



## The relationship between diet patterns and physical activity with the incidence of overweight in adolescents at SMAN 8 Maros

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### Abstract

**Background:** Adolescents are a vulnerable age group prone to nutritional problems, particularly overweight and obesity, which often result from an imbalance between energy intake and energy expenditure. Dietary patterns high in energy and fat but low in fiber, combined with insufficient physical activity, contribute to the rising prevalence of overweight and obesity. Preliminary data at SMAN 8 Maros showed that 10.13% of students were overweight and 9.03% were obese.

**Objective:** This study aimed to examine the relationship between dietary patterns and physical activity with the incidence of overweight among adolescents at SMAN 8 Maros.

**Methods:** This research employed a quantitative design with a case-control approach. A total of 82 students from grades X and XI were selected using simple random sampling, with a 1:1 ratio between the case group (41 students with overweight/obesity) and the control group (41 students with normal nutritional status). Dietary data were collected using 2x24-hour food recall and Food Frequency Questionnaire (FFQ), while physical activity was measured using the Global Physical Activity Questionnaire (GPAQ). Data were analyzed using the Spearman rank correlation test.

**Results:** Statistical analysis revealed a significant relationship between dietary intake including energy ( $p=0.000$ ), protein ( $p=0.006$ ), fat ( $p=0.008$ ), and carbohydrate ( $p=0.002$ )—and the incidence of being overweight. In contrast, no significant association was found between the frequency of main meal and processed food consumption ( $p=0.828$  &  $p=0.824$ ) and overweight incidence. Physical activity demonstrated a significant correlation ( $p=0.002$ ) with being overweight.

**Conclusion:** Dietary intake (energy, protein, fat, carbohydrates) and physical activity are significantly associated with being overweight among adolescents. However, no significant relationship was observed between meal frequency and overweight incidence among adolescents at SMAN 8 Maros.

**Keywords:** dietary pattern, physical activity, overweight, adolescents

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## Introduction

Adolescence is a transitional period between childhood and adulthood characterized by rapid biological, psychological, and social changes. According to the World Health Organization (WHO), adolescence refers to individuals aged 10–19 Years.<sup>1</sup> During this period, nutritional requirements increase to support growth and development; however, adolescents often adopt unhealthy eating behaviors influenced by peers, family, and media exposure.<sup>2</sup>

Overweight and obesity among adolescents have become major global public health concerns. WHO defines overweight and obesity as excessive fat accumulation that may impair health and increase the risk of non-communicable diseases, including type 2 diabetes, cardiovascular disease, musculoskeletal disorders, and certain cancers.<sup>3</sup> In 2022, more than 390 million children and adolescents aged 5–19 years were classified as overweight or obese, an increase from 8% in 1990 to 20% in 2022.<sup>4</sup> This trend was observed in both sexes, with a prevalence of 19% among adolescent girls and 21% among boys.<sup>4</sup>

In Indonesia, the prevalence of overweight and obesity among adolescents has also shown an upward trend. The Indonesia Health Survey (SKI) in 2023 reported that 8.8% of adolescents aged 16–18 years were overweight, and 3.3% were obese.<sup>5</sup> In South Sulawesi Province, the prevalence of overweight reached 8.8% and obesity 4.1%.<sup>5</sup> Similarly, the 2018 South Sulawesi Basic Health Research (Riskesdas) revealed that in Maros Regency, the prevalence of overweight among adolescents was 7.93%, and obesity 2.72%.<sup>6</sup> Moreover, 30.05% of residents aged  $\geq 10$  years were categorized as having low physical activity, accompanied by high consumption of sugary foods (41.51%), sweetened beverages (59.40%), and fatty foods (36.08%), with low intake of fruits and vegetables (15.92%).<sup>6</sup>

The causes of overweight in adolescents are multifactorial, involving an imbalance between energy intake and expenditure, poor dietary habits, and low physical activity levels.<sup>7</sup> According to the energy balance theory, body weight increases when energy intake exceeds energy expenditure through metabolism and physical activity.<sup>8</sup> Other contributing factors include stress, insufficient sleep, and environmental influences from school and family.<sup>9</sup>

