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THE RELATIONSHIP BETWEEN A HISTORY OF ANEMIA AND CHRONIC ENERGY DEFICIENCY (CED) IN PREGNANT WOMEN AND THE INCIDENCE OF STUNTING IN TODDLERS AT SINGAJAYA PUBLIC HEALTH CENTER, GARUT REGENCY

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Abstract
Background: Stunting remains a major public health issue in Indonesia, with chronic maternal malnutrition contributing significantly to its prevalence. Maternal anemia and chronic energy deficiency (CED) during pregnancy have been identified as potential risk factors for impaired child growth. This study aimed to analyze the relationship between a history of anemia and chronic energy deficiency (CED) in pregnant women and the incidence of stunting in toddlers at Singajaya Public Health Center, Garut Regency. **Methods:** This was an analytical observational study with a case-control design, involving 52 toddlers aged 6–59 months—26 stunted and 26 non-stunted. Data were collected through medical records and structured questionnaires. Anemia was defined as hemoglobin <11 g/dL, while CED was defined as mid-upper arm circumference (MUAC) <23.5 cm. Bivariate analysis was conducted using the chi-square test at a significance level of 0.05. **Results:** A significant association was found between maternal CED and stunting (p = 0.02; OR = 4.900; 95% CI: 1.413–16.988). However, no significant relationship was observed between maternal anemia and stunting (p = 0.75). The majority of mothers in the stunting group had lower educational attainment and were unemployed, potentially influencing their nutritional status during pregnancy. **Conclusion**: Maternal CED during pregnancy is significantly associated with the incidence of stunting in toddlers, while anemia is not. These findings highlight the need for targeted maternal nutrition interventions, particularly routine MUAC screening and nutrition education during pregnancy, to reduce stunting prevalence in the Singajaya PHC area.

Introduction

Stunting remains a major public health concern worldwide, particularly in developing countries. It is a critical issue affecting children's brain growth, cognitive and motoric

disorders, and reduced learning abilities. In the long term, this can lead to lower productivity, reduced economic contributions, and increased vulnerability to health problems (1). In 2019, approximately 144 million children globally were affected by stunting, with Southeast Asia identified as one of the most impacted regions. Among Southeast Asian countries, Indonesia ranks among the highest in stunting prevalence, surpassing neighboring nations such as the Philippines and Timor Leste (2). The national context reflects a similar concern. Based on the 2022 Indonesian Nutrition Status Survey (SSGI), the national stunting rate declined from 27.7% in 2019 to 20.2% in 2022. However, this figure remains above the WHO target of below 20%, especially in provinces like West Java. Garut Regency, in particular, recorded a stunting prevalence of 24.1%, higher than nearby regions such as Bandung City (16%) and Sumedang Regency (14.4%) (3). These data underscore the persistent burden of stunting in specific localities, highlighting the need for targeted interventions.

The causes of stunting are multifactorial, encompassing biological, maternal, socio-economic, and environmental dimensions. Maternal health and nutrition during pregnancy play a crucial role in determining fetal growth and birth outcomes. Health conditions such as anemia and Chronic Energy Deficiency (CED) in pregnant women have been associated with low birth weight, intrauterine growth restriction, and developmental delays in infants (4,5). In particular, anemia is associated with a 3.2-fold increased risk of stunting, while CED increases the risk up to 4.85 times (3). Anemia in pregnancy remains a global issue, with a prevalence of 41.8%, mostly due to iron deficiency infants (4). Poor maternal dietary diversity and limited access to antenatal care exacerbate this condition, especially in rural areas (6). CED, which reflects prolonged inadequate energy and protein intake, is another serious concern. Both conditions not only affect fetal development but also reduce maternal resilience during pregnancy and childbirth, further perpetuating cycles of malnutrition and poor child growth.

