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# Factors associated to Body Mass Index (bmi) in adolescent in south Jakarta: cross sectional study

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## ABSTRACT

**Introduction:** Nutrition plays a vital role in the health and well-being of adolescents, particularly for high school students, as it influences physical, cognitive, and academic performance. This study examines the relationship between energy intake, macronutrient composition, and physical activity, and their impact on nutritional status among senior high school students.

**Methods:** this research using cross-sectional study and was conducted in August 2024, involving 216 students (109 females and 107 males) from Muhammadiyah Senior High Schools 3 and 18. The study assessed dietary intake using a 24-hour recall questionnaire and physical activity through the IPAQ-Short Form. Nutritional status was evaluated using BMI-for-age criteria.

**Results:** showed that 31% of students had adequate calorie intake, while 69% had insufficient intake. Additionally, 79% had inadequate fat intake, and 113 students had insufficient protein intake. A significant gender difference in BMI categories was observed, with more males falling into the overweight category, while females were more likely to have normal BMI. No significant correlation was found between physical activity or caloric intake and BMI with (p=0.930), although a higher percentage of students with excessive calorie intake tended to be overweight.

**Conclusion:** The study highlights the importance of balanced energy intake and regular physical activity in maintaining a healthy weight. Furthermore, it underscores the need for targeted interventions in adolescents to promote optimal nutrition and physical activity, especially in school settings. The findings suggest that while gender influences BMI distribution, the role of calorie intake and physical activity is complex and requires further investigation to understand its full impact on adolescent health.

## KEYWORD

Anthropometry; nutritional categories; nutritional trends; malnutrition; overweight.

## ABBREVIATION

BMI: Body Mass Index.

METs: Metabolic Equivalent Task.

## INTRODUCTION

Nutrition is one of the determinants of health and well-being, particularly during adolescence, a phase of rapid growth and development. For high school students, optimal nutritional status is critical for promoting physical, cognitive, and academic performance[1]. Yet, one of the main factors is dietary energetic intake, macronutrient composition, and physical activity level which is connected with nutritional status in adolescents and should be considered[2].

Energy intake (total calories consumed in food and beverages) is a primary driver of nutritional status. Nutritional status is also influenced by energy intake levels; inadequate or excessive energy intake can cause undernutrition and overnutrition, respectively, which are both critical for health. Energy requirements for adolescents depend on their age,

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sex, physical activity levels, and metabolic rates[3]. In addition, the balance and quality of macronutrient intake i.e. including carbohydrates, protein, and fat also contribute to supporting growth, immune health, and energy needs. Macronutrient excesses or shortages, such as fat-rich or protein-poor diets frequently triggered by obesity, thinness, or micronutrient deficits, lead to imbalances in macronutrient intake[4].

The interplay of dietary intake and a second determinant, physical activity, is another domain critical to nutritional status. Involving regular physical activity is also a lifestyle that can regulate energy balance, maintain a normal body composition, and avoid other diseases related to lifestyle. In contrast, being inactive is associated with a higher risk of overweight and other related comorbidities[5]. The balance between energy intake, macronutrient quality, and physical activity can affect energy homeostasis and the subsequent dietary habits of an adolescent[6].

Grasping the interaction between energy intake and macronutrient consumption in combination with physical activity is vital to developing refugee-targeted interventions for enhanced nutritional outcomes amongst high school students. This paper aims to study these relationships focusing on nutritional intake, physical activity, and nutritional status among senior high school students.

## RESEARCH METHOD

### *Study Design*

This study was a cross-sectional study conducted in August 2024, with 216 students (109 female and 107 male) who were randomly selected using the lameshow formula from 1117 students from two different high schools, ages 14-18 years old, participating in the study. The number of respondents who were willing on the first day was 220 respondents, but decreased by 4 people due to illness and absence when the study was conducted The study includes participating students from Muhammadiyah Senior High School 3 and Muhammadiyah Senior High School 18.

