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Macronutrient intake and triglyceride levels in overweight late adolescents in an Islamic boarding school

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ABSTRACT

Background: *Being overweight has become an epidemic health problem worldwide. The prevalence of overweight and obesity in the Islamic boarding school was 20.92%. It occurs due to an imbalance in food intake that affects the body's metabolism, resulting in the accumulation of fat in the blood and an increase in triglyceride levels.* ***Objective:*** *This study aimed to determine the relationship between macronutrient intake and triglyceride levels in overweight adolescents in an Islamic boarding school.* ***Methods:*** *This type of research employed observational analysis using a cross-sectional design. The research was conducted at Universitas Darussalam Gontor from November 2022 to February 2023. The study included 50 female students aged 17 to 25 years. BMI of overweight measurements using digital weight scales of the GEA medical brand type EB 9360 and microtoise types of portable stadiometer brands. Macronutrient intake was determined using the 24-hour food recall method, and triglyceride levels were measured using Pictus 400 with Wiener brand reagent for laboratory tests. The statistical test used was the gamma test.* ***Results:*** *The majority of respondents were found to have a lower macronutrient intake, while 44% had more than adequate intake, and 38% had a higher carbohydrate intake. For protein intake, most respondents (90%) were categorized as having excessive intake. Similarly, for fat intake, some respondents (88%) were also categorized as having excessive intake. The results of examining triglyceride levels in the respondents' bodies showed that 88% had normal triglyceride levels and 12% had abnormal levels. The gamma test showed that the p-value of carbohydrate intake with triglyceride levels was p = 0.166, for protein intake with triglyceride levels, p = 0.051, and for fat intake with triglyceride levels, p = 0.037.* ***Conclusions:*** *A relationship was found between fat intake and triglyceride levels. But, there was no significant relationship between carbohydrate and protein intake and triglyceride levels.*

KEYWORDS: *carbohydrate; fat; overweight; protein; triglycerides*

INTRODUCTION

Being overweight has become an epidemic health problem worldwide. The World Health Organization (WHO) in 2016 said that more than 1.9 billion late adolescents aged 18 years and over were overweight or obese. The prevalence of overweight is almost two times greater in developed countries (11.7%) than in developing countries (6.1%) [1]. The problem of being overweight also occurs in Indonesia. According to the Basic Health Research (Riskesdas) in 2018, the prevalence of overweight individuals in Indonesia aged 18 and above is approximately 11.2% [2]. The prevalence of overweight in East Java reaches 13.2%, ranking the third highest in Indonesia. The prevalence of adolescents in Islamic boarding schools with overweight and obese status was 20.92% [3].

Being overweight occurs due to an imbalance between the three energy components: energy intake, energy expenditure, and energy storage. The primary source of energy, which comes from food intake consumed every day more than what is needed by the body, is the main factor for this imbalance [4]. Several

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other factors, including social and economic status, education level, physical activity, genetics, area of residence, and parenting history, also contribute to this imbalance. In children and adolescents, these factors become universal risk factors that significantly influence future growth and development [5].

Overweight events can also increase the risk of cardiovascular disease due to abnormalities in fat metabolism. The accumulation of fat levels in the body's tissues results in abnormalities of fat metabolism in the blood, one of which is an increase in triglyceride levels [6]. A study states that in men, as much as 13%, and in women as much as 37%, there is a relationship between high triglycerides in the blood and the risk of cardiovascular disease [7]. Increased triglyceride levels occur due to carbohydrate metabolism that occurs in the small intestine. If you consume excess calories, especially those from carbohydrates, the liver will increase the production of triglycerides [8].

The Prophet Muhammad SAW taught how to eat well and exemplified this practice. As the hadith reads "No child of Adam fills something worse than his stomach, it is enough for the child of Adam a few mouthfuls to straighten his spine, and if he has to do it, he should share one third for his food, one third for his drink, and one third for his breath." (narrated by Tirmidhi, Ibn Majah, and Ahmad). Regarding this hadith, Ibn Qayyim explained that the Prophet taught a person to consume only a few mouthfuls of food to straighten their spine, so that their stamina does not decrease and their body does not become weak [9].