Adolescents tend to consume high-calorie foods such as fast food, sweetened beverages, and snacks due to accessibility, peer influence, and modern lifestyle patterns.<sup>10</sup> Such dietary habits are associated with an increased risk of overweight and obesity.<sup>11</sup> Studies have reported that high intake of fat and sugar, coupled with low consumption of fiber, fruits, and vegetables, is positively correlated with higher body mass index (BMI).<sup>12</sup> Physical activity plays a crucial role in maintaining energy balance by enhancing energy expenditure and improving fat metabolism.<sup>8</sup>

Several studies have confirmed the relationship between dietary habits, physical activity, and overweight among adolescents. Pajriyah and Sulaeman,<sup>13</sup> found a significant association between nutrition knowledge, dietary patterns, and physical activity with overweight incidence among adolescents. Similarly, Wahyuningsih and Pratiwi,<sup>14</sup> reported that adolescents with low physical activity levels were more likely to experience overweight compared to those with moderate or high activity levels. Roring<sup>15</sup> also demonstrated that physical activity contributes to maintaining ideal body weight by increasing metabolism and promoting fat utilization.



Overweight not only affects physical health but also has psychological consequences such as decreased self-esteem, increased anxiety, and negative body image perception.<sup>16</sup> Therefore, preventive measures focusing on healthy eating behaviors and regular physical activity are essential to reduce the risk of overweight and obesity among adolescents. Preliminary data from SMAN 8 Maros revealed that 10.13% of students were overweight and 9.03% were obese out of a total of 454 students.<sup>17</sup> These findings indicate that overweight remains a significant public health concern among high school adolescents in the region.

Based on the above considerations, it is necessary to investigate factors associated with overweight among adolescents, particularly focusing on dietary habits and physical activity.

The objective of this study is to determine the relationship between dietary habits and physical activity with the incidence of overweight among adolescents at SMAN 8 Maros.

## Methods

This research is case control study was conducted between January and July 2025 at SMAN 8 Maros, a public senior high school located in Maros Regency, South Sulawesi, Indonesia. The study aimed to examine the relationship between dietary habits and physical activity with overweight among adolescents. A quantitative analytic approach was applied using a case–control design, which retrospectively investigates determinants of a specific health outcome.<sup>17,18</sup> The case group consisted of students from grades X and XI classified as overweight or obese, while the control group comprised students with normal nutritional status. The independent variables were dietary habits and physical activity, and the dependent variable was overweight status. The total school population included 454 students enrolled in grades X and XI. The sample size was determined using the Lemeshow formula, yielding a minimum of 82 participants, divided equally between case (n=41) and control (n=41) groups. A simple random sampling method was employed using Microsoft Excel (RAND function) to ensure random and representative selection. This study uses the Spearman Rank test. Participants were included if they (1) were actively enrolled in grades X or XI, (2) were aged 15–17 years, and (3) had anthropometric measurements recorded during the initial screening. Students classified as overweight or obese were assigned to the case group, while those with normal nutritional status formed the control group. Exclusion criteria included (1) withdrawal from the study before completion and (2) failure to meet inclusion requirements. Data collection was conducted using structured interviews and validated questionnaires.

Anthropometric measurements include body weight and height. Body weight is measured using a calibrated digital scale, Onemed EB 9312-10097, with participants wearing light clothing and no shoes. Height is measured using a portable Seca 213 stadiometer, with participants standing upright, without shoes, and with the head positioned in the Frankfurt plane. All measurements were conducted following standard anthropometric procedures recommended by WHO. Body Mass Index (BMI) was calculated as weight (kg) divided by height squared (m<sup>2</sup>) and classified according to WHO standards for adolescents. Measurements were carried out by the researcher to minimize measurement bias. Nutritional status was assessed using BMI-for-age Z-scores (BAZ) according to the Indonesian Ministry of Health Regulation No. 2 of 2020.<sup>19</sup> Classifications were defined as: normal (–2 SD to +1 SD), overweight (>+1 to +2 SD), and obese (>+2 SD). Dietary habits were assessed using two complementary methods: 2



x 24-hour recalls (weekday and weekend) to find out the respondents' food intake, to estimate daily energy and nutrient intake (carbohydrates, protein, and fat). Insufficient if intake is <80%, adequate if intake is 80-110%, excessive if intake is >110%. To minimize recall bias in the 24-hour recalls, the researchers conducted interviews with guiding questions such as meal times and types of food with the participants. The researchers used household measurements and a food photo book aid to help participants estimate portion sizes more accurately.

