



STUDY OF CHOLESTEROL INTAKE, PROPORTION OF FAT IN THE DIET TO BODY FAT IN ADOLESCENTS

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ABSTRACT

The increase of body fat over students is caused by changes in lifestyle, especially diet, where adolescents often consume high-energy foods sourced from fat. High consumption of saturated fats can increase cholesterol and inflammation in the body, leading to fat storage disorders. To prevent this increase in excess, it is necessary to increase the intake unsaturated fat, like MUFA and PUFA which are known as one of the anti-inflammatory substances that can reduce fat in the body. Therefore, when consuming fats, a larger proportion of PUFA and MUFA is needed compared to the proportion of saturated fats. Objective: To analyze the relationship between cholesterol intake and the proportion of fat intake with percent body fat. Method: This study used a cross-sectional design with multistage random sampling involving 161 adolescents aged 15-18 years who attended high schools and vocational schools in Surakarta. Food intake data was collected using food frequency questionnaire (SQFFQ). Percent body fat was measured using Bioelectrical Impedance Analysis (BIA) Omron HBF -375 Karada scan. Bivariate data analysis using spearman rank. Results: The results of the analysis showed no relationship between cholesterol intake and percent body fat ($p=0.531$), proportion of saturated fat ($p=0.332$), proportion of MUFA ($p=0.269$), proportion of PUFA ($p=0.213$) Conclusions: It can be concluded that cholesterol intake and proportion of saturated fat, PUFA, and MUFA are not associated with percent body fat.

Keywords: cholesterol intake; mufa intake; obesity; overweight; percent body fat; pufa intake

How to cite (in APA style)

Lourena, C., Tamtomo, D. G., & Wiboworini, B. (2024). Study of Cholesterol Intake, Proportion of Fat in the Diet to Body Fat in Adolescents. *Indonesian Journal of Global Health Research*, 6(S5), 199-208. <https://doi.org/10.37287/ijghr.v6iS5.4543>.

INTRODUCTION

Adolescence is a phase of a person experiencing changes both physically and psychologically, so that it can expand the opportunity for adolescents to get influence in eating patterns and experience changes in nutritional status that have an impact on future health conditions (Beal et al., 2019). However, with the development of information technology today, there are lifestyles that have a negative impact on the health of the body, one of which is the increasing cases of obesity and overweight in adolescents. The World Health Organization (WHO) states that as many as 340 million adolescents in the world are currently obese. In Indonesia, 8% of adolescents are overweight and 3% are obese. Surakarta is a city with an obesity prevalence of 11.47% which is the highest prevalence rate in Central Java and an overweight prevalence of 9.98% which exceeds the Central Java prevalence rate (Risksedas, 2018). According to WHO in 2023, obesity is the accumulation of fat that poses a risk to health. Based on this definition, it is known that fat mass in the body can be used as an indicator of obesity or overweight.

The increase in body fat mass itself can occur due to energy imbalance due to the consumption of high-energy foods for a long time, which causes fat accumulation in the body. Fat is one of the nutrients that have high energy value. Currently, adolescents tend to consume foods that contain saturated fat, cholesterol which can increase body fat composition (Rahman

et al., 2021; Suhaimah.,2024). Besides the consumption of saturated fat, consumption of foods high in cholesterol can increase LDL (Vincent et al., 2019) and results in an increase in percent body fat (Oda, 2018). Consumption of foods with high cholesterol can change the concentration of LDL in the blood (Vincent et al., 2019). Continuous increase in cholesterol intake can increase fat accumulation in the liver and cause inflammation (Gao et al., 2023). So that the accumulation of fat in the liver can lead to insulin resistance and result in an increase in visceral fat in the body (Wijarnpreecha et al., 2023). Fat storage disorders will worsen when a person with excess body fat has impaired cholesterol metabolism due to increased secretion of bile (Mc Auley, 2020). Cholesterol-containing foods can be consumed as long as they do not exceed 300 mg in a day and saturated fat intake is not more than 10% of daily energy intake (Schwingshackl et al., 2021). However, in Surakarta itself, there are still many traders who sell food with oil content in the school environment. The potential for repeated use of oil by traders can lead to fat oxidation which results in increased saturated fat content and reduced essential fat content in it (Ministry of Health, 2022). So that it can lead to increased intake of saturated fat and cholesterol in adolescents.

