Original Research Report

PHYSICAL ACTIVITY LEVELS AND TOTAL FOOD INTAKE AMONG PRECLINICAL STUDENTS AT A SCHOOL OF MEDICINE AND HEALTH SCIENCES

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ABSTRACT

One of the most crucial ways a person can do to enhance the well-being of their body is to engage in regular physical activities. However, currently, many people still have low physical activity levels. It is stated that habitual physical activity can affect the sensitivity of food intake regulation. This study aimed to determine the correlation between the total food intake and physical activity of preclinical students. This study was conducted using the cross-sectional method among preclinical students (n=238) in the classes of 2017, 2018, and 2019 at the School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia. Subjects with appetite-manipulating supplements, a diet program, a history of metabolic disease, a history of eating disorders, stress, or trauma were excluded from this study. The physical activity level was evaluated using the Baecke Physical Activity Questionnaire (BPAQ), while the total food intake was evaluated using the three-day food record method. The statistical test applied in this study was the Spearman test, with a significance of $p<0.05$. This study found that 22.3% of the respondents had a low physical activity level, and 9.7% of the respondents had a total food consumption higher than the recommended intake. The statistical analysis showed a significant negative correlation between physical activity levels and total food intake ($p=0.008$). In conclusion, there is an association between students' physical activity levels and their total food intake.

Keywords: Physical activity; total food intake; health risk

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Article history
●Submitted 3/5/2023 ● Revised 11/7/2023 ● Accepted 15/8/2023 ● Published 10/9/2023

How to cite: Halim LE, Tjhay F, Prastowo NA, et al (2023). Physical Activity Levels and Total Food Intake among Preclinical Students at a School of Medicine and Health Sciences. Folia Medica Indonesiana 59 (3), 256-261, https://doi.org/10.20473/fmi.v59i3.47290

pISSN:2355-8393, eISSN: 2599-056x

Highlights:
1. This is the first cross-sectional study in Indonesia that was conducted specifically to find a correlation between physical activity levels and food intake.
2. As lower physical activity was found to be associated with higher food intake, this study suggests that physical activity might be taken into consideration to manipulate one's food consumption.

INTRODUCTION

Body weight is strongly influenced by energy balance, which consists of caloric intake and energy expenditure. Caloric or food intake that exceeds energy expenditure will create an energy surplus, increase body weight, and lead to obesity. Conversely, food intake that is less than energy expenditure will cause an energy deficit and reduce a person's weight (Romieu et al. 2017). In Indonesia, the prevalence of obesity among adults was approximately 14.8% in 2013. The number increased to 21.8% in 2018, according to basic health research in the country (Minister of Health of the Republic of Indonesia 2013, 2018). A study by Poobalan & Aucott (2016) found an increase in

obesity and overweight among young adults. The increased prevalence of obesity was most evident among students. These findings match those of another study conducted by Peltzer et al. (2014) that discovered a relationship between obesity, overweight, and inactivity.

Everyone has varying daily calorie requirements based on their age and gender. The consumption of more food than required is known as overconsumption (Finlayson 2017, Minister of Health of the Republic of Indonesia 2019). There have been limited studies that have particularly investigated the prevalence of overconsumption in Indonesia. According to the American Psychological Association (2013), about 83% of adults in the United States overeat. Excessive food intake can have a variety of consequences. People who overeat may experience body fat accumulation, altered appetite regulation, and an increased risk of various illnesses (Johnson & Wardle 2014, Leaf & Antonio 2017, Cercato & Fonseca 2019).

A person's total food intake is influenced by appetite regulation, which is affected by several factors that can be divided into internal and external factors. The internal factors consist of a history of genetic disorders, stress, and certain diseases (Grimm & Steinle 2011, Morton et al. 2014, Batchelor & German 2019), while the external factors consist of a history of trauma, the consumption of drugs, and the consumption of supplements to increase or reduce appetite. Habitual physical activity can enhance appetite regulation, according to research on exercise levels and appetite control by Morton et al. (2014) and Beaulieu et al. (2016). It was also found that there was an increase in short-term control of food intake among subjects who exercised regularly compared to those who were inactive. Several studies indicate that exercise training reduces meal size while eating a calorie-dense meal but not when eating a low-calorie meal. People who engage in less physical exercise show a preference for calorie-dense meals. This phenomenon occurs due to the influence of physical activity on insulin resistance, thus affecting hunger management (Beaulieu et al. 2016).

The purpose of this study was to determine the correlation between overall dietary consumption and physical activity among preclinical students enrolled in the School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia. To the best of the authors' knowledge, this study represents the first cross-sectional investigation conducted in Indonesia that examined the correlation between physical activity levels and food intake.