Socio-economic conditions also influence stunting rates. Children born to mothers with low education levels or those from lower-income households face greater risks due to limited access to health services, nutrition knowledge, and adequate food. Maternal education plays a significant role in shaping dietary habits and nutritional knowledge. It is associated with improved infant and young child feeding (IYCF) practices, such as exclusive breastfeeding, early initiation of breastfeeding, and appropriate complementary feeding (7). The relationship between maternal education and health-seeking behavior extends beyond nutrition. It encompasses actions such as seeking antenatal care, which are significantly influenced by the mother's educational level. Educational interventions can mediate improvements in both nutritional practices and broader health-seeking behaviors among beneficiaries, indicating a positive feedback loop between education and health outcomes (8).

In Garut Regency, Singajaya Public Health Center (PHC) is among the top four contributors to stunting prevalence, with a rate of 15.92%. Measurements in early 2024 revealed that 5.6% of toddlers were classified as short and 9.5% as severely short, with the highest concentration found in Karangagung Village (19.74%). These figures prompted a closer look into the local determinants of stunting. Preliminary observations from Singajaya PHC suggested that a significant proportion of mothers had a history of anemia or experienced CED during pregnancy. Furthermore, many mothers had low educational attainment and limited access to nutrition information or antenatal care.

Given these observations, this study aims to analyze the relationship between a history of anemia and Chronic Energy Deficiency (CED) during pregnancy and the incidence of stunting in toddlers at Singajaya Public Health Center, Garut Regency. Understanding these relationships is essential for designing appropriate and context-specific interventions to reduce stunting rates in the region.

Materials and Methods

This study employed an analytical observational design with a case-control approach, suitable for examining causal relationships between maternal anemia and chronic energy deficiency (CED) during pregnancy and stunting in toddlers. The research was conducted at Singajaya Public Health Center, Garut Regency, from December 2024 to January 2025. The sample consisted of 26 cases (stunted toddlers) and 26 controls (non-stunted toddlers) in a 1:1 ratio, selected using a non-probability method based on outcome status and availability of maternal medical records, without specific stratification. Inclusion criteria included toddlers aged 6–59 months with complete data (height, age, maternal hemoglobin and MUAC records) and maternal consent to participate. Exclusion criteria were toddlers with chronic illnesses or genetic disorders. The sample size was calculated using the Lemeshow formula, assuming a 20% exposure prevalence in the control group, an expected odds ratio of 4.9, a 95% confidence level, and 80% statistical power.

Data were collected through a structured questionnaire and maternal medical records. Toddler height was measured using a microtoise and weight with a digital scale, both by trained health workers. Stunting status was classified using the WHO z-score standard, with a cutoff of <−2 SD for height-for-age. Anemia was defined as maternal hemoglobin <11 g/dL, measured during the second or third trimester. CED was identified by MUAC <23.5 cm, measured in the second trimester. Data were analyzed using the chi-square test at a significance level of $\alpha = 0.05$ with SPSS software.

Results

The characteristics of toddlers in the working area of the Singajaya Public Health Center can be seen based on the toddler's gender and age, as presented in Table 1.

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Table 1. Distribution of Toddlers

Variable	Stunting		Non- Stunting	
	n	%	n	%
Toddler Gender				
Male	16	61.5	12	46.2
Female	10	38.5	14	53.8
Toddler Age				
0-6 Months	1	3.9	0	0.0
7-11 Months	2	7.7	0	0.0
1-3 Years	11	42.3	16	61.5
4-5 Years	12	46.2	10	38.5
Total	**26**	**100.0**	**26**	**100.0**

Table 1 presents the distribution of toddlers based on gender and age in both the stunting and non-stunting groups. A higher proportion of male toddlers was found in the stunting group (61.5%), whereas in the non-stunting group, female toddlers were slightly more prevalent (53.8%). Regarding age, most toddlers in the stunting group were aged 4–5 years (46.2%), while the majority in the non-stunting group were aged 1–3 years (61.5%). This age distribution difference may suggest an age-related pattern that could be explored further in the discussion. However, no statistical test was conducted to assess the significance of this difference.