Prevention of body fat accumulation can be done by fulfilling the intake of poly unsaturated fatty acid (PUFA) and monounsaturated fatty acid (MUFA). PUFA intake in a day should be around 12- 15% of energy intake and MUFA intake in a day should be around 6-11% of energy intake (Schwingshackl et al., 2021). MUFA has anti-inflammatory properties that improve glucose homeostatic, increase insulin sensitivity, and increase fat metabolism, resulting in a decrease in fat composition in the body (DiNicolantonio & O'Keefe, 2017; Monnard & Dulloo, 2021; Weta et al., 2020; Zhong et al., 2022) and PUFAs can decrease fat in the body by increasing energy expenditure (Bai et al., 2024). Currently, most adolescents today still cannot meet their daily PUFA and MUFA needs (Erdenetsetseg et al., 2024). In Indonesia itself, adolescents are still unable to fulfill food intake containing PUFA and MUFA (Pinasti et al., 2023).Currently, most studies that relate fat intake to body fat only focus on adults or people with metabolic syndrome and there are still few studies that focus on adolescents. Based on this background, a study was conducted to determine the relationship between cholesterol intake and the proportion of fat intake to percent body fat in adolescents.

METHOD

The type of research conducted was observational analytic with a cross-sectional approach. The method used was data collection using the semi-quantitative food frequency questionnaire (SQ-FFQ) form, it is by conducting interviews regarding the frequency of several food ingredients and their weight consumed during the last month to determine the intake of total fat, cholesterol, saturated fat, PUFA and MUFA. This study was conducted in high schools and vocational schools in Surakarta in April and May of 2024. Subjects in this study were 10th and 11th grade students in five schools in Surakarta who met the criteria, it is aged 15-18 years and were not doing sports with heavy intensity. Sampling in this study used multistage random sampling method and obtained a sample of 161 people. The independent variables in this study were cholesterol intake and fat proportion while the dependent variable was body fat percentage. The data taken in this study are characteristic data, anthropometric data including height, weight, and percent body fat, and food intake data. Data collection begins with collecting data in the form of sample identity, then measuring height using a microtoise and measuring body weight and body fat percent using Bio Impedence Analysis (BIA) omron karada scan HBF-375. The next data taken was the intake of cholesterol and various types of fat. Cholesterol intake was defined as the average cholesterol consumed daily and fat proportion was defined as the proportion of saturated fat, PUFA, and MUFA to total fat intake obtained using SQ FFQ. The data obtained was then converted into gram units and

calculated the amount of intake using nutrisurvey application so that the intake of fat and cholesterol in a day was obtained. Then the proportion was obtained by comparing the intake of various types of fat with total fat intake, thus obtaining the proportion of saturated fat, PUFA and MUFA intake.

Measurement of body fat percentage was carried out by entering data such as date of birth, gender, and height. Then the respondent is asked to stand on the BIA, then the percentage of body fat that appears on the screen is recorded on the paper provided. The results obtained are expressed in percent (%) and then the numbers obtained are put into the appropriate category, it is obesity $\geq 30\%$, overfat 26-29%, normal 20-25%, or thin $\leq 19\%$. Univariate analysis was conducted to describe and analyze each variable. Bivariate analysis was used to determine the relationship of cholesterol intake with percent body fat, proportion of PUFA intake with body fat, proportion of MUFA intake with body fat, proportion of saturated fat intake with body fat. Before conducting the analysis, data normality test was conducted using Kolmogorv Smirnov. Because the data were not normally distributed, the analysis was conducted using Spearman rank. The relationship between variables was declared to be related if the p value was <0.05 . The strength of the relationship between variables can be known from the correlation coefficient (r) with various types of relationship strength, it is no correlation if r is 0, very weak correlation if it is 0.01-0.25, moderate correlation with a value of 0.26-0.50, strong correlation worth 0.51-0.75, very strong correlation worth 0.76-0.99, and perfect correlation worth 1 (Sumardiyono et al., 2020). Ethical approval was obtained from the Health Research Ethics Comitte, Dr Moewardi General Hospital, Surakarta, Indonesia (804/III/HREC/2024).

