Indonesian Journal of Global Health Research
Volume 8 Number 3, June 2026
e-ISSN 2715-1972; p-ISSN 2714-9749
http://jurnal.globalhealthsciencegroup.com/index.php/IJGHR

THE RELATIONSHIP BETWEEN FAMILY INCOME AND MARONUTRIENT INTAKE WITH THE INCIDENCE OF CHRONIC ENERGY DEFICIENCY IN PREGNANT WOMEN

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ABSTRACT
Chronic Energy Deficiency (CED) in pregnant women remains a major public health problem in developing countries, including indonesian. Socioeconomic factors such as family income and inadequate macronutrient intake play an important role in the occurrence of CED. This study aimed to analyse the relationship betwen family income and macronutrient intake with the incident of chronic enegry deficiency in pregnant women. This study employed an observational analytic design with cross-sectional apporach. The study population consisted of pregnant women who attended antenatal care service at primary health centres. Family income data were collected using structured questionnaires, while amcronutrient intake (enegry, protein, fat and carbohydrate) was assessed using a 24-hour dietary recall. The incidence of CED was determined based on MUAC measurement. Data were analysed using appopriate statistical test with a significance level of 0.05. The result showed the signicant relationship between family income and the incidence of chronic energy deficiency in pregnant women ($p<0.05$). in addition, inadequate macronutrient intake, particularly enegry and protein intake, was significantly associated with the incident of CED ($p<0.05$). family income and macronutrient intake are significantly associated with the incident of chronic energy deficiency in pregnant women. Effort to impove household economic conditions and maternal mutritional intake are essential to prevent CED during pregnancy.

Keywords: chronic energy deficiency; famili income; macronutrient intake; pregnant women and maternal

How to cite (in APA style)
Raodah, S., Suminah, S., & Novika, R. G. H. (2026). The Relationship between Family Income and Maronutrient Intake with the Incidence of Chronic Energy Deficiency in Pregnant Women. *Indonesian Journal of Global Health Research*, *8*(3), 795–802. https://doi.org/10.37287/ijghr.v8i3.1291.

INTRODUCTION

Chronic Energy Deficiency (CED) among pregnant women remains a major public health concern, particularly in low- and middle-income countries. CED reflects a long-term imbalance between energy intake and physiological requirements, which can adversely affect maternal health and fetal development. Pregnant women experiencing CED are at increased risk of adverse pregnancy outcomes, including low birth weight, preterm birth, and increased maternal and neonatal morbidity and mortality (WHO, 2021).

Socioeconomic factors, especially household income, play a critical role in determining maternal nutritional status during pregnancy. Household income influences food purchasing power, dietary diversity, and access to nutritionally adequate foods (Maulinda, 2023). Pregnant women from low-income households are more likely to experience food insecurity and inadequate dietary intake, increasing their vulnerability to chronic undernutrition (Husniah; et al., 2022) . Limited financial resources often force households to prioritize food quantity over quality, resulting in insufficient intake of essential macronutrients required during pregnancy (Amrang et al., 2020). Adequate macronutrient intake comprising energy, protein, fat, and carbohydrates is essential to support

physiological changes during pregnancy and optimal fetal growth (Rahardjo and Wati, 2022). Energy and protein deficiencies can lead to the depletion of maternal energy reserves, while inadequate fat and carbohydrate intake may impair metabolic balance and nutrient absorption. Previous studies have shown that insufficient macronutrient consumption during pregnancy is significantly associated with maternal undernutrition and increased risk of CED. Despite this evidence, maternal nutrition programs often emphasize micronutrient supplementation, while the role of macronutrient adequacy receives comparatively less attention (Hasanah et al., 2023). In Indonesia, maternal undernutrition remains a persistent challenge. National health surveys have reported that a considerable proportion of pregnant women continue to experience CED, with higher prevalence observed among women from socioeconomically disadvantaged households (SKI, 2023). Rural and semi-urban areas often face additional constraints related to income instability, food access, and dietary patterns, which may further exacerbate the risk of CED among pregnant women (Rahayu and Purnomo, 2024).