As with carbohydrates and fats, several studies suggest that there is a significant relationship between protein intake and triglyceride levels. Like the theory put forward by Guyton, that excess amino acids that are not converted into protein after reaching their limit are broken down in other forms and become fat or glycogen. The fat breakdown will increase the amount of free fatty acids, which will also increase triglyceride levels [10]. The risk factors for cardiovascular disease in adolescents are better when compared to men, but at a later age, the risk factors in women increase compared to men. Elevated triglycerides are a more important cause of atherosclerosis in women than men. An increase in triglyceride levels of 90 mg/dl can increase the risk of coronary heart disease by 75% in women and 30% in men [11].

Studies related to analyzing the relationship between macronutrient intake and triglyceride levels in female students at Universitas Darussalam Gontor's Islamic boarding school campus have not been conducted. Other Islamic boarding schools' intake and triglyceride research covers anthropometric profiles with triglycerides in adult participants, as well as lipid profile and BMI screening in Islamic boarding school directors [12,13]. Even though the prevalence of overweight among Islamic boarding school students is relatively high, this can disrupt their health as they grow up, potentially impacting their role in society. This study aimed to determine the relationship between macronutrient intake and triglyceride levels in overweight late adolescents in an Islamic boarding school.

METHODS

Study design and participants

This research employed an analytical observational design with a cross-sectional approach. The study was conducted at Universitas Darussalam Gontor, Female Campus, from November 2022 to February 2023. The research population consisted of all female late adolescents at Darussalam Gontor University who were overweight, with an age range of 17 to 25 years, as per the Guidelines of the Indonesian Health Department. A purposive sampling technique was employed to select 50 participants. The sample criteria, derived from the inclusion criteria, were Darussalam Gontor University students aged 17-25 years with a body mass index of 25.1-27 kg/m², as per the Ministry of Health, and were willing to fast for 8-10 hours before taking blood [14]. Exclusion criteria are students who are sick or under doctor's care related to coronary heart disease, diabetes mellitus, hypertension, kidney failure, and other chronic diseases, and students who are currently taking anti-hyperlipidemic drugs such as simvastatin, gemfibrozil, lovastatin, and others. This research was conducted according to established procedures in the form of a letter of approval from the ethical clearance section at the Health Research Ethics Committee (KEPK), Semarang State University, number 550/KEPK/EC/2022.

Measures

Triglyceride levels. The triglyceride levels were checked at Widodo Medika's laboratory. The blood sample was placed in a sterile test tube (vacutainer tube) and tested using a Pictus 400 with Wiener brand reagent. Triglyceride was categorized as normal (<150 mg/dL) and high (≥150 mg/dL).

Macronutrient intake. Measuring macronutrient intake was conducted through interviews using a 24-hour food recall form three times a week (on weekdays and weekends), with a food photograph as a tool to describe or standardize perceptions of food portions or quantity. The intake of macronutrients is categorized as: high (>110% of RDA), normal (80-110% of RDA), and low (< 80% of RDA). Body mass index (BMI) as a result of overweight measurements using a GEA medical brand digital weight scale type EB 9360 and microtoise types of portable stadiometer brands.

Data analysis

Data analysis employed univariate and bivariate methods, utilizing the gamma test, which incorporates measurement requirements into nonparametric statistics. This approach measures the relationship between two variables on an ordinal scale that can be represented in a contingency table, thereby examining a symmetrical relationship. Data testing was processed using the SPS for Windows version 16.0 program.

