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Association Between Obesity Knowledge, Macronutrient Intake, and Nutritional Status Among Adolescents in Lamongan, Indonesia

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ABSTRACT

Obesity is a global health epidemic that needs urgent attention and a health problem that must be addressed (World Health Organization). this study aims to analyze the relationship between obesity-related knowledge and dietary intake with the nutritional status of adolescents at SMA Pancamarga Lamongan. This quantitative study used a cross-sectional correlational design involving 47 students from SMA Pancamarga Lamongan, with data collected through interviews, food recalls, and anthropometric measurements, and analyzed using Spearman correlation. The results showed that the majority of respondents had a normal nutritional status (61.7%) and carbohydrate intake in the severely deficient category (51.1%). Spearman correlation analysis indicated no significant relationship between obesity-related knowledge (ρ = 0.111) or carbohydrate intake (ρ = 0.193) with the nutritional status of students at SMA Pancamarga Lamongan. The results showed that most respondents had normal nutritional status and severely inadequate carbohydrate intake, with no significant correlation found between obesity-related knowledge or carbohydrate intake and nutritional status.

INTRODUCTION

Adolescents are individuals aged 10 to 19 years who are in a transitional phase from childhood to adulthood, marked by physical, psychological, and social changes[1]. During this stage, nutritional status plays a vital role in supporting optimal growth and development[2]. One of the common nutritional problems faced by adolescents is obesity, which is defined as an excessive accumulation of body fat[3]. According to the World Health Organization (WHO) for the Asia-Pacific region, adolescents are classified as obese if their Body Mass Index-for-Age (BMI/Age) is greater than +2 standard deviations[4,5].

Obesity among adolescents can be triggered by various factors, including excessive energy intake, frequent consumption of fast food, low levels of physical activity[6,7], and limited knowledge of balanced diets and healthy lifestyles. Data from the 2018 Basic Health Research (Riskesdas) indicates that the prevalence of overweight and obesity among Indonesian adolescents aged 13–15 years is 16.0%, and 13.5% among those aged 16–18 years[8]. In East Java Province, the prevalence of obesity reached 16%, or approximately 1,163,118 individuals[9], while in Lamongan Regency, 4,070 out of 12,734 residents were recorded as obese[10].

Obesity is not only an aesthetic issue but is also closely associated with an increased risk of non-communicable diseases (NCDs) such as diabetes mellitus, hypertension, and cardiovascular disease. WHO reports that obesity is responsible for approximately 2.8 million deaths globally each year (WHO, 2013). The negative impacts of obesity may persist into adulthood, especially when it begins during adolescence[11–13].

Despite the high prevalence of obesity, there is still a lack of research examining the relationship between obesity-related knowledge, dietary intake, and nutritional status among adolescents, particularly in private senior high schools such as SMA Pancamarga Lamongan. A preliminary study conducted with 10 students at the school revealed that 6 students (60%) were classified as overweight or obese, indicating a significant nutritional issue in the school environment. Therefore, this study aims to analyze the relationship between obesity-related knowledge and dietary intake with the nutritional status of adolescents at SMA Pancamarga Lamongan.

MATERIALS AND METHODS

This study is a quantitative research with a cross-sectional and correlational approach, conducted at SMA Pancamarga Lamongan from January to June 2022. The population consisted of all students at SMA Pancamarga Lamongan, totaling 276 individuals. A sample of 47 respondents was selected using the Proportional Random Sampling technique. The inclusion criteria were students in grades X and XI, not currently ill, and willing to participate in the study. The exclusion criteria included students who were sick or on a special diet that could affect their nutritional status.

Data collection was carried out through direct interviews using a closed-ended questionnaire that had been tested for validity and reliability. Knowledge levels were categorized as good, moderate, and poor. Dietary intake data were obtained using the 2x24-hour food recall method (one weekday and one weekend day), analyzed using nutrition software, and compared to the Recommended Dietary Allowance (RDA) to classify intake into three levels: severely inadequate (<70%), moderately inadequate (70–89%), and adequate (≥90%). Anthropometric data were collected through measurements of weight and height, then used to calculate Body Mass Index for age (BMI-for-age), and categorized according to the WHO Asia-Pacific standards (2013). Data analysis was conducted univariately to describe respondents' characteristics and bivariately using Spearman correlation tests. This study received ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Surabaya.

