

Determinants of Chronic Energy Deficiency among Adolescent Girls: A Cross-Sectional Study at SMP Negeri 44 Surabaya

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ABSTRACT

Chronic Energy Deficiency (CED) is a nutritional issue with long-term implications for the health and productivity of adolescent girls. This study aimed to analyze the determinants associated with CED among seventh- and eighth-grade students at SMP Negeri 44 Surabaya. Using an analytical observational design with a cross-sectional approach, the study involved 69 respondents selected via stratified random sampling. Data were collected through mid-upper arm circumference measurements, dietary intake questionnaires, assessments of nutritional knowledge, physical activity, and sociodemographic factors. Statistical analysis was conducted using the Chi-square test. The results showed a CED prevalence of 81.2%, with most respondents experiencing deficits in energy (89.9%) and carbohydrate intake (98.6%). Significant associations were found between energy intake ($p=0.012$), carbohydrate intake ($p=0.037$), and nutritional knowledge ($p=0.015$) with CED status. Other variables, including protein and fat intake, physical activity, parental education and income, and body image perception, were not significantly associated. The study concludes that low energy and carbohydrate intake, along with limited nutritional knowledge, are key contributors to CED. School-based nutritional interventions and parental involvement are essential strategies to prevent CED in adolescents.

INTRODUCTION

Chronic Energy Deficiency (CED) among adolescent girls represents a pressing public health issue in many developing countries, including Indonesia¹⁻³. CED arises when energy and protein intake are insufficient over an extended period, leading to impaired growth, development, and physiological function in adolescents. Young women, particularly those in urban areas, face heightened risks due to socioeconomic disparities⁴, and body image concerns⁵.

According to data from the 2023 Indonesian Health Survey, the magnitude of the problem of Chronic Energy Deficiency (CED) in non-pregnant Women of Childbearing Age (WUS) that occurs in Indonesia is 41.9%. Meanwhile, the magnitude of the problem of Chronic Energy Deficiency (CED) in non-pregnant Women of Childbearing Age (WUS) that occurred in East Java was 19.7%. In addition, the prevalence of Chronic Energy Deficiency (CED) based on the age group of 15-19 years is 41.9%⁶. When compared to Riskesdas data in 2018, the magnitude of the problem of Chronic Energy Deficiency (CED) in non-pregnant women that occurred in Indonesia was 14.5%. Meanwhile, the magnitude of the problem of Chronic Energy Deficiency (CED) in non-pregnant women that occurred in East Java was 13.9%. In addition, the prevalence of Chronic Energy Deficiency (CED) based on

the age group of 15-19 years is 36.3%⁷.

In adolescent girls, malnutrition like this has an impact on various aspects of life, including decreased cognitive ability, delayed physical growth, and decreased academic productivity⁸. As mothers-to-be, malnutrition in adolescent girls will have an impact on the health of the child at birth, increasing the risk of stunting which ultimately contributes to a less qualified generation⁹. Therefore, identifying the factors that affect CED in adolescent girls is very important to overcome these problems.

The factors that cause the occurrence of CED can be grouped into direct and indirect factors. Direct factors include low energy and protein intake and the presence of infectious diseases that can worsen the body's condition. Indirect factors include low nutritional knowledge, poor consumption patterns, and lack of physical activity¹⁰. In adolescent girls, especially those living in urban areas, body image factors also play a significant role in decreasing nutritional intake. Many adolescents who, due to social pressure and negative perceptions of the body, choose to limit their food intake, which then leads to malnutrition¹.

In the North Surabaya area, which is one of the urban areas with a dense population and various socioeconomic statuses, social pressure related to physical appearance is still relatively strong¹¹. Teens often feel dissatisfied with their body shape, which leads them to adopt unhealthy diets, avoid certain foods, or even reduce the frequency of meals to achieve (ideal body shape)¹². This method will worsen the condition of the CED they experience. In addition, socio-economic conditions in urban areas that are full of economic stress also affect the quality and quantity of food consumed by young women¹³.