### *Data Collection*

This stage of the research begins with respondent screening. Information about the screening activities will be communicated by the person in charge at each school, assisted by the guidance and counseling teacher (BK). The screening activities will be conducted on school days according to the time allocation provided by the school authorities. Respondents who have expressed their willingness to participate in the research will undergo interviews and anthropometric measurements, which are part of the screening phase. Data collection at this stage will be conducted by the principal researcher, assisted by 10 enumerators who have been trained to align their perceptions with the principal researcher.

The amount of food ingested is measured using a 24-hour recall questionnaire. The results are then assessed using the Nutri Survey and the food composition table (TKPI), which has categories for sufficient (≥ 77% RDA) and insufficient (<77%) food intake[7].

Physical activity data were obtained using the IPAQ-Short Form. The MET score is obtained by multiplying the MET value of each activity by the duration in minutes and the frequency/ week (Lee et al. 2011). Physical activity is categorized into three; 1) light activity; if<600 METs minutes/week; 2) moderate activity; with a total METs of at least ≥600 – 1499 METs minutes/week; 3) high activity: with a total METs of at least ≥1500 METs-minutes/week[8].

Nutritional status measurement is carried out by collecting anthropometric data obtained through weighing and measuring height and age. Age is included because the research subjects are adolescents so that the measurement of nutritional status uses BMI/U (Body Mass Index according to Age). With the cut off category of overweight nutritional status, namely zscore >+1SD[9].

### *Statistical Analysis*

Gender, calorie intake, physical activity are the independent variables, and BMI is the dependent variable. The continuous variable's normal-ity was examined using the Kolmogorov-Smirnov test. For continuous variables and normal data distributions, the mean and standard deviation were used, whereas for non-normal data distributions, the median, minimum, and maximum were used. The categorical variables were expressed as frequency and percentage. To examine the association between the variables, a Chi-square test was used. Statistical significancewas established at a p-value of less than 0.05.

### *Ethical Approval*

This study was approved by the Ethics Committee of Respati University, Jakarta, Indonesia. Written informed consent was obtained from each participant. This study was registered with number 696/SK.KEPK/UNR/X/2024.

## RESULT

The subjects in this study were high school teenagers aged 14-18 years. There were 107 male respondents and 109 female respondents. Of the 216 respondents, 31 respondent had adequate calorie intake and 185 respondent had insufficient calorie intake (mean ± SD 1.281.66 ± 642.69), 38 respondent had adequate carbohydrate intake and 178 respondent had insufficient carbohydrate intake (mean ± SD 165.48 ± 70.91). 79 respondent had adequate fat intake and 137 people had insufficient fat intake (mean ± SD 583.14 ± 344.70), 103 respondent had adequate protein intake and 113 respondent had insufficient protein intake (mean ± SD 54.25 ± 27.24). There were 63 respondents who did not do enough physical activ-

**Table 1.** Characteristics of respondents

| Variable | N | Min- Max | Mean±SD |
|---|---|---|---|
| **Gender** | | | |
| Male | 107 | | |
| famele | 109 | | |
| **Calori Intake** | | | |
| Adequate | 31 | 16.8±4,682.4 | 1,281.66±642.69 |
| Insufficient | 185 | | |
| **Carbohydrate intake** | | | |
| Adequate | 38 | 31.4±447.5 | 165.48±70.91 |
| Insufficient | 178 | | |
| **Fat intake** | | | |
| Adequate | 79 | 27.0±2,870.0 | 583.14±344.70 |
| Insufficient | 137 | | |
| **Protein intake** | | | |
| Adequate | 103 | 5.5±181.3 | 54.25±27.24 |
| Insufficient | 113 | | |
| **Physical activity** | | | |
| < 600 MET | 63 | 339±5864 | 1572.53±1423.73 |
| 600-1500 MET | 81 | | |
| ≥ 1500 MET | 72 | | |
| **Nutritional Status** | | | |
| Overweight | 103 | -2.44 ± 6.15 | 1.03±1.79 |
| Normal | 107 | | |
| Thin | 6 | | |

ity (< 600 MET). 81 people had moderate physical activity (600-1500 MET) and 72 people had heavy physical activity (≥ 1500 MET) (mean ± SD 1572.53 ± 1423.73). 103 people had an overweight, 107 respondent with normal and 6 responden fall in to the thin catogory.

