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The Relationship Between Dietary Patterns and the Incidence of Overweight among Adolescents

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ABSTRACT

This study employed a cross-sectional design to investigate the association between dietary patterns and the occurrence of overweight status in urban adolescents. A total of 124 respondents were recruited using purposive sampling. Data collection involved anthropometric measurements and completion of the Semi Quantitative Food Frequency Questionnaire (SQ-FFQ) using a self-administered questionnaire method. The study findings revealed that 29% of adolescents experience overweight status. Most frequent food consumption occurs in staple foods (82.3%), animal protein (73.4%), plant-based protein (63.7%), fats (82.3%), and vegetables (50.8%). Conversely, infrequent consumption was observed for fruits (58.9%), snacks (68.5%), fast food (71.8%), and beverages (55.6%). Furthermore, deficits are prevalent in energy (44.4%), protein (46.8%), and carbohydrates (60.5%), while excess intake is seen in fats (57.3%). Respondents exhibit predominantly low physical activity (66.9%). Chi-square tests indicate significant associations between consumption frequency in the plant-based protein and vegetable groups ($p \leq 0.05$) and between energy intake and macronutrients ($p \leq 0.05$) with overweight status.

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- Most respondents frequently consume staple foods, animal-based dishes, plant-based dishes, fats, and vegetables, while fruit, snack, fast food, and beverage consumption is less frequent. A significant number of respondent's experience deficits in energy, protein, and carbohydrate intake, whereas their fat intake often exceeds recommended levels. There is a notable association between frequent plant-based and vegetable consumption and overweight status among adolescents at SMAN 5 Tangerang City. Additionally, significant relationships are found between energy and macronutrient (protein, fat, carbohydrates) intake and the prevalence of overweight status in these students.
- Students should monitor their weight monthly and limit the intake of unhealthy foods high in sugar, salt, and fat

Introduction

Adolescents during the crucial period tend to experience nutritional issues. This is because adolescents have higher nutritional requirements compared to adults due to rapid physical growth, muscle mass, fat mass, hormonal changes, and high levels of physical activity. It is essential to pay attention to the balance between energy intake and expenditure, including engaging in physical activities, to prevent an energy imbalance that could lead to nutritional problems. (1,2). The nutritional challenges faced by adolescents pose an 80% risk of experiencing overweight or obesity in adulthood, potentially shortening life expectancy due to the risk of non-communicable diseases (3).

Based on WHO research results (2016), it is known that more than 340 million children and adolescents suffer from overweight. Most countries in Asia experienced an increase in the prevalence of overweight by 14% and obesity by 3% for the Southeast Asia region (4). In addition, survey results by

Mazidi et al, in 2018 showed that 24.5% in the East Asia Region and 11.9% of the West Asia Region of children and adolescents were overweight and obese (5).

The surge in overweight incidence in developing countries is driven by shifts in lifestyle and consumption patterns. Urban populations, particularly teenagers, exhibit preferences for calorie-dense, sugary, and sodium-rich foods while consuming low-fiber diets (2). Any change in bad behavior in consumption patterns will affect the quality of life in the future so teenagers are vulnerable to overnutrition (6). Based on the results of Basic Health Research of Indonesia (Riskesdas) in 2018, shows that the prevalence of overweight and obesity in teenagers at the national level based on Body Mass Index according to Age (BMI/U) aged 13-18 years is 29.5% (7). It is known that the prevalence of overweight nutritional status among adolescents aged 13-18 years in Banten Province is 19.41% based on BMI-for-age. When considering the place of residence, urban areas (21.54%) have a higher prevalence compared to rural areas (14.65%). This difference can be attributed to lifestyle changes in urban areas, which tend to lean toward Westernization. According to the 2018 Basic Health Profile data, the prevalence of overweight nutritional status among adolescents aged 13-18 years in Tangerang City exceeds the provincial average in Banten, reaching 19.49% (8).