Several previous studies have examined the relationship between income or dietary intake and CED separately; however, comprehensive analyses that simultaneously evaluate household income and detailed macronutrient intake remain limited (Sukmawati et al., 2023). Moreover, many studies focus on specific nutrients or use bivariate approaches, which may not fully capture the complex interaction between socioeconomic factors and dietary intake. Understanding these relationships is essential for designing effective maternal nutrition interventions that address both economic and dietary determinants of CED (Nugroho, 2023). Therefore, this study aims to analyze the association between household income and macronutrient intake specifically energy, protein, fat, and carbohydrates with the occurrence of chronic energy deficiency among pregnant women. The findings of this study are expected to provide evidence-based insights to support integrated nutrition and socioeconomic strategies for preventing maternal undernutrition and improving pregnancy outcomes.

METHOD

This study employed an analytical observational design with a cross-sectional approach. The research was conducted in Karanganyar Regency, Central Java, Indonesia, an area representing both semi-urban and rural characteristics. Data collection was carried out between October 2025 to November 2025. at selected primary health care centers that provide routine antenatal care services. The study population consisted of all pregnant women who attended antenatal care services at the selected health centers during the study period. A total of 116 pregnant women were included in the study. The sampling technique used in this study was multistage sampling by combining two or more techniques in the sampling process. The purposive sampling technique was used to determine the sample size in the study in accordance with the criteria that had been established. The sample size was determined based on the availability of eligible participants who met the inclusion criteria. The inclusion criteria were pregnant women in any trimester, aged 15–35 years, who were willing to participate and provided informed consent. Pregnant women with severe chronic illnesses or conditions that could affect nutritional status, such as tuberculosis or other debilitating diseases, were excluded from the study. Data were collected by trained enumerators using structured questionnaires and standardized measurement tools. Socioeconomic data, including household income, were obtained through face-to-face interviews. Dietary intake data were collected using a 24-hour food recall method, which captured all foods and beverages consumed by the respondents during the previous day. Anthropometric measurements were conducted following standard procedures. Mid-upper arm circumference (MUAC) was measured using a non-stretchable measuring tape to assess chronic energy deficiency. Chronic Energy Deficiency (CED) was the dependent variable in this study and was defined based on MUAC measurements. Pregnant women with MUAC < 23.5 cm were classified as having CED, while those with MUAC ≥ 23.5 cm were classified as non-CED (WHO, 2021). The independent variables included household income and macronutrient intake (energy, protein, fat, and carbohydrates). Household income was categorized

according to the regional minimum wage standard. Macronutrient intake was calculated based on the 24-hour food recall and analyzed using food composition tables to estimate daily intake of energy (kcal), protein (g), fat (g), and carbohydrates (g). Intake levels were categorized based on the Indonesian Recommended Dietary Allowances (RDA). Data were analyzed using statistical software. Descriptive analysis was conducted to summarize the characteristics of respondents and study variables. Bivariate analysis was performed to examine the association between household income, macronutrient intake, and CED using appropriate statistical tests. Multivariate analysis was conducted using path analysis to assess the combined effects of household income and macronutrient intake on the occurrence of CED. Statistical significance was set at $p < 0.05$. This study received ethical approval from the Health Research Ethics Committee of Dr. Moewardi General Hospital (Ethical Clearance No: 2.128/X/HREC/2025). Written informed consent was obtained from all participants prior to data collection. Confidentiality and anonymity of respondents were strictly maintained throughout the study. Statistical analysis revealed a significant relationship between family income and the incidence of chronic energy deficiency in pregnant women ($p < 0.05$). Pregnant women from low-income families were more likely to experience CED compared to those from higher-income families. In addition, inadequate macronutrient intake, particularly low energy and protein intake, was significantly associated with the incidence of CED ($p < 0.05$).

