



The relationship between fiber intake and sedentary lifestyle with the risk of metabolic syndrome in adolescents at SMA Batik 1 Surakarta

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ABSTRACT

Change pattern eating and style life sedentary contribute to the improvement case disease degenerative, including syndrome metabolic. Syndrome this, which is marked with five criteria (circle waist, glucose blood high, low HDL levels, and triglycerides high), can increase risk disease No contagious. Research This aiming for to study connection between intake fiber, pattern life sedentary, and risk syndrome metabolic disorders in adolescents at SMA Batik 1 Surakarta. Research This is studies observational analytic with cross sectional design, involving 65 selected respondents use proportional random sampling method. Data were collected through interview with SQ-FFQ questionnaire for intake fiber and ASAQ for activity sedentary. Data analysis was carried out using the Chi-Square test to test connection intake fiber and activity sedentary with risk syndrome metabolic. Results study show that No existence connection intake fiber with risk incident metabolic syndrome (p-value = 1.000) and the presence of connection pattern life sedentary with risk incident syndrome metabolic (p-value = 0.035). Teenagers who consume intake fiber Good not enough and also excessive No influence existence risk syndrome metabolic and adolescents who have pattern life sedentary ≥ 5 hours per day at risk experience syndrome metabolic.

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1. Introduction

Adolescence is phase important development behavioral, psychological, and physical as transition from children to adults. As they grow older age, many change physical changes that occur. According to WHO, adolescence is at in range age 12-24 years (Hadi et al., 2021). Meanwhile that, in 2010, the Indonesian Minister of Health established that teenagers who have not Marry is at in range ages 10 to 19 years. Age teenager often faced with various problem related nutrition with pattern life, one of them is obesity (Qureshi & Memon, 2020).

According to Riskesdas data in study (Edwardson et al., 2012), prevalence obesity in adolescents experience improvement to 7.3% in 2013, with 1.6% in between experience obesity heavy, especially in adolescents aged 16-18 years. In Central Java, 17% of teenagers over 15 years old suffer obesity, with number incidents in adolescents Woman more tall compared to men (Mohamed et al., 2023). Teenagers who experience obesity and risk experience syndrome metabolic amounting to 29.2% of population. According to Riskesdas 2018, 20% of Indonesian teenagers aged 13-15 years experience overweight t or

obesity, while 13.6% at the age of 16-18 years (Park et al., 2020). This matter can be concluded that there is an increase in incident teenager obesity from year to year. Almost 90% of teenagers who experience obesity own at least one characteristic syndrome metabolic. Based on the results of the study (Puteri et al., 2023) analyzing the 2013 Riskesdas data, the prevalence of metabolic syndrome in adolescents aged 15-24 years is 5.93%, according to NCEP-ATP III criteria (Malina, 2024).

Improvement in metabolic syndrome risk is one of the impacts from obesity, which is increasing along with the increase in the amount of obesity sufferers. This risk, if it occurs at a young age, has the potential to be continued until adulthood. As one of the factors of the occurrence of metabolic syndrome, obesity has various complex causes. Obesity, along with lipid disorders, hypertension, and uncontrolled blood glucose levels, is part of the metabolic syndrome. This condition can increase the risk of the occurrence of cardiovascular disease in individuals who experience it. Obesity is the result of a complex interaction between environmental factors, such as eating patterns, social interaction, and lack of physical activity, as well as genetic factors that play a role (Mandriyarni et al., 2017).

Metabolic syndrome in adolescents can cause an increase in the risk of heart disease and type 2 DM in adulthood, besides that metabolic syndrome can trigger inflammation activity that can hinder metabolism in the brain that influences cognitive function. Factors that influence someone's experience of metabolic syndrome include lifestyle habits, age, socioeconomic status, and other related medical problems covering obesity and overweight body weight, which is influenced by genetic factors and family history. Advantages of weight and obesity can lower HDL cholesterol levels and increase triglycerides, blood pressure, and low density lipoprotein (LDL), so it can have an impact on the occurrence of metabolic syndrome (Pradifa et al., 2023).

