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Determinan Kurang Energi Kronik pada Ibu Hamil di Wilayah Endemik Stunting di Sulawesi Selatan, Indonesia: Studi Cross-Sectional

Determinants of Chronic Energy Deficiency among Pregnant Women in Stunting-Endemic Communities of South Sulawesi, Indonesia: A Cross-Sectional Study

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ABSTRACT/ABSTRAK

Chronic Energy Deficiency (CED) among pregnant women remains a major public health problem because it increases the risk of adverse pregnancy outcomes and child stunting. Evidence on factors associated with CED in stunting-endemic areas is still limited. This study aimed to identify determinants of CED among pregnant women in stunting-endemic communities of Bone Regency, South Sulawesi, Indonesia. A community-based cross-sectional study was conducted among 209 pregnant women from 40 stunting-focus villages using a total sampling approach. CED was defined as a mid-upper arm circumference (MUAC) of <23.5 cm. Data were analyzed using Chi-square tests and multivariable logistic regression. The prevalence of CED was 29.7%. Factors significantly associated with CED were age of the last child (AOR=4.53; 95% CI: 1.46–14.38), ANC utilization (AOR=3.81; 95% CI: 2.69–5.66), pregnancy spacing (AOR=5.36; 95% CI: 2.53–11.37), household smoking history (AOR=4.63; 95% CI: 2.35–9.14), and family income (AOR=4.82; 95% CI: 2.31–9.53). Pregnancy spacing was the strongest determinant. CED remains common among pregnant women in stunting-endemic areas. Strengthening family planning, improving ANC utilization, promoting smoke-free households, and supporting low-income families are essential to improve maternal nutrition and support stunting prevention.

Keywords: *Chronic Energy Deficiency, pregnant women, stunting-endemic area, risk factors, antenatal care*

Kurang Energi Kronik (KEK) pada ibu hamil masih menjadi masalah kesehatan masyarakat yang penting karena dapat meningkatkan risiko komplikasi kehamilan, gangguan pertumbuhan janin, dan stunting pada anak. Bukti mengenai faktor-faktor yang berhubungan dengan KEK di wilayah endemik stunting masih terbatas. Penelitian ini bertujuan untuk menganalisis faktor-faktor yang berhubungan dengan kejadian KEK pada ibu hamil di wilayah endemik stunting Kabupaten Bone, Sulawesi Selatan. Penelitian observasional analitik dengan desain potong lintang dilakukan pada 209 ibu hamil yang berasal dari 40 desa lokus stunting. Sampel dipilih menggunakan metode total sampling. Status KEK ditentukan berdasarkan lingkar lengan atas (LILA) <23,5 cm. Data dianalisis menggunakan uji Chi-square dan regresi logistik multivariat. Prevalensi KEK pada ibu hamil sebesar 29,7%. Faktor yang berhubungan signifikan dengan kejadian KEK adalah usia anak terakhir (AOR=4,53; IK95%: 1,46–14,38), pemanfaatan pelayanan antenatal care (ANC) (AOR=3,81; IK95%: 2,69–5,66), jarak kehamilan (AOR=5,36; IK95%: 2,53–11,37), riwayat merokok dalam keluarga (AOR=4,63; IK95%: 2,35–9,14), dan pendapatan keluarga (AOR=4,82; IK95%: 2,31–9,53). Jarak kehamilan merupakan faktor yang paling dominan berhubungan dengan KEK. KEK masih banyak ditemukan pada ibu hamil di wilayah endemik stunting. Penguatan program keluarga berencana, peningkatan pemanfaatan ANC, promosi rumah tangga bebas asap rokok, serta dukungan bagi keluarga berpendapatan rendah perlu diprioritaskan untuk memperbaiki status gizi ibu hamil dan mendukung percepatan penurunan stunting.