Food Frequency Questionnaire (FFQ) was used to find out the respondents' eating frequency, adapted from the Indonesian Ministry of Health, evaluated food type, portion, and consumption frequency. Scores  $\geq 408$  for staple foods,  $\geq 50$  for processed foods.<sup>20-22</sup> Physical activity was measured using the Global Physical Activity Questionnaire (GPAQ) developed by WHO. MET (Metabolic Equivalent of Task) values were calculated to categorize activity levels as light (<600 MET), moderate (600–3000 MET), or vigorous (>3000 MET).<sup>8,23</sup> Sociodemographic characteristic such as age, gender, parental education, occupation, and household income were obtained using a structured background form completed by students. All completed questionnaires were checked for completeness and accuracy prior to data entry. Data were coded, cleaned, and analyzed using IBM SPSS Statistics version 26. Descriptive statistics were used to summarize participant characteristics. Univariate analysis was performed to present frequency and percentage distributions of each variable.<sup>24</sup> Bivariate analysis employed the Spearman Rank correlation test to assess the association between dietary habits, physical activity, and overweight status.<sup>25</sup> A *p*-value <0.05 was considered statistically significant. This study was reviewed and approved by the Health Research Ethics Committee of Universitas Muslim Indonesia (Approval No.410/A.1/KEP-UMI/VII/2025). All participants and their guardians received verbal and written explanations about the study objectives and procedures. Written informed consent was obtained prior to participation. Confidentiality and anonymity were strictly maintained throughout data collection and analysis.

## Results

The sociodemographic characteristics of the subjects are shown in **Table 1** below. This study involved 82 respondents, consisting of 41 students in the case group (overweight/obese) and 41 students in the control group (normal nutritional status).

Most respondents were 16 years old (58.5%), with a balanced gender distribution between males and females. Most respondents brought pocket money <IDR 16,000 (56.1%). Most respondents came from families with incomes <UMK (regional minimum wage) (54.9%). Most respondents' fathers were employed (91.5%), while most respondents' mothers were unemployed (80.5%). The education levels of respondents' fathers and mothers were predominantly higher (68.3%) and higher (59.8%).

**Table 1.** Sociodemographic characteristics of the respondents (n = 82)

Respondent Characteristics	Case		Control		Total	
	n	%	n	%	n	%
<b>Age</b>						
15 years	0	0	1	1.2	1	1.2
16 years	24	29.3	24	29.3	48	58.5
17 years	17	20.7	16	19.5	33	40.2
<b>Gender</b>						
Man	16	19.5	16	19.5	32	39
Woman	25	30.5	25	30.5	50	62.2
<b>Pocket money</b>						
< IDR 16,000	22	26.8	24	29.3	46	56.1
≥ IDR 16,000	19	23.2	17	20.7	36	43.9
<b>Parents' Income</b>						
< Regional Minimum Wage (UMK)	17	20.7	28	34.1	45	54.9
≥ Regional Minimum Wage (UMK)	24	29.3	13	15.9	37	45.1
<b>Father's Occupation</b>						
Doesn't work	5	6.1	2	2.4	7	8.5
Work	36	43.9	39	47.6	75	91.5
<b>Mother's Occupation</b>						
Doesn't work	32	39	34	41.5	66	80.5
Work	9	11	7	8.5	16	19.5
<b>Father's Education</b>						
Low (no formal education, incomplete PS, JHS, and SHS)	8	9.8	18	22	26	31.7
High (completion of SHS or equivalent and higher education)	33	40.2	23	28	56	68.3
<b>Mother's Education</b>						
Low (no formal education, incomplete PS, JHS, and SHS)	13	15.9	20	24.4	33	40.2
High (completion of SHS or equivalent and higher education)	28	34.1	21	26.6	49	59.8

Notes: PS: Primary School, JHS: Junior High School, SHS: Senior High School



**Table 2** shows that the control group (48.8%) was dominated by low energy intake. Meanwhile, respondents with high energy intake were dominated by the case group (2.4%). Respondents with low protein intake were dominated by the control group (28%). Meanwhile, respondents with high protein intake were dominated by the case group (12.2%). Respondents with low fat intake were dominated by the control group (34.1%). Meanwhile, respondents with high fat intake were dominated by the case group (9.8%). Low carbohydrate intake was dominated by the control group (48.8%), and there were no respondents with high carbohydrate intake. Respondents with low frequency of main meal consumption were dominated by the case group (24.4%), while high frequency of main meal consumption was dominated by the control group (26.8%). Respondents with low frequency of processed product consumption were dominated by the case group (20.7%), while high frequency of processed product consumption was dominated by the control group (30.5%).