Table 2. Distribution of Maternal Characteristics

Variable	Stunting		Non-Stunting	
	n	%	n	%
Mother's Age During Pregnancy				
Risk <20 Years	13	50.0	4	15.4
Risk >35 Years	9	34.6	6	23.1
No Risk 20-35 Years	4	15.4	16	61.5
Mother's Job				
Housewives	18	69.2	13	50.0
Self-employed	2	7.7	5	19.2
Private employees	6	23.1	6	23.1
Civil Servants (CS)	0	0.0	2	7.7
Mother's Education				
Elementary School (ES	7	26.9	1	3.8
Junior High School (JHS)	17	65.4	9	34.6
Senior High School (SHS)	2	7.7	15	57.7
Higher Education (HE)	0	0.0	1	3.8
Total	**26**	**100.0**	**26**	**100.0**

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Table 2 shows the distribution of maternal characteristics including age at pregnancy, occupation, and education level. In the stunting group, a higher proportion of mothers gave birth at a risky age (<20 or >35 years), with 50.0% under 20 years and 34.6% over 35 years. In contrast, most mothers in the non-stunting group were within the optimal reproductive age range (20–35 years), accounting for 61.5%.

Occupationally, housewives dominated the stunting group (69.2%), while in the non-stunting group, a greater variety of employment was observed, including civil servants (7.7%) and private employees (23.1%). Educational attainment also differed notably; 92.3% of mothers in the stunting group had only elementary or junior high education, compared to 61.5% in the non-stunting group who completed senior high school or higher. These differences may reflect underlying socio-economic disparities between groups.

Table 3. Distribution of Maternal Anemia and Chronic Energy Deficiency (CED) Status

Variable	Stunting		Non-Stunting	
	n	%	n	%
Anemia Status				
Anemia	6	23.1	8	30.8
Not Anemic	20	76.9	18	69.2
CED Status				
CED	14	53.8	5	19.2
Not CED	12	46.2	21	80.8
Total	**26**	**100.0**	**26**	**100.0**

Table 3 provides a focused comparison of maternal anemia and CED status between the two groups. Most mothers in both groups did not have a history of anemia; 76.9% in the stunting group and 69.2% in the non-stunting group. This binary classification of anemia (yes/no) did not take into account the severity (mild, moderate, severe) or timing of measurement during pregnancy. Additionally, the possible mitigating effects of antenatal iron supplementation at the local health center may have influenced these results. In contrast, CED status showed a clearer difference: 53.8% of mothers in the stunting group experienced CED (MUAC <23.5 cm), compared to only 19.2% in the non-stunting group. This finding aligns with known mechanisms whereby inadequate maternal energy and protein intake disrupts fetal growth, potentially leading to linear growth retardation postnatally. Essential macronutrient and micronutrient deficiencies in CED, such as inadequate protein, iron, zinc, and folate, can impair placental function, tissue development, and bone growth during gestation.

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Table 4. Relationship Between Maternal Anemia and CED with Stunting in Toddlers

Variable	Stunting		Non-Stunting		OR 95% CI	p value
	n	%	n	%		
Anemia Status					0.675 (0.196-2.322)	0.75
Anemia	6	23.1	8	30.8		
Not Anemic	20	76.9	18	69.2		
CED Status					4.900 (1.413-16.988)	0.02
CED	14	53.8	5	19.2		
Not CED	12	46.2	21	80.8		
Total	**26**	**100.0**	**26**	**100.0**		

Table 4 presents the bivariate analysis of maternal anemia and CED status with the incidence of stunting. No significant association was found between maternal anemia and stunting (p = 0.75; OR = 0.675; 95% CI: 0.196–2.322), suggesting that anemia alone may not be a strong predictor in this population. Further investigation is needed to assess whether the timing and severity of anemia influence this result. Conversely, maternal CED showed a significant association with stunting (p = 0.02; OR = 4.900; 95% CI: 1.413–16.988). Mothers with CED were nearly five times more likely to have stunted children compared to those with adequate nutritional status during pregnancy.