An unbalanced diet and low protein and carbohydrate consumption in adolescent girls are the main factors that cause CED¹⁴. Research shows that urban teens tend to consume fast food that is low in nutritional value, while access to nutritious and often difficult foods is hard to come by. In contrast, rural adolescents are more exposed to local foods that are generally more nutritious, albeit in smaller portions¹⁵.

Based on a preliminary study that has been carried out using LiLA band measurements conducted on grade VIII adolescent girls at SMP Negeri 44 Surabaya, there are 77% of students experiencing Chronic Energy Deficiency (CED) and 23% of normal students. Given the high prevalence and potential long-term consequences, this study aims to analyze the determinants of Chronic Energy Deficiency (CED) among adolescent girls in grades VII and VIII at SMP Negeri 44 Surabaya.

MATERIALS AND METHODS

This study employed an analytical observational method with a cross-sectional approach to analyze determinant factors associated with Chronic Energy Deficiency (CED) in adolescent girls. The cross-sectional design allowed simultaneous observation of both independent variables (e.g., dietary intake, knowledge) and the dependent variable (CED status), making it effective for estimating prevalence and associated factors, although it does not establish causality.

The research was conducted at SMP Negeri 44 Surabaya, located in Simolawang Village, Simokerto District, East Java Province, from January to May 2025. The school was selected purposively due to its high prevalence of CED (77%) based on preliminary data among eighth-grade students. The research stages included administration and preparation in January–February, instrument validation in February, data collection in March, verification in April, and data analysis and report writing in April–May 2025.

The study population consisted of all female students in grades VII and VIII, totaling 224 individuals. Using the Slovin formula with a 10% precision level, a total sample of 69 respondents was determined and selected using proportionate stratified random sampling according to grade level. Inclusion criteria included girls aged 10–15 years, actively attending school, communicative, present during data collection, and willing to participate with informed consent from parents or guardians. Exclusion criteria included refusal to participate, presence of acute illness during data collection, or incomplete data.

The dependent variable in this study was CED status, measured using Mid-Upper Arm Circumference (MUAC or LiLA), with a cut-off point of <23.5 cm indicating CED, and ≥23.5 cm indicating normal status. To strengthen the accuracy of classification, Body Mass Index (BMI) was also measured as a comparative indicator, calculated from weight and height and categorized based on WHO BMI-for-age z-score standards for adolescents.

Independent variables included energy, protein, fat, and carbohydrate intake, which were assessed using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) referring to the previous month's intake. Data were then averaged and analyzed using the Indonesian Food Composition Table. Physical activity levels were assessed using the Physical Activity Level (PAL) form based on WHO recommendations, categorizing activity as light, moderate, or heavy. Nutritional knowledge was evaluated through a structured 20-item multiple-choice questionnaire. The instrument had been validated by experts, yielding a Content Validity Index (CVI) of 0.88 and a Cronbach's alpha reliability score of 0.76 based on a pilot study involving 20 students. Other variables such as parental education, income (categorized using the 2025 Surabaya City Minimum Wage), and body image perception (assessed via a Likert scale questionnaire) were also included.

All instruments, including consent forms, anthropometric forms, knowledge questionnaires, SQ-FFQ, PAL questionnaires, and socio-demographic surveys, were reviewed by nutrition experts and pilot tested. The instruments demonstrated adequate validity and reliability. Data collection began with coordination with the school and obtaining informed consent from students and parents. MUAC and BMI measurements were conducted in the school's health unit (UKS) by trained personnel. Structured interviews using questionnaires were conducted for approximately 20–30 minutes per respondent under supervision to ensure accurate data entry and completeness.

To ensure data quality, anthropometric tools were calibrated before each measurement, inter-rater reliability was maintained during data collection, and daily form checks were conducted for completeness. Data analysis was performed using SPSS version 26. Descriptive statistics were used to summarize respondent characteristics and variable distributions. Chi-Square tests were applied to identify bivariate associations between independent variables and CED status. A significance level of $p < 0.05$ was applied for all statistical tests.