The provided data examines the relationship between gender, caloric intake, and physical activity with Body Mass Index (BMI) categories: overweight, normal, and thin. The p-values indicate statistical significance for gender differences in BMI, but not for caloric intake or physical activity. This suggests that gender may play a more significant role in BMI categorization than the other factors examined. The following sections will delve into the implications of these findings.

The data shows a significant difference in BMI categories between males and females (p=0.038), with a higher percentage of females being in the normal BMI category compared to males. This aligns with research indicating that gender differences in body composition and fat distribution can influence BMI outcomes. The p-value for caloric intake (p=0.269) suggests no significant relationship with BMI categories in this dataset. However, literature emphasizes the importance of caloric balance in weight management, where insufficient caloric intake can lead to weight loss, and excess intake can contribute to weight gain. The p-value for physical activity (p=0.930) indicates no significant association with BMI categories in this study. Contrarily, other studies highlight that physical activity is crucial for maintaining a healthy BMI by increasing energy expenditure and reducing fat reserves

## DISCUSSION

### *Gender with body mass index*

The results of the analysis show that there is a significant difference in the distribution of BMI between men and women with a p value = 0.038, which indicates a strong relationship between gender and BMI category. More men were in the overweight category (53.3%), while more women tended to be in the normal BMI category (56.9%). This finding is consistent with previous research, which suggests that men are more likely to be overweight due to hormonal factors and eating patterns that are often less controlled. Meanwhile, other studies explain that women tend to pay more attention to diet and physical activity, which can explain why more women are in the normal BMI category. Research has also shown that women are more frequently found in the normal weight category compared to men[10].

Sex differences in BMI distribution are not only related to dietary factors and physical activity, but are also related to general health. In other research revealed that in sepsis patients, the relationship between BMI and 28-day mortality showed a different pattern between men and women, with a U-shaped pattern in men and an L-shaped pattern in women[11]. This suggests that differences in BMI based on gender can influence health outcomes. Additionally, it has been found that obesity in women has a greater impact on quality of life than in men[12]. Thus, gender factors play an important role in determining BMI distribution and associated health risks, which need to be considered in health interventions and risk assessment of chronic diseases such as heart disease and type 2 diabetes[13,14].

### *Calorie intake with body mass index*

Calorie intake is closely related to Body Mass Index (BMI), although no significant differences were found in the distri-

**Table 2.** relationship between gender, physical activity and energy intake with Body mass Indeks

| Characteristic | Body Mass Indeks | | | | | | Total | p-Value |
|---|---|---|---|---|---|---|---|---|
| | Overweight | | Normal | | Thin | | | |
| | n | % | n | % | n | % | | |
| **Gender** | | | | | | | | |
| Male | 57 | 53,3 | 45 | 42,1 | 5 | 4,7 | 107 | 0,038 |
| Famale | 46 | 42,2 | 62 | 56,9 | 1 | 0,9 | 109 | |
| **Calori Intake** | | | | | | | | |
| Adequate | 12 | 38,7 | 19 | 61,3 | 0 | 0 | 31 | 0,269 |
| Insufficient | 91 | 49,2 | 88 | 47,6 | 6 | 3,2 | 185 | |
| **Physical Activity** | | | | | | | | |
| < 600 MET | 27 | 42,9 | 34 | 54 | 2 | 3,2 | 63 | 0,930 |
| 600-1500 | 40 | 49,4 | 39 | 48,1 | 2 | 2,5 | 81 | |
| >1500 MET | 36 | 50 | 34 | 47,2 | 2 | 2,8 | 72 | |

bution of BMI based on the number of calories consumed (p-value = 0.269), there was a tendency that individuals with higher calorie intake tended to fall into the overweight category (38.7%) compared to those with less intake (49.2%). These findings indicate that excess calories, if not balanced with physical activity, can increase the risk of overweight[15]. However, this relationship is not deterministic, as it is influenced by moderating factors such as food cravings and environmental conditions. It has been revealed that the desire to overeat is related to an increase in BMI, especially when calorie intake is not controlled[16]. In addition, environmental factors such as the availability of fast food and a history of maternal overweight also influence individual eating patterns, as explained by Téllez-Rojo et al[17].

