

Determinants of chronic energy deficiency (CED) in pregnant women in stunting

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ABSTRACT

Introduction: Chronic Energy Deficiency (CED) in pregnant women results from prolonged malnutrition, particularly insufficient energy and protein intake. This condition significantly increases the risk of maternal and infant mortality, low birth weight (LBW), and contributes to stunting in children. This study aims to identify the determinants influencing the incidence of CED among pregnant women in the stunting.

Method: A cross-sectional observational study was conducted among 201 pregnant women selected through purposive sampling from 30 stunting-prone villages. Data collection involved Android-based questionnaires and anthropometric measurements using Mid-Upper Arm Circumference (MUAC). Statistical analyses included chi-square tests for bivariate analysis and logistic regression for multivariate analysis.

Results: The prevalence of CED among the participants was 15.9%. Significant factors associated with CED included maternal age ($p=0.000$; OR=2.79; 95% CI: 1.67–4.64), employment status ($p=0.016$; OR=6.73; 95% CI: 1.58–27.94), antenatal care visits ($p=0.004$; OR=11.31; 95% CI: 2.71–28.19), pregnancy spacing ($p=0.023$; OR=6.80; 95% CI: 1.31–26.8), family smoking history ($p=0.002$; OR=0.45; 95% CI: 0.27–0.75), and family income ($p=0.013$; OR=5.24; 95% CI: 1.73–26.02).

Conclusion: CED among pregnant women is significantly influenced by age, occupational status, antenatal care frequency, pregnancy interval, family exposure to cigarette smoke, and low household income. Strengthening antenatal care services, promoting family planning, enhancing nutrition education, and mitigating environmental risk factors such as secondhand smoke exposure are essential strategies to reduce CED and its adverse health outcomes.

Keywords: Chronic Energy Deficiency; Pregnancy; Risk Factors; Stunting.



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INTRODUCTION

One common nutritional problem in pregnant women is chronic energy deficiency (CED), caused by long-term malnutrition and recognisable by a reduced mid-upper arm circumference (MUAC) of less than 23.5 cm. Chronic energy deficiency (CED) in pregnant women has very serious impacts on maternal health and fetal development. CED increases the risk of anemia, maternal death, and pregnancy complications such as low birth weight (LBW) babies, premature delivery, and congenital abnormalities (Arnianti, Adelliana, and Hasnitang, 2022). This condition can also weaken the mother's immune system, making her more susceptible to infections during pregnancy. In the fetus, CED has the potential to inhibit intrauterine growth, which impacts physical and cognitive development after birth. This will trigger the emergence of new cases of stunting (Akib and Rukinah, 2024).

Approximately 20% of growth disorders begin during fetal development in mothers experiencing malnutrition, resulting in the fetus not receiving sufficient nutrition for optimal growth and development. Stunting occurs before delivery, underscoring the importance of prevention efforts starting during antenatal care. Babies born to mothers with Chronic Energy Deficiency (CED) are 1.6% more likely to experience growth disorders compared to babies born to mothers without CED. This underscores the crucial role of maternal nutritional status in fetal development and the urgency of early intervention to reduce potential negative impacts (Arda, Lalla, and Suprpto, 2023).

Chronic Energy Deficiency (CED) remains a problem in Indonesia. Women and children are the groups at highest risk of Chronic Energy Deficiency (CED). Currently, CED is a concern for the government and healthcare professionals because a woman of childbearing age with CED has a high risk of giving birth to a child who will also experience CED later in life. In addition, malnutrition causes health problems such as morbidity, mortality, and disability, reducing the quality of a nation's human resources. On a broader scale, malnutrition can threaten a nation's resilience and survival (Wells *et al.*, 2021).

Based on the 2023 Indonesian Health Survey (SKI), 16.9% of pregnant women throughout Indonesia experience Chronic Energy Deficiency (CED). However, the province of South Sulawesi recorded a significantly higher prevalence of CED among pregnant women, at 19.7%. This high prevalence is related to inadequate consumption of nutritious food during pregnancy and low maternal knowledge regarding optimal eating practices to ensure sufficient nutrition during pregnancy (Marshall *et al.*, 2022).