RESULT

Characteristics Respondence

Tabel 1 Characteristics Respondence

	n	%
Gender		
Man	22	46,8
Woman	25	53,2
Age		
13-15 years	13	27,7
16-18 years	34	72,3
Knowledge Level		
Good	23	49
Enough	9	19
Less	15	32
Dietary Intake (Energy)		
More	2	4,3
Normal	12	25,5
Mild Deficit	8	17
Medium Deficit	5	10,6
Severely Inadequate	20	42,6
Dietary Intake (Protein)		
More	5	10,6
Normal	14	29,8
Mild Deficit	4	8,5
Medium Deficit	5	10,6
Severely Inadequate	19	40,5
Dietary Intake (Fat)		
More	11	23,4
Normal	3	6,4
Mild Deficit	4	8,5
Medium Deficit	6	12,7
Severely Inadequate	23	49
Dietary Intake (Carbohydrates)		
More	3	6,4
Normal	10	21,3
Mild Deficit	8	17
Medium Deficit	2	4,3
Severely Inadequate	24	51
Nutritional Status		
Severely thin	0	0
Thin	2	4,3
Normal	29	61,7
Overweight	5	10,6
Obese	11	23,4
Total	**47**	**100**

Source : Primary Data, 2022

Based on Table 1, of the 47 respondents, 53.2% were female (25 individuals), while 46.8% were male (22 individuals), indicating a slightly higher participation rate among females. Table 2 shows that most respondents (72.3%) were aged 16–18 years, while 27.7% were in the 13–15 age

group, suggesting that the majority were in late adolescence. Table 3 highlights that 49% of respondents had good knowledge levels, while 19% had moderate knowledge and 32% had poor knowledge, reflecting the need for targeted educational interventions.

Table 4 indicates that 42.6% of respondents experienced a severe energy intake deficit, 10.6% had moderate deficits, and 17% had mild deficits. Only 25.5% had normal energy intake, and 4.3% consumed excessive energy. Similarly, Table 5 shows that 40.5% of respondents had severe protein intake deficits, while 29.8% had normal protein intake and 10.6% exceeded recommendations. Table 6 reveals that 49% had severe fat intake deficits, with only 6.4% achieving normal fat intake and 23.4% consuming excess fat. Table 7 indicates that 51% had severe carbohydrate deficits, while 21.3% had normal intake and 6.4% consumed more than recommended levels. These findings highlight widespread inadequacies in macronutrient intake.

Finally, Table 8 shows that 61.7% of respondents had normal BMI-for-age, but 10.6% were overweight and 23.4% obese, indicating a notable trend of overnutrition. Only 4.3% were classified as thin, suggesting the need for interventions addressing both undernutrition and overnutrition among adolescents.

The Relationship between Knowledge Level About Obesity and Nutritional Status at Pancamarga High School in Lamongan Regency

Table 2 Cross-tabulation of Obesity Knowledge Level with Nutritional Status

Knowledge Level	Nutritional Status								Total		*p-value*	R
	Malnutrition		Good Nutrition		More Nutrition		Obesity					
	n	%	n	%	n	%	n	%	n	%	0,282	0,160
Good	2	8,7	15	65,2	3	13	3	13	23	100		
Enough	0	0	4	44,4	0	0	5	55,6	9	100		
Less	0	0	10	66,7	2	13,3	3	20	15	100		
Total	**2**	**8,7**	**29**	**61,7**	**5**	**10,6**	**11**	**23,4**	**47**	**100**		

Source : Primary Data, 2022

Based on Table 2, most respondents with a good level of knowledge had a normal nutritional status (65.2%), although 13% were classified as obese and another 13% as overweight. Respondents with a moderate level of knowledge were predominantly in the obese category (55.6%), while those with poor knowledge also showed a considerable percentage of overweight and obese statuses (33.3%). The statistical test showed a p-value of 0.282 and a correlation coefficient (R) of 0.160, indicating no significant relationship between the level of knowledge about obesity and nutritional status among students at Pancamarga High School in Lamongan. This suggests that having good knowledge does not necessarily lead to a normal nutritional status, likely due to other influencing factors such as dietary habits, physical activity, and environmental influences.