Based on research conducted by Wismoyo et al. (2017), it is evident that a significant number of students from a senior high school of SMA Negeri 5 Surabaya exhibit a tendency toward overweight when following excessive eating patterns (more than three main meals per day) (9). Specifically, these students are 2.6 times more likely to experience overweight compared to their peers who maintain a balanced diet (consuming three main meals per day) or have insufficient food intake (less than three main meals per day). These habits stem from a history of excessive food consumption, particularly an accumulation of macro-nutrients derived from fast food, snacks, and fried main dishes. Notably, urban areas experience a shift in lifestyle patterns, especially in terms of food consumption. High-calorie foods and frequent eating contribute to an excess of energy, which ultimately leads to fat accumulation in the body. Given the data and insights presented, researchers are motivated to explore this phenomenon further at a senior high school of SMAN 5 Tangerang City.

This research is conducted because adolescence represents a pre-maturation phase in thinking and behavior, making teenagers susceptible to the lifestyle changes prevalent in their surroundings. Based on data from the Central Statistics Agency (BPS) for Tangerang City in 2020, it is revealed that the Karawaci Subdistrict has the highest number of restaurants among all subdistricts in Tangerang City, totaling 101 dining establishments (10). This observation suggests that adolescents in the area are likely to frequent eateries or restaurants that predominantly serve high-calorie fast food and beverages. Consequently, this contributes to an increased prevalence of overweight status among teenagers in Tangerang City. As a result, researchers are motivated to explore the connection between dietary consumption patterns and the occurrence of overweight status among students at a senior high school of SMAN 5 Kota Tangerang.

Methods

This research employed a cross-sectional study design with a quantitative approach. The study investigated two main variables: the dependent variable, overweight status, and the independent variable, dietary consumption patterns. The latter included the frequency of food intake, energy intake, and macro-nutrients (carbohydrates, fats, and proteins). The study was conducted in July 2023 at a senior high school of SMAN 5, Tangerang City, located at Ciujung Raya Street No. 3, Perumnas 1, Karawaci Subdistrict, Tangerang City, Banten. The study population comprised all 11th and 12th-grade students during the 2023/2024 academic year. A purposive sampling method was used to select a sample of 124 individuals, based on specific inclusion and exclusion criteria. Inclusion criteria encompassed students aged 15-18 years, physically healthy, mentally capable, and willing to participate in the research procedures. Exclusion criteria excluded students with obesity.

Primary data collection involved respondents completing a self-administered questionnaire on dietary patterns using the Semi Quantitative Food Frequency Questionnaire (SQ FFQ). Enumerators facilitated the estimation of portion sizes (URT) and food weight by showing food photographs using a laptop. The frequency of food consumption was assessed through open-ended questions, capturing how often participants consumed specific foods and beverages over the past month. Each frequency received a score: 2-3 times/day = 2.5, 1 time/day = 1, 3-6 times/week = 0.43, 1-2 times/week = 0.14, 1-3 times/month = 0.07, and never = 0. Researchers categorized these scores as “frequent” (≥0.43) or “infrequent” (<0.43). (11). In addition, data on energy intake and macronutrient consumption were obtained from the frequency of food consumption and the weight of consumed food, which were then converted into average grams per day. Subsequently, the nutritional content in terms of energy, protein, fat, and carbohydrates was determined, and the total nutritional content was calculated. After

identifying the total daily consumption of respondents, it was compared with the Recommended Dietary Allowances (RDA) for 2019. The processing of total nutritional requirements data was performed using Microsoft Excel, utilizing a database of nutritional content based on Nutrisurvey, TKPI, and FatSecret. Furthermore, the percentage of RDA for each respondent was determined, and researchers categorized it into the following groups: excessive nutrition (≥120% RDA), normal nutrition (90-119% RDA), and deficient nutrition (<90% RDA).

Additional primary data were obtained through direct anthropometric measurements to assess the nutritional status of respondents. Nutritional status was calculated using the WHO Anthro Plus application, comparing the categories with reference standards for adolescent anthropometric Z-scores of Body Mass Index for Age (BMI-for-age) in the 15-18 age group. Based on individual BMI-for-age Z-scores, respondents were categorized as either "overweight" or "non-overweight."

Data analysis involved both univariate and bivariate analyses using SPSS version 25 for Windows. Bivariate analysis aimed to explore the relationship between dietary consumption patterns and the occurrence of overweight status among adolescents at senior high schools of SMAN 5 Tangerang City. If the assumptions for the chi-square test were not met, an alternative Linear-by-Linear Association test was employed.