RESULTS

Table 1. Respondent Characteristics

Respondent Characteristics		n	%
Class	VII	28	40,6
	VIII	41	59,4
Age	12 years	1	1,5
	13 years	27	39,1
	14 years	34	49,3
	15 years	7	10,1
Age of First Menstruation	Not Menstruating	10	14,5
	10 years	3	4,4
	11 years	9	13,0
	12 years	33	47,8
	13 years	13	18,8
	14 years	1	1,5
Pocket Money in a Day	Low	36	52,2
	Medium	18	26,1
	High	15	21,7
Father's Work	Civil Servant	4	5,8
	Private	27	29,1
	Self Employed	29	42,0
	Laborer	4	5,8
	Not Working	5	7,3
Mother's Work	Civil Servant	1	1,5
	Private	8	11,5
	Self Employed	15	21,7
	Laborer	1	1,5
	Housewives	44	63,8
Total		69	100

Source: Primary Data, 2025

The frequency distribution of adolescents in grades VII and VIII at SMP Negeri 44 Surabaya can be seen in Table 1, namely the distribution of the frequency of respondents based on class is

class VIII of 41 people (59.4%), based on the age of the most respondents is 14 years of age for 34 people (49.3%), based on the age of the first period with the highest number of 12 years for 33 people (47.8%). Meanwhile, based on the amount of pocket money in <Rp11,600, 36 people (52.2%). The distribution of the frequency of respondents based on father's work was the most self-employed with 29 people (42.0%). The frequency distribution based on maternal work is the most housewives with 44 people (63.8%).

Table 2. Respondent Characteristics

Research Variables		n	%
Dietary Intake	Deficit	62	89,9
	Normal	6	8,7
	More	1	1,4
Protein	Deficit	40	58
	Normal	14	20,3
	More	15	21,7
Fat	Deficit	53	76,8
	Normal	10	14,5
	More	6	8,7
Carbohydrates	Deficit	68	98,6
	Normal	1	1,4
	More	0	0
Diet	Good	60	87,0
	Less	9	13,0
	Yes	4	5,8
Infectious Diseases	No	65	94,2
	Basic Education	36	52,2
	Secondary/Higher Education	33	47,8
Mother's Last Education	Basic Education	29	42,0
	Secondary/Higher Education	40	58,0
Physical Activity	Light	49	71,0
	Moderate	10	14,5
	Heavy	10	14,5
Nutritional Knowledge	Light	17	24,6
	Moderate	30	43,5
	Heavy	22	31,9
Parental Income	Low	59	85,5
	High	10	14,5
Body Image Perception	Negative	31	44,9
	Positive	38	55,1
Prevalence of CED	Non CED	13	18,8
	CED	56	81,2
Total		69	100

Source: Primary Data, 2025

The results showed that most of the respondents experienced energy deficits (89.9%) and carbohydrates (98.6%), and 81.2% suffered from Chronic Energy Deficiency (CED). Although most have a good diet (87%) and do not experience infectious diseases (94.2%), nutritional status remains

low. Most have light physical activity and come from low-income families. Economic factors, nutritional intake, and physical activity are suspected to contribute to the high prevalence of CED in adolescent girls.

Table 3. Prevalence of CED Based on Dietary Intake, Dietary Habit, Infectious Diseases, Parental Education Level, Physical Activity, Nutritional Knowledge, Parental Income, and Body Image Perception of Determinants of Respondents of Chronic Energy Deficiency in Adolescent Girls in Grades VII and VIII at SMP Negeri 44 Surabaya

