The Relationship of Physical Activity, Energy, and Protein Intake with Nutritional Status in Adolescents at Junior High School

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ABSTRACT	ARTICLE INFO

Indonesia is still in a nutritional emergency. Undernutrition or overnutrition is a health problem that is often found in adolescence. Nutritional problems that occur are influenced by an imbalance between physical activity and macronutrient intake in adolescents. This study aims to determine the relationship between physical activity, energy intake, and protein intake with nutritional status in adolescent girls. Observational study with a cross-sectional approach conducted in July – August 2023 at Junior High School 2 Long Bagun, Mahakam Ulu Regency, East Kalimantan. A total of 42 adolescents were included as samples based on purposive sampling by setting inclusion and exclusion criteria. Physical activity variables were measured in the International Physical Activity Questioner (IPAQ) while energy and protein intake were obtained through a 24-hour food recall form. The BMI / U formula measures nutritional status-data analysis using the Spearman Rank correlation test. Our findings show the majority of adolescents with moderate physical activity (76.2%), adequate energy intake (66.7%), and adequate protein intake (66.6%). The results of the relationship analysis showed physical activity (p = 0.001, r = 0.512), energy intake (p = 0.001, r = 0.503), protein intake (p = 0.002, r = 0.459) with the nutritional status of adolescents at Junior High School 2 Long Bagun. There is a significant relationship between physical activity, energy intake, and protein intake with the nutritional status of adolescents at Junior High School 2 Long Bagun. These findings are empirical evidence for the formation of better adolescent health programs.

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Key Messages:
- Adolescence is an important period in the life course that has implications for adult health, the socio-economic well-being of a country, and even the future health of children.
- Maintaining adolescent health is an effective way to reduce nutritional problems across generations.

Introduction

The World Health Organization (WHO) defines adolescence as 10–19 years(1). Adolescence is the transition from puberty to adulthood always wanting to try new things so that it can result in rapid psychological and physiological changes(2). This is an important period in the course of life that has implications for adult health, the socio-economic well-being of a country, and even the future health of children(1) Adolescent development is as complicated as children's development, as there is a complex interplay between puberty, neurocognitive maturity, and social role transitions(3). In psychology, adolescents are known as puberty or adolescence which comes from the Latin adolescere which means growing towards maturity, both physically, socially, and psychologically(2).

Adolescence is a time when nutritional needs increase, and malnutrition is a form of malnutrition(4). Adequate nutrition is essential in the transition from adolescence to healthy adulthood because the impact of malnutrition on children and adolescents includes stunted growth, impaired cognitive maturation, low intellectual intelligence, behavioural problems and an increased risk of contracting infectious diseases (5). Malnutrition is one of the most common causes of illness and death among children and adolescents and along with poor diet, malnutrition is now considered the biggest risk factor responsible for the global burden of disease(6).

Basic Health Research Data (Riskesdas) in 2018 showed 25.7% of adolescents aged 13-15 years and 26.9% of adolescents aged 16-18 years of short and very short nutritional status, 8.7% of adolescents aged 13-15 years and 8.1% of adolescents aged 16-18 years were thin and very thin, 16.0% of adolescents aged 13-15 years and 13.5% of adolescents aged 16-18 years were obese(7). As a result of the prevalence of nutritional problems in East Kalimantan province, adolescents aged 16-18 years experienced nutritional status problems (BMI / U) emaciation (2.57%) and underweight (7.19%), while obesity (12.91%) and obesity (5.84%) (7).

Recently, there has been an epidemiological shift from malnutrition and stunted growth to increasing obesity rates, and many developing countries are now bearing the double burden of malnutrition, due to the emerging issues of overweight and obesity as well as high rates of stunting and other diseases(6). A recent review study by Ruiz et al (2020) in adolescents suggests symptoms of chronic cardiometabolic diseases usually seen in adults, such as hypertension, hyperglycemia, dyslipidemia, and inflammation, are now increasingly common in adolescents with obesity. In addition, there is a dynamic interaction between obesity and psychosocial health, as adolescents with obesity may experience increased levels of stress, depressive symptoms, and decreased endurance(8).

