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Body Image and Macronutrient Intake as Predictors of Chronic Energy Deficiency in Adolescent Girls: A Cross-Sectional Study

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ABSTRACT

Chronic Energy Deficiency (CED) is a serious nutritional problem to which adolescent girls are susceptible, and it can have detrimental effects on health and productivity. The prevalence of CED in Indonesia, particularly in Nusa Tenggara Timur (NTT), remains high. The factors causing CED are multifactorial, including direct factors such as macronutrient intake and indirect factors such as body image, which can trigger unhealthy dieting behaviors. This study aimed to analyze the relationship between body image and intake of energy, protein, fat, and carbohydrates with the incidence of CED in adolescent girls at SMAN 7 Kupang. This quantitative study employed a cross-sectional design and was conducted from February to June 2025 at SMAN 7 Kupang. A sample of 93 female students from grades X and XI was selected using the Simple Random Sampling technique. Body image data were collected using the MBSRQ-AS questionnaire, macronutrient intake using a 24-hour food recall form, and CED status was measured with a Mid-Upper Arm Circumference (MUAC) tape (cutoff <23.5 cm). Data analysis was performed using the chi-square test at a significance level of $p<0.05$. The majority of respondents were aged 15-16 years (66.7%) and came from families with income below the regional minimum wage (77.4%). Bivariate analysis results showed a significant relationship between negative body image ($p=0.009$), insufficient energy intake ($p=0.016$), insufficient protein intake ($p=0.000$), insufficient fat intake ($p=0.024$), and insufficient carbohydrate intake ($p=0.030$) with the incidence of CED.

Key Messages:

- Chronic Energy Deficiency (CED) in adolescent girls is not only caused by insufficient nutrient intake but is also influenced by psychological factors such as negative body image. Therefore, effective intervention must be holistic, targeting both nutritional improvement and mental health simultaneously.

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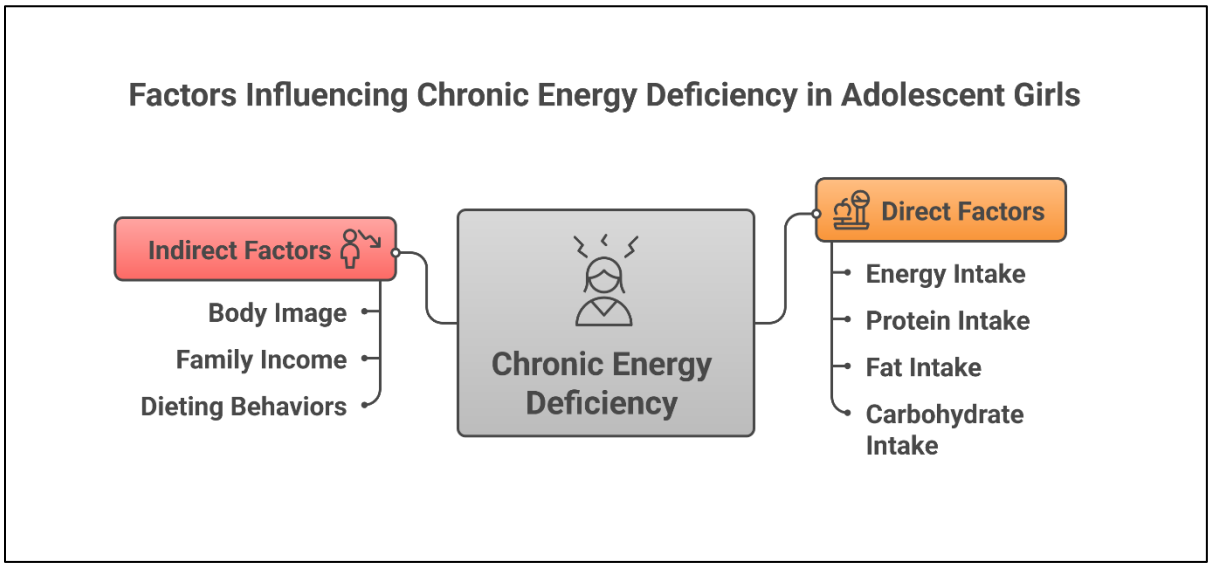
GRAPHICAL ABSTRACT