Variabel		Prevalence of CED				Total		p value
		CED		Non CED				
		n	%	n	%	n	%	
Dietary Intake								
Energy	Deficit	53	76,8	9	13,0	62	89,8	0,012
	Normal	3	4,4	3	4,4	6	8,8	
	More	0	0	1	1,4	1	1,4	
Protein	Deficit	34	49,3	6	8,7	40	58	0,592
	Normal	11	15,9	3	4,3	14	20,3	
	More	11	15,9	4	5,8	15	21,7	
Fat	Deficit	45	65,2	8	11,6	53	76,8	0,116
	Normal	8	11,6	2	2,9	10	14,5	
	More	3	4,3	3	4,3	6	8,7	
Carbohydrates	Deficit	56	81,2	12	17,4	68	98,6	0,037
	Normal	0	0	1	1,4	1	1,4	
Dietary Habit								
Less		49	71,1	11	15,9	60	87,0	0,781
Good		7	10,1	2	2,9	9	13,0	
Infectious Diseases								
Yes		4	5,8	0	0	4	5,8	0,321
No		52	75,4	13	18,8	65	94,2	
Parental Education Level								
Dad's Last Education Level	Basic	29	42,1	7	10,1	36	52,2	0,893
	Medium/High	27	39,1	6	8,7	33	47,8	
Mother's Last Education Level	Basic	22	31,9	7	10,1	29	42,0	0,338
	Medium/High	34	49,3	6	8,7	40	58,0	
Physical Activity								
Light		43	62,3	6	8,7	49	71,0	0,077
Moderate		7	10,2	3	4,3	10	14,5	
High		6	8,7	4	5,8	10	14,5	
Nutritional Knowledge								
Less		12	17,4	5	7,2	17	24,6	0,015
Enough		29	42,1	1	1,4	30	43,5	
Good		15	21,7	7	10,2	22	31,9	
Parental Income								
Low		48	69,6	11	15,9	59	85,5	0,919
High		8	11,6	2	2,9	10	14,5	
Body Image Perception								
Negative		24	34,8	7	10,1	31	44,9	0,473

Positive	32	46,4	6	8,7	38	55,1
Total	56	81,2	13	18,8	69	100

Source: Primary Data, 2025

The results showed that the prevalence of Chronic Energy Deficiency (CED) in adolescent girls was significantly correlated with energy intake ($p=0.012$), carbohydrates ($p=0.037$), and nutritional knowledge ($p=0.015$). Most adolescents with CED status experience energy (76.8%) and carbohydrate (81.2%) deficits, and have low to moderate nutritional knowledge. Other variables such as protein intake, fat, eating habits, infectious diseases, parental education, physical activity, parental income, and body image perception did not show a statistically significant relationship ($p>0.05$) with CED. These findings indicate that adequate energy and carbohydrates, as well as a good level of nutritional knowledge, are important factors in preventing CED in adolescents. Therefore, nutrition interventions in this group need to be focused on increasing nutritious food intake and proper nutrition education from an early age, especially in the school environment.

DISCUSSION

This study revealed that the prevalence of Chronic Energy Deficiency (CED) among adolescent girls at SMP Negeri 44 Surabaya was 81.2%, a significantly high rate compared to the national prevalence of 41.9% (SKI 2023) and 19.7% in East Java. These findings highlight a notable nutritional vulnerability within urban adolescent populations that requires targeted public health attention.

Energy and Carbohydrate Intake

From the results of the analysis, there was a significant relationship between energy and carbohydrate intake and CED status ($p=0.012$ and $p=0.037$). The majority of adolescents with CED status experience energy (76.8%) and carbohydrate (81.2%) deficits. These findings are in line with research by Yulia *et al.* (2024) which showed that adolescents in urban areas tend to consume low-nutrient foods due to preferences for fast food and irregular diets¹.

Low energy intake in the long term has a direct impact on chronic energy deficits because the body does not get enough calories to support growth and activity. In addition, carbohydrates as the main source of energy also play an important role in the daily energy metabolism of adolescents. A lack of carbohydrates causes the body to use protein as a secondary source of energy, which ultimately interferes with growth and development^{16,17}.

Nutritional Knowledge

Nutritional knowledge was significantly related to CED status ($p=0.015$). Respondents with low to moderate nutritional knowledge are more at risk of developing CED. The results of this study are in line with (Puspita Sari & Dian Khairani, 2024) that based on the results of bivariate analysis, a p -

value of 0.364 was obtained, meaning that there is no relationship between nutritional knowledge and the incidence of CED in adolescent girls at SMAN 2 Pringsewu. On the other hand, the number of adolescent girls with good nutritional knowledge but still Chronic Energy Deficiency (CED) is higher than those who only have sufficient dietary awareness. This proves that knowledge in theory alone is not necessarily followed by application in daily life¹⁸.