**Table 2.** Relationship between eating patterns and the incidence of being overweight

Dietary habit	Case		Control		p-value	r value
	n	%	n	%		
<b>Energy Intake</b>						
Not enough	19	23.2	40	48.8		
Enough	20	24.4	1	1.2	0.000*	0.569
Over	2	2.4	0	0		
<b>Protein Intake</b>						
Not enough	13	15.9	23	28		
Enough	18	22	16	19.5	0.006*	0.300
Over	10	12.2	2	2.4		
<b>Fat Intake</b>						
Not enough	17	20.7	28	34.1		
Enough	16	19.5	11	13.4	0.008*	0.293
Over	8	9.8	2	2.4		
<b>Carbohydrate Intake</b>						
Not enough	30	36.6	40	48.8		
Enough	11	13.4	1	1.2	0.002*	0.345
<b>FFQ Main Food</b>						
Not enough	20	24.4	19	23.2		
Over	21	25.6	22	26.8	0.828	-.024
<b>FFQ Processed Products</b>						
Not enough	17	20.7	16	19.5		
Over	24	29.3	25	30.5	0.824	-.025

Notes: \*p < 0.05 indicates statistical significance



Based on the results of the study, **Table 3** shows the results of the highest and lowest FFQ respondents, the highest consumption of staple foods with a daily frequency was rice, in the case group (46.3%), in the control group (50%). While the lowest consumption of staple foods with a frequency of 3-6 times per week in the case group was sweet potatoes (2.4%), while in the control group it was cassava and sweet potatoes (1.2%). The highest consumption of side dishes with a frequency of 3-6 times per week in the case group and the control group was chicken (30.5%) and (29.3%). The lowest frequency of side dish consumption in the case group was squid, beef, green beans and red beans (1.2%) and the control group was snapper and beef (1.2%). The highest consumption of vegetables with a frequency of 3-6 times per week in the case group was carrots (17.1%), while in the control group it was kale (19.5%). The lowest vegetable consumption in the case group was eggplant and bean sprouts (1.2%), while in the control group it was moringa leaves and long beans (1.2%). The highest fruit consumption with a frequency of 3-6 times per week in the case group was papaya (13.4%), while in the control group it was banana (17.1%). The lowest fruit consumption frequency in the case group was guava (1.2%), while in the control group it was avocado (3.7%). The highest consumption of processed products with a frequency of 3-6 times per week was meatballs, UHT milk, and sweetened condensed milk. In the case group, meatball consumption was 9.8%, UHT milk (12.2%), and sweetened condensed milk (11%). In the control group Meatball consumption (9.8%), UHT milk (20.7%), and sweetened condensed milk (11%). Meanwhile, the lowest consumption of processed products was nuggets, in the case group (1.2%) and the control group (3.7%).

**Table 4** shows that light physical activity was dominated by the case group (3.7%). Meanwhile, respondents with vigorous physical activity were dominated by the control group (11%).

## Discussion

Energy intake is the result of the metabolism of carbohydrates, fats, and proteins, which serve as energy sources for metabolism, body temperature regulation, growth, and physical activity. Weight loss and other nutritional deficiencies will occur if energy intake is low over a prolonged period.<sup>28</sup> The results of the study in Table 2 indicate that most respondents had a daily energy intake that was classified as insufficient or sufficient, as found in overweight adolescents or in the case group. This condition is caused by respondents tending to have irregular eating patterns. This study using the Spearman Rank test obtained a value of  $p = 0.000 < 0.05$ , which means that there is a significant relationship between energy intake and the occurrence of being overweight. The interpretation of the correlation coefficient  $r = 0.569$  that there is a positive correlation shows the result of a one-way relationship. It means that the higher the energy intake, the greater the possibility of being overweight in adolescents. Based on interviews, respondents stated that they often skipped breakfast or main meals, but replaced them with snacks high in sugar, salt, and fat. In a study by Rokhmah,<sup>27</sup> it was stated that energy intake from food should be in line with the body's needs. If there is an imbalance between energy consumed and energy used over a long period of time, it can cause problems with nutritional status.