Factors influencing the occurrence of CED in pregnant women include both direct and indirect factors. Direct factors primarily involve insufficient energy, protein intake, and susceptibility to infectious diseases. Indirect determinants encompass various aspects, including maternal age, parity, education level, knowledge of nutritional needs, employment status, household income, expenditure on food, availability of nutritious food, and the frequency of antenatal care (ANC) visits. These factors collectively influence the prevalence and severity of anemia in pregnant women (N. P. Hariram *et al.*, 2023).

It should be noted that the risk factors influencing the occurrence of SAM differ in each region, depending on the characteristics of the local community, prevailing consumption patterns, and the existing socio-economic and cultural conditions within that

society. This emphasises the importance of appropriate intervention adjustments to address the local factors contributing to Chronic Energy Deficiency (CED) in pregnant women. Given the various challenges, it became clear that the nutritional status of pregnant women is a crucial issue in Indonesia. Therefore, this study aims to identify the factors contributing to Chronic Energy Deficiency (CED) in pregnant women. By understanding these factors, focused and effective interventions can be designed and implemented to reduce the prevalence of CED in pregnant women, thereby improving the overall nutritional status and health outcomes for both mother and fetus.

RESEARCH METHODOLOGY

This study employed an observational analytic approach using a cross-sectional design. The research was conducted in two districts of South Sulawesi, Bone and Enrekang, specifically targeting 40 stunting focus villages in Bone and 30 stunting focus villages in Enrekang. The provincial government selected these locations based on a high prevalence of stunting and their designation as priority intervention areas (stunting locus). The study population consisted of all pregnant women residing in these villages. The sample included pregnant women who met predetermined inclusion criteria: having a Maternal and Child Health (MCH) handbook and not participating in regular prenatal checkups during the study period. Exclusion criteria included pregnant women with infectious diseases, hypertension, or HIV/AIDS. The sampling technique used was cluster random sampling to ensure the representation of pregnant women across multiple villages with varying socio-demographic backgrounds.

A total of 201 pregnant women from Enrekang Regency were selected for analysis. Data were collected through structured questionnaires integrated into an Android-based application and anthropometric measurements. The Mid-Upper Arm Circumference (MUAC) was used to assess nutritional status. MUAC measurements were conducted using a standardised tape with 0.1 cm precision. Pregnant women with a MUAC of less than 23.5 cm were classified as experiencing Chronic Energy Deficiency (CED). The study's independent variables included maternal age, pregnancy spacing, education level, occupation, knowledge of maternal nutrition, age of the youngest child, utilisation of antenatal care (ANC) services, family income, family smoking history, physical activity, iron tablet (TTD) consumption, and dietary habits. The primary dependent variable was CED.

Data were analysed using SPSS version 25. Univariate analysis was conducted to describe the characteristics of the study population. Bivariate analysis using the Chi-square test was employed to examine the association between independent variables and the incidence of CED. Variables that showed a significant relationship in the bivariate analysis ($p < 0.05$) were included in the multivariate analysis. Multivariate logistic regression was used to determine the most dominant factors influencing CED among pregnant women, and to calculate the odds ratio (OR) and 95% confidence intervals (CI). This methodological approach was selected to ensure a comprehensive analysis of the relationships between various maternal and environmental factors and the occurrence of CED. The findings aim to provide evidence-based insights for public health interventions targeting maternal nutrition and prevention, particularly in stunting-prone regions of South Sulawesi.

RESULT

In this study, the characteristics of the respondents include the mother's age, education, occupation, and number of children as follows:

Table 1. Characteristics of pregnant women in the study (n=201)