Health Code of Ethics

The study received ethical approval from the Ethics Commission of the Faculty of Medicine, Universitas Sultan Ageng Tirtayasa, with reference number 736/UN43.20/KEPK/2023.

Results

Based on the frequency distribution of respondent characteristics in Table 1, four age groups were identified: 15 years old (15 individuals, 12.1%), 16 years old (63 individuals, 50.8%), 17 years old (43 individuals, 34.7%), and 18 years old (3 individuals, 2.4%). Regarding gender categories, female respondents outnumbered male respondents, with 84 individuals (67.7%) and 40 individuals (32.3%), respectively. School profile data indicated that SMA Negeri 5 Tangerang predominantly enrolled female students (575 female students). Additionally, based on the distribution results, most respondents were from grade 11, born between 2008 and 2007, corresponding to an age range of 16-17 years.

Table 1. Characteristics of Respondents and Their Families

Characteristics	n	%
Age (Years old)		
15	15	12.1
16	63	50.8
17	43	34.7
18	3	2.4
Gender		
Male	40	32.3
Female	84	67.7
Pocket money		
< IDR 20,000.00/day	50	40.3
≥ IDR 20,000.00/day	74	59.7
Father occupation		
civil servants	11	8.9
Private employees	56	45.2
Self-employed	25	20.2
Other	24	19.4
Doesn't work	8	6.5
Mother's occupation		
civil servants	7	5.6
Private employees	18	14.5
Self-employed	4	3.2
Other	15	12.1
Housewife	80	64.5
Total	**124**	**100.0**

Furthermore, the categorization of pocket money revealed that 74 individuals (59.7%) had high allowances (≥ Rp20,000.00/day), while 59 individuals (40.3%) had low allowances (< IDR 20,000.00/day). Family characteristics, based on paternal occupation, were divided into five groups:

civil servants (11 individuals, 8.9%), private employees (56 individuals, 45.2%), entrepreneurs (25 individuals, 20.2%), others (online motorcycle taxi drivers, freelancers, traders, journalists, police officers, and military personnel; 24 individuals, 19.4%), and unemployed (8 individuals, 6.5%). Maternal occupation distribution also fell into five categories: civil servants (7 individuals, 5.6%), private employees (18 individuals, 14.5%), entrepreneurs (4 individuals, 3.2%), others (laborers, teachers, nurses, and traders; 15 individuals, 12.1%), and unemployed (80 individuals, 64.5%).

Table 2. An overview of overweight status among adolescents at SMAN 5 Tangerang City.

Nutritional Status	n	%
Overweight	36	29.0
Non-overweight	88	71.0
Total	**124**	**100,0**

Table 3. Distribution of Dietary Consumption Patterns Among Adolescents at SMAN 5 Tangerang City

Dietary Consumption Pattern Variables	n	%
Staple Food Frequency		
Often	102	82.3
Seldom	22	17.7
Frequency of Animal Side Dishes		
Often	91	73.4
Seldom	33	26.6
Frequency of Vegetable Side Dishes		
Often	79	63.7
Seldom	45	36.3
Fat Frequency		
Often	102	82.3
Seldom	22	17.7
Vegetable Frequency		
Often	63	50.8
Seldom	61	49.2
Fruit Frequency		
Often	51	41.1
Seldom	73	58.9
Frequency of Snacks		
Often	39	31.5
Seldom	85	68.5
Ready to Eat Frequency		
Often	35	28.2
Seldom	89	71.8
Drink Frequency		
Often	55	44.4
Seldom	69	55.6
Energy Intake		
Over	26	21.0
Normal	43	34.7
Deficit	55	44.4
Protein Intake		
Over	35	28.2
Normal	31	25.0
Deficit	58	46.8
Fat Intake		
Over	71	57.3
Normal	31	25.0
Deficit	22	17.7
Carbohydrate Intake		
Over	14	11.3
Normal	35	28.2