**Table 3.** Distribution of respondents' consumption frequency of staple foods and processed products

Food material	FREQUENCY																							
	A		B				C				D				E				F					
	Case		Control		Case		Control		Case		Control		Case		Control		Case		Control		Case		Control	
	n	%	n	%	n	%	n	%	n	%	n	%	N	%	n	%	n	%	n	%	n	%	n	%
<b>The main food</b>																								
Rice	38	46.3	41	50	3	3.7	0	0	0	0	0	0	0	3.7	0	0	0	0	0	0	0	0	0	0
Cassava	0	0	0	0	0	0	0	0	3	3.7	1	1.2	11	13.4	16	19.5	17	20.7	16	19.5	10	12.2	8	9.8
Sweet potato	0	0	0	0	0	0	0	0	2	2.4	1	1.2	13	15.9	13	15.9	17	20.7	14	17.1	9	11	13	15.9
Chicken meat	0	0	0	0	6	7.3	4	4.9	25	30.5	24	29.3	10	12.2	13	15.9	0	0	0	0	0	0	0	0
Squid	0	0	0	0	0	0	0	0	1	1.2	0	0	10	12.2	11	13.4	19	23.2	15	18.3	11	13.4	15	18.3
Beef	0	0	0	0	0	0	0	0	1	1.2	1	1.2	19	23.2	17	20.7	19	23.2	22	26.8	2	2.4	1	1.2
Snapper	0	0	0	0	0	0	0	0	0	0	1	1.2	7	8.5	9	11	7	8.5	7	8.5	27	32.9	24	29.3
Mung beans	0	0	0	0	0	0	0	0	1	1.2	0	0	8	9.8	18	22	13	15.9	8	9.8	19	23.2	15	18.3
Red beans	0	0	0	0	0	0	0	0	1	1.2	0	0	1	1.2	4	4.9	6	7.3	14	17.1	33	40.2	23	28
Spinach	0	0	0	0	0	0	0	0	12	14.6	16	19.5	25	30.5	23	28	3	3.7	2	2.4	1	1.2	0	0
Carrot	0	0	0	0	1	1.2	0	0	14	17.1	14	17.1	23	28	22	26.8	1	1.2	1	1.2	2	2.4	4	4.9
Eggplant	0	0	0	0	0	0	0	0	1	1.2	0	0	13	15.9	9	11	9	11	13	15.9	18	22	19	23.2
Bean sprouts	0	0	0	0	0	0	0	0	1	1.2	6	7.3	9	11	16	19.5	13	15.9	7	8.5	18	22	12	14.6
Moringa Leaves	0	0	0	0	0	0	1	1.2	3	3.7	1	1.2	6	7.3	11	13.4	15	18.3	11	13.4	17	20.7	17	20.7
Long beans	0	0	0	0	0	0	0	0	4	4.9	1	1.2	15	18.3	19	23.2	7	8.5	10	12.2	15	18.3	11	13.4
Papaya	0	0	0	0	1	1.2	0	0	11	13.4	10	12.2	18	22	20	24.4	6	7.3	6	7.3	5	6.1	5	6.1
Banana	0	0	0	0	1	1.2	0	0	11	13.4	14	17.1	21	25.6	23	28	4	4.9	4	4.9	4	4.9	0	0
Avocado	0	0	0	0	0	0	0	0	0	0	3	3.7	15	18.3	10	12.2	13	15.9	13	15.9	13	15.9	15	18.3
Guava	0	0	0	0	0	0	0	0	1	1.2	0	0	3	3.7	2	2.4	22	26.8	24	29.3	15	18.3	15	18.3
<b>Processed Products</b>																								
Meatball	0	0	0	0	0	0	0	0	8	9.8	8	9.8	31	37.8	30	36.6	2	2.4	2	2.4	0	0	1	1.2
UHT milk	0	0	0	0	2	2.4	0	0	10	12.2	17	20.7	23	28	20	24.4	2	2.4	4	4.9	4	4.9	0	0
Sweetened condensed milk	0	0	0	0	0	0	0	0	9	11	9	11	27	32.9	26	31.7	3	3.7	5	6.1	2	2.4	1	1.2
Nuggets	0	0	0	0	0	0	0	0	1	1.2	3	3.7	16	19.5	10	12.2	13	15.9	18	22	11	13.4	10	12.2