Characteristics	n = 201	%
Maternal Age		
< 20 years	17	8.5
20 – 35 years	151	75.1
> 35 years	33	16.4
Number of Children		
0 – 5 months	4	1.9
6 – 11 months	13	6.5
12 – 23 months	29	14.4
24 – 59 months	53	26.4
> 5 years	93	46.3
Haven't had children yet	9	4.5
Educational		
Never went to school.	0	0
Didn't finish elementary school	2	1
Elementary school	42	20.9
Middle school	36	17.9
High school	74	36.8
Diploma	13	6.5
University	34	16.9
Mother's employment		
Working	31	15.4
Not Working	170	84.6
Utilization of ANC services		
<2 times TM I and II	3	1.5
≥2 times TM I and II	198	98.5
Pregnancy spacing		
<24 months	30	14.9
≥24 months	171	85.1
Drinking water source		
Pond/reservoir river	6	3
Cemented well	10	5
Uncemented well	2	1
Rainwater harvesting	0	0
Spring	143	71.1
Hand pump	19	9.5
Tap water/PDAM	17	8.5
Gallon	3	1.5
Borehole	1	0.5
Daily meal frequency		
2 times	7	3.5
3 times	186	92.5
> 3 times	8	4
Prohibited foods		
Yes	30	14.9
No	171	85.1
Family history of smoking		
Yes	150	74.6
No	51	25.4
Family Income		
< 1 Million	30	14.9
1 – 2 Million	171	85.1
> 2 Million		
BPJS Ownership		
Yes	124	61.7
No	46	22.9
Chronic Energy Deficiency (CED)	31	15.4
Yes	174	86.5
No	27	13.5

MUAC <23 cm	32	15.9
MUAC ≥23.5 cm	169	84.1

This study involved 201 pregnant women, and the data on the characteristics of the pregnant women are presented in Table 1. Most pregnant women (75.1%) are between 20 and 35 years old, and 46.3% have children over 5 years old. Additionally, 36.8% had secondary education, 84.6% were unemployed, 98.5% had ≥2 antenatal checkups in the first and second trimesters, 85.1% had a pregnancy interval ≥24 months, 71.1% used rainwater as their drinking water source, 92.5% ate three meals a day, 85.1% had no dietary restrictions, 74.6% had a family history of smoking, and 61.7% had an average family income < 1 million.

Table 2. Factors associated with chronic energy deficiency in pregnant women (n=2010)

Variable	CED (N=32)		Non CED (N =169)		p-Value
	n	%	n	%	
Maternal Age					
< 20 years	7	21.9	10	5.9	0.000
20 – 35 years	14	43.8	137	81.1	
> 35 years	11	34.4	22	13	
Number of Children					0.271
0 – 5 months	1	3.1	3	1.8	0.218
6 – 11 months	2	6.3	11	6.5	
12 – 23 months	7	21.9	22	13	
24 – 59 months	8	25	45	26.6	
> 5 years	13	40.6	80	47.3	
Haven't had children yet	1	3.1	8	4.7	
Educational					
Never went to school.	0	0	0	0	0.016
Didn't finish elementary school	1	3.1	1	0.6	
Elementary school	6	18.8	36	21.3	
Middle school	8	25	28	16.6	
High school	16	50	58	34.3	
Diploma	1	3.1	12	7.1	
University	2	6.3	32	18.9	
Mother's employment					0.004
Working	12	37.5	19	11.2	0.023
Not Working	20	62.5	150	88.8	
Utilization of ANC services					
<2 times TM I and II	2	6.3	1	0.6	0.023
≥2 times TM I and II	30	93.8	168	99.4	
Pregnancy spacing					
<24 months	19	59.4	11	6.5	0.528
≥24 months	13	40.6	158	93.5	
Drinking water source					
Pond/reservoir river	2	6.3	4	2.4	0.137
Cemented well	3	9.4	7	4.1	
Uncemented well	1	3.1	1	0.6	
Rainwater harvesting	0	0	0	0	
Spring	23	71.9	120	71.0	
Hand pump	2	6.3	17	10.1	
Tap water/PDAM	1	3.1	16	9.5	
Gallon	0	0	3	1.8	
Borehole	0	0	1	0.6	
Daily meal frequency					
2 times	4	12.5	3	1.8	
	25	78.1	161	95.3	

3 times	3	9.4	5	3	0.134
> 3 times					
Prohibited foods	14	43.8	16	9.5	0.002
Yes	18	56.3	153	90.5	
No					0.002
Family history of smoking					
Yes	26	81.3	122	72.2	0.013
No	6	18.8	47	27.8	
Family Income					0.513
< 1 Million	11	34.4	113	66.9	
1 – 2 Million	18	56.3	28	16.6	0.762
> 2 Million	3	9.4	28	16.6	
BPJS Ownership					0.762
Yes	21	65.5	153	90.5	
No	11	34.4	16	9.5	
PKH assistancedid					
Yes	18	56.3	69	40.8	
No	14	43.8	100	59.2	

The Chi-square test results indicate a statistically significant relationship with chronic energy deficiency. The research results show that 15.9% of pregnant women experience chronic energy deficiency (CED). Univariate analysis found that maternal age ($p=0.000$), working mothers ($p=0.016$), antenatal care ($p=0.004$), pregnancy spacing ($p=0.023$), daily meal frequency ($p=0.037$), family history of smoking ($p=0.002$), and family income ($p=0.013$) were significantly associated with the occurrence of CED in pregnant women.