The Relationship between Energy Intake Regarding Obesity and Nutritional Status at Pancamarga Lamongan High School

Table 3 Cross-tabulation of Energy Intake on Obesity with Nutritional Status

Energy Intake	Nutritional Status								Total		*p-value*	R
	Malnutrition		Good Nutrition		More Nutrition		Obesity					
	n	%	n	%	n	%	n	%	n	%	0,527	0,095
More	0	0	2	100	0	0	0	0	2	100		
Normal	0	0	8	66,7	2	16,7	2	0	12	100		
Mild Deficit	2	22,2	3	33,3	1	11,1	3	33,3	9	100		
Medium Deficit	0	0	3	75	1	25	0	0	4	100		
Severely Inadequate	0	0	13	65	1	5	6	30	20	100		
Total	**2**	**8,7**	**29**	**61,7**	**5**	**10,6**	**11**	**23,4**	**47**	**100**		

Source : Primary Data, 2022

Based on Table 3, the majority of respondents with severe energy deficits had a normal nutritional status (65%), though 30% of them were obese. Among those with a mild energy deficit, 33.3% were obese, while others were distributed across various nutritional statuses. Respondents with normal energy intake mostly had normal nutritional status (66.7%), but some were overweight (16.7%) or obese (16.7%). Interestingly, both respondents with excessive energy intake were classified as having normal nutritional status. The statistical analysis yielded a p-value of 0.527 and a correlation coefficient (R) of 0.095, indicating no significant relationship between energy intake and nutritional status. This suggests that energy intake alone may not directly determine nutritional status and could be influenced by other factors such as metabolism, physical activity, and dietary composition.

The Relationship between Protein Intake on Obesity and Nutritional Status at Pancamarga Lamongan High School

Table 4 Cross-Tabulation of Protein Intake on Obesity with Nutritional Status

Protein Intake	Nutritional Status								Total		*p-value*	R
	Malnutrition		Good Nutrition		More Nutrition		Obesity					
	n	%	n	%	n	%	n	%	n	%	0,197	0,192
More	0	0	4	80	1	20	0	0	5	100		
Normal	2	14,3	8	57,1	2	14,3	2	14,3	14	100		
Mild Deficit	0	0	2	50	1	25	1	25	4	100		
Medium Deficit	0	0	3	60	0	0	2	40	5	100		
Severely Inadequate	0	0	12	63,2	1	5,3	6	31,6	19	100		
Total	**2**	**14,3**	**29**	**61,7**	**5**	**10,6**	**11**	**23,4**	**47**	**100**		

Source : Primary Data, 2022

Based on Table 4, most respondents with severe protein deficits had a normal nutritional status (63.2%), while 31.6% were classified as obese. Among those with moderate protein deficits,

60% had a normal nutritional status and 40% were obese. In the group with mild protein deficits, half had a normal status, while the rest were either overweight (25%) or obese (25%). Respondents with normal protein intake mostly had normal nutritional status (57.1%), with the rest spread among the other categories. Interestingly, 80% of those with excessive protein intake had normal nutritional status, and 20% were overweight, with no respondents classified as obese. Statistical analysis showed a p-value of 0.197 and a correlation coefficient (R) of 0.192, indicating no significant relationship between protein intake and nutritional status. These findings suggest that while there are patterns between protein intake and nutritional outcomes, other factors may also contribute significantly to nutritional status.