Unhealthy eating patterns, if not properly controlled, can lead to obesity, especially when practiced excessively. This condition significantly contributes to the increasing prevalence of metabolic syndrome. Research indicates that obese teenagers tend to consume higher amounts of energy, carbohydrates, protein, and fat compared to non-obese teenagers, often exceeding the recommended nutritional intake (Dobrowolski et al., 2022). In fact, about 90% of obese adolescents consume excessive amounts of fat, even beyond the recommended intake levels. They are also more likely to consume large quantities of food, including fast food and snacks. One of the main factors associated with the development of metabolic syndrome is inadequate fiber intake (Garvey et al., 2014). Increasing dietary fiber has been shown to lower blood lipid levels, improve glycemic response, and help normalize blood pressure, triglyceride levels, and LDL cholesterol (Nur Islami Dini Hanifah, 2016).

Teenagers need fiber from food as much as 29 grams/day and adolescent men as 37 grams/day. In the results of the study (Lepping et al., 2022), respondents who did not comply with the recommended fiber intake daily (21 grams/day) have a higher risk of metabolic syndrome compared to respondents who follow the recommended fiber intake daily (OR: 4.24, 95% CI: 1.75, 10.30) (Wiardani et al., 2011).

Factors that also influence the occurrence of obesity are physical activity. According to the study (Yulistianingsih & Firdaus, 2023) teenagers who have a risk of obesity are those who are rarely active. Compared to active teenagers, those who are rarely doing activities are three times more at risk of obesity. Obesity figures in teenagers increase with increasing media usage and decreasing physical activity (Amrynia & Prameswari, 2022). Physical activity factors, especially a sedentary lifestyle, can be influential in the occurrence of obesity and metabolic syndrome in a person. According to the results of the study (Nurzakiah et al., 2021) it is stated that the more time someone spends practicing a sedentary lifestyle, the more likely they are to have metabolic syndrome by 73% (OR 1.73, 95% CI 1.55-1.94, $p < 0.0001$).

The influence of adolescents' perception of the importance of fiber intake can moderate the relationship between fiber consumption and the risk of metabolic syndrome. If adolescents have a positive perception and understand the importance of fiber in their diet, they are more likely to be disciplined in consuming fiber-rich foods, which in turn can reduce the risk of metabolic syndrome. On the other hand, if their perception is lacking, they may not pay much attention to fiber intake, even if they are physically consuming sufficient fiber. Therefore, understanding and awareness of the benefits

of fiber play a crucial role in shaping healthy eating habits and preventing the risk of metabolic syndrome in adolescents.

The primary focus on fiber intake and sedentary lifestyle in this study was chosen because both factors have been widely recognized as key contributors to the development of metabolic syndrome, particularly in adolescents. Fiber is crucial for regulating blood sugar and cholesterol levels, while a sedentary lifestyle is associated with increased risk of obesity and related metabolic disorders. Other nutritional factors like trans fats and added sugars were not considered in this research model to maintain a more focused analysis on these two significant, modifiable lifestyle factors, which are easier to assess and directly linked to the adolescent population's daily habits.

Based on problem said, researchers want to know connection intake fiber and style life sedentary (*sedentary lifestyle*) with risk incident syndrome metabolic in adolescents at SMA Batik 1 Surakarta.

2. Methods

Study This aiming for analyze relatedness between intake fiber and style sedentary life with risk syndrome metabolic. For reach objective said, research This use cross-sectional design with approach observational analytical. This method allow researcher observe connection variable in One time certain, so that can to obtain a better picture clear about relatedness both of them (Rukminingsih, 2020).

In research this, is used approach taking *proportional random sampling* as method election sample. Based on calculation use formula (Rochlani et al., 2017), as many as 65 students chosen from population class XI consisting of 248 people. The election sample done through raffle in a way random based on roll call students who attended until obtained 65 students. The criteria is those who consume supplement fat burner and filling criteria inclusion, namely healthy teenager in a way physical, capable communicate with well, no currently fast moment data retrieval, no undergoing a special diet, and not consuming multivitamins (Sugiyono, 2021).