Deficit	75	60.5
Total	**124**	**100.0**

Based on Table 2, the proportion of overweight individuals was 36 (29%), while those non-overweight accounted for 88 individuals (71%). Notably, in this study, respondents with non-overweight nutritional status outnumbered those with overweight status. Based on Table 3, the proportion of staple food consumption was frequent for 102 individuals (82.3%) and infrequent for 22 individuals (17.7%). The frequency of animal protein dishes was high for 91 individuals (73.4%) and low for 33 individuals (26.6%). Similarly, plant-based protein dishes were frequent for 79 individuals (63.7%) and infrequent for 45 individuals (36.3%). Regarding fat consumption, 102 individuals (82.3%) consumed it frequently, while 22 individuals (17.7%) did so infrequently. Vegetables were frequently consumed by 63 individuals (50.8%) and infrequently by 61 individuals (49.2%). For fruits, 51 individuals (41.1%) consumed them frequently, whereas 73 individuals (58.9%) did so infrequently. Snack consumption was frequent for 39 individuals (31.5%) and infrequent for 85 individuals (68.5%). Ready-to-eat meals were frequently consumed by 35 individuals (28.2%) and infrequently by 89 individuals (71.8%). Additionally, the proportion of frequent beverage consumption was 55 individuals (44.4%), while 69 individuals (55.6%) consumed beverages infrequently.

Based on the distribution of respondents' dietary intake, it was observed that 26 individuals (21%) had excessive energy intake, 43 individuals (34.7%) had normal intake, and 55 individuals (44.4%) had a deficit. Regarding protein intake, 35 individuals (28.2%) exceeded the recommended amount, 31 individuals (25%) had a normal intake, and 58 individuals (46.8%) were deficient. As for fat intake, 71 individuals (57.3%) consumed more than recommended, 31 individuals (25%) had a normal intake, and 22 individuals (17.7%) were deficient. Finally, concerning carbohydrate intake, 14 individuals (11.3%) exceeded the recommended amount, 35 individuals (28.2%) had a normal intake, and 75 individuals (60.5%) were deficient.

Table 4. Results of the Analysis of the Relationship Between Dietary Consumption Patterns and the Occurrence of Overweight Status in Adolescents at SMAN 5 Tangerang City

Variable	Nutritional Status				Total		p-value*
	Overweight		*Non-Overweight*				
	n	%	n	%	n	%	
Staple Food Frequency							
Often	28	27.5	74	72.5	102	82.3	0.404
Seldom	8	36.4	14	63.6	22	17.7	
Frequency of Animal Side Dishes							
Often	27	29.7	64	70.3	91	73.3	0.795
Seldom	9	27.3	24	72.7	33	26.7	
Frequency of Vegetable Side Dishes							
Often	29	36.7	50	63.3	79	63.7	**0.013***
Seldom	7	15.6	38	84.4	45	36.3	
Fat Frequency							
Often	27	26.5	75	73.5	102	82.3	0.176
Seldom	9	40.9	13	59.1	22	17.7	
Vegetable Frequency							
Often	24	38.1	39	61.9	63	50.8	**0.024***
Seldom	12	19.7	49	80.3	61	49.2	
Fruit Frequency							
Often	16	31.4	35	68.6	51	41.1	0.631
Seldom	20	27.4	53	72.6	73	58.9	
Frequency of Snacks							
Often	12	30.8	27	69.2	39	31.5	0.773
Seldom	24	28.2	61	71.8	85	68.5	
Ready to Eat Frequency							
Often	12	34.3	23	65.7	35	28.2	0.419
Seldom	24	27	65	73	89	71.8	
Drink Frequency							
Often	17	30.9	38	69.1	55	44.3	0.681
Seldom	19	27.5	50	72.5	69	55.7	