Information : A: Every day (>1 time a day), B: 1 time a day, C: 3-6 times/week, D: 1-2 times/week, E: Twice a month, F: Never

**Table 4.** Relationship between physical activity and the incidence of overweight

Physical Activity	Case		Control		p-value	r value
	n	%	n	%		
Light	3	3.7	1	1.2		
Moderate	38	46.3	31	37.8	0.002*	-.344
Vigorous	0	0	9	11		

Notes: \* $p < 0.05$  indicates statistical significance

This study is also in line with Wijayanti's study<sup>28</sup> related to nutritional status, namely energy intake, carbohydrate intake, and protein intake ( $p < 0.05$ ). The relationship is negative, meaning that the lower the energy, carbohydrate, and protein intake, the higher the BMI. The relationship between energy, carbohydrate, and protein intake and BMI has a sufficient/moderate correlation because the r value is  $>0.25$  and  $<0.5$ . Based on the research data, it was found that respondents in the control group had a significantly lower energy intake than respondents in the case group. Furthermore, respondents in the case group tended to have a higher proportion of energy intake than respondents in the control group. This clearly indicates a relationship between energy intake and the incidence of overweight in respondents. Thus, excess energy intake is a major factor in the occurrence of overweight in respondents.

Protein is an essential macronutrient that functions in the growth, repair, and maintenance of various body tissues such as muscles, skin, hair, and organs. Its role is crucial in improving the nutritional status of adolescents, particularly in supporting growth, the formation and development of muscle mass, and maintaining bone health.<sup>31</sup> The result of the Spearman Rank test shows that  $p = 0.006 < 0.05$ , which means there is a significant relationship between protein intake and the occurrence of excess bodyweight. As for the interpretation of the correlation coefficient  $r = 0.300$ , that there is a positive correlation but weak and shows a one-way relationship, which means that the higher the protein intake, the greater the possibility of being overweight in adolescents. Regarding the respondents' protein intake, it can be concluded that the control group had a lower protein intake than the case group. Conversely, the case group had a higher proportion of protein intake than the control group. This indicates that high protein intake has the potential to contribute to weight gain in respondents. Based on the results of interviews with respondents, processing methods and consumption portions varied and were not always in the same portion. Some respondents also admitted to reducing food intake or on a diet, and some even deliberately skipped food at certain meal times. However, adolescents' protein needs increase during the growth period, due to the growth process. If energy intake is insufficient, protein will be used to meet energy needs, so there is not enough available to build or repair damaged tissue. This can lead to a decrease in the amount of growing muscle mass. This also shows that high consumption frequency does not guarantee adequate protein intake.<sup>26</sup> This research is in line with the research of Sari which stated that there is a relationship between protein intake and nutritional status, proven by a p-value of 0.006.<sup>30</sup> This research is also in line with the research conducted by Ristanti<sup>31</sup> with the results of statistical tests using the *Spearman correlation test* of protein intake and nutritional status of adolescent girls, obtained a p-value of 0.000 so that there is a significant relationship between protein intake and nutritional status.

Fat is the body's largest source of energy reserves, formed from a combination of energy-producing nutrients such as carbohydrates and proteins. In addition to storing



energy, fat also functions to help transport vitamins and minerals, maintain stable body temperature, serve as a primary energy source, and protect vital organs.<sup>33</sup> Excessive fat consumption can lead to obesity because the energy content of fat is twice as high as the energy content of carbohydrates. Foods containing fat are generally tasty, leading people to overconsume them. Obesity can lead to various long-term diseases such as heart disease, blood vessel disease, and diabetes mellitus.<sup>34</sup> Based on the results of the Spearman Rank test showing  $p = 0.008 < 0.05$  which means that there is a significant relationship between fat intake and the occurrence of overweight. As for the interpretation of the correlation coefficient  $r = 0.293$  that there is a positive but weak correlation which shows the result of a one-way relationship. It means that the higher the fat intake, the greater the possibility of being overweight in adolescents. In the interview results in this study, some respondents stated that they frequently consume fried foods, such as fried chicken, *tempe mendoan* (thin-sliced battered and lightly fried tempeh), *risoles* (fried pastry filled with vegetables and/or meat), *martabak* (stuffed pan-fried pancake, sweet or savory), fried eggs, or other fried snacks. Sari's study<sup>30</sup> also aligns with this research, stating that there is a relationship between fat intake and nutritional status, as evidenced by a  $p$  value of  $<0.001$ . Consumption of processed products can contribute significantly to high fat intake in some adolescents. This means that high consumption frequency, especially if fried, can contribute to excess fat intake. Optimal nutritional status is influenced by the consumption of fats containing balanced nutrients. If fat intake is excessive, this can lead to overweight or obesity and increased cholesterol levels. Conversely, a lack of fat in the diet can lead to low calorie intake, deficiencies in fat-soluble vitamins, and the risk of causing the body to become thin.<sup>32</sup> Therefore, it can be concluded that the control group had a lower fat intake than the case group. Conversely, the case group had a higher proportion of excess fat intake than the control group. This condition indicates that high fat intake can contribute to overweight in respondents.