RESULT

Table 1.
Characterization of Research Subjects (n=161)

Variables	Male		Female	
	f	%	f	%
Age				
15	6	3,7	9	5,6
16	29	18	40	24,8
17	31	19,3	43	26,7
18	1	0,6	2	1,2
Percent Body Fat				
Skinny	50	31,1	18	11,2
Normal	11	6,8	42	26,1
Overfat	2	1,2	15	9,3
Obesity	4	2,5	19	11,8
BMI/U				
Undernourished	11	6,8	7	4,3
Good Nutrition	40	24,8	7	4,5
Overweight	4	2,5	12	7,5
Obesity	12	7,5	5	3,1
TOTAL	67		94	

Based on table 1, it is known that the distribution of respondent characteristics based on age, most of the students are 17 years old, which is classified as late adolescence. While the distribution of respondent characteristics according to gender, most of the students are female, it is 94 students. Based on BMI for age, *overweight* nutritional status is dominated by female students by 7.5%, while obese nutritional status is dominated by male students by 7.5%. Data on percent body fat in students showed that female students who had body fat in the overfat category were 9.3% and the obese category was 11.8%, while male students with body fat in the overfat category were only 1.2% and obesity was 4%. This shows that female students tend

to have greater body fat than male students.

Table 2.
Distribution of Fat Type Intake among Adolescents in Surakarta

Variables	Min	Max	Mean	SD
Total fat (g)	9.4	209.5	62.8	39.1
PUFA (g)	0.89	38.8	9.5	7.7
Cholesterol (mg)	21.8	1473.4	242.7	187.5
SAFA(g)	2.49	117.1	29.4	20.3
MUFA (g)	1.28	85.9	14.2	11.2
Proportion of PUFA (%)	2.8	31.3	14.6	5.7
Proportion of MUFA (%)	6.1	50.2	21.5	6.3
Proportion of Saturated Fat (%)	8	72.5	47.1	10.7

Table 2 shows data on the distribution of respondents' fat intake by type. The results of the SQ FFQ interview showed that the average total fat intake in adolescents was 62.8 grams, which was sufficient to meet the needs of the Indonesia Recommended Dietary Allowances in adolescents. PUFA intake in students showed an average intake of 9.5 which was included in the deficient intake because it did not reach the daily requirement. Similar conditions were also found in the MUFA intake of students with an average of 14.2 grams. Cholesterol intake in respondents showed an average intake of 242.2 milligrams where this intake was not classified as excessive because it was less than 300 mg. The proportion of PUFA intake found that the average proportion of PUFA intake was 14.6%. And the average proportion of MUFA intake in respondents was 21.5%. The interesting thing in this data was found that most of the students' fat intake was dominated by saturated fat intake because the proportion reached 47.1%.

Relationship between cholesterol intake and percent body fat

Cholesterol intake data obtained from students were correlated with data on student body fat percent presented in Table 3. Based on the results of the *Spearman Rank Correlation* test, the significance value of $p > 0.05$ ($p = 0.531$) means that there is no relationship between cholesterol intake and body fat percent. Both relationships in this variable are included in a weak relationship and are negative.