Variable	Nutritional Status				Total		p-value*
	Overweight		*Non-Overweight*				
	n	%	n	%	n	%	
Energy Intake							
Over	18	69.2	8	30.8	26	20.9	
Normal	6	14.0	37	86.0	43	34.7	**0.000***
Deficit	12	21.8	43	78.2	55	44.4	
Protein Intake							
Over	15	42.9	20	57.1	35	28.2	
Normal	10	32.3	21	67.7	31	25.0	**0.044***
Deficit	11	19.0	47	81.0	58	46.8	
Fat Intake							
Over	27	38.0	44	62.0	71	57.3	
Normal	7	22.6	24	77.4	31	25	**0.022***
Deficit	2	9.1	20	90.9	22	17.7	
Carbohydrate Intake							
Over	7	50.0	7	50.0	14	11.3	
Normal	14	40.0	21	60.0	35	28.2	**0.006***
Deficit	15	20.0	60	80.0	75	60.5	
Total	**36**	**29.0**	**88**	**71.0**	**124**	**100**	

Based on the bivariate analysis results in Table 4, it is evident that respondents with overweight status have frequent consumption of staple foods (27.5%) and infrequent consumption of staple foods (36.4%). Additionally, the frequency of animal protein consumption among overweight respondents is 29.7% for frequent consumption and 27.3% for infrequent consumption. However, the Chi-Square statistical test for these two variables indicates no significant relationship due to p-values > 0.05, specifically (p = 0.404) and (p = 0.795). Consequently, the null hypothesis (Ho) is accepted, and the alternative hypothesis (Ha) is rejected. Regarding the frequency of plant-based protein consumption, respondents with overweight status exhibit 36.7% frequent consumption and 15.6% infrequent consumption. The Chi-Square test yields a p-value ≤ 0.05 (p = 0.013), indicating a significant association, leading to the rejection of Ho and acceptance of Ha. However, for fat consumption frequency among overweight respondents, the results show 26.5% frequent and 40.9% infrequent consumption. The Chi-Square test does not reveal a significant relationship (p = 0.176). Furthermore, vegetable consumption is frequent (38.1%) and infrequent (19.7%) among respondents with overweight status, demonstrating a significant analysis result (p = 0.024).

Analyzing fruit consumption frequency among respondents with overweight status, we find 31.4% frequent and 27.4% infrequent consumption. Similarly, snack consumption frequency among overweight respondents is 30.8% frequent and 28.2% infrequent. Additionally, ready-to-eat meal consumption frequency among overweight respondents is 34.3% frequent and 27% infrequent. Lastly, beverage consumption frequency among overweight respondents is 30.9% frequent and 27.5% infrequent. However, the Chi-Square tests for these four variables do not indicate significant associations (p-values > 0.05), specifically (p = 0.631), (p = 0.773), (p = 0.419), and (p = 0.681). Regarding the relationship between energy intake and macronutrient consumption among respondents with overweight status, energy intake is categorized as excessive (42.9%), normal (14%), and deficient (21.8%). Protein intake among overweight respondents is categorized as excessive (42.9%), normal (32.3%), and deficient (19%). Similarly, fat intake among overweight respondents is categorized as excessive (38%), normal (22.6%), and deficient (9.1%). Finally, carbohydrate intake among overweight respondents is categorized as excessive (50%), normal (40%), and deficient (20%). The Chi-Square tests for these four variables reveal significant associations (p-values ≤ 0.05), specifically (p = 0.000), (p = 0.044), (p = 0.022), and (p = 0.006).

Discussion

Overweight is a condition where a person's body is overweight by 10-20% of normal body weight due to an energy imbalance between intake and physical activity (12,13). According to this study, the proportion of overweight status among adolescents is 29%. This percentage exceeds 20%, indicating a prevalence of overweight status in the research location. The findings align with data from Riskesdas (2018), which show that the prevalence of overweight status among adolescents in the Banten Province and Kota Tangerang, based on BMI-for-age, is 19.41% and 19.49%, respectively. These results indicate that the prevalence of overweight status among adolescents at senior high school of SMAN 5 Tangerang

City surpasses the average prevalence observed in both the Banten Province and Tangerang City. Overweight conditions during adolescence can lead to various degenerative health risks in adulthood, causing metabolic disturbances and increasing morbidity and mortality rates (14). If obesity is not treated immediately in the short term, it can lead to obesity, so teenagers experience low self-esteem, experience depression, and tend to have difficulty learning at school compared to teenagers with normal nutritional status. This is proven by previous research that the higher the level of nutritional status of students, the lower their self-confidence and mental health problems (15).