RESULTS

The study included 50 respondents, as shown in **Table 1**. The age of the respondents was known to be 21 years old (36%). Most of the respondents were found to have carbohydrate intake in the low category (44%), 18% of respondents had intake in the normal category (18%), and 38% of respondents had high carbohydrate intake. For protein intake, most respondents were categorized as having a high intake (90%), and for fat intake, a similar proportion of respondents were also categorized as having a high intake (88%). Most respondents (88%) showed normal triglyceride levels, while only a small percentage (12%) exhibited high triglyceride levels.

Most respondents had a low carbohydrate intake and normal triglyceride levels. The analysis results using the gamma test showed no significant correlation between carbohydrate intake and triglyceride levels in overweight adolescents (p-value = 0.166). Still, they revealed a strong correlation with an r-value of 0.518. However,

Table 1. Characteristics of respondents

Characteristics	n (%)
Age	
18	8 (16)
19	8 (16)
20	4 (8)
21	18 (36)
22	9 (18)
23	2 (4)
24	1 (2)
Carbohydrate	
High	19 (38)
Normal	9 (18)
Low	22 (44)
Proteins	
High	45 (90)
Normal	4 (8)
Low	1 (2)
Fat	
High	44 (88)
Normal	2 (4)
Low	4 (8)
Triglyceride levels	
High	7 (12)
Normal	43 (88)

Table 2. Relationship between macronutrient intake and triglyceride levels

Macronutrient intake	Triglyceride levels		Correlation coefficient (r)	p-value
	High	Normal		
Carbohydrate				
High	5 (10.0)	14 (28.0)	0.518	0.166
Normal	0 (0)	9 (18.0)		
Low	2 (4.0)	20 (40.0)		
Protein				
High	7 (14.0)	38 (76.0)	1.00	0.051
Normal	0 (0)	4 (8.0)		
Low	0 (0)	1 (2.0)		
Fat				
High	7 (14.0)	37 (74.0)	1.00	0.037
Normal	0 (0)	2 (4.0)		
Low	0 (0)	4 (8.0)		

five respondents (10%) with high triglyceride levels also had high carbohydrate intake. Most respondents had high protein intake, while their triglyceride levels were normal (76%). The study revealed no significant relationship between protein intake and triglyceride levels in overweight adolescents (p-value = 0.051; r = 0.00). The analysis of fat intake showed a significant positive relationship with triglyceride levels, characterized by a robust correlation (r = 1.00; p = 0.037). However, most respondents had high fat intake, with normal triglyceride levels.

DISCUSSION

The composition of food, such as carbohydrates, is thought to have an essential role in the incidence of overweight, considering that these nutrients will be metabolized into triglycerides if the levels are too high [15]. High consumption of carbohydrates tends to increase triglyceride levels. Triglyceride compounds are a type of fat that is usually found in the blood and contains more glucose [16]. The results of this study are in line with research from Kirkpatrick et al (2023), which stated that there was no relationship directly between carbohydrate intake and triglyceride levels. Participating in daily physical activity and reducing adiposity in overweight or obese individuals are two additional lifestyle factors that lower triglyceride levels. Additionally, restricting intakes of alcohol, added sugars, and refined starches [17] can also help reduce triglyceride levels. This statement is reinforced by Khasanah et al (2017) [18], whose test was conducted to determine the relationship between carbohydrate intake and triglyceride levels in female aerobic gymnasts in 30 subjects who were mostly teenagers and had abnormal nutritional status. The study's results indicated that there was no relationship between carbohydrate intake and triglyceride levels.

Carbohydrates are known as a staple food that must be consumed daily by the Indonesian people. Carbohydrates include the macronutrients needed by the body. Carbohydrate nutrition is the primary source of food required by humans [19]. Although there is no statistically significant relationship, the proportion of individuals reporting elevated carbohydrate consumption is associated with unusual blood triglyceride levels, with 10% of those surveyed exhibiting both high carbohydrate intake and irregular triglyceride levels. An increase in carbohydrate intake will increase triglyceride levels because if carbohydrate intake increases, the formation of pyruvate and acetyl-CoA also increases, causing an increase in the formation of free fatty acids, which will later be stored in the form of triglycerides. Increasing carbohydrate intake will also increase triglyceride levels in the blood [20].