Table 3. Multivariate logistic regression analysis of factors associated with chronic energy deficiency (CED).

Variable	CED		OR 95% CI (Min-Max)	p-Value
	n	%		
Maternal Age				
< 20 years	7	21.8	2.79 (1.67-4.64)	0.000
20 – 35 years	14	43.8		
> 35 years	11	34.4		
Mother's employment				
Working	12	37.5	6.73 (1.58-27.94)	0.016
Not Working	20	62.5		
Utilization of ANC services				
<2 times TM I and II	2	6.2	11.31 (2.71-28.19)	0.004
≥2 times TM I and II	30	93.8		
Pregnancy spacing				
<24 months	19	59.4	6.80 (1.31-26.8)	0.023
≥24 months	13	40.6		
Family history of smoking				
Yes	26	81.2	9.45 (3.27-31.75)	0.002
No	6	18.8		
Family Income				
< 1 Million	11	34.4	5.24 (1.73-26.02)	0.013
1 – 2 Million	18	56.3		
> 2 Million	3	9.3		

The multivariate analysis shows that maternal age, working mothers, prenatal checkups, pregnancy spacing, daily meal frequency, dietary restrictions, family history of smoking, and family income contribute to Chronic Energy Deficiency (CED). Respondents with a maternal age were 2.7 times more likely, working mothers were 6.7

times more likely, prenatal checkups were 11.3 times more likely, and pregnancy spacing was 6.8 times more likely. A family history of smoking was 9.4 times more likely. Family income was 5.2 times more likely to have an incident of Chronic Energy Deficiency (CED). Other variables, such as the number of children, education, source of drinking water, BPJS ownership, and PKH assistance, do not show statistically significant associations with the occurrence of Chronic Energy Deficiency.

DISCUSSION

The research results showed that the best time to get pregnant is between 20 and 35 years, as participants within this age range mostly had no CED. A study reported a significant relationship between age and the incidence of CED in pregnant women. Specifically, shows that extreme maternal age (<20 years and >35 years) is a significant predictor of anemia in pregnancy. Shi *et al.* (2022) revealed that pregnant adolescents have a 2.3 times higher risk of anemia due to biological immaturity and nutritional competition between maternal and fetal growth. Meanwhile, older pregnant women (>35 years old) face decreased metabolic efficiency and the accumulation of comorbidities, which increases energy needs (Parrettini, Caroli, and Torlone, 2020).

Age differences affect physiological adaptation during pregnancy. In adolescents, ongoing bone and muscle growth creates "nutritional competition" with the fetus, while in older mothers, decreased placental function and insulin resistance reduce energy utilization efficiency (Kelly, Powell, and Jansson, 2020). A longitudinal study by Susanti *et al.* (2025) also found that mothers over 35 with chronic energy deficiency (CED) were more likely to give birth to low birth weight (LBW) babies, indicating the cumulative impact of energy deficits. The risk of wasting in extreme age groups is exacerbated by social determinants such as poverty, low education, and early marriage. In North Gorontalo, the prevalence of chronic energy deficiency (CED) among pregnant adolescents from low-income families reaches 58%, which is significantly higher than the optimal age group (20-35 years) at only 32% (Nasaru *et al.*, 2024). Cultural factors such as specific food restrictions practised by pregnant adolescents also contribute to energy deficits (Anggriani Harahap *et al.*, 2025).