Respondent characteristics were collected based on several predetermined indicators. To evaluate the risk of metabolic syndrome, waist circumference was measured using a metline with an accuracy of 0.1 cm to ensure more precise results. In addition, fasting blood glucose levels, HDL cholesterol, and triglyceride levels were assessed using blood samples analyzed in the Laboratory of the Faculty of Health Sciences, Muhammadiyah University of Surakarta (UMS). Blood pressure measurements were carried out using a calibrated sphygmomanometer to ensure more accurate readings.

In this study, stratification based on gender and nutritional status was conducted to clarify the relationship between sedentary lifestyle and the risk of metabolic syndrome. This subgroup analysis allowed for a more detailed examination of how these factors may differently impact males and females, as well as individuals with varying nutritional statuses, providing a clearer understanding of the potential risks and outcomes in different adolescent groups.

Once collected, the data were converted into units of grams per day (g/day). Descriptive analysis of fiber intake using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) was categorized as "good" (≥ 37 g/day for men and ≥ 29 g/day for women) and "not good" (≤ 37 g/day for men and ≤ 29 g/day for women). Meanwhile, sedentary lifestyle patterns were classified as "good" if the time spent was ≤ 5 hours per day, and "not good" if ≥ 5 hours per day. Since the data were categorical, the Chi-Square test was used at a 95% confidence level ($\alpha = 0.05$) to analyze the relationship between fiber intake and the risk of metabolic syndrome, as well as between sedentary lifestyle patterns and the risk of metabolic syndrome.

The reliability of the SQ-FFQ (Semi-Quantitative Food Frequency Questionnaire) and ASAQ (Adolescent Sedentary Activity Questionnaire) was confirmed through a pre-test conducted on a small sample of adolescents prior to the main study. This process involved assessing the internal consistency of the questionnaires by calculating Cronbach's alpha, ensuring that the questions were clear and consistently measured the intended constructs. Additionally, test-retest reliability was conducted to determine the stability of responses over time. The questionnaires were also reviewed by experts to verify their content validity before being used with the adolescent respondents in the study.

3. Results and Discussion

The results of table 1 show that part big sample study dominated by men as many as 34 respondents (52.3%), with normal nutritional status as many as 44 respondents (67.7%). The majority Mother No Work as many as 38 respondents (58.5%), while part big father works as many as 64 respondents (98.46%). On income House stairs, all Respondent own income exceeding the minimum wage (100%).

Table 1.
Characteristics Respondents

| Characteristics Respondents | n | % |
|-----------------------------|----|-------|
| Gender | | |
| Man | 34 | 52.3 |
| Woman | 31 | 47.7 |
| Nutritional Status (BMI/A) | | |
| Normal | 44 | 67.7 |
| Overweight | 13 | 20 |
| Obesity | 8 | 12.3 |
| Mother's Employment Status | | |
| Work | 27 | 41.5 |
| Doesn't work | 38 | 58.5 |
| Father's Employment Status | | |
| Work | 64 | 98.46 |
| Doesn't work | 1 | 1.53 |
| Household Income | | |
| <UMR | 0 | 0 |
| >UMR | 65 | 100 |
| Total | 65 | 100 |

Based on Table 2 results, some big Respondent own pressure normal blood (70.8%), levels normal glucose (100%), levels normal triglycerides (72.3%), and circumference waist (61.5%) in normal range. Three of the five criteria syndrome metabolic fulfilled by 16 respondents (24.6%), who indicated risk more tall for experience syndrome metabolic.

Table 2.
Analysis Characteristics Syndrome Metabolic Respondents

| Characteristics Syndrome Metabolic | n | % |
|------------------------------------|----|------|
| Waist circumference | | |
| Normal | 40 | 61.5 |
| Central Obesity | 25 | 38.5 |
| Blood pressure | | |
| Normal | 46 | 70.8 |
| Tall | 19 | 29.2 |
| Glucose Levels | | |
| Normal | 65 | 100 |
| Abnormal | 0 | 0 |
| HDL levels | | |
| Normal | 55 | 84.7 |
| Abnormal | 10 | 15.3 |
| Triglyceride Levels | | |
| Normal | 47 | 72.3 |
| Abnormal | 18 | 27.7 |
| Risk Syndrome Metabolic | | |
| At risk | 16 | 24.6 |
| No Risk | 49 | 75.4 |

Connection Fiber Intake and Sedentary Lifestyle with Risk of Sedentary Syndrome Metabolic