Protein intake is obtained from staple food ingredients of 4 grams, protein from animal side dishes is 10 grams, from vegetable side dishes is 6 grams, from group B vegetables is 3 grams, and from milk is 7 grams. Several related studies have demonstrated that the inclusion of soy protein in a diet with minimal animal protein intake can impact plasma lipid levels while also influencing hemostasis and platelet function. The addition of 25–50 grams of soy protein/per day in this case can improve the risk factors for cardiovascular disease [13]. In this study, the types of protein consumed by the samples came from vegetable protein obtained from tempeh, tofu, and nuts, while animal protein was obtained from milk, eggs, and chicken meat [21]. The results of this study stated that there was no significant relationship between protein intake and triglyceride levels. This finding aligns with the results of a study by Willems et al. (2020), which investigated the relationship between macronutrient intake and markers of metabolic syndrome in individuals with obesity. It was found that protein intake appeared to be most relevant for reducing body weight, not for improving markers of MetS, one of which is the lipid profile [22].

This finding does not align with research carried out by Kemala, which indicated that the results had a significant effect on protein intake and triglyceride levels, due to differences in research locations and the dietary patterns of the samples, who were primarily vegetarians [23]. The need for fat in adolescents is different. Based on PMK number 28 of 2019 regarding the recommended dietary allowance rate for the Indonesian population, it was found that the average fat adequacy for adolescents aged 15-24 years is approximately 68 grams. Adolescents aged 18-29 years need 65 grams of fat per day. This fat intake is obtained from foods that contain vegetable fats such as margarine and coconut milk. In addition, fat is also obtained from animal side dishes that contain

fat or oil, such as fatty tissue under the skin and fatty tissue that is buried with meat [24]. High fat intake can increase triglyceride levels in the blood. The study's results showed that the average triglyceride level of the respondents was relatively normal, despite their high fat intake. Triglyceride metabolism in the body through exogenous pathways forms free fatty acids in the fat tissue or muscle cells and is converted back into triglycerides as an energy reserve [25].

The results of this study indicated a significant relationship between fat intake and triglyceride levels. This research aligns with the survey by Septyne et al., which investigated the correlation between food intake and triglyceride levels in obese students. The analysis results show a p-value of 0.01, indicating a significant relationship between fat intake and triglyceride levels [10]. According to Al Rahmad et al., a correlation exists between the consumption of foods high in fat content and elevated blood lipid levels. Within a specific time frame, this has a significant impact on the incidence of coronary heart disease. In addition, excessive consumption of fat can increase body weight, which can lead to malnutrition, thereby increasing the risk of death [19]. Fat intake directly affects triglyceride levels. Increasing fat intake will lead to increased lipogenesis activity, so that more free fatty acids are formed. Furthermore, there is the mobilization of FFA from fatty tissue to the liver, which binds to glycerol to form triacylglycerols. So that the higher the fat consumption, the higher the triacylglycerol synthesis in the liver and the higher the triglyceride levels in the blood [26].

Several limitations in this study should be noted. In this study, researchers did not examine other variables that might be confounding variables related to intake. Apart from that, researchers do not work alone, enumerators also assist them in collecting and inputting data. Although similarities in perception have been noted, there is still the possibility of differences. The 24-hour food recall method has a weakness: the respondent's memory.

CONCLUSIONS

There was no significant relationship between carbohydrate and protein intake with triglyceride levels in overweight adolescents in an Islamic boarding school. But there was a relationship between fat intake and triglyceride levels in overweight adolescents. Late adolescent student in boarding schools should reduce their fat intake, because high fat intake can increase triglyceride levels.

Declaration of conflicting interests

This research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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