Other factors that influence the relationship between calorie intake and BMI are food composition and timing of calorie consumption[18]. It has been found that consumption of ultra-processed food (UPF) was positively related to increasing BMI, while minimally processed food (MPF) was negatively related[19]. Thus, the quality of the calorie source becomes very important in weight management. In addition, consumption time also plays a significant role; Calorie consumption after 20.00 is associated with an increased risk of obesity, although sleep duration does not influence this[20]. Calorie restriction (CR) interventions have also been shown to be effective in reducing BMI, especially in individuals with a predominant gut microbiota composition of Prevotella, which increases fiber metabolism[21].

Calorie restriction (CR) has been proven to be effective in reducing fat mass, including visceral fat which is at risk of metabolic disease. The results of the CALERIE-2 study show that two years of CR can reduce body weight by 7.6% and fat mass by 5.4%, with a proportional decrease in fat-free mass[22]. However, combining CR with physical activity provides more holistic benefits. In addition to reducing abdominal fat, physical exercise improves cardiovascular fitness and helps maintain muscle mass[23]. Although physical activity alone does not have a significant effect on BMI[24], its synergy with calorie restriction (CR) is able to moderate the negative impact of food cravings and increase adherence to diet. Research has also confirmed that long-term CR not only reduces the size of fat storage organs, but also does not interfere with the body's physiological functions[25].

### *Physical activity with body mass index*

The results of the analysis show that although there is no significant difference in the distribution of BMI based on physical activity level (*p-value* = 0.930), proportionally, the group with high physical activity (>1500 METs) is actually more likely to be in the overweight category (50%) than the low activity group (<600 METs) (42.9%). This finding contrasts with research by Garcia et al. (2021) which states that high physical activity generally correlates with normal BMI. However, it has been emphasized that physical activity alone is not enough to control body weight without a healthy diet. Similar support comes from research showing that a combi-

nation of diet and physical activity interventions was more effective in reducing BMI than physical activity alone, especially in the child and adolescent population[26].

Genetic factors and specific population context also influence the physical activity-BMI relationship. It has been found that physical activity can reduce BMI more significantly in individuals with a high genetic risk of obesity, indicating a complex interaction between genes and the environment[27]. On the other hand, a study in Sub-Saharan Africa revealed that physical activity related to work or transportation (such as walking) was inversely related to BMI, especially in men[28]. However, in post-bariatric surgery patients, physical activity actually contributes greatly to reducing BMI, because surgical intervention and lifestyle changes reinforce each other[29].

The type and intensity of physical activity influences its relationship with BMI differently[30]. It has been differentiated the effects of "moderate" and "intense" physical activity, where intense activity (>3000 MET/week) was negatively correlated with BMI, whereas moderate activity (600-3000 MET/week) was actually associated with increased BMI in a Chinese population[31]. Additionally, research has revealed a bidirectional relationship: a decrease in physical activity triggers an increase in BMI, while an increase in BMI also reduces the tendency to be physically active[32]. This emphasizes the importance of intensive and consistent physical activity, as well as the need for holistic interventions that include dietary regulation[26].

## CONCLUSSION

The research results show that there are significant differences between the distribution of Body Mass Index (BMI) based on gender. Men were more often found in the overweight category (53.3%), while women were more often found in the normal weight category (56.9%). This is influenced by hormonal factors and less controlled diet in men, while women tend to pay more attention to diet and physical activity. In addition, although there is no significant difference between calorie intake and BMI, there is a tendency that individuals with high calorie intake are more likely to have a higher BMI, especially if the calorie intake is not balanced with physical activity. Physical activity, although not showing significant differences in BMI distribution, suggests a more complex relationship. High levels of physical activity are not always matched by a normal BMI, indicating that a combination of a healthy diet and consistent physical activity is essential for managing body weight effectively.

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