THE RELATIONSHIP BETWEEN ENERGY INTAKE, MACRONUTRIENTS, AND GLYCEMIC INDEX OF SNACK FOODS WITH NUTRITIONAL STATUS AMONG ADOLESCENTS AT SMAN 07 BENGKULU CITY

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Abstract

Nutritional status is a condition of body health influenced by the intake of nutrients obtained from food and beverages in accordance with the body's needs. Adolescents are particulary vulnerable to nutritional problems due to behavioral and lifestyle changes. They require adequate nutrient intake to support their growth and development. This study aims to determine the relationships between energy, macronutrient intake, and glycemic index of snack foods with nutritional status among adolescents at SMAN 07 Bengkulu City in 2025. This research used a descriptive-analytic method with a cross-sectional approach. Data were collected through simple random sampling involving 60 students. Instrument included snack food SQ-FFQ, digital body weight scale, and microtoise. Data analysis was conducted using univariate and bivariate analysis with the chi-square test. The results showed a significant relationship between energy, protein, fat, and carbohydrate intake from snack foods and the nutritional status of adolescents at SMAN 07 Bengkulu City (p-value < 0.05). Menawhile, glycemic index intake showed no significant relationship with nutritional status (p-value = 0.176).

Keywords: Energy, Macronutrient, Glycemic Index, Snack Foods, Adolescent, Nutritional Status

INTRODUCTION

Adolescence is a crucial period characterized by rapid physical, cognitive, and psychosocial changes, making nutritional needs during this stage highly critical. Adequate nutrient intake is essential to support optimal growth and development, while both deficiencies and excesses in intake may affect adolescents' nutritional status and long-term health (Ma'sunnah *et al.,* 2021).

Globally, adolescent nutrition remains a significant concern. WHO (2016) reported that 75 million adolescent girls and 117 million adolescent boys were undernourished, while more than 340 million children and adolescents aged 5–19 years were overweight or obese (Triwahyuningsih *et al.,* 2024). A

similar trend is observed in Indonesia, where the 2018 Basic Health Research (Riskesdas) reported high prevalence rates of undernutrition, stunting, and overnutrition among school-aged adolescents (Kemenkes RI, 2018). Local data from Bengkulu in 2023/2024 also showed that 24.5% of adolescents aged 16–18 years were underweight, while 21.4% were overweight.

Both underweight and overweight negatively impact adolescent health. Underweight may hinder growth, reduce concentration, and affect physical, mental, and social well-being. Meanwhile, overweight during adolescence tends to persist into adulthood and increases the risk of degenerative diseases such as diabetes mellitus and cardiovascular disease (Makaryani, 2013).

One factor contributing to adolescent nutritional problems is daily dietary patterns, particularly the habit of consuming snack foods. Adolescents tend to choose snacks high in calories, sugar, fat, and glycemic index (GI), which can lead to energy imbalance (Puspasari & Farapti, 2020). On the other hand, an adequate balance of macronutrients—protein, carbohydrates, and fats—is essential for maintaining good nutritional status (Rahmah *et al.,* 2024).

The glycemic index is also an important indicator in evaluating the metabolic effects of foods. Consuming foods with a high GI may cause spikes in blood glucose levels and affect nutritional status as well as the risk of metabolic disorders (Eliza *et al.,* 2020). However, research linking energy intake, macronutrients, and the glycemic index of snacks to adolescent nutritional status remains limited, particularly in Bengkulu.

Based on this background, this study aims to analyze the relationship between energy intake, macronutrients, and the glycemic index of snack foods with the nutritional status of adolescents at SMA Negeri 07 Bengkulu City in 2025.Introduction section should provide a comprehensive overview, covering the study's background, problem statement, objectives, and benefits. It is essential to describe the current situation and establish the significance of the research by contextualizing the problem on a global, regional, national, and local scale. Discuss existing programs, interventions, policies, and the findings of previous studies to demonstrate the current state of knowledge. Finally, articulate the clear rationale for conducting this research and present the specific research questions or hypotheses that your study aims to address.

MATERIALS AND METHODS

The research design employed was an observational analytic study with a cross-sectional approach, in which data were collected simultaneously at a single point in time to determine the relationship between energy intake, macronutrient intake, and the glycemic index of snack foods with the

nutritional status of adolescents at SMAN 07 Bengkulu City. This study was conducted at SMAN 07 Bengkulu City, with data collection carried out from April to May 2025.