Kata kunci: Kurang Energi Kronik, ibu hamil, stunting, faktor risiko, antenatal care

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INTRODUCTION

Maternal nutrition plays a critical role in ensuring healthy pregnancy outcomes and optimal fetal development. One of the most common nutritional problems among pregnant women is Chronic Energy Deficiency (CED), a condition resulting from prolonged inadequate energy intake and commonly identified by a mid-upper arm circumference (MUAC) of less than 23.5 cm (Kementerian Kesehatan Republik Indonesia, 2025). Despite ongoing efforts to improve maternal nutrition, CED remains a significant public health challenge in many low- and middle-income countries. Poor maternal nutritional status has been associated with adverse pregnancy outcomes, including fetal growth restriction, low birth weight, preterm birth, and increased maternal morbidity (Apostolopoulou et al., 2024; González-Fernández et al., 2024).

The consequences of CED extend beyond pregnancy and childbirth. Maternal undernutrition can limit the supply of nutrients required for optimal fetal growth and development, thereby increasing the risk of intrauterine growth restriction and poor neonatal outcomes (Apostolopoulou et al., 2024). Furthermore, inadequate maternal nutritional status has been linked to impaired physical growth and developmental outcomes in children, contributing to the intergenerational cycle of malnutrition (González-Fernández et al., 2024). These conditions are particularly concerning in countries with a high burden of stunting, where maternal undernutrition remains an important underlying determinant of child growth failure (World Health Organization, 2024).

Previous studies have identified multiple determinants of CED among pregnant women. Nutritional factors, such as inadequate energy intake and poor dietary diversity, have consistently been associated with maternal undernutrition (Khammarnia et al., 2024; Tareke et al., 2024). In addition, socioeconomic factors including educational attainment and household income, reproductive factors such as parity and birth spacing, and healthcare-related factors including antenatal care (ANC) utilization have been reported as important predictors of CED (Harna et al., 2024; Ningtyias et al., 2024; Zewude et al., 2024). These findings indicate that CED is a multifactorial condition influenced by the interaction of nutritional, socioeconomic, reproductive, and healthcare-related factors.

In Indonesia, maternal CED remains a persistent nutritional problem. According to the Indonesian Health Survey (SKI) 2023, the prevalence of CED among pregnant women was 16.9% nationally, while South Sulawesi reported a higher prevalence of 19.7%, indicating that maternal undernutrition continues to be a significant concern in the province (Ministry of Health of the Republic of Indonesia, 2024). The high prevalence of CED is often associated with inadequate dietary intake, socioeconomic vulnerability, and unequal access to maternal health services (WHO, 2024; Ningtyias et al., 2024). However, evidence regarding the determinants of CED in stunting-endemic areas remains limited, despite the coexistence of maternal undernutrition and child stunting as major public health challenges.

To the best of our knowledge, limited studies have comprehensively examined the combined effects of maternal age, educational attainment, household income, parity, birth spacing, energy intake, and ANC utilization on the occurrence of CED among pregnant women in stunting-endemic areas. Existing studies have generally focused on selected determinants, resulting in a fragmented understanding of the multifactorial nature of CED. Therefore, this study addresses this important knowledge gap by simultaneously investigating socioeconomic,

reproductive, nutritional, and healthcare-related factors within a single analytical framework in a high-stunting-burden setting. The novelty of this study lies in its comprehensive assessment of multiple determinants of CED among pregnant women in a stunting-endemic population. The findings are expected to identify the dominant factors associated with CED and provide context-specific evidence to support targeted maternal nutrition interventions, strengthen maternal health programs, and contribute to accelerating stunting reduction efforts in Indonesia.

METHODS

This study employed a community-based analytical observational design with a cross-sectional approach to investigate the determinants of Chronic Energy Deficiency (CED/KEK) among pregnant women in stunting locus areas of Bone Regency, South Sulawesi, Indonesia. The study was conducted in 40 stunting-focus villages in 2025 identified by the local government as priority areas due to their high prevalence of stunting and maternal nutritional problems.