Table 3.
Relationship Fat Intake and Sedentary Lifestyle with Risk of Syndrome Metabolic

| Variables | Risk of Event MetS | | | | Total | | p-value |
|---------------------|--------------------|-------|---------|-------|-------|-----|---------|
| | At risk | | No Risk | | N | % | |
| | n | % | n | % | | | |
| Fiber Intake | | | | | | | |
| Good | 1 | 33.3% | 2 | 66.7% | 3 | 100 | 1,000 |
| Not good | 15 | 24.2% | 47 | 75.8% | 62 | 100 | |
| Total | 16 | 24.6% | 49 | 75.4% | 65 | 100 | |
| Sedentary Lifestyle | | | | | | | |
| Good | 3 | 10.3% | 26 | 89.7% | 29 | 100 | 0.035 |
| Not good | 13 | 36.1% | 23 | 63.9% | 36 | 100 | |
| Total | 16 | 24.6% | 49 | 75.4% | 65 | 100 | |

The results of Table 3 show that 75.8% of respondents with intake fiber low No at risk syndrome metabolic. The results of the statistical test (p-value = 1,000) showed No There is connection between consumption fiber and risk syndrome metabolic, although 24.2% of respondents with intake fiber low at risk experience syndrome metabolic. Meanwhile, the sedentary lifestyle variable shows that respondents have a good sedentary lifestyle (89.7%). The results of the analysis statistics indicates existence significant relationship between pattern life sedentary with improvement risk syndrome metabolic ($p < 0.035$). Findings This supported by data that shows that 36.1% of respondents with pattern life sedentary in category No Healthy own risk more tall for experience syndrome metabolic.

Connection Fiber Intake with Risk of Events Syndrome Metabolic

This study shows that fiber intake has no effect on the risk of metabolic syndrome in adolescents at SMA Batik 1 Surakarta. Fiber intake consumed either excessively or less than daily needs does not affect the risk of metabolic syndrome. This is evidenced by the results of statistical tests using the *Chi-Square* test which showed that 24.2% of respondents who had a risk of metabolic syndrome had a poor amount of fiber intake. Meanwhile, respondents who did not have a risk of metabolic syndrome were 33.3% with a good amount of fiber intake. Most respondents who were not at risk had good or bad fiber intake. There were 66.7% who had good fiber intake who were not at risk of metabolic syndrome and there were 75.8% who had poor fiber intake who were not at risk of metabolic syndrome (Dieny et al., 2015).

Based on the results of the research that has been conducted, it was found that there is no significant relationship between fiber intake and the incidence of metabolic syndrome among the respondents involved in this study. These findings are not in line with previous studies, which revealed that the consumption of fruits and vegetables plays an important role in reducing the risk of metabolic syndrome.

Dietary fiber and micronutrients are essential in managing metabolic syndrome. Fiber, found in various food sources, slows down carbohydrate absorption and increases satiety, thereby lowering blood glucose levels. Studies have shown a link between higher fiber consumption and a lower incidence of type 2 diabetes. In a study by (et al., 2024), it was revealed that the pre-metabolic syndrome group consumed more fiber and had a more diverse, higher-quality, and sufficient dietary pattern compared to the metabolic syndrome group.

Fiber intake has been proven to help regulate body weight and waist circumference, with a significant impact on body fat distribution. Fiber can influence fat distribution due to its effect on insulin expression, which has a greater impact on visceral fat in the abdomen than on subcutaneous fat. Fiber slows down the digestive process, making the stomach feel fuller compared to complex carbohydrates and simple sugars. Research shows that fiber consumption plays a role in weight management by slowing digestion and increasing the feeling of fullness (Gargari & Chatterjee, 2023). Consuming foods

high in fiber especially soluble fiber can help lower blood pressure, making it beneficial for individuals with hypertension. The provision of soluble fiber for just three days has been shown to increase insulin sensitivity, as demonstrated in other studies involving individuals with obesity (Nurzakiah et al., 2021).