RESULT

Tabel 1.
Responden Characteristics

Charakteristics	f	%
Age		
20	3	2.6
21	11	9.5
22	9	7.8
23	14	12.1
24	6	5.2
25	15	12.9
26	9	7.8
27	12	10.3
28	11	9.5
29	1	.9
30	7	6.0
31	3	2.6
32	2	1.7
33	7	6.0
34	2	1.7
35	4	3.4
Job		
Doesn’t Work	60	51.7
Work	56	48.3
Education		
Junior High School	17	14.7
Senior High School	75	64.7
University	24	20.7
Family income		
Less	65	56.0
Better	25	21.6
More	26	22.4
Age at Merriage		
< 19 years	22	19.0
> 19 years	94	81.0
Member of Family		
< 4 people	56	48.3
> 4 people	60	51.7

Charakteristics	f	%
Nutrition Status		
Less (<23.5 cm)	91	78.4
Better (>23.5 cm)	25	21.6
Trimester		
First Trimester	59	50.9
Second Trimester	57	49.1
Food Intake		
Energi		
Less	74	63.8
Better	39	33.6
More	3	2.6
Protein		
Less	68	78.8
Better	43	19.0
More	5	2.2
Fat		
Less	85	73.3
Better	26	22.4
More	5	4.3
Carbohydrat		
Less	56	48.3
Better	49	42.2
More	11	9.5

A total of 116 pregnant women participated in this study. The respondents were distributed across all trimesters of pregnancy. Based on socioeconomic assessment, a considerable proportion of respondents were categorized as having household income below the regional minimum wage. Anthropometric assessment showed that a notable number of pregnant women were classified as experiencing chronic energy deficiency based on MUAC measurements. Bivariate analysis demonstrated a significant association between household income and the occurrence of chronic energy deficiency among pregnant women ($p < 0.05$). Pregnant women from lower-income households were more likely to experience CED compared to those from households with higher income. Analysis of dietary intake revealed that a substantial proportion of respondents had inadequate intake of energy, protein, fat, and carbohydrates. Bivariate analysis showed that inadequate intake of each macronutrient was significantly associated with the occurrence of chronic energy deficiency ($p < 0.05$). Pregnant women with insufficient macronutrient intake had a higher prevalence of CED compared to those who met the recommended dietary allowances. Multivariate path analysis was conducted to assess the combined effects of household income and macronutrient intake on chronic energy deficiency. The results indicated that household income and macronutrient intake variables contributed significantly to the occurrence of CED ($p < 0.05$). Lower household income was associated with inadequate macronutrient intake, which in turn increased the risk of chronic energy deficiency among pregnant women.

Tabel 2.
Path coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
MACRO NUTRIENT INTAKE -> PREGNANT WOMEN	0.466	0.464	0.065	7.193	0.000
MACRONUTRIENT INTAKE -> NUTRITIONAL STATUS	0.287	0.284	0.081	3.550	0.000
INCOME -> MACRO NUTRIENT INTAKE	-0.028	-0.029	0.087	0.325	0.745
INCOME -> PREGNANT WOMEN with CED	0.090	0.092	0.088	1.021	0.307
INCOME -> NUTRIENT INTAKE	0.036	0.038	0.090	0.401	0.689

Based on the table above, the results of *the path analysis* between exogenous variables and endogenous variables with the application of SMARTPLS.4. Path analysis is read at standardized beta coefficient values, in addition to path analysis, independent variables with the names of exogenous variables and dependent variables are endogenous variables. In the results of the path analysis, there are several statistically significant relationships. Macronutrient intake was significantly related to the incidence of chronic energy deficiency (KEK) in pregnant women (p = 0.000) and to nutritional status (p = 0.000). In addition, income had an insignificant relationship with macronutrient intake (p = 0.745), income had an insignificant relationship with pregnant women's CED (p = 0.307) and income had an insignificant relationship with nutritional intake (p = 0.689). Thus, not all paths in the model have statistically significant relationships when viewed from *p-value alone*.

Tabel 3.