The study population comprised all pregnant women residing in the selected villages during the study period. Eligible participants were pregnant women who possessed a Maternal and Child Health (MCH) handbook and were willing to participate in the study. Pregnant women who had limited attendance at antenatal care services were not excluded to ensure adequate representation of the target population. The exclusion criteria included pregnant women diagnosed with infectious diseases, hypertension, or HIV/AIDS, as these conditions may influence maternal nutritional status and potentially confound the study findings. A total sampling approach was employed, whereby all pregnant women who met the inclusion criteria in the selected villages were invited to participate. Therefore, no sample size calculation was performed. A total of 209 pregnant women met the eligibility criteria and were included in the final analysis. This approach enabled comprehensive coverage of the target population and enhanced the representativeness of pregnant women living in stunting-endemic communities in Bone Regency.

The independent variables included maternal age, age of the last child, educational, mother's employment, utilization of ANC services, pregnancy spacing, drinking water source, daily meal frequency, prohibited foods, family history of smoking, family income, BPJS ownership. The dependent variable was Chronic Energy Deficiency (CED), assessed using Mid-Upper Arm Circumference (MUAC) with a precision of 0.1 cm. Pregnant women were categorized as having CED if their MUAC is <23.5 cm.

Data were analyzed using the Chi-square test, followed by multivariable logistic regression to identify factors independently associated with Chronic Energy Deficiency (CED) among pregnant women. Variables with a p-value <0.25 in the bivariate analysis were included in the multivariable model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of associations. Model fitness was assessed using the Hosmer–Lemeshow goodness-of-fit test, and a p-value >0.05 indicated an adequate model fit. Statistical analyses were performed using SPSS version 25. Respondents will receive an explanation from the researcher regarding the research procedure. Research respondents are given the freedom to choose whether or not to be involved in the research. Respondents who

agree to be involved in the research are proven by signing an informed consent sheet. This research does not burden respondents and the research data that has been collected is confidential in order to maintain the privacy of respondents.

RESULT

Tabel 1. Characteristics of Pregnant Women in the Study (n=209)

Characteristics		n	%
Maternal Age	< 20 years	30	14.4
	20 – 35 years	158	75.6
	> 35 years	21	10.0
Age of the Last Child	0 – 5 months	16	7.7
	6 – 11 months	11	5.3
	12 – 23 months	21	10.0
	24 – 59 months	48	23.0
	> 5 years	95	45.5
	Haven't had children yet	18	8.6
Educational	Never went to school	4	1.9
	Didn't finish elementary school	10	4.8
	Elementary school	52	24.9
	Middle school	45	21.5
	High school	69	33.0
	Diploma	11	5.3
	University	18	8.6
Mother’s employment	Working	47	22.5
	Not Working	162	77.5
Utilization of ANC services	<2 times TM I and II	12	5.7
	≥2 times TM I and II	197	94.3
Pregnancy spacing	<24 months	32	15.3
	≥24 months	177	84.7
Drinking water source	Pond/reservoir river	2	1.0
	Cemented well	80	38.3
	Uncemented well	1	0.5
	Rainwater harvesting	2	1.0
	Spring	62	29.7
	Hand pump	3	1.4
	Tap water/PDAM	16	7.7
	Gallon	33	15.8
	Borehole	10	4.8
Daily meal frequency	2 times	36	17.2
	3 times	161	77.0
	> 3 times	12	5.7
Prohibited foods	Yes	36	17.2
	No	173	82.8
Family history of smoking	Yes	148	70.8
	No	61	29.2

Characteristics		n	%
Familiy Income	< 1 Million	139	66.5
	1 – 2 Million	38	18.2
	> 2 Million	32	15.3
BPJS Ownership	Yes	178	85.2
	No	31	14.8
Chronic Energy Deficiency (CED)	MUAC <23.5 cm	62	29.7
	MUAC ≥23.5 cm	147	70.3

Source: Primary Data, 2025

This study involved 209 pregnant women, and the data on the characteristics of the pregnant women are presented in Table 1. The majority of pregnant women (75.6%) are between 20-35 years old, and 45.5% have children over 5 years old. Additionally, 33.0% completed high school education, 77.5% were unemployed, 94.3% had ≥2 antenatal checkups in the first and second trimesters, 84.7% had a pregnancy interval ≥24 months, 38.3% used cemented well as their drinking water source, 77% ate three meals a day, 82.2% had no dietary restrictions, 70.8% had a family history of smoking, and 66.5% had an average family income < 1 million, 85.2% had BPJS Ownership, 29.7% MUAC <23 cm.