The study population consisted of 445 eleventh-grade students of SMAN 07 Bengkulu City in 2025. Sampling was conducted using a simple random sampling technique, with samples taken from each class, resulting in a total of 60 respondents. Data collection methods included anthropometric measurements (body weight and height) and interviews with students regarding their snacking habits. Energy and macronutrient intake levels were assessed using a semi-quantitative Food Frequency Questionnaire (semi-FFQ), analyzed using Nutri-Survey, and categorized as insufficient (<80% of RDA), adequate (80–110% of RDA), and excessive (>110% of RDA). The glycemic index (GI) was estimated using the comprehensive GI formula based on carbohydrate intake and the respondents' meal frequency.

The instruments used to collect data included a microtoise and a digital scale, a semi-FFQ form for snack consumption, and a food photo booklet. Data processing techniques involved data entry, cleaning, verification, coding, tabulation, and analysis. Univariate analysis was conducted to describe each variable under study. Bivariate analysis was performed to examine the relationship between independent and dependent variables using the Chi-Square test. This study was ethically approved by the Ethics Committee of Poltekkes Kemenkes Bengkulu (No. KEPK.BKL/381/05/2025).

RESULTS AND DISCUSSION

Overview of Energy and Macronutrient Intake from Snack Foods and Nutritional Status of Adolescents at SMAN 07 Bengkulu City

Table 1 presents the results of the study conducted at SMAN 07 Bengkulu City using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), which was then compared with the Recommended Dietary Allowance (RDA) based on adolescents' sex and age. The percentage of nutrient adequacy was subsequently calculated. The findings revealed that the majority of adolescents had inadequate energy intake, accounting for 65%. This indicates that energy intake from snack foods alone was insufficient to meet adolescents' daily energy requirements. Snack foods are generally light, consumed in small amounts, and often prioritize taste over balanced energy content.

Protein intake from snack foods was also found to be inadequate, with 56.7% of respondents not meeting the recommended intake. This low protein intake may be attributed to the limited availability

of snacks containing significant amounts of animal or plant-based protein, such as sempol, sausages, or rolled eggs, which were consumed only occasionally or in small portions.

Meanwhile, fat intake showed an inadequacy proportion of 55%, which was nearly equal to the proportion of respondents who met the adequacy level (45%). This suggests that while many snack foods consumed, such as fried foods and fast foods, contain high fat, their frequency or portion sizes may not have been sufficient to fulfill the daily fat requirements of some respondents.

For carbohydrates, 63.3% of respondents also had inadequate intake, whereas only 36.7% met the recommended adequacy. Carbohydrates serve as the primary energy source, and many types of snacks are made from flour or simple sugars, which should theoretically contribute to carbohydrate intake. This inadequacy might be due to low consumption frequency or small portion sizes among respondents.

Overall, these results indicate that although adolescents consume a variety of snacks, their contribution to meeting macronutrient requirements remains suboptimal. Snack foods alone cannot serve as the primary source of nutrient intake, particularly for meeting daily nutritional adequacy.

Table 1. Overview of Energy and Macronutrient Intake from Snack Foods and Nutrtional Status of Adolescents at SMAN 07 Bengkulu CityTable 1. Captions for Tables are placed above

Variable	n=60	%
Energy Intake		
Insufficient	39	65
Adequat	21	35
Protein Intake		
Insufficient	34	56.7
Adequat	26	43.3
Fat Intake		
Insufficient	33	55
Adequat	27	45
Carbohydrate Intake		
Insufficient	38	63.3
Adequat	22	36.7

Overview of Glycemic Index of Snack Foods and Nutritional Status of Adolescents at SMAN 07 Bengkulu City

Table 2 shows that the majority of respondents, namely 56 students (93.3%), consumed snack foods with a low to moderate glycemic index, while only 4 respondents (6.7%) consumed snack foods with a high glycemic index. This indicates that most of the snacks consumed by adolescents at SMAN 07 Bengkulu City were not high-glycemic-index foods.

Table 2. Overview of Glycemic Index of Snack Foods and Nutritional Status of Adolescents at SMAN 07 Bengkulu City

Glycemic Index Content	n=60	%
High	4	6.7
Low to Moderate	56	93.3
Total	60	100

Overview of Nutritional Status of Adolescents at SMAN 07 Bengkulu City

Table 3 shows the results of body weight and height measurements using BMI-for-age (BMI/A) calculated with the Z-score formula, indicating that 27 respondents (45%) had an abnormal nutritional status, while the remaining respondents were classified as normal. This finding indicates that more than half of the adolescents experienced nutritional problems, either undernutrition or overnutrition.