INTRODUCTION

Adolescent girls are a vulnerable group for various nutritional problems, one of which is Chronic Energy Deficiency (CED), necessitating the maintenance of adequate nutrient intake. Adolescents or women of reproductive age who experience CED before pregnancy face risks of anemia, infectious diseases, and adverse impacts on longevity, such as impaired work productivity and decreased immune system function, which increases the likelihood of illness or even death (1).

Based on 2023 SKI data, the prevalence of CED in Indonesia for adolescents aged 15-19 years reached 41.9%. In the province of NTT, the prevalence among non-pregnant women is 35.7%, making it the province with the highest CED prevalence (2). The prevalence of CED among women of reproductive age (WRA) who are not pregnant in Kupang City reached 25.31%. Maulafa sub-district has the second-highest population in Kupang City, at 109,993 people (3). Maulafa sub-district has the second-highest population in Kupang City, at 109,993 people. SMAN 7 in the Maulafa sub-district has the largest number of students among all high schools in the area, totaling 1,164 students, with 596 being female students (4). Previous research at SMAN 7 Kupang revealed that out of 148 respondents, 96 female students (64.9%) were at risk of CED, and 52 (35.1%) were not.

Food intake, especially energy and protein intake, is a direct cause of CED. The availability of fat and protein, used as alternative energy sources, decreases when energy intake is insufficient for the body's needs. Insufficient energy intake causes protein and fat to be redirected to function as energy sources, thus neglecting their primary functions. In addition to direct factors, CED can also be influenced by indirect factors. One of these indirect factors is body image. Body image is an individual's perception encompassing satisfaction with body shape and weight, as well as their body orientation. This body image issue is crucial for adolescent girls as it coincides with a strong phase of self-identity searching, where perceptions of physical appearance are often heavily influenced by the massive ideal beauty standards on social media. Body image is divided into two types: positive body image and negative body image. Individuals with a negative body image tend to be dissatisfied with their body shape, which leads to decreased self-confidence and may cause them to pursue various measures to achieve what they consider an ideal body shape. One such measure is engaging in strict and unhealthy dieting, which later leads to nutritional problems. A positive body image means an individual is satisfied with their current appearance, appreciates everything their body provides, and accepts all its shortcomings. Individuals who are satisfied with what they possess tend to value themselves more and be more grateful for what they have (5). The general objective of this study was to determine the relationship between body image, macronutrient intake, and the incidence of CED in adolescent girls at SMAN 7 Kupang.

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METHODS

This study was quantitative research with a cross-sectional design conducted at SMAN 7 Kupang between February and June 2025. The study population consisted of 375 female adolescents in grades X and XI at SMAN 7 Kupang. The sampling technique used was simple random sampling, yielding a sample size of 93 people. Inclusion criteria for the sample were 1) female adolescents willing to be respondents and 2) female adolescents aged 15-18 years. Exclusion criteria were 1) students who were sick and unable to participate in activities during the research process; 2) students who dropped out or transferred schools during the research; and 3) not being present at the research location.

The data collected included sample characteristics: age, grade, religion, father's occupation, mother's occupation, father's education, mother's education, and parental income, using a structured questionnaire. Body image data, defined as an individual's experience including their perception of body shape and weight and behaviors related to their evaluation of physical appearance, were collected using the MBSRQ-AS (Multidimensional Body Shape Self-Relation Questionnaire – Appearance Scale) (6). The objective criteria for body image were positive (≥ 50) and negative (< 50) (7).