Tabel 2. Factors Associated with Chronic Energy Deficiency in Pregnant Women (n=209)

Variable	CED (N=62)		Non CED (N=147)		*p-Value*
	n	%	n	%	
Maternal Age					
< 20 years	22	73.3	8	26.7	
20 – 35 years	30	19.0	128	81.0	0.518
> 35 years	10	47.6	11	52.4	
Age of the Last Child					
0 – 5 months	11	68.8	5	31.3	
6 – 11 months	8	72.7	3	27.3	
12 – 23 months	5	23.8	16	76.2	0.001*
24 – 59 months	7	14.6	41	85.4	
> 5 years	18	18.9	77	81.1	
Haven't had children yet	13	72.2	5	27.8	
Educational					
Never went to school	2	50	2	50	
Didn't finish elementary school	8	80.0	2	20.0	
Elementary school	12	23.1	40	76.9	
Middle school	11	24.4	34	75.6	0.416
High school	18	26.1	51	73.9	
Diploma	7	63.6	4	36.4	
University	4	22.2	14	77.8	
Mother’s employment			147		
Working	27	57.4	20	42.6	
Not Working	35	21.6	127	78.4	
Utilization of ANC services					

Variable	CED (N=62)		Non CED (N=147)		*p-Value*
	n	%	n	%	
<2 times TM I and II	9	75.0	3	25.0	0.034*
≥2 times TM I and II	53	26.9	144	73.1	
Pregnancy spacing					
<24 months	20	62.5	12	37.5	0.003*
≥24 months	42	23.7	135	76.3	
Drinking water source					
Pond/reservoir river	1	50.0	1	50.0	0.307
Cemented well	12	15.0	68	85.0	
Uncemented well	0	0.0	1	100	
Rainwater harvesting	2	100	0	0.0	
Spring	14	22.6	48	77.4	
Hand pump	2	66.7	1	33.3	
Tap water/PDAM	0	0.0	16	100	
Gallon	31	93.9	2	6.1	
Borehole	0	0.0	10	100	
Daily meal frequency					
2 times	28	77.8	8	22.2	0.307
3 times	28	17.4	133	82.6	
> 3 times	6	50.0	6	50.0	
Prohibited foods					
Yes	27	75.0	9	25.0	0.504
No	35	20.2	138	79.8	
Family history of smoking					
Yes	51	32.1	108	73.0	0.000*
No	11	22.0	39	63.9	
Familiy Income					
< 1 Million	26	18.7	113	81.3	0.039*
1 – 2 Million	25	65.8	13	34.2	
> 2 Million	11	34.4	21	65.6	
BPJS Ownership					
Yes	44	24.7	134	75.3	0.612
No	18	58.1	13	41.9	

