT

Background: Dietary diversity is an indicator of diet quality, while mid-upper arm circumference (MUAC) is used to screen pregnant women for chronic energy deficiency risk. This study examined the association between dietary diversity and chronic energy deficiency risk among pregnant women in Kolang, Central Tapanuli, Indonesia.

Methods: A cross-sectional study was conducted in February 2025 among 40 pregnant women recruited through total sampling. Data were collected using questionnaires and MUAC measurements. Dietary diversity was classified as diverse (≥ 5 food groups) or less diverse (< 5 food groups). Chronic energy deficiency risk was defined as MUAC < 23.5 cm. Associations were assessed using a two-sided Fisher's exact test and a crude prevalence ratio (PR) with a 95% confidence interval (CI).

Results: Twenty-five women (62.5%) consumed diverse diets, and 12 (30.0%) screened positive for chronic energy deficiency risk. Risk prevalence was 60.0% (9/15) in the less diverse group and 12.0% (3/25) in the diverse group. Recalculation of the aggregated contingency table indicated an association between dietary diversity and chronic energy deficiency risk ($p = 0.003$; PR = 5.00; 95% CI: 1.60–15.62).

Conclusion: Lower dietary diversity was associated with a higher prevalence of chronic energy deficiency risk. These findings support attention to dietary diversity in antenatal care but do not establish causality or preventive effectiveness. Longitudinal studies using standardized dietary assessments and adjustment for confounding are needed.

BACKGROUND

Maternal nutrition before and during pregnancy plays a crucial role in maternal health and fetal development. Malnutrition during this period contributes to the burden of maternal and child malnutrition, therefore, meeting nutritional needs requires a focus for health services (Black et al., 2013). A report by the United Nations Children's Fund (UNICEF, 2023) highlighted the barriers women face in accessing nutritious diets, nutrition services, and social support. Therefore, maternal nutrition issues need to be understood through the interaction of food intake, socioeconomic conditions, and access to services.

Regional evidence suggests that pregnant women's dietary intake does not always meet their needs. A systematic review and meta-analysis in Indonesia and Malaysia found deficiencies in energy and several macro- and micronutrient intakes, with variations between studies and countries (Agustina et al., 2023). These findings highlight the need for dietary assessments that consider both food quality and quantity, without assuming that a diverse diet always meets energy needs.

Dietary diversity describes the variety of food groups consumed over a period. The Food and Agriculture Organization of the United Nations (FAO, 2021) defines Minimum Dietary Diversity for Women

(MDD-W) as the consumption of at least five of ten food groups during the previous 24 hours in women aged 15–49 years. This indicator is primarily used as a proxy for micronutrient adequacy at the population level. Validation studies have shown an association between food group diversity indicators and micronutrient adequacy in women, but this relationship is not identical to the diagnosis of individual nutritional status (Arimond et al., 2010). A review of dietary diversity indicators also emphasized that their associations with health outcomes depend on the indicator definition and the measurement context (Verger et al., 2021).

In the Indonesian context, an Upper arm circumference of <23.5 cm is a screening criterion for pregnant women at risk of CED in the technical guidelines for providing supplementary feeding made from local foods (Ministry of Health of the Republic of Indonesia, 2023). Upper arm circumference has practical advantages as an anthropometric measure, but the cutoff and intended use need to be tailored to the service and population context (Ververs et al., 2013). Therefore, the term "at risk of CED" is more appropriate for Upper arm circumference screening results than for a confirmed CED diagnosis.

Previous research provides a basis for examining dietary diversity during pregnancy. A cohort study in Ethiopia reported an association between dietary diversity and maternal anemia and birth outcomes (Zerfu et al., 2016). A systematic review suggested that low dietary diversity may be associated with low birth weight, although evidence comes from mixed observational studies (Kheirouri & Alizadeh, 2021). A more recent meta-analysis found an association between inadequate dietary diversity and low birth weight and small for gestational age, but found no significant association with preterm birth (Tareke et al., 2024).

This evidence cannot directly replace information at the local service level. In this study, the relationship between dietary diversity categories and Upper arm circumference screening results was examined in pregnant women in Kolang District, Central Tapanuli. The objective was to analyze the relationship between dietary diversity and the risk of CED in pregnant women in February 2025. The study results are expected to provide baseline information for antenatal nutrition assessment and further research planning, without claiming the effectiveness of preventive interventions.

METHOD

Design, location and participants

An analytical observational study with a cross-sectional design was conducted in Kolang District, Central Tapanuli Regency, in February 2025. The population reported in the source text was 40 pregnant women. All were included through total sampling, resulting in a sample size of 40 participants. Inclusion criteria were being pregnant and willing to be respondents. Mothers who could not be interviewed due to illness were excluded; refusal to participate was considered a condition that did not meet the inclusion criteria.