Table 3.
Relationship between Cholesterol Intake and Percent Body Fat

Relationship between Cholesterol Intake and Percent Body Fat				
correlations				
Spearman's rho	Percent body fat	Correlation	Percent body fat	Cholesterol (mg)
		Coefficient	1.000	-0.050
		Sig. (2-tailed)	.	0.531
	Cholesterol (mg)	N	161	161
		Correlation	-0.50	1.000
		Coefficient	0.531	.
		Sig. (2-tailed)	N	
		0.531	161	

Relationship between Proportion of Saturated Fat Intake and Percent Body Fat

Data on the proportion of saturated fat intake obtained from students are correlated with data on students' body fat percent presented in Table 4. Based on the results of the *Spearman Rank Correlation* test, the significance value of $p > 0.05$ ($p = 0.332$) means that there is no relationship between the proportion of saturated fat and percent body fat. Both relationships in this variable are included in a weak relationship and the direction of the relationship between the two variables is included in a unidirectional relationship because the correlation

coefficient value is positive.

Table 4.
Relationship between Saturated Fat Proportion and Percent Body Fat

		Correlations		
			Percent body fat	Percent SAFA
Spearman's rho	Percent body fat	Correlation Coefficient	1.000	.077
		Sig. (2-tailed)	.	.332
		N	161	161
	Percent SAFA	Correlation Coefficient	.077	1.000
		Sig. (2-tailed)	.332	.
		N	161	161

Relationship between MUFA Proportion and Percent Body Fat

MUFA proportion data obtained from students are correlated with data on student body fat percent presented in Table 5. Based on the results of the *Spearman Rank Correlation* test, the significance value of $p > 0.05$ ($p = 0.269$) means that there is no relationship between the proportion of MUFA and percent body fat. Both relationships in this variable are included in a weak relationship and the direction of the relationship between the two variables is included in an unidirectional relationship because the correlation coefficient value is negative.

Table 5.
Relationship between MUFA Proportion and Percent Body Fat

		Correlations		
			Percent body fat	Percent MUFA
Spearman's rho	Percent body fat	Correlation Coefficient	1.000	-0.088
		Sig. (2-tailed)	.	0.269
		N	161	161
	Percent MUFA	Correlation Coefficient	-0.088	1.000
		Sig. (2-tailed)	0.269	.
		N	161	161

Relationship between proportion of PUFA intake and percent body fat

Data on the proportion of PUFA intake obtained from students were correlated with data on student body fat percent presented in Table 6. Based on the results of the *Spearman Rank Correlation* test, the significance value of $p > 0.05$ ($p = 0.213$) means that there is no relationship between the proportion of PUFA intake and percent body fat. Both relationships in this variable are included in the weak relationship and the direction of the relationship between the two variables is included in the unidirectional relationship because the correlation coefficient value is negative.

Table 6.
Relationship between PUFA Proportion and percent body fat

		Correlations		
			Percent body fat	Percent PUFA
Spearman's rho	Percent body fat	Correlation Coefficient	1.000	-0.099
		Sig. (2-tailed)	.	0.213
		N	161	161
	Percent PUFA	Correlation Coefficient	-0.099	1.000
		Sig. (2-tailed)	0.213	.
		N	161	161

DISCUSSION

Based on the analyzed data, it was found that high cholesterol food intake was not associated with percent body fat. Research with similar results was conducted by Rahmala et al (2021) who found that cholesterol intake was not associated with body fat in female college students in Surakarta. The absence of a relationship between cholesterol intake and percent body fat can occur because high cholesterol is not only caused by cholesterol intake alone, but the presence of other nutrients such as saturated fat, trans fat which contribute to increasing cholesterol levels in the body. In addition, the use of oil in student meals cannot be known for its quality considering that repeated use of cooking oil can increase cholesterol content. In addition, cholesterol also has a role in increasing vitamin D in the body with the help of sunlight (Surdu et al., 2021). School adolescents spend most of their time doing activities at school and still often do outdoor activities so they are often exposed to sunlight which can increase vitamin D levels in the body. Vitamin D is known to improve fat metabolism (Szymczak-Pajor et al., 2020) so that it can reduce fat in the body. Increased cholesterol is not only caused by cholesterol-sourced foods, but the presence of other foods containing saturated fat can increase LDL in the blood and affect body composition (Ozen et al., 2020). Apart from these explanations, there are also studies with different results where the intake of foods with high cholesterol is known to be associated with changes in macrophages in the visceral tissue of healthy people (Poledne et al., 2022).