MATERIALS AND METHODS

The subjects of this study were preclinical students in the classes of 2017, 2018, and 2019 at the School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia. A total of 238 preclinical students, 66 males and 172 females, were included in the study by using a simple random sampling method. The exclusion criteria were those who consumed supplements to enhance or reduce appetite, were on a diet program, had a history of metabolic disorders (e.g., diabetes mellitus, hyperthyroidism, or hypothyroidism), had a history of bulimia or anorexia nervosa, and were stressed or traumatized. The subjects were requested to complete an online survey using Google Forms, providing personal details such as name, age, sex, and anthropometric information, including height and weight. Physical activity levels were assessed using the Baecke Physical Activity Questionnaire (BPAQ) (Oyeyemi et al. 2016). The categorization of physical activity levels (PAL) used in this study was designed for the average adult population. These levels were categorized as follows: 1.4 for individuals with low PAL, 1.6 for individuals with moderate PAL, and 1.8 for individuals with high PAL. The three-day food record was utilized to record subjects' daily food intake, and the total calories from food intake were calculated using NutriSurvey version 2007 (EBISpro, Willstaett, Germany). The data were further calculated for basal metabolic rate (BMR) and recommended calorie intake (RCI) (Mardani et al. 2020). The formula is presented in Table 1.

Table 1. Basal metabolic rate and recommended calorie intake formula.

Measurements	Formula
Male BMR	(13.75 x weight (kg)) + 66.5 + (5.003 x height (cm)) – (6.755 x age (years))
Female BMR	(9.563 x weight (kg)) + 655.1 + (1.850 x height (cm)) – (4.676 x age (years))
RCI	BMR x PAL factor

The subjects' total food intake was compared with their recommended calorie intake. The results were then categorized as underconsumption, normal consumption, and overconsumption. Total food intake within 80–100% of the subjects' recommended calorie intake was considered normal consumption (Mardani et al. 2020). Additionally, the Spearman test with a significance of $p<0.05$ was used as the statistical test in this study. Analysis was carried out using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, N.Y., USA). The Research Ethics Board of the School of Medicine and Health Sciences, Atma Jaya Catholic University

of Indonesia, Jakrata, Indonesia, granted ethical approval for this study. The information collected in this study was used for research purposes only.

RESULTS

The study revealed that among the 238 preclinical students examined, the group with a moderate level of physical activity exhibited the highest prevalence (70.1%), whilst the group with a high degree of physical activity had the lowest prevalence (7.6%). Table 2 displays the distribution of physical activity levels among the students who participated in this study.

Table 2. Distribution of the participants' physical activity levels.

PAL	n	%
Low	53	22.3
Moderate	167	70.1
High	18	7.6
Total	238	100

PAL: Physical activity levels.

Table 3. Distribution of the participants' total food intake.

TFI	n	%
Underconsumption	124	52.1
Normal Consumption	91	38.2
Overconsumption	23	9.7
Total	238	100

TFI: Total food intake.

Table 4. Crosstabs between physical activity levels and total food intake.

PAL	Total food intake			Total
	Under-consumption (%)	Normal consumption (%)	Over-consumption (%)	
Low	21 (39.6%)	19 (35.8%)	13 (24.5%)	53
Moderate	93 (55.7%)	65 (38.9%)	9 (5.4%)	167
High	10 (55.6%)	7 (38.9%)	1 (5.5%)	18

PAL: Physical activity levels.

Table 5. Association between physical activity levels and total food intake.

Variable	Correlation coefficient	p
PAL	-0.171	0.008

PAL: Physical activity levels.

Table 3 shows the distribution of the subjects' total food intake. The underconsumption group was found to be the most prevalent (52.1%), while the overconsumption group was found to be the least prevalent (9.7%). As shown in Table 4, subjects with a low physical activity level had the lowest prevalence of normal food consumption (35.8%) and the highest prevalence of overconsumption (24.5%). Subjects with moderate and high physical activity levels demonstrated comparable results, characterized by a low prevalence of over-consumption (5.4% and 5.5%, respectively).

Table 5 presents the results of the correlation analysis between physical activity levels and total food intake using the Spearman test. There was a statistically significant association between physical activity levels and total food intake, with a p-value of 0.008. The correlation coefficient of -0.171 indicated a weak negative correlation between the variables.