Variables and data collection

The exposure variable was food consumption diversity. Based on the categories in the source table, consumption of ≥ 5 food groups was classified as diverse, while consumption of < 5 groups was classified as less diverse. Information on food consumption and participant characteristics was obtained through a questionnaire. Reported characteristics included age, education, occupation, and trimester of pregnancy. The outcome variable was the risk of CED based on the Upper arm circumference. Participants with an Upper arm circumference < 23.5 cm were classified as at risk of CED, while those with an Upper arm circumference ≥ 23.5 cm were classified as not at risk based on this threshold (Ministry of Health of the Republic of Indonesia, 2023). The term not at risk in this article is limited to the Upper arm circumference screening results and does not imply that all aspects of the participant's nutritional status are normal.

Statistical analysis

Categorical data are presented as frequencies and percentages. The association between dietary diversity and CED risk was analyzed using a two-tailed Fisher's exact test with a significance level of 0.05. The Fisher's exact test was chosen because one in four cells (25%) in the 2×2 table had an expected frequency < 5 , necessitating consideration of the asymptotic chi-square approach (Kim, 2017). The magnitude of the association is reported as a crude prevalence ratio (RP) with a 95% confidence interval (CI), as outcomes were assessed at a single point in time in a cross-sectional design (Barros & Hirakata, 2003).

The RP is calculated as the prevalence of CED risk in the less diverse group divided by the prevalence in the diverse group. The 95% CI was calculated using a logarithmic (Wald) approach. The analyses presented have not been adjusted for confounding factors. The aggregated tables do not allow for multivariable analysis or examination of individual data.

RESULTS

Participant characteristics

A total of 40 pregnant women were included in the study data. The majority were aged 20–35 years (80.0%), had secondary education (60.0%), and were unemployed/housewives (67.5%). The second trimester was the largest group (45.0%). Twenty-five participants (62.5%) had a diverse food consumption, while 15 participants (37.5%) had less diverse food consumption. The Upper arm circumference screening results showed that 12 participants (30.0%) were at risk for CED and 28 participants (70.0%) were not at risk according to the Upper arm circumference threshold (Table 1).

Table 1. Participant characteristics, food consumption diversity, and CED risk (n = 40)

Variables	Category	n	%
Age	<20 years	3	7.5
	20–35 years	32	80.0
	>35 years	5	12.5
Education	Base	8	20.0
	Intermediate	24	60.0
	Tall	8	20.0
Work	Not working/housewife	27	67.5
	Work	13	32.5
Trimester of pregnancy	I	7	17.5
	II	18	45.0
	III	15	37.5
Diversity of food consumption	Diverse (≥ 5 groups)	25	62.5
	Less diverse (< 5 groups)	15	37.5
CED risk based on Upper arm circumference	At risk (Upper arm circumference < 23.5 cm)	12	30.0
	No risk (Upper arm circumference ≥ 23.5 cm)	28	70.0

Note: Percentages are calculated based on 40 participants. Operational definitions of education, trimester, and dietary diversity measurements need to be supplemented from the original protocol.

The relationship between food consumption diversity and the risk of CED

In the less diverse consumption group, 9 out of 15 mothers (60.0%) were at risk of CED. In the diverse consumption group, 3 out of 25 mothers (12.0%) were at risk of CED. Recalculation based on the cell frequencies of the source table showed an association between food consumption diversity and CED risk (two-sided Fisher's exact test, $p = 0.003$). The crude RP was 5.00 (95% CI: 1.60–15.62), which means the prevalence of screening results at risk of CED in the less diverse group was five times the prevalence in the diverse group. This estimate does not indicate the risk of new events and has not been controlled for confounding factors.

Table 2. Relationship between food consumption diversity and the risk of CED in pregnant women (n = 40)

Food diversity	CED risk, n (%)	No risk, n (%)	Total, n
Less diverse (< 5 groups)	9 (60.0)	6 (40.0)	15
Diverse (≥ 5 groups)	3 (12.0)	22 (88.0)	25
Total	12 (30.0)	28 (70.0)	40

Note: Percentages in the two group rows are calculated per row; total row percentages are calculated over all participants. Two-tailed Fisher exact test: $p = 0.003$. Crude RP of less diverse than diverse groups = 5.00 (95% CI: 1.60–15.62; CI log-Wald approximation). Expected frequencies: 4.5; 10.5; 7.5; 17.5. Totals and statistics are recalculations of the four cell frequencies of the source manuscript and need to be confirmed against the original dataset.