Frequency of consumption is how much food and drink a person consumes in a day, including main meals and snacks (16). Overall, there is almost no significant relationship between food consumption frequency and the occurrence of overweight status among adolescents at senior high school of SMAN 5 Tangerang City, except for the frequency of plant-based protein dishes and vegetables. In this study, respondents frequently consumed tofu and tempeh, with a frequency of more than 3-6 times per week. This preference can be attributed to the relatively lower cost and adequate availability of tempeh and tofu, both of which are popular among many adolescents (17). The results of the Chi-Square test in this study obtained a p-value of 0.013, which shows that there is a significant relationship between the frequency of consumption of vegetable side dishes and the incidence of overweight in teenagers at senior high school of SMAN 5 Tangerang City. Naturally, plant-based proteins have low saturated fat and cholesterol content, while also containing fiber and complex carbohydrates. Soy protein contains all essential amino acids for human nutrition, making soy products nearly equivalent to animal protein but with low saturated fat (18).

Vegetables and fruits are the highest sources of dietary fiber and low-calorie foods, playing a beneficial role in the body by reducing plasma lipids, lowering glycemic response, and aiding weight management (19). In this study, evidence indicates a significant association between vegetable consumption frequency ($p = 0.024$) and overweight occurrence among adolescents at senior high schools of SMAN 5 Tangerang City. Respondents with excess nutritional status, who consumed vegetables both in whole form and as processed foods (such as in chicken noodles, instant noodles, or fritters), contributed to an increased risk of excessive nutrition potential. Consequently, vegetables, initially low in energy, become high-energy sources when incorporated into meals or processed. Based on theory, higher fiber consumption is associated with a reduced likelihood of excessive nutrition. However, insufficient fiber intake is not the sole factor contributing to excessive nutritional status. Other factors influencing excessive nutritional status include nutritional knowledge, excessive food intake, physical activity, negative body image, and gender (20).

Energy is derived from the combustion of carbohydrates, proteins, and fats, which the body requires for respiration, growth, and physical activity. Based on the Chi-Square test results in this study, a p-value of ≤ 0.05 ($p = 0.000$) indicates a significant association between energy intake and overweight occurrence among adolescents at senior high schools of SMAN 5 Tangerang City. This finding aligns with Yanti et al. (2021), which also demonstrated a meaningful relationship between energy intake and excess nutritional status in high school students (with a p-value of 0.001). According to Smith (2006), adolescents generally prefer and choose high-calorie foods derived from carbohydrate sources, thus contributing to the occurrence of excess nutrition in this age group. This observation is consistent with the theory that nutrient intake directly influences nutritional status (3) In developing countries, dietary patterns have shifted. Initially, traditional diets were high in carbohydrates and fiber, but now they tend to be low in carbohydrates, low in fiber, high in fat, and energy-dense. This dietary shift leads adolescents to consume energy beyond their daily requirements. Prolonged excessive energy consumption can trigger hyperphagia (overeating), accompanied by excessive fat intake, resulting in weight gain (21).

The highest source of protein intake in this study comes from animal and plant-based dishes. The Chi-Square test results indicate a significant association (p-value ≤ 0.05, $p = 0.044$) between protein intake and overweight occurrence among adolescents at senior high schools of SMAN 5 Tangerang City. The study revealed that non-overweight respondents had a higher proportion of adequate and insufficient protein intake. Adequate protein intake in non-overweight adolescents contributes to energy accumulation, directly supporting muscle tissue formation and growth. Commonly consumed protein sources among adolescents are animal-based proteins. However, excessive consumption of animal-based proteins may increase insulin resistance due to amino acids such as arginine, histidine, and leucine, which are associated with lipid metabolism