Table 3 Overview of Nutritional Status of Adolescents at SMAN 07 Bengkulu City

Nutritional Status	n=60	%
Abnormal	27	45
Normal	33	55
Total	60	100

Relationship Between Energy and Macronutrient Intake from Snack Foods and Nutritional Status of Adolescents at SMAN 07 Bengkulu City

There was a significant relationship between energy, protein, fat, and carbohydrate intake from snack foods and the nutritional status of adolescents at SMAN 07 Bengkulu City (p-value < 0.05 for all variables). This finding indicates that the adequacy level of macronutrients from snack foods plays an important role in determining adolescents' nutritional status. Interestingly, the results showed that adolescents with adequate energy and macronutrient intake were more frequently classified as having abnormal nutritional status compared to those with insufficient intake. For instance, among the 21 respondents with adequate energy intake, 18 (30%) were categorized as having abnormal nutritional status. A similar pattern was observed for protein, fat, and carbohydrate intake. This suggests that macronutrient adequacy from snack foods does not necessarily reflect good nutritional status (Limboto *et al.,* 2024).

This study also found respondents with adequate energy intake who still presented abnormal nutritional status (30%). Similar findings were reported by (Herawati et al., 2023), who stated that even with adequate energy intake, some respondents had poor nutritional status due to frequently skipping breakfast, which contributed to undernutrition, while others consumed excessive carbohydrates, such as rice combined with instant noodles, and preferred sweet snacks, leading to overnutrition. This is likely because instant noodles lack balanced nutrients and mainly provide energy, and frequent consumption may result in excess energy accumulation in the body, which negatively affects nutritional status (Rarastiti, 2023).

In addition to energy, protein plays a crucial role in the body as it is a building block for tissues. Protein deficiency in adolescents can impair growth and development (Ristanti *et al.,* 2024). Protein deficiency may lead to stunted physical and mental development and even reduced red blood cell production, while excessive protein intake may cause kidney and liver disorders (Puspasari & Farapti, 2020). As previously mentioned, this study found that adequate macronutrient intake was more frequently observed among respondents with abnormal nutritional status. This was also reported by Herawati et al. (2023), who noted that although respondents had sufficient protein intake, many consumed excessive carbohydrates and fats, resulting in under- or overnutrition. Achieving optimal nutritional status requires food consumption aligned with nutritional needs and balanced diet recommendations, and physical activity is another key factor influencing adolescent nutritional status (Sulistyadewi & Masitah, 2020).

This phenomenon can be explained by two main possibilities. First, although adolescents consumed snack foods with adequate macronutrients, the overall dietary composition tended to be unbalanced, high in energy but low in micronutrients and fiber (Millatashofi & Adi, 2023). Second, in Indonesia, snack foods are commonly rich in energy, saturated fats, sugar, and salt but contain limited vegetables, fruits, and whole grains. High consumption of such snack foods contributes significantly to total energy intake, nutrient balance, and ultimately nutritional status (Nuryani & Rahmawati, 2018).

A study by (Vardia & Sartika, 2024) also demonstrated that the consumption of high-energy and high-carbohydrate snacks, such as fried foods and sweet foods, increases the risk of overnutrition in adolescents. Thus, adequate energy and macronutrient intake from snack foods does not automatically indicate a healthy dietary pattern or support normal nutritional status. Overall, these findings emphasize the importance of snack food quality rather than solely focusing on quantity or adequacy. Adolescents should be encouraged to choose snacks that not only provide energy but also contain

essential nutrients, including vitamins and minerals, while being low in saturated fats and added sugars.

This finding aligns with the study by (Kaluku et al., 2023), which showed that snacking habits were observed across all nutritional status categories. In a study at SD Negeri 1 Gianyar, most children with snacking habits were undernourished (58.2%), followed by those with normal nutritional status (26.6%) and those who were overweight (15.2%). Snacking habits were also shown to influence children's nutritional status. Another study at SDN 04 Petang, East Jakarta, found a significant relationship (p = 0.003, p < 0.05) between total energy intake from snack foods and home meals with children's nutritional status.