A recent study suggested a significant relationship between diet, macronutrient intake and micronutrients related to adolescent nutritional status(9). Recent studies have also suggested similar things between physical activity and the nutritional status of adolescents(10). The International Summit on Adolescent Girls' and Young Women's Nutrition in 2015 recognized the gap and called for action to: raise the urgency of addressing adolescent girls' and young women's malnutrition to new heights. high international priorities; improve the visibility, social status, and health status of AW worldwide; address knowledge gaps in adolescent biology and proper nutrition; and take actions that improve the nutritional status of adolescent girls and their children(9).

Nutritional needs in adolescence are quite high, especially in women, and macro micronutrient intake needs to be balanced to maintain adequate nutritional status and a healthy lifestyle. This stage is considered the second window of opportunity, after the first 1000 days of life, to reduce nutritional risks, reduce the growing burden of chronic disease, and break the intergenerational cycle of malnutrition(9). State Junior High School 2 Long Bagun, is one of the Junior High Schools in Mahakam Ulu Regency located in Mamahak Besar Village, Long Bagun District. In Teaching Year 2022/2023, 49 students from classes VII, VIII and IX are active. So far there has been no study that examines the relationship between physical activity, energy and protein intake with nutritional status in female students in Mahakam Ulu Regency, especially at Junior High School 2 Long Bagun. This study aims to determine the relationship between physical activity, energy intake, and protein intake with nutritional status in adolescent girls.

Methods

The study was an observational study with a cross-sectional approach. In this study, the taking of independent and dependent variables was carried out at the same time by observing the relationship between variables. This research was conducted in July – August 2023 at Junior High School 2 Long Bagun, Mamahak Besar Village, Long Bagun District, Mahakam Ulu Regency, East Kalimantan, Indonesia. The population in this study was all students at Junior High School 2 Long Bagun which amounted to 49 people. The sample was 42 students. Sampling is carried out by purposive sampling where purposive sampling is based on a certain consideration, with characteristics and conditions of the population that have been known previously by setting inclusion and exclusion criteria. The inclusion criteria are students of Junior High School 2 Long Bagun, aged 12 – 16 years, willing to be respondents. Meanwhile, the exclusion criteria are not willing to be respondents and are not present at data collection.

The independent variables in this study were physical activity energy and protein intake. In comparison, the dependent variable is the nutritional status of adolescents. Physical activity is any body movement produced by skeletal muscles and requires energy expenditure measured using the International Physical Activity Questioner (IPAQ) measuring instrument. Physical activity is measured based on 3 criteria, namely light physical activity (<600 minutes/week), moderate physical activity (600-3000 minutes/week), and heavy physical activity (>3000 minutes/week). Energy and protein intake is the amount of energy and protein intake, in the body consumed daily obtained through a 24-hour food recall form. Energy intake is divided into 3 criteria, namely less <80% Daily Value (RDA), Sufficient 80-110% RDA, and more >110% RDA. Nutritional status is defined as the health status produced by the balance between nutrient needs and inputs. Nutritional status is measured using scales and microtomes, and anthropometric data obtained are formulated with the BMI / U formula which is divided into 3 criteria, namely management: -3 Standard Deviations (SD) to < -2 SD, normal: -2 SD to 1 SD, fat: >1 SD to 2 SD, and obesity: >2SD.

Data analysis is carried out with the help of computer software using the SPSS 25 program. The data analysis used was univariate and bivariate. Univariate analysis was conducted to see the frequency and percentage distribution of each student characteristic based on age, gender, and pocket money. Bivariate analysis is carried out to determine the relationship between the dependent variable and the independent variable. This study used the Spearman Rank correlation test with a significance level of 9.5% confidence level. Spearman rank correlation is a statistical test used to find relationships with criteria 0.00 – 0.2 = very low relationship, 0.26 – 0.50 = sufficient relationship, and 0.51 – 0.75 = strong relationship, and 1.00 = perfect relationship.