Fiber intake not only helps reduce cholesterol in blood plasma but can also lower blood cholesterol levels by $\geq 5\%$. Research on the relationship between total cholesterol levels and fiber intake by (Malina, 2024) shows that fiber consumption can significantly reduce blood cholesterol levels. Moreover, fiber that contains β -glucan has a specific effect in lowering LDL cholesterol the undesirable type of cholesterol without affecting beneficial HDL cholesterol or triglyceride levels. This means that consuming fiber rich in β -glucan can provide selective and beneficial improvements to the blood lipid profile.

Fiber has a physical structure and fermentable properties that can influence various metabolic processes in the body. It plays a role in maintaining lipid homeostasis, enhancing insulin sensitivity, and regulating inflammation, all of which contribute to the development or prevention of metabolic syndrome. Through these mechanisms, in theory, adequate fiber intake can help control the risk of metabolic syndrome and prevent its negative health impacts (Pramesti et al., 2024).

Connection Sedentary Lifestyle with Risk of Incident Syndrome Metabolic

Measurement of sedentary lifestyle using the ASAQ questionnaire which was then statistically tested using the *Chi-Square* test obtained results in the form of respondents who have a sedentary lifestyle that is carried out ≥ 5 hours per day are at risk of experiencing metabolic syndrome (36.1%). Research This find connection between sedentary lifestyle and syndrome metabolic. Findings This in line with study by Ekelund et al. (2021), which shows that individual with more sedentary activities tall at risk experience disturbance metabolic like hypertension, hypertriglyceridemia, and obesity (Rochlani et al., 2017). A sedentary lifestyle also increases the risk of cardiovascular disease, which often accompanies metabolic syndrome. Even if a person engages in regular physical activity, excessive sitting time can exacerbate negative metabolic effects (Rahmawati, 2022).

A sedentary lifestyle also increases the risk of cardiovascular disease, which often accompanies metabolic syndrome. Even if a person engages in regular physical activity, excessive sitting time can exacerbate negative metabolic effects. Research by Moller *et.al* . (2020) showed that these risks do not appear to be completely overcome by regular exercise alone, suggesting that reducing sitting time is also important for heart health. Replacing sitting time with short periods of physical activity has been shown to reduce the risk of metabolic syndrome.

Research by (Saraswati et al., 2021) shows that switching from sitting to standing regularly can reduce post-meal blood glucose levels and improve insulin sensitivity. Adding light physical activity to your daily routine, such as taking a short walk or stretching, can help reduce the negative impacts of a sedentary lifestyle and improve your overall metabolic profile.

Lifestyle changes recommendations to prevent metabolic syndrome include not smoking, doing daily physical activity for 30 to 60 minutes, implementing a plant-based Mediterranean diet with or without energy restrictions, a low-sodium diet to prevent hypertension, limiting saturated fat and trans fat intake, increasing fiber intake, reducing intake of sweet foods and drinks. By implementing these recommendations, it is hoped that obese adolescents can live healthy to avoid metabolic syndrome in the future (Yulistianingsih & Firdaus, 2023).

4. Conclusion

Based on results research on adolescents at SMA Batik 1 Surakarta shows existence connection between pattern life sedentary and risk syndrome metabolic. However, it is not found connection significant between intake fiber and risk syndrome Metabolic. Lack of or excessive fiber intake does not affect the risk of metabolic syndrome in adolescents, but it is better to maintain good fiber intake to reduce the risk of other degenerative diseases. In an excessive sedentary lifestyle (≥ 5 hours) can affect the risk of metabolic syndrome, actively doing physical activities can help prevent the risk of metabolic syndrome.

Further research can be done to see the relationship between variables such as age, gender, adolescent knowledge level, and dietary patterns based on the nutritional content of carbohydrates,

protein, fat, sodium, magnesium, and chromium. These variables theoretically support the idea that these factors may influence the risk of metabolic syndrome.

The results of this study can inform school-based programs aimed at reducing sedentary time in adolescents by raising awareness of its health risks, particularly metabolic syndrome. The program can include fun physical activities and education on fiber intake and the importance of regular movement, encouraging adolescents to adopt healthier lifestyles. The finding that a sedentary lifestyle is associated with the risk of metabolic syndrome highlights the importance of school health intervention programs. These programs can focus on reducing sedentary time and increasing physical activity among students, while also educating them to prevent metabolic syndrome and improve their long-term health.

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