This is also consistent with findings by (Ratnasari & Fitriani, 2024), who reported that snacking patterns are a factor that needs attention, as they are related to adolescents' nutritional status at SMA Pangudi Luhur Sedayu. Adolescents are highly vulnerable to environmental influences, and lifestyle factors play a major role in shaping their dietary patterns. Other contributing factors to poor dietary patterns include thequality of food available in their surroundings.

Vardia & Sartika (2024) further stated that many students with unhealthy snacking habits still had normal nutritional status, while some with healthier snack choices had poor nutritional status. This may occur because adolescent overnutrition/obesity is not solely influenced by snacking frequency but also by main meal consumption (Kurniawati & Fayasari, 2023) and physical activity (Jeki & Isnaini, 2022).

Table 4. Relationship Between Energy and Macronutrient Intake from Snack Foods and
          Nutritional Status of Adolescents at SMAN 07 Bengkulu City

Variabel		Nutritional Status				Total		P-Valeu
		Abormal		Normal				
		n=60	%	n=60	%	N=60	%	
Energy	Insufficient	9	15	30	50	39	100	0.000
	Adequate	18	30	3	5	21	100	
	Total	27	45	33	55	60	100	
Protein	Insufficient	10	16.7	24	40	34	100	0.012
	Adequate	17	28.3	9	15	26	100	
	Total	27	45	33	55	60	100	
Fat	Insufficient	9	15	24	40	33	100	0.005
	Adequate	18	30	9	15	27	100	
	Total	27	45	33	55	60	100	
Carbohydrate	Insufficient	10	16.7	28	46.7	38	100	0.000
	Adequate	17	28.3	5	8.3	22	100	
	Total	27	45	33	55	60	100	

Relationship Between Glycemic Index of Snack Foods and Nutritional Status of Adolescents at SMAN 07 Bengkulu City

Table 5 shows that, based on the analysis results, the majority of adolescents (93.3%) consumed snacks with a low to moderate glycemic index (GI), while only 6.7% consumed snacks with a high GI. Statistical analysis revealed no significant association between the GI of snack foods and the nutritional status of adolescents at SMAN 07 Bengkulu City (p = 0.176). This suggests that the types of snacks consumed by adolescents generally do not have an extremely high GI, thereby minimizing their direct impact on nutritional status (Agung et al., 2022).

Foods with a high GI, when consumed, rapidly and significantly increase blood glucose levels. In contrast, the consumption of low-GI foods results in a slower rise in blood glucose, with lower peak levels (Sukarmi, 2021). Many carbohydrate-rich foods such as rice, potatoes, and bread can be digested and absorbed quickly, leading to a rapid increase in blood glucose levels. Carbohydrates in foods that are broken down quickly during digestion have a high GI, whereas those broken down more slowly result in a gradual release of glucose into the blood and have a low GI. Frequent consumption of high-GI foods has been positively associated with an increased risk of developing diabetes mellitus (Eliza et al., 2020).

The lack of a significant relationship in this study may be attributed to several factors, including individual metabolic differences, variations in the frequency of snack consumption, and the more dominant influence of other nutrients, such as total energy, protein, and fat, on nutritional status. These findings are consistent with (Sales & Oliveira, 2018), who stated that while several studies have examined the effects of glycemic index (GI) and glycemic load (GL) on health, there is currently no clear consensus due to conflicting results from various clinical studies. Although low-GI/GL diets have been considered beneficial for controlling blood glucose levels and nutrient absorption, the outcomes are highly dependent on the prevailing dietary patterns in each country or region. Furthermore, research focusing on GI/GL among children and adolescents remains very limited, both nationally and internationally.

Table 5. Relationship Between Glycemic Index of Snack Foods and Nutritional Status of Adolescents at SMAN 07 Bengkulu City

Glycemic Index Content	Nutritional Status				Total		P-Valeu
	Abormal		Normal				
	N	%	n	%	n	%	
High	0	0	4	6.7	4	100	0.176
Low to Moderate	27	45	29	48.3	56	100	
Total	27	45	33	55	60	100	

CONCLUSION

Based on the findings described above, it can be concluded that there is a significant relationship between the consumption of energy and macronutrients from snack foods and the nutritional status of adolescents. However, no significant association was found between the glycemic index of snack foods and the nutritional status of adolescents at SMAN 07 Bengkulu City. The authors would like to express their deepest gratitude to all parties who contributed to the completion of this study, including Poltekkes Kemenkes Bengkulu, SMAN 07 Bengkulu City, and all respondents who participated in the research. The authors declare that they have no conflict of interests.

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