The study revealed that a significant risk factor for CED was the mother's employment, which shows that heavy physical labor, such as farming or manual work, significantly increases the risk of malnutrition. They were associated with a 6.7-fold increase in the risk of CED among pregnant women compared to those who did not work. A study found that pregnant women with high physical activity had a 2.3 times higher prevalence of chronic energy deficiency (CED) compared to those who were not working, primarily due to increased energy needs not met by nutritional intake. However, light-intensity or sedentary work does not correlate similarly, provided nutritional intake is met (Abadi and Putri, 2020). Employment status alone cannot predict KEK without considering access to healthcare services and income. Pregnant women working in the informal sector with low wages are more likely to experience chronic energy deficiency (CED) due to their inability to afford nutritious food, even though they are employed (Erna K. Wati *et al.*, 2024). Conversely, workers with health insurance and workplace nutrition programs show a lower prevalence of CED (Rachmi *et al.*, 2024).

The study results elucidated a statistically significant relationship between the frequency of ANC services and the incidence of CED among pregnant women. The frequency of ANC visits is inversely proportional to chronic energy deficiency (CED)

risk. Pregnant women with ≥ 4 ANC visits have a 58% lower risk of CED compared to those with < 4 visits, especially if visits begin in the first trimester (Matenchuk *et al.*, 2023). This protection mechanism is related to the early detection of malnutrition through Upper Arm Circumference (MUAC) measurement and nutritional counselling integrated into ANC services (Keats *et al.*, 2021).

Some studies show a significant relationship between short pregnancy intervals (< 24 months) and an increased risk of Chronic Energy Deficiency (CED) in pregnant women. A study by Lanita *et al.* (2024) found that short birth intervals were correlated with poor maternal nutritional status. Wati *et al.* (2024) confirmed that pregnancies with intervals < 24 months significantly increased the likelihood of CED due to depletion of maternal nutrient reserves. Who linked closely spaced pregnancies to low birth weight and poor perinatal outcomes. Physiologically, short interpregnancy intervals do not provide enough time for the mother's nutrient stores, especially iron and folate, to recover (Prasetyo, Permatasari, and Susanti, 2023).

Based on the research findings, it was found that pregnant women with a family history of smoking are 9.4 times more likely to experience chronic energy deficiency (CED). Exposure to cigarette smoke during pregnancy can disrupt fetal development and increase the risk of childhood obesity, which is indirectly related to the energy balance of pregnant women. This finding suggests that a family environment with smoking habits can create less supportive conditions for meeting the nutritional needs of pregnant women. Exposure to secondhand smoke in smoking households can affect the nutritional status of pregnant women through several pathways. Research (Astuti, Handayani, and Astuti, 2020) reveals that exposure to cigarette smoke increases the risk of stunting in children, indicating a possible similar effect on the nutritional status of pregnant women. Cigarette smoke can interfere with nutrient absorption, increase metabolic demands, and cause oxidative stress, impacting energy balance. Further research indicates that the dietary patterns and access to nutritious food for pregnant women from smoking families are often limited due to household budget allocation for purchasing cigarettes (Muchlis *et al.*, 2023).

Research indicates that household income is a determining factor in Chronic Energy Deficiency (CED) in pregnant women. Bell *et al.* (2024) found a significant correlation between low income and increased CED prevalence, where financial limitations hinder access to the nutritious food needed during pregnancy. Similar findings were reported by Jamil *et al.* (2024), who highlighted how low-income households tend to have less diverse and healthier food consumption patterns. Access to nutritious food: Low-income families are often limited in purchasing highly nutritious foods such as animal protein, vegetables, and fruits.

CONCLUSION

This study found that 15.9% of pregnant women experience chronic energy deficiency (CED). Factors influencing the occurrence of chronic energy deficiency (CED) in pregnant women include maternal age, working mothers, prenatal care, pregnancy spacing, daily meal frequency, dietary restrictions, family history of smoking, and family income. The data indicate that efforts are still needed to improve knowledge through tailored educational programs to raise awareness of the importance of nutrition during pregnancy. Additionally, it's important to strengthen routine prenatal checkups so that nutritional and health problems can be detected and addressed early on. Family

support is essential, including keeping the mother away from cigarette smoke. Thus, appropriate preventive measures can be taken to reduce the risk of CED and other health complications during pregnancy, thereby improving the health of both mother and fetus.

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Conflict of Interest

There are no potential conflicts of interest relevant to this article..

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