Carbohydrate intake is the primary source of energy, and if consumed in excess, the body will store it as glycogen. Nutritional status can be affected by several factors, one of which is the type of food consumed, especially those containing carbohydrates. Carbohydrates are converted into glucose in the blood and become an energy reserve for the body. If carbohydrate intake is not balanced with the body's needs, it can cause nutritional health problems.<sup>35</sup> The results of the Spearman Rank test show that  $p = 0.002 < 0.05$  which means there is a significant relationship between carbohydrate intake and the occurrence of being overweight. As for the interpretation of the correlation coefficient  $r = 0.345$  that there is a positive correlation that shows a one-way relationship. It means that the higher the carbohydrate intake, the greater the possibility of being overweight in adolescents. In the interview results, some respondents stated that they often consume fried rice, and some consume instant noodles. Some respondents also buy snacks such as meatballs, *batagor* (*fried meatball and tofu*), and chicken noodles. The types and amounts of carbohydrate sources frequently consumed by respondents are simple carbohydrates such as sweetened drinks and sweet bread. Excessive carbohydrate intake can trigger fat formation in the body, while carbohydrate deficiency has the potential to cause weight loss. An unbalanced carbohydrate consumption pattern will have a negative impact on health. If excess carbohydrates occur continuously, it can cause nutritional deficiencies and increase the risk of diabetes.<sup>32</sup> Excess carbohydrate intake does not always cause obesity if the carbohydrate source consumed comes from high-fiber foods, such as vegetables, fruits, and grains. This type of carbohydrate has a different effect compared to simple carbohydrates, such as sugar.<sup>33</sup> This study is in line with research conducted by



Fauziah<sup>34</sup> that the p value on carbohydrate intake ( $p = 0.000$ ) which means  $p < 0.05$  indicates a significant relationship between macronutrient intake and the nutritional status of adolescents in Wiyung District, Surabaya. Based on the research results, it can be concluded that the control group had a higher proportion of insufficient carbohydrate intake than the case group. Meanwhile, the case group had a higher proportion of adequate carbohydrate intake. This indicates that respondents with higher nutritional status tended to have more adequate carbohydrate consumption patterns.