The Relationship between Fat Intake About Obesity and Nutritional Status at Pancamarga Lamongan High School

Table 5 Cross-Tabulation of Fat Intake on Obesity with Nutritional Status

Fat Intake	Nutritional Status								Total		*p-value*	R
	Malnutrition		Good Nutrition		More Nutrition		Obesity					
	n	%	n	%	n	%	n	%	n	%	0,382	-0,130
More	0	0	8	72,7	1	9,1	2	18,2	11	100		
Normal	0	0	0	0	0	0	3	100	3	100		
Mild Deficit	0	0	2	50	1	25	1	25	4	100		
Medium Deficit	1	14,3	4	57,1	1	14,3	1	14,3	7	100		
Severely Inadequate	1	4,5	15	68,2	2	9,1	4	18,2	22	100		
Total	**2**	**4,3**	**29**	**61,7**	**5**	**10,6**	**11**	**13,4**	**47**	**100**		

Source : Primary Data, 2022

Based on Table 5, the majority of respondents with excessive fat intake had a normal nutritional status (72.7%), while 18.2% were obese and 9.1% were overweight. Among those with a normal fat intake, all respondents (100%) were categorized as obese, although this group only consisted of 3 individuals. For respondents with a mild fat deficit, half had normal nutritional status, 25% were overweight, and 25% were obese. In the moderate fat deficit category, most had normal nutritional status (57.1%), while 14.3% were found in each of the other three categories. The largest group, those with a severe fat deficit, mostly had normal nutritional status (68.2%), followed by obese (18.2%), overweight (9.1%), and underweight (4.5%). Statistical analysis yielded a p-value of 0.382 and a correlation coefficient (R) of -0.130, indicating no significant relationship between fat intake and nutritional status, and suggesting a weak negative correlation. This implies that higher or lower fat intake was not strongly associated with being underweight, overweight, or obese among the participants.

The Relationship between Carbohydrate Intake Regarding Obesity and Nutritional Status at Pancamarga Lamongan High School

Table 6 Cross-tabulation of Carbohydrate Intake on Obesity with Nutritional Status

Carbohydrate intake	Nutritional Status								Total		*p-value*	R
	Malnutrition		Good Nutrition		More Nutrition		Obesity					
	n	%	n	%	n	%	n	%	n	%	0,193	0,193
More	0	0	2	66,7	1	33,3	0	0	3	100		
Normal	1	10	7	70	0	0	2	20	10	100		
Mild Deficit	1	12,5	5	62,5	0	0	2	25	8	100		
Medium Deficit	0	0	1	50	0	0	1	50	2	100		
Severely Inadequate	0	0	14	58,3	4	16,7	6	25	24	100		
Total	**2**	**4,3**	**29**	**61,7**	**5**	**10,6**	**11**	**23,4**	**47**	**100**		

Source : Primary Data, 2022

Based on Table 6, among respondents with excessive carbohydrate intake, 66.7% had normal nutritional status, and 33.3% were overweight. None were classified as underweight or obese. In the normal carbohydrate intake category, the majority (70%) also had normal nutritional status, while 20% were obese, and 10% were underweight. For those with a mild carbohydrate deficit, 62.5% had normal nutritional status, 25% were obese, and 12.5% were underweight. In the moderate carbohydrate deficit group, 50% were normal and 50% were obese, with no respondents in the other categories. Lastly, among those with a severe carbohydrate deficit, most (58.3%) had normal nutritional status, followed by obese (25%), overweight (16.7%), and none were underweight. Statistical analysis showed a p-value of 0.193 and a correlation coefficient (R) of 0.193, indicating that there is no statistically significant relationship between carbohydrate intake and nutritional status. Although the correlation is positive, it is weak, suggesting only a slight tendency for higher carbohydrate intake to be associated with higher nutritional status or body weight among respondents.

DISCUSSION

Respondent Characteristics

The majority of respondents were aged 15–18 years, with a balanced gender distribution (48% male, 52% female). This condition is consistent with the demographic data of school adolescents in Indonesia which shows almost the same prevalence between boys and girls in this age range[14]. Adolescence at this age is an important period for the formation of eating habits and sustainable nutritional status[15].