Macronutrient intake data (protein, fat, and carbohydrate intake consumed daily) were collected using the 24-hour food recall form and a food photo book. Categories for intake were insufficient (< 80%), good (80-110%), and excessive (> 110%) (8). CED status is a prolonged state of undernutrition (energy and protein) lasting for a long time or even years, measured using MUAC tape (9). The objective criteria were CED (< 23.5 cm) and Not CED (≥ 23.5 cm) (2). Data analysis was conducted using the SPSS for Windows program, employing the chi-square test with a significance level of $p < 0.05$.

RESULTS

The profile of the 93 research respondents shows that the majority were in the early adolescence age group, 15-16 years (66.7%), with an almost even distribution between grade 10 (51.6%) and grade 11 (48.4%). In terms of belief, respondents were predominantly Christian (82.8%). The family's socioeconomic background revealed that the most common occupation of fathers was farming (32.3%), while the majority of mothers were Housewives (77.4%). The parents' education level was dominated by High School (father, 48.4%; mother, 53.8%), consistent with the data showing that the majority of respondent families had an income below the regional minimum wage (77.4%).

The results of the bivariate analysis demonstrate that all independent variables tested—body image, energy intake, protein intake, fat intake, and carbohydrate intake—have a statistically significant relationship with nutritional status (incidence of CED). The strongest statistical relationship was found for the protein intake variable ($p < 0.05$), indicating its crucial role in nutritional status.

Descriptively, the highest prevalence of CED was observed in the group with insufficient fat intake, where 71.0% experienced CED, followed by the group with insufficient energy intake (60.2%). Beyond dietary factors, psychological factors such as body image also proved significant, with 51.6% of respondents having a negative body image experiencing CED ($p=0.009$). Collectively, these findings confirm that both psychological factors and macronutrient intake deficiencies are significant predictors of the risk of Chronic Energy Deficiency (CED) in the studied population.

Table 1. Respondent Characteristics

Characteristic	Category	n	%
Age	15-16 years	62	66.7
	17-18 years	31	33.3
Grade	10	48	51.6
	11	45	48.4
Religion	Christian	77	82.8
	Catholic	13	14.0
	Islam	3	3.2
Father's Occupation	Civil Servant/Military/Police	23	24.7
	Private Employee	5	5.4
	Entrepreneur	24	25.8

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	Farmer	30	32.3
	Fisherman	2	2.2
	Laborer	9	9.7
Mother's Occupation	Civil Servant	9	9.7
	Housewife	72	77.4
	Entrepreneur	6	6.5
	Private Employee	6	6.5
Father's Education	D3/S1/S2	24	25.8
	Senior High School	45	48.4
	Junior High School	16	17.2
	Elementary School	8	8.6
Mother's Education	D3/S1/S2	23	24.7
	Senior High School	50	53.8
	Junior High School	8	8.6
	Elementary School	12	12.9
Parental Income	< Regional Minimum Wage	72	77.4
	≥ Regional Minimum Wage	21	22.6
Total		**93**	**100.0**

Table 2. Relationship between Body Image, Nutrient Intake, and the Incidence of CED

Variable	Nutritional Status (MUAC)				Total		P-value
	Normal		CED				
	n	%	n	%	n	%	
Body Image							
Negative	6	6.5	48	51.6	54	58.1	0.009
Positive	13	14.0	26	28.0	39	41.9	
Energy Intake							
Insufficient	9	9.7	56	60.2	65	69.9	0.016
Good	10	10.8	18	19.4	28	30.1	
Protein Intake							
Insufficient	2	2.2	42	45.2	44	47.3	0.000
Good	17	18.3	32	34.4	49	52.7	
Fat Intake							
Insufficient	13	14.0	66	71.0	79	84.9	0.024
Good	6	6.5	8	8.6	14	15.1	
Carbohydrate Intake							
Insufficient	8	8.6	51	54.8	59	63.4	0.030
Good	11	11.8	23	24.7	34	36.6	