Consumption frequency can be defined as how often a person consumes a type of food within a specific period, as evaluated based on weekly consumption scores for different food groups. Eating frequency is an indicator of food consumption patterns, showing how often an individual consumes a particular type of food within a specific time period.<sup>36</sup> Based on the results of the Spearman Rank test showing that the value of  $p > 0.05 = 0.828$  and  $0.824$  shows that there is no significant relationship between the frequency of the main food and processed products with the occurrence of overweight. The results of this study produce an interpretation of the correlation coefficient  $r = (-0.024)$  and  $(-0.025)$ , which means that there is a negative correlation and is very weak, showing the opposite relationship, but the strength is very weak (close to 0), which means that it has no statistical meaning. Thus, the frequency of consumption is not related to the occurrence of being overweight, and the frequency of eating alone may not be the main factor in the occurrence of being overweight. In this study, some respondents were recorded as consuming several processed products, such as meatballs, UHT milk, and sweetened condensed milk, which were used as food supplements and brewed as additional drinks. Theoretically, the consumption of *ultra-processed foods* (UPF) is often associated with increased Body Mass Index due to their high calorie, low fiber, and high sugar content.<sup>38</sup> Although there was no significant relationship between consumption frequency and the incidence of overweight, the results of this study indicate that respondents had a high consumption frequency, both in the control and case groups. This means that some control respondents are at risk of becoming overweight, and caution is needed. If increased nutritional needs are not accompanied by a balance between energy intake and expenditure, adolescents are at risk of overnutrition. Overnutrition during adolescence can lead to various health problems, such as cardiovascular disease, dyslipidemia, joint disorders, and other chronic diseases that have the potential to reduce life expectancy.<sup>39</sup> Improved nutritional status can be influenced by unhealthy eating patterns, for example the habit of consuming foods high in saturated fat and sugar excessively.<sup>40</sup> Nutritional status is not solely influenced by eating patterns, but also by various other factors, such as parental support, food availability at home, amount of pocket money, knowledge about nutrition, perception of body image, and habits in choosing food.<sup>41</sup> Research by Sativa<sup>37</sup> also aligns with this study, stating that there is no relationship between the frequency of fast food consumption and the incidence of overnutrition in adolescents, with a p-value of  $0.879$  and an r-value of  $0.023$ , respectively. Therefore, this study can be concluded that the control group with normal nutritional status consumed more types of food, especially vegetables and fruit as the main foods, compared to the overweight case group. This may be caused by differences in the quality and nutritional composition of the food consumed by respondents. In other words, overweight respondents have an unbalanced consumption pattern, namely high energy and fat intake but low fiber or micronutrients from fruits and vegetables. The frequency of consumption of liquid dairy products was higher in the control group. Therefore, this indicates that liquid milk consumption is not always related to weight gain. This indicates that the type and quality of milk, as well as the balance of



overall energy intake, play a greater role in determining the nutritional status of respondents.

Based on the interview results in this study, some respondents engaged in light physical activity, such as walking or sitting for long periods while studying, or lying down while using a mobile phone. Meanwhile, more frequent vigorous physical activity included regular exercise such as running, cycling, playing futsal or soccer, or extracurricular sports. Differences in the type and intensity of these activities affect the amount of energy expended. Therefore, respondents with higher levels of vigorous physical activity tended to have a better energy balance and a lower risk of being overweight. Based on the Spearman Rank test, it produces a significance value with  $p = 0.002 < 0.05$  showing that there is a significant relationship between physical activity and the occurrence of overweight. The value of the correlation coefficient  $r = (-0.344)$ , which means that there is a weak-medium relationship with the negative direction, shows the opposite direction which means that the heavier the level of physical activity, the lower the risk of the possibility of being overweight. People with light physical activity had a higher risk of obesity than those with moderate or vigorous activity. This occurs because calories are not burned optimally, so most of them are stored as fat in the body, leading to weight gain.<sup>42</sup> Based on Table 4 in this study, it can be concluded that respondents in the case group tended to have lower levels of physical activity than respondents in the control group. While there were no respondents with vigorous physical activity in the case group, indicating that lack of physical activity can be a contributing factor to overweight in respondents. Conversely, respondents with vigorous physical activity in the control group demonstrated that adequate and regular physical activity plays an important role in maintaining energy balance and maintaining normal nutritional status. This research aligns with the findings of Purwaningsih and Sumarni<sup>43</sup> who found a relationship between physical activity and the nutritional status of adolescents at Muhammadiyah 7 High School, Sutorejo, Surabaya. The study also stated that low physical activity increases the risk of obesity in adolescents. This research also aligns with the findings of Roring<sup>44</sup> who used the *Spearman test* to determine a relationship between physical activity and nutritional status, with a significant value of 0.003. The strength of the relationship is moderate and positive.

## Conclusions

Based on this research, there is a relationship between dietary patterns in terms of energy, protein, fat and carbohydrate intake, and the incidence of being overweight. However, there is no relationship between eating patterns and food frequency and the incidence of being overweight. There is a relationship between physical activity and the incidence of being overweight.

## Conflict of interest

The authors declared no conflict of interest regarding this article.

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## Author Contributions

Firdhawati: Conceptualization, methodology, data collection and analysis, as well as initial draft writing and manuscript finalization; St. Masithah: Supervision, methodology validation, writing error correction, and critical revision of the manuscript; Siti Uswatun Hasanah: Development of theoretical framework, instrument evaluation, and manuscript editing; Andi Rahmani MB: Accompanying data analysis, result verification, and final approval of the published.

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