Lack of nutrition education causes adolescents to not understand the importance of breakfast, balanced food proportions, and the negative effects of excessive eating restrictions. On the other hand, school-based nutrition education programs have been proven to be effective in increasing energy and protein intake and improving nutritional status¹⁹.

Physical Activity

Most respondents (71%) did light physical activity. Although no statistically significant association was found ($p=0.077$), this trend supports that lack of physical activity can worsen nutritional status indirectly through metabolism and low energy burn. The misalignment between energy intake and energy expenditure can lead to CED, especially if high energy expenditure is not balanced against adequate intake. Thus, the analysis of the relationship between physical activity and the incidence of CED is important to understand the risk factors that adolescent girls may experience.

The results of this study are in line with (Wahidah, 2023) that based on testing using the Fisher test, it was proven that H_0 was accepted at a p value of 0.337 ($p>0.05$). This proves that there is no significant relationship between physical activity and the risk of CED in adolescent girls at SMAN 13 Semarang²⁰.

Socio-Economic Factors

Most of the respondents came from low-income families (85.5%) and with limited parental education. Although the results of statistical tests are not significant, epidemiologically, poverty is an important determinant in the CED problem. A study by Angkasa *et al.* (2024) confirms that economic limitations greatly affect access to nutritious food, and low-income families tend to choose cheap but less nutritious foods²¹. Similarly, parental education plays an important role in food decision-making at home. Parents with low education tend to have limited nutritional knowledge and are less likely to encourage healthy eating habits in their children^{22,23}.

Body Image Perception

About 44.9% of adolescents have a negative perception of body image. Although these variables did not show a significant relationship, these results remained contextually relevant. Negative perceptions of the body can encourage teens to go on strict diets, limit eating, or avoid high-calorie foods in order to achieve an ideal body shape according to social standards. A study by Garbett *et al.* (2023) showed that adolescent girls in Indonesia have high social pressure on thin body shape, which correlates with unhealthy diets and the risk of CED⁵.

Diet and Infectious Diseases

Most of the respondents had a diet that was categorized as good (87%) and did not experience infectious diseases (94.2%), which means that these two variables were not the dominant factors in the target group. However, it is important to note that the perception of 'good' here refers to self-reports that may be biased, as they do not necessarily reflect the adequacy of food quality and quantity based on balanced nutrition guidelines. Similarly, the low proportion of infectious diseases does not adequately explain the causal relationship. Even so, previous studies have stated that gastrointestinal infections and ISPA can worsen nutritional status through loss of appetite and increased energy requirements^{24,25}.

This study has several limitations that need to be considered in interpreting the results. The design used is cross-sectional, so it cannot show a cause-and-effect relationship between independent variables and Chronic Energy Deficiency (CED) status. The relatively small sample size (69 respondents) also limited the generalization of the results to a wider population. In addition, most of the data was obtained through self-report instruments such as SQ-FFQ, physical activity, and body image perception, which are susceptible to recall bias and social desirability bias.

Nutritional status was measured using only Upper Arm Circumference, without anthropometric or other biochemical indicators such as Body Mass Index (BMI) or protein levels, thus less reflective of overall nutritional status. The nutritional knowledge measured does not always reflect real practice, as adolescents with good knowledge can still experience CED due to other factors such as economic limitations or social pressure. This study also did not explore socio-cultural aspects in depth, such as the influence of social media and beauty standards on adolescent diet. Finally, potential participation bias or non-response bias may occur, where non-participating students are likely to have conditions that are significantly different from those studied.

CONCLUSION

This study demonstrates a high prevalence of Chronic Energy Deficiency (CED) among adolescent girls at SMP Negeri 44 Surabaya (81.2%). Significant associations were identified between CED status and energy intake, carbohydrate intake, and nutritional knowledge. Although most participants reported good dietary practices and lacked infectious disease symptoms, energy and carbohydrate deficits were widespread. Other factors, such as physical activity, parental income, and body image perception, were not statistically significant but remain contextually relevant. Based on these findings, collaborative efforts between schools and health centers are recommended to implement practical and sustainable nutrition education. Interventions should focus on improving energy and carbohydrate intake and involve parental engagement, while also promoting a healthy

lifestyle and positive body image among adolescents.

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