DISCUSSION

Interpretation of main findings

This study found that the group of pregnant women with a less diverse dietary intake had a higher prevalence of CED risk based on the Upper arm circumference than the diverse group. The large RP indicates a noteworthy association, but the wide CI reflects the uncertainty of the estimates in the small sample. Because dietary intake and Upper arm circumference were assessed at a single point in time, this study cannot confirm that low dietary diversity preceded the decline in Upper arm circumference. The term association is more appropriate than effect or prevention effectiveness.

This finding aligns with a meta-analysis in Ethiopia that identified low dietary diversity scores, household food insecurity, and lack of antenatal nutrition advice as factors associated with maternal malnutrition (Zewude et al., 2024). The alignment of these associations does not imply direct comparison of the magnitudes of the associations, as anthropometric indicators, category thresholds, socioeconomic conditions, and adjustments for confounding factors may differ. The 30.0% proportion at risk of CED in this study also cannot be considered a representative prevalence for all of Central Tapanuli.

Dietary diversity, nutritional adequacy, and pregnancy outcomes

Consuming a variety of food groups can broaden the range of nutrients obtained from food. Validation studies in women in several countries have shown that food group diversity is associated with micronutrient adequacy (Arimond et al., 2010). However, the number of food groups does not directly measure portion size, total energy, protein, or overall diet quality. Therefore, the association between food diversity and MUAC in this study does not provide evidence for specific mechanisms of energy or micronutrient deficits. Energy and nutrient fulfillment still require more detailed quantitative assessment (Agustina et al., 2023; Verger et al., 2021).

The use of the MDD-W terminology must comply with FAO (2021) data collection procedures, including ten food groups and a 24-hour period. The threshold of ≥ 5 groups in this study's table is insufficient to ensure that the standard indicators are truly applied. Unclear reference periods and food classifications could potentially influence the placement of participants in diverse or less diverse categories. Instrument verification is a prerequisite for interpreting findings and comparing them with other studies.

Evidence related to birth outcomes provides context but was not the outcome measured in this study. The Zerfu et al. (2016) cohort study found an association between dietary diversity and anemia and birth outcomes; Kheirouri and Alizadeh's (2021) systematic review and Seid et al.'s (2023) meta-analysis also showed an association between low dietary diversity and low birth weight. The Geta et al. (2024) cohort, which measured dietary diversity on three occasions, found a higher risk of low birth weight in the suboptimal diversity group. The Kolang study did not measure hemoglobin, birth weight, or child growth and therefore cannot claim improvements in these outcomes.

International findings need to be read critically. Tareke et al.'s (2024) meta-analysis found an association between inadequate dietary diversity and low birth weight and small for gestational age, but not preterm birth; there was also heterogeneity and the potential influence of publication bias on low birth weight estimates. Therefore, the association between dietary diversity and maternal and infant health cannot be expressed uniformly across populations.

Implications of antenatal care

Screening results for CED risk can be used to guide further nutritional assessments, including meal quantity and frequency, food access, and health status. The MUAC is a practical measure, but its interpretation should be limited by the screening objectives and thresholds used (Ververs et al., 2013). In Indonesian services, this assessment can be linked to nutritional counseling and management based on national guidelines (Ministry of Health of the Republic of Indonesia, 2023).

WHO antenatal guidelines include counseling on healthy eating patterns and balanced energy and protein supplementation in undernourished populations (World Health Organization [WHO], 2016). A

Cochrane review supports the potential benefits of nutrition education and balanced energy-protein supplementation on several infant outcomes, with limited quality of evidence for some outcomes (Ota et al., 2015). Reviews of maternal and child nutrition interventions also emphasize the importance of effective intervention coverage and reaching vulnerable groups (Keats et al., 2021). These service recommendations are based on intervention literature and guidelines, not on evidence of effectiveness from this cross-sectional study.

Counseling should consider food availability, economic capacity, and family eating habits. A variety of animal and plant-based side dishes, vegetables, and fruits can be discussed, along with the need for adequate portion sizes. Supporting access to food and nutrition services is also crucial, as barriers to women's nutrition are not solely related to individual choices (UNICEF, 2023). Local food-based programs should be evaluated separately to determine their impact on dietary intake and anthropometric indicators.

CONCLUSION

Dietary diversity was associated with the risk of CED based on the Life Cycle Monitoring Index (UPPER ARM CIRCUMFERENCE) in 40 pregnant women in Kolang District, Central Tapanuli. The less diverse group had a prevalence of CED risk of 60.0%, compared to 12.0% in the diverse group (two-sided Fisher's exact test, $p = 0.003$; crude RP = 5.00; 95% CI: 1.60–15.62). These findings support the emphasis on dietary diversity in antenatal nutrition assessment, but do not prove a preventive effect or causal relationship. Further data confirmation, complete reporting of methods, and longitudinal studies are needed to strengthen the conclusions.

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