Discussion

The results of this study show that the status of Chronic Energy Deficiency (CED) in pregnant women has a significant relationship with the incidence of stunting in children under five (p = 0.02; OR = 4.900; 95% CI: 1.413–16.988), while a history of anemia in mothers does not show a significant relationship (p = 0.75). These findings are consistent with the research by Vera et al. (2023), which shows that mothers with CED are at a 12.066 times higher risk of giving birth to babies with short birth length compared to mothers with normal nutritional status. Another study by Ningrum and Cahyaningrum (2018) also found that mothers with CED have a 6.2 times higher risk of giving birth to babies with short birth length (p = 0.008). Various sources in the literature state that inadequate energy and protein intake over a prolonged period during pregnancy directly impacts fetal growth, low birth weight (LBW), and the child's linear growth after birth. CED in pregnant women leads to disruption of nutrient and oxygen supply to the fetus through the placenta, resulting in impaired tissue formation and the growth of the baby's long bones.

A typical characteristic of mothers experiencing CED in this study is that most also have a low educational background and are not employed in the formal sector. A total of 92.3% of mothers in the stunting group had only completed elementary or junior high school education, and 69.2% of them were housewives. Low education level is closely linked to a lack of knowledge about nutritional needs during pregnancy, which can lead to insufficient

intake of macro and micronutrients such as protein, iron, zinc, and folate. Additionally, economic limitations and restricted access to information among housewives also hinder adequate nutrition fulfillment. Therefore, the characteristics of mothers in the stunting group further strengthen the association between CED status and stunting incidence.

Meanwhile, anemia does not show a significant association with stunting, which may be due to several factors. First, anemia in this data is categorized in a binary manner (anemic/not anemic) without accounting for severity. Most cases were mild anemia detected in the second or third trimester, which may have less impact on fetal growth compared to severe anemia or anemia in the first trimester, which is more critical for bone formation. Second, the use of secondary data from the MCH (Maternal and Child Health) handbook has its limitations, including potential misclassification of anemia status due to incomplete or inaccurate recordkeeping. Moreover, intervention programs such as regular iron tablet supplementation at Singajaya Health Center may have contributed to reducing the impact of anemia in pregnant women.

These results differ from several studies, including the results of Mantasia and Sumarni (2022) research showed that there was no relationship between a history of anemia during pregnancy and the incidence of stunting in toddlers (p value = 0.45) . Similar findings were also reported by Warsini et al (2016), who found no association between a history of maternal anemia in the third trimester and the incidence of stunting (p value 0,605). These differences may be due to confounding factors that were not measured in this study, such as a history of recurrent infections in the child, water quality and sanitation, or postnatal nutrition intake. These factors may directly affect the child's nutritional status and should be taken into account when interpreting the results.

This study has several limitations. First, the relatively small sample size (n=52) may limit the statistical power to detect weaker associations, such as between anemia and stunting. Second, the use of secondary data from the MCH handbook opens the possibility of information bias, especially if there are incomplete or erroneous records. Third, the case-control design can only demonstrate associative relationships, not direct causality. Fourth, there are other unmeasured factors that may act as confounders, such as household environmental quality, sanitation, and the child's postnatal dietary patterns.

Nevertheless, this study makes an important contribution in the local context, especially in the service area of Singajaya Health Center, which has a high prevalence of stunting and community characteristics marked by limited education and economic resources. This study strengthens the evidence that CED in pregnant women is a significant risk factor for stunting and emphasizes the importance of monitoring maternal nutritional status during pregnancy, particularly through regular MUAC (mid-upper arm circumference) measurements. More intensive nutritional interventions and comprehensive

nutrition education are urgently needed, especially for mothers with low education and limited access to information.

Conclusion

This study found that Chronic Energy Deficiency (CED) in pregnant women is significantly associated with stunting in toddlers, whereas anemia was not found to have a significant relationship. These findings highlight that maternal nutritional status during pregnancy—particularly adequate energy and protein intake—is a key factor in stunting prevention. In the context of Singajaya Public Health Center, this study contributes valuable insight by identifying CED as a primary risk factor for stunting in the area. This underscores the need to strengthen nutritional interventions and routinely monitor maternal nutritional status, especially through MUAC measurements and nutrition education at the primary healthcare level. Stunting prevention efforts in this region should focus on meeting the nutritional needs of pregnant women and raising community awareness about the importance of balanced nutrition during pregnancy, as part of a long-term strategy to reduce stunting prevalence

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