Source: Primary Data (Processed), 2025

The Chi-square analysis demonstrated that several factors were significantly associated with chronic energy deficiency among pregnant women. Bivariate analysis identified age of the last child, ANC utilization, pregnancy spacing, household smoking history, and family income as factors significantly associated with CED among pregnant women. The analysis found that Age of the Last Child (p=0.001), Utilization of ANC services (p=0.034), Pregnancy spacing (p=0.003), family history of smoking (p=0.000), and family income (p=0.039) 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		Adjusted Odds Ratio (AOR) (95% CI)	*p-Value*
	n	%		
Age of the Last Child				
0 – 5 months	11	17.7	4.53 (1.46-14.38)	0.001
6 – 11 months	8	12.9		
12 – 23 months	5	8.1		
24 – 59 months	7	11.3		
> 5 years	18	29		
Haven't had children yet	13	21		
Utilization of ANC services				
<2 times TM I and II	9	14.5	3.81 (2.69-5.66)	0.034
≥2 times TM I and II	53	85.5		
Pregnancy spacing				
<24 months	20	32.3	5.36 (2.53-11.37)	0.003
≥24 months	42	67.7		
Family history of smoking				
Yes	40	64.5	4.63 (2.35-9.14)	<0.001
No	22	35.5		
Familiy Income				
< 1 Million	26	41.9	4.82 (2.31-9.53)	0.039
1 – 2 Million	25	40.3		
> 2 Million	11	17.7		

Source: Primary Data (Processed), 2025

The final logistic regression model demonstrated an adequate goodness-of-fit based on the Hosmer–Lemeshow test ($p > 0.05$). Multivariable logistic regression analysis indicated that age of the last child, ANC utilization, pregnancy spacing, household smoking history, and family income were independently associated with CED among pregnant women. Maternal age, educational, maternal employment status, drinking water source, daily meal frequency, Prohibited foods, and BPJS Ownership were not significantly associated with CED

DISCUSSION

This study revealed that 29.7% of pregnant women in stunting-endemic communities of Bone Regency experienced Chronic Energy Deficiency (CED). This prevalence is considerably higher than the national prevalence reported in the 2023 Indonesian Health Survey, indicating that maternal undernutrition remains a substantial public health challenge in areas where stunting is highly prevalent (Ministry of Health of the Republic of Indonesia, 2024). Maternal nutritional inadequacy during pregnancy is a critical concern because it increases the risk of adverse maternal and neonatal outcomes, including fetal growth restriction, low birth weight, preterm birth, and impaired child growth and development (Apostolopoulou et al., 2024; González-Fernández et al., 2024). These findings emphasize the importance of addressing maternal nutrition as part of broader strategies to reduce stunting and improve maternal and child health.

The multivariable analysis demonstrated that the age of the last child was significantly associated with CED. Women whose previous child was younger were more likely to experience CED than those whose children were older. This finding may reflect inadequate maternal nutritional recovery following previous pregnancies and breastfeeding periods. Mothers who conceive again before restoring their nutritional reserves are more likely to enter subsequent pregnancies with compromised energy stores. This observation is consistent with the maternal depletion hypothesis, which suggests that repeated reproductive demands without sufficient recovery time can negatively affect maternal nutritional status. Similar findings have been reported among Indonesian pregnant women, where reproductive factors, including parity and child age, were associated with maternal undernutrition (Rachmi et al., 2024). The finding also supports evidence indicating that cumulative reproductive burden contributes to poor maternal nutritional outcomes, particularly in resource-constrained settings.

Utilization of antenatal care (ANC) services was also significantly associated with CED. Pregnant women with inadequate ANC attendance were more likely to experience CED than those who attended ANC according to recommendations. ANC services provide opportunities for nutritional screening, counseling, supplementation, monitoring of maternal health status, and early identification of nutritional problems. Consequently, women who do not adequately utilize ANC services may miss essential interventions designed to improve maternal nutrition during pregnancy. This finding is consistent with previous evidence indicating that access to and utilization of maternal health services play an important role in preventing maternal undernutrition and improving pregnancy outcomes (Zewude et al., 2024). Strengthening the quality and coverage of ANC services therefore remains a key strategy for improving maternal nutritional status in stunting-endemic areas.