DISCUSSION

A total of 238 preclinical students were involved in this study, ranging in age from 17 to 23 years old. There were 53 respondents (22.3%) with a low physical activity level, 167 respondents (70.2%) with a moderate physical activity level, and 18 respondents (7.6%) with a high physical activity level. These findings are comparable to data from the World Health Organization, which stated that 28% of adults were not active enough in 2016 globally. Similar studies conducted by Wattanapisit et al. (2016) and Nacar et al. (2015) found that more than half of medical students have low physical activity. This is due to the perception that studying is more important than doing physical activity and that physical activity can decrease academic performance. On the other hand, two other investigations revealed that medical students generally engage in more physical activity than the average person (Stanford et al. 2013, Wattanapisit et al. 2015). This discrepancy between studies happened because not all medical schools provide enough places and policies for medical students to be physically active. Overall, physical activity is affected not only by environmental matters but also by several other factors, such as social and cultural factors (Saimon et al. 2015a, 2015b).

The distribution of total food intake showed that underconsumption (52.1%) was more prevalent among the subjects, followed by normal consumption (38.2%) and overconsumption (9.7%). High food intake among the students was the least prevalent, which might occur due to the students' knowledge of the negative impact of obesity. In the studies carried out by Sheikh et al. (2016) and

Bergeron et al. (2017), they found that social and psychological factors from the environment and efficient nutritional education influenced medical students to adopt healthy eating habits.

The data in this study analyzed using the Spearman test showed a statistically significant association between the students' physical activity levels and total food intake (p=0.008). The analysis showed a weak negative correlation, with a correlation coefficient value of -0.171. It indicated that the relationship between the two variables was opposite or not in the same direction. Therefore, the results can suggest that an increase in physical activity levels causes a decrease in total food intake. This is similar to the findings of previous studies, which found that individuals with high physical activity had stronger appetite regulation so that total food intake was more balanced with energy expenditure (Hopkins et al. 2022, Catenacci et al. 2014, Alkahtani et al. 2014).

Bird & Hawley (2017) stated in their study that muscle contraction during exercise stimulates adenosine monophosphate-activated protein kinase (AMPK) activity. Subsequently, Tre-2, Bub-2, cell division cycle 16 (CDC 16) domain family, member 1 (TBC1D1) will be deactivated, which promotes the translocation of glucose transporter type 4 (GLUT4) to cell membranes and thereby increases glucose uptake. Insulin sensitivity itself is known to play a role in compensatory responses to high energy intake. Jeong et al. (2018) found that pro-opiomelanxocortin (POMC) neurons in the arcuate nucleus have receptors that are similar to those in the transient receptor potential cation channel subfamily V member 1 (TRPV1). An increase in body temperature (from 37 °C to 38 °C) due to exercise or high physical activity will activate the TRPV1-like receptors on POMC neurons, resulting in an anorectic effect that reduces food intake. Slower gastric emptying and a higher release of ghrelin also affect appetite control in populations with high physical activity (Schubert et al. 2014, Horner et al. 2015).

Strength and limitations

This is the first cross-sectional study in Indonesia that specifically presents the correlation between physical activity levels and food intake. This study involved a large number of respondents so that the data obtained could represent the population of medical school students. However, the use of the Baecke Physical Activity Questionnaire and the three-day food record method potentially caused recall bias because, in order to fill out the questionnaire, the participants needed to rely on their memory. This cross-sectional study could not determine whether a low level of physical activity causes more food intake than the total energy requirement or whether the amount of excess food intake causes a low level of physical activity. This study did not investigate other aspects that could potentially become confounding factors, such as sleep quality and psychological stress.

CONCLUSION

Preclinical students with a low physical activity level have the highest prevalence of overconsumption. Physical activity levels and total food intake have a statistically significant relationship with a weak negative correlation. A higher level of physical activity is associated with a reduction in the excessive consumption of total food intake.

Acknowledgment

The authors acknowledge the School of Medicine and Health Sciences of Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia.

Conflict of interest

None.

Ethical consideration

Research ethics certification No. 10/07/KEP-FKIKUAJ/2020 was issued on 13/7/2020 by the Ethical Clearance Committee of the School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia.

Funding disclosure

None.

Author contribution

LEH contributed to the conception and design, the drafting of the article, the final approval of the article, the provision of study materials, the funding, the administrative, technical, or logistical support, and the collection and assembly of data. FT contributed to the conception and design, the analysis and interpretation of the data, the drafting of the article, the critical revision of the article for important intellectual content, the final approval of the article, the provision of study materials, the statistical expertise, and the administrative, technical, and logistic support. NAP and V contributed to the critical revision of the article for important intellectual content and the final approval of the article. NTW contributed to the final approval

of the article, the provision of study materials or patients, and the statistical expertise.

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