Nutritional Knowledge and Nutritional Status

Most students had good nutritional knowledge, but statistical analysis did not show a significant relationship between nutritional knowledge and nutritional status ($p > 0.05$, $r < 0.2$). This

shows that despite high knowledge, healthy nutritional behaviors are not automatically formed. Health Belief Model-based intervention research shows significant improvements in knowledge and attitudes, but does not mean improvements in healthy eating behaviors occur directly. This supports the theory that knowledge alone is not enough to drive behavior change if it is not accompanied by risk perception, self-efficacy, and environmental factors[16].

Macronutrient Intake and Nutritional Status

The recall data showed that many respondents experienced severe deficits: energy (<50%), protein (<60%), fat (<65%), and carbohydrates (>80%) according to similar reports in various regions of Indonesia[14,17]. However, the majority of students have normal nutritional status or mild obesity, not a thin condition. This phenomenon can be explained by food recall bias that is common in adolescents such as underreporting the consumption of snacks or sugary drinks and is supported by data that the majority of obese adolescents consume excess sugar and fat and are low in fiber[18–20].

The BMC Pediatr study (2022) in Yogyakarta showed <98% of adolescents were obese with low fiber intake, 65% total excess fat, and 36% excess sugar, as well as a significant correlation between fiber intake and HDL levels ($\beta = 0.165$; $p = 0.033$)[19]. This supports the finding that the quality of dietary patterns—not just the amount of overall energy—plays an important role in nutritional status and metabolic risk.

No significant relationship was found between macronutrient intake and nutritional status ($p > 0.05$, $r < 0.2$). This suggests that other factors—such as physical activity, screen time patterns, stress, and sleep quality—may play a more dominant role[17,19]. The latest narrative study also highlights a shift to a "Western" diet—high in sugar, fat, low in fiber—that has a major impact on adolescent obesity[21]. In addition, longitudinal research from the community shows that snacking and exercise patterns influence changes in body composition: increased physical activity (MVPA) and the proportion of high-protein snacks are associated with decreased body fat percentage (BFP) while high-calorie snacks without protein worsen the condition[22,23]. This confirms the importance of a combination of quality nutritional intake and physical activity in managing obesity.

These findings point to the need for a comprehensive approach to nutrition interventions, not only improving student knowledge, but also changing behavior and environment. A recent intervention in Indonesia that combines nutrition education in schools, weekly iron-folic acid supplementation (WIFS), and communication of social behavior changes has been shown to increase fruit consumption, reduce consumption of sugary drinks, and increase physical activity in 60 minutes per day[14]. The use of digital applications or online food logs and physical activity monitoring can improve the validity of intake and lifestyle data. Recent eHealth studies have shown that social networking and app-based interventions can lower age percentile BMI and improve diet scores (KIDMED) and physical activity (PAQ-A) among adolescents[24,25].

This study was conducted with a relatively small sample size of 47 students from a single high school, which may limit the generalizability of the findings to broader populations. Additionally, the study employed a cross-sectional design, making it impossible to establish causality between macronutrient intake and nutritional status. Self-reported food intake data, collected through a questionnaire, may also be subject to recall errors or underreporting, particularly in adolescents. These limitations should be considered when interpreting the results.

Potential bias in this study may have arisen from the use of self-administered dietary questionnaires, which rely on the participants' memory and honesty. Adolescents may not accurately report their food intake, either due to forgetfulness or the desire to provide socially acceptable responses. Furthermore, selection bias may have occurred if students who were more health-conscious were more willing to participate in the study, potentially skewing the results. To reduce these biases, future research should consider using more objective dietary assessment tools and a larger, more diverse sample.

CONCLUSION

In conclusion, this study found that most students at SMA Pancamarga Lamongan had normal nutritional status and severely deficient carbohydrate intake. However, there was no significant relationship between obesity-related knowledge or carbohydrate intake with their nutritional status. These findings suggest that other factors beyond knowledge and intake may contribute to adolescent obesity. Therefore, it is recommended that schools implement more comprehensive nutrition education and promote healthy lifestyle habits to support the prevention of obesity among students. Further longitudinal studies are needed to better understand the causal pathways between dietary behaviors and adolescent obesity.

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