The proportion of saturated fat intake in this study was not associated with percent body fat in respondents. Similar studies have also found that saturated fat intake is not associated with changes in body composition, especially fat (Rosqvist et al., 2024). Other studies have found that saturated fat intake is not associated with visceral fat in adults (Ozen et al., 2022).. The absence of an association between saturated fat intake and percent body fat can be caused by the source of food consumed. In this study, the average respondent consumed saturated fat from milk and saturated fat from cooking oil and animals, potentially causing no effect on body fat percent. As in research conducted Duarte et al (2019) found that people who consumed saturated fat from milk had a lower percent body fat than people who consumed saturated fat from meat. In addition, the use of repeated cooking oil can affect saturated fat because of the oxidation, polymerization, and hydrolysis reactions of coconut oil which cause an increase in free fatty acids (Duarte et al., 2019). But apart from the results of the above studies, there are also several studies with different results, it is the relationship between saturated fat intake and increased fat in the abdomen of women (Alpionira et al., 2019). Saturated fat intake is associated with an increase in body fat percent (Duarte et al., 2019) and limiting consumption of saturated fat intake can reduce body fat mass in adults (Kahleova et al., 2019).

Based on the analyzed data, it was found that the proportion of PUFA intake was not associated with percent body fat. This is similar to research conducted by Duarte et al (2019) who found no relationship between PUFA and percent body fat. Another study also showed that PUFA intake was not associated with body fat composition (Suhaimah, 2024). The same thing was also found in the proportion of MUFA which was not associated with percent body fat in adolescents. Research with similar results was also found in children in Malaysia where there was no relationship between MUFA intake and the incidence of overweight and obesity (Chen et al., 2024). The absence of a relationship in both PUFA and MUFA proportions could be due to the fact that almost all respondents could not meet their daily PUFA and MUFA needs. This is because all respondents rarely consume foods high in PUFA and MUFA. Economic factors can be one of the causes of adolescents not being able to meet their PUFA and MUFA needs because these food sources have high prices so they are not easily

accessible to the community (Chen et al., 2024). In addition, there are studies that reveal MUFA intake can increase the risk of insulin resistance because excess MUFA intake can increase adipogenesis resulting in increased fat accumulation, and changes in cell morphological structure during adipogenesis (Małodobra-Mazra-Mazra, et al., 2024).

Changes in body fat composition are not only influenced by the factors being studied by researchers. Changes in body fat composition can also be influenced by gender because adolescent girls will tend to experience an increase in body fat compared to adolescent boys who tend to experience an increase in muscle mass. (Adami et al., 2020). When women experience puberty, they experience an increase in estradiol (Adami et al., 2020). In addition, in women there is an increase in leptin while men experience a decrease in leptin, which can affect the increase in fat mass in the body (Adami et al., 2020; Horlick et al., 2000). Apart from fat intake, the increase of fat in the body can be caused by various things. The main factor causing fat gain is energy imbalance caused by sedentary activities, diet and food sources, sleep patterns, and physical activity. In addition to these factors, there are other supporting factors such as the diet and lifestyle of the mother and baby that are carried over to adolescence, which can result in future health outcomes. (Kim et al., 2020).

The limitation of this study is the restricted time, which led to some interviews being conducted alongside other students, resulting in some respondents underreporting, particularly among adolescent girls with excess weight, which could affect the results of the data analysis. In addition, the data was collected using a cross-sectional approach, so the picture of food intake is not clearly depicted because it was only taken once, and there is a possibility that students may not accurately recall the types, weights, or frequencies of food items.

CONCLUSION

Based on these studies, it can be concluded that cholesterol intake is not associated with percent body fat, and the proportion of intake of various types of fat does not affect percent body fat. In next research, the researchers need to add detailed information on food processing and the proportions of certain nutrient sources, one of which is sources of saturated fats.

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