R-Square

	R-square	R-square adjusted
Prenant women with CED	0.223	0.209
Nutrition status	0.083	0.067
Macronutrent intake	0.00	-0.008

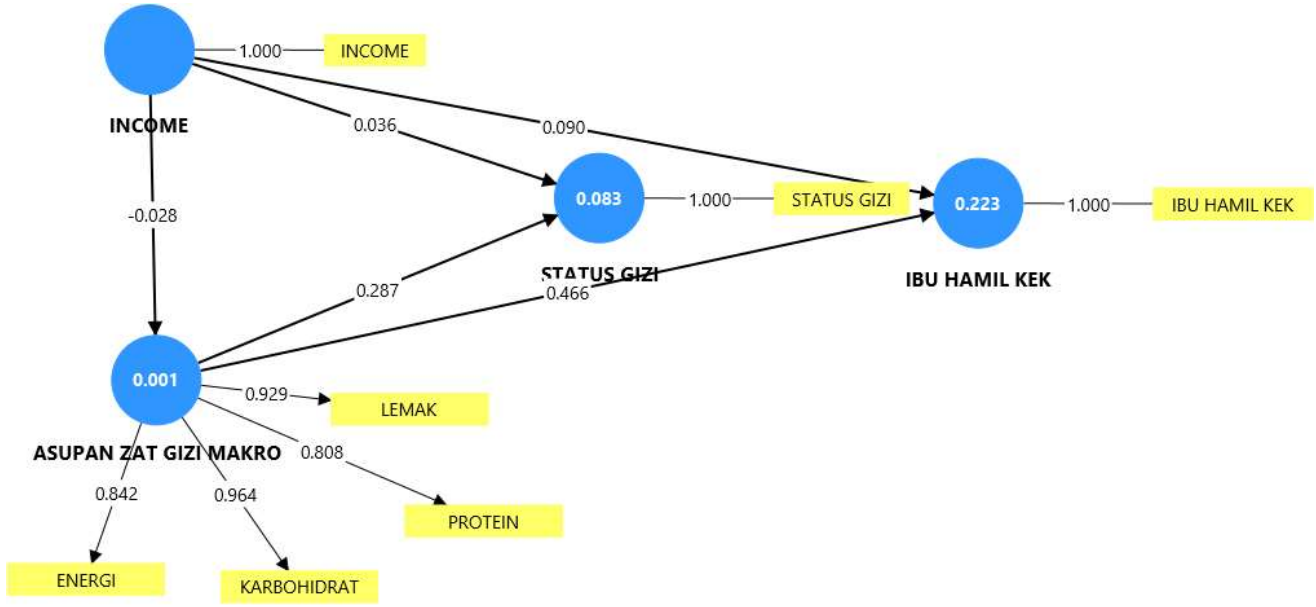
The R-square value in pregnant women with CED of 0.223 indicates that the model is only able to explain 22.3% of endogenous variable variations in the weak to moderate category. The R-square value at nutritional status of 0.083 indicates that the model is only able to explain 8.3% and the R-square value at macronutrient intake of 0.001 indicates that the model is only able to explain 0.1% variation of endogenous variables can be explained by exogenous variables, which fall into the weak to moderate category.

Tabel 3.

F-Square

	Prenant women with CED	Nutrition status	Macronutrent intake
Macronutrient intake	0.279	0.090	
Family income	0.010	0.001	0.001

The f-square value (f^2) between macronutrient intake and CED incidence is 0.279, macronutrient intake with nutritional status of 0.090 shows a large effect, which means that predictor variables have a strong and important contribution in explaining endogenous variables. On the other hand, the f^2 value in income with CED of 0.010, income with nutritional status of 0.001 and *income* with macronutrient intake of 0.001 showed a very small effect, indicating that the contribution of the predictive variable was very minimal to the dependent variable and was less meaningful in practical terms.