Fat provides 2.5 times more energy, equivalent to 9 calories per gram, compared to the energy derived from carbohydrates and proteins. Based on the Chi-Square test results in this study, a p-value of ≤ 0.05 ($p = 0.022$) indicates a significant association between fat intake and overweight occurrence among adolescents at senior high schools of SMAN 5 Tangerang City. This finding aligns with Rahmita

et al. (2021), which also demonstrated a meaningful relationship between fat intake and excess nutritional status in high school students (with a p-value of 0.003). Notably, the study identified common high-fat foods consumed by respondents with excess nutritional status, including cooking oil, chicken meat, butter, chicken eggs, and cafeteria snacks such as fried tofu, fried tempeh, and chocolate (3). Similarly, in this study, the majority of non-overweight respondents (62%) had higher fat intake. The primary source of fat intake for these respondents was fried foods prepared using palm kernel oil, which falls under the category of saturated fats. Examples of such fried foods include fried chicken, sunny-side-up eggs, fried tempeh, fried tofu, fast food, and fried snacks. Urban environments, influenced by Westernization, have led to changes in lifestyle patterns, supporting the availability of restaurants and cafes that predominantly serve high-fat fast food (22,23). High-fat foods are perceived as more palatable, leading to continuous consumption due to reduced satiety levels. The body's fat storage capacity is virtually unlimited and not accompanied by fat oxidation; thus, approximately 96% of ingested fat is stored. In other words, excess fat intake, no longer needed for immediate energy, is stored and contributes to the formation of adipose tissue, ultimately leading to weight gain (24).

It is known that the primary source of carbohydrates frequently consumed by high school students at the senior high school of SMAN 5 Tangerang City is rice, with a frequency of 1-3 times per day. Rice holds a central position as a staple food in Indonesia, ingrained as a tradition or habitual dietary practice during the three main meals. This observation is supported by data showing that carbohydrate content typically constitutes the largest proportion (70-80%) of daily food intake among Asian populations, including Indonesia (25). When consumed, carbohydrates are metabolized into glucose within the bloodstream, serving as immediate energy and stored as glycogen in the liver and muscle tissues. Some of these carbohydrates are also converted into fat, which is stored as an energy reserve in adipose tissue (26). Notably, the results of the Chi-Square test in this study yielded a p-value ≤ 0.05 (p = 0.006), indicating a significant association between carbohydrate intake and overweight occurrences among adolescents at SMAN 5 Kota Tangerang. Excessive long-term carbohydrate consumption can lead to hepatic fat accumulation, subsequently transporting fat to adipose cells without bounds, thereby increasing the risk of adolescent nutritional status deterioration (27). The study further reveals that a majority of respondents—20% classified as overweight and 80% as non-overweight—have insufficient carbohydrate intake levels. Despite frequent consumption of carbohydrate sources, the daily portion or average gram intake may not meet their nutritional requirements. Additionally, respondents obtain carbohydrates from fruits and vegetables, albeit infrequently (not daily) or only 1-2 times per week, resulting in inadequate daily gram intake. Furthermore, the consumption of sugary snacks and beverages contributes to this pattern.

Limitations of the study

Fiber intake was not measured because most respondents consumed vegetables as part of processed dishes or not as a main meal, resulting in small portions and limited fiber intake. No significant association was found between physical activity and overweight status among adolescents at SMAN 5 Kota Tangerang. This is likely due to the use of a Physical Activity Level (PAL) questionnaire that only assessed physical activity for a single 24-hour period on a weekday. As a result, the types of physical activities and the time allocation for these activities were likely similar among the respondents.

Conclusion

Most respondents exhibit frequent consumption patterns in staple foods, animal-based dishes, plant-based dishes, fats, and vegetables. Conversely, respondents who consume fruits, snacks, fast food, and beverages fall into the infrequent consumption category. Furthermore, a majority of respondents experience deficits in energy intake, protein intake, and carbohydrate intake, while their fat intake tends to exceed recommended levels. Notably, significant associations emerge between the frequency of plant-based and vegetable consumption and the occurrence of overweight status among adolescents at a senior high school of SMAN 5 Tangerang City. Additionally, the study reveals significant relationships between energy intake and macronutrients (protein, fat, and carbohydrates) and the prevalence of overweight status in these young individuals.

Recommendations

Students should monitor their weight monthly and limit unhealthy foods such as those high in sugar, salt, and fat. Additionally, regular physical activity and screen time less than 2 hours daily are encouraged. Schools can implement monthly weight monitoring with tools in the school health unit. Researchers can analyze fiber intake and physical activity levels (including weekdays and weekends) for a more comprehensive picture of student health.

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