DISCUSSION

The study results show a significant relationship between negative body image and the incidence of Chronic Energy Deficiency (CED) in adolescent girls (p=0.009). This finding reinforces the evidence that psychological factors play a crucial role in adolescent nutritional status. Adolescent girls with a negative perception of their body shape tend to be dissatisfied and have a desire to be thin, which often leads them to engage in unhealthy restrictive eating habits. This restrictive dietary behavior, if carried out without adequate nutritional knowledge, can lead to long-term energy and nutrient deficits, ultimately resulting in CED. Body image dissatisfaction is a strong predictor of dieting behavior in adolescents, directly affecting their intake and nutritional status (10). Therefore, a negative body image perception can be an initial trigger for more serious nutritional problems like CED

Furthermore, misconceptions about body image can cause a distortion in self-image perception, creating unrealistic expectations regarding the ideal appearance. Research by Groesz et al. (11), indicated that adolescent girls under 19 experienced the most drastic decline in body satisfaction due to exposure to media displaying thin body images. This phenomenon is exacerbated by diet, exercise, and beauty trends on social media and reality television, which, according to recent studies, actively shape unhealthy body perceptions in adolescents. Social media and advertisements play a significant role in perpetuating these

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misconceptions by constantly presenting an ideal body type that is often unattainable. As evidence, it has been reported that 24.2% of junior and senior high school adolescents have negative body image issues, even though they have a normal Body Mass Index (BMI) (12). This suggests that pressure from the media and unrealistic beauty standards can trigger body dissatisfaction, even in physically healthy adolescents.

Further analysis confirms that a deficiency in macronutrient intake is significantly related to the incidence of CED**.** The strongest statistical relationship was found for protein intake ($p < 0.000$), underscoring the vital role of protein as the primary building block during the rapid growth phase of adolescence. Protein deficiency inhibits the synthesis of new tissues and cell repair, reflected by a low Mid-Upper Arm Circumference (MUAC) measurement. In addition, energy intake ($p = 0.016$), fat intake ($p = 0.024$), and carbohydrate intake ($p = 0.030$) were also found to be significantly related. This aligns with the fundamental concept of CED as a manifestation of chronic energy imbalance. Dietary patterns (eating frequency and food variety), nutrient intake (energy, protein, fat, and iron), body image, and BMI-for-age are related to the incidence of CED, with most adolescent girls who have dietary patterns inconsistent with balanced nutrition guidelines, insufficient iron intake, and negative body image experiencing CED. Conversely, most adolescent girls who have a good intake of energy, protein, and fat do not experience chronic energy deficiency (13).

Overall, the findings of this analysis have important implications: the problem of CED in adolescent girls is multifactorial, involving a complex interaction between psychological factors and nutritional intake. The strong relationship between negative body image and CED suggests that nutritional interventions alone will not be sufficiently effective. A holistic approach is required, integrating balanced nutrition education with psychological counseling programs to build a positive and healthy body image. As recommended by UNICEF (2021), adolescent health programs should include a component of mental health and psychosocial support alongside nutritional services (14). Research shows that nutritional education intervention has proven to be an effective approach to improving unhealthy eating behaviors and misconceptions about body image in the target population. Specifically, this intervention has successfully demonstrated positive increases in nutritional knowledge, self-efficacy, healthy eating habits, physical activity levels, and increased consumption of fruits and vegetables. On the other hand, the findings also confirm a negative relationship between conditions such as overweight, obesity, and unethical weight loss practices with increased body image dissatisfaction (15).

CONCLUSION

Based on the research results and discussion, it can be concluded that there is a statistically significant relationship between body image, energy intake, protein intake, fat intake, and carbohydrate intake with the incidence of Chronic Energy Deficiency (CED) in adolescent girls at SMAN 7 Kupang. These findings confirm that the problem of CED in adolescents is multifactorial, not only caused by deficiencies in nutrient intake but also strongly influenced by psychological factors. Negative body image is proven to be a risk factor that promotes unhealthy eating behaviors, ultimately contributing to CED status. Therefore, intervention efforts to tackle CED in adolescent girls will not be effective if they only focus on nutritional improvement. A holistic and integrated approach is needed, combining balanced nutrition education with psychosocial support programs to build a positive and healthy body image.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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