Pregnancy spacing emerged as the strongest predictor of CED in this study. Women with pregnancy intervals of less than 24 months had a substantially higher likelihood of experiencing CED compared with those with longer intervals. This finding supports the maternal depletion hypothesis, which proposes that repeated pregnancies without adequate recovery time may reduce maternal nutrient reserves and increase vulnerability to nutritional deficiencies. Short interpregnancy intervals have been associated with insufficient restoration of maternal energy and micronutrient stores, leading to poorer maternal health outcomes and increased nutritional risks during subsequent pregnancies (Conde-Agudelo et al., 2007). Similar findings have been reported among pregnant women in Indonesia, where inadequate birth spacing was associated with an increased risk of maternal undernutrition (Rachmi et al., 2024). These results highlight the importance of family planning programs and reproductive health interventions aimed at promoting optimal birth spacing.

Another important finding was the significant association between household smoking history and CED. Pregnant women living in households with smokers were more likely to experience CED than those living in smoke-free households. This relationship may be explained by both economic and environmental mechanisms. One possible explanation is that household expenditure on tobacco products may reduce resources available for food and healthcare, particularly among economically vulnerable families. In addition, exposure to cigarette smoke may adversely affect maternal health and pregnancy outcomes. The finding reflects the broader influence of household behaviors on maternal nutrition and suggests that maternal nutrition

programs should incorporate tobacco control and smoke-free household initiatives as part of comprehensive public health strategies.

Family income was also significantly associated with CED. Pregnant women from lower-income households were more likely to experience undernutrition than those from households with higher income levels. Economic status influences food availability, dietary diversity, healthcare access, and overall living conditions. Limited household income often restricts the ability to obtain nutrient-rich foods needed to meet the increased nutritional demands of pregnancy. This finding is consistent with evidence showing that socioeconomic disadvantage remains a fundamental determinant of maternal nutritional status in low- and middle-income countries (Ningtyias et al., 2024; Victora et al., 2021). Therefore, efforts to improve maternal nutrition should not focus solely on individual behavior change but also address broader social and economic barriers affecting access to adequate nutrition. This pattern may reflect differences in household size, expenditure priorities, or other unmeasured socioeconomic factors that were not assessed in this study.

Interestingly, maternal age, educational level, employment status, source of drinking water, meal frequency, food taboos, and health insurance ownership were not significantly associated with CED in this study. The absence of significant associations may reflect the relatively homogeneous characteristics of the study population or the stronger influence of reproductive and socioeconomic factors within the study setting. Although these variables were not statistically significant, they may still contribute indirectly to maternal nutritional status through complex pathways that were not fully captured in the present analysis.

Overall, the findings indicate that CED among pregnant women is a multifactorial problem influenced by reproductive factors, healthcare utilization, household behavior, and socioeconomic conditions. The dominant influence of pregnancy spacing, household smoking, and family income suggests that interventions should extend beyond nutritional supplementation alone. Integrated approaches that combine family planning services, strengthened ANC utilization, smoke-free household campaigns, and socioeconomic support for vulnerable families are likely to be more effective in reducing maternal undernutrition and supporting ongoing stunting reduction efforts in high-risk communities.

CONCLUSIONS

This study found that 29.7% of pregnant women experience chronic energy deficiency (CED). Pregnancy spacing was the strongest predictor, indicating that women with shorter intervals between pregnancies were at substantially greater risk of experiencing CED. In addition, exposure to household smoking, inadequate utilization of ANC services, lower family income, and a shorter interval since the last childbirth were associated with an increased likelihood of maternal undernutrition. These findings highlight that CED is a multifactorial problem influenced by reproductive, behavioral, healthcare, and socioeconomic factors. Therefore, comprehensive interventions focusing on optimal birth spacing, improved ANC utilization, smoke-free households, and economic support for vulnerable families are essential to improve maternal nutritional status and strengthen stunting prevention efforts in high-risk communities.

Strengthening family planning services, improving antenatal care utilization, promoting smoke-free households, and enhancing economic support for vulnerable families should be

prioritized to reduce the burden of Chronic Energy Deficiency (CED) among pregnant women. These interventions should be integrated into maternal nutrition and stunting prevention programs, particularly in stunting-endemic areas. Further longitudinal studies are recommended to clarify the causal relationships between reproductive, behavioral, socioeconomic, and healthcare-related factors and maternal CED.

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