DISCUSSION

This study demonstrates that household income and macronutrient intake are significantly associated with the occurrence of chronic energy deficiency among pregnant women. These findings highlight the importance of both socioeconomic conditions and dietary adequacy in determining maternal nutritional status during pregnancy (Afrinis et al., 2022). The significant association between household income and chronic energy deficiency found in this study is consistent with previous research conducted in low- and middle-income countries. Household income is a fundamental determinant of food access, dietary quality, and nutritional adequacy. Pregnant women from low-income households are more vulnerable to food insecurity, which limits their ability to meet increased nutritional requirements during pregnancy (Hasanah et al., 2023). Limited financial resources often lead households to rely on monotonous, low-cost diets that are insufficient in both energy and macronutrient content, increasing the risk of chronic undernutrition. The findings also reveal significant associations between inadequate intake of energy, protein, fat, and carbohydrates and the occurrence of chronic energy deficiency. Adequate energy intake is essential to support increased metabolic demands and physiological changes during pregnancy. Prolonged energy deficits may result in the depletion of maternal energy reserves, reflected in reduced mid-upper arm circumference measurements (WHO, 2022). This result aligns with previous studies reporting that insufficient energy intake is a strong predictor of maternal undernutrition and CED (Hasanah et al., 2023).

Protein intake plays a crucial role in supporting tissue growth, plasma volume expansion, and fetal development. Inadequate protein consumption during pregnancy has been associated with impaired maternal nutritional status and increased risk of adverse pregnancy outcomes. The significant association observed in this study supports earlier findings that low protein intake contributes to chronic energy deficiency among pregnant women, particularly in resource-limited settings (Nuradhiani, 2022). Fat and carbohydrate intake were also significantly associated with CED in this study. Dietary fat serves as a dense source of energy and is essential for the absorption of fat-soluble vitamins, while carbohydrates provide the primary source of energy for daily activities and metabolic processes. Insufficient intake of these macronutrients may compromise overall energy balance, leading to chronic undernutrition (Sri Lestari et al., 2023). Previous studies have emphasized that diets low in fat and carbohydrates are commonly observed among pregnant women from low socioeconomic backgrounds and are associated with poor nutritional status (Nugroho, 2023).

Multivariate analysis further indicates that household income may indirectly influence the occurrence of chronic energy deficiency through its effect on macronutrient intake. This finding suggests that economic constraints may limit the quantity and quality of food consumed, resulting in inadequate macronutrient intake and increased risk of CED. Similar pathways have been reported in previous studies, highlighting the interconnected relationship between socioeconomic factors, dietary intake, and maternal nutritional outcomes (Agedew et al., 2022). Despite its contributions, this study has several limitations. The cross-sectional design limits the ability to establish causal relationships between household income, macronutrient intake, and chronic energy deficiency. Dietary intake was assessed using a single 24-hour food recall, which may not fully represent habitual intake and is subject to recall bias. Additionally, the study was conducted in a specific geographic area, which may limit the generalizability of the findings to populations with different socioeconomic and cultural characteristics. Nevertheless, the findings of this study have important public health implications. Interventions aimed at preventing chronic energy deficiency among pregnant women should not only focus on nutritional education and supplementation but also address underlying socioeconomic constraints. Strengthening household economic capacity and improving access to affordable, energy-ufficient foods may play a critical role in improving maternal nutritional status and pregnancy outcomes.

CONCLUSION

The findings of this study indicate that family income is significantly associated with the incidence of chronic energy deficiency in pregnant women. Low family income limits household food purchasing power, which may result in inadequate quantity and quality of food intake during pregnancy. This finding is consistent with previous studies showing that socioeconomic status is a key determinant of maternal nutritional status. Inadequate macronutrient intake, particularly energy and protein intake, was also found to be significantly associated with CED. Pregnant women with insufficient energy intake are unable to meet the increased metabolic demands of pregnancy, leading to long-term energy deficiency. Protein deficiency further exacerbates this condition by impairing tissue growth and fetal development. These results support previous research that emphasises the importance of adequate dietary intake and socioeconomic support in preventing maternal undernutrition. Therefore, interventions aimed at improving household economic conditions and promoting balanced dietary intake during pregnancy are essential to reduce the prevalence of CED.

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