Results

Table 1 shows that the distribution of students by age is in the range of 12-14 years. The gender percentage of female students is higher than that of male students, with a percentage of 5.9.5% in female students. While the percentage of respondents who get Rp. 5,000 – 9,000 pocket money is 4.8%, Rp. 10,000 – 14,000 pocket money is 73.8%, Rp. 15,000 – 19,000 pocket money is 14.3% and ≥20,000 pocket money is 7.1%.

Table 1 Respondent Characteristics

Characteristic	n	%
Age (years)		
12	22	52.4
13	16	38.1
14	4	9.5
Gender		
Man	17	40.5
Woman	25	59.5
Pocket Money per day (Rp)		
5.000 – 9.000	2	4.8
10.000 – 14.000	31	73.8
15.000 – 19.000	6	14.3
≥20.000	3	7.1
Total	42	100

Table 2 shows the percentage of students who had light physical activity was 23.8% and moderate physical activity was 76.2%. As for the energy intake of students with fewer categories, there are 4 people (9.5%), and the intake is sufficient for as many as 28 students (66.7%). Students who had more energy intake were as many as 10 people (23.8%). While the protein intake of students with a frequency of less than 7 (16.7%), adequate intake with a frequency of 28 (66.7%) and more protein intake with a frequency of 7 (16.7%). Finally, the nutritional status of most experienced normal status, namely 2.5 students (5.9.5%), overweight status as many as 12 students (28.6%) and 5 students with obese nutritional status (11.9 %).

Table 2 Physical Activity, Energy, and Protein Intake, Nutritional Status in Adolescents at Junior High School

Variable	n	%
Physical Activity		
Light	10	28.3
Keep	32	76.2
Energy Intake		
Less	4	9.5
Enough	28	66.7
More	10	23.8
Protein Intake		
Less	7	16.7
Enough	28	66.6
More	7	16.7
Nutritional Status		
Normal	25	59.5
Overweight	12	28.6
Obesity	5	11.9
Total	42	100

Table 3 shows light physical activity with good nutritional status at 4.7%, overnutrition at 9.5% and obesity at 9.5%. Of the 32 moderate physical activities, there was a normal status of 54.7%, overweight of 19.1% and obesity of 2.4%. obtained a p-value of <0.001 which means there is a significant relationship between physical activity and nutritional status and an r-value of 0.512, As for energy intake is less there is a normal status of 7.1%, nutrition is more than 2.4%. From 28 adequate energy intakes, there was a normal status of 47.6%, with nutrition of more than 19.1%. Of the 10 more energy intakes, there was a normal status of 4.8%, more nutrition of 7.1% and obesity of 11.9% obtained p value = 0.001, there was a significant relationship between energy intake and nutritional status and r value of 0.503. While protein intake is lacking, there is a normal status of 11.9% and nutrition is more than 4.8%. From 2 8 adequate protein intake there was normal status 47.6%, nutritional status over weight 14.3% and obesity 4.8%. Of the 7 more protein intakes, there was a nutritional status of 9.5% and obesity of 7.1%. obtained p value = 0.002, there is a significant relationship between protein intake with nutritional status and an r-value of 0.459.

Table 3 The Relationship of Physical Activity, Energy, and Protein Intake with Nutritional Status in Adolescents at Junior High School

Variable	Nutritional Status						Total		*p*	*r*
	Normal		Overweight		Obesity					
	n	%	n	%	n	%	n	%		
Physical Activity										
Light	2	4.7	4	9.5	4	9.5	10	23.8	0.001	0.512
Keep	23	54.7	8	19.1	1	2.4	32	76.2		
Energy Intake										
Less	3	7.1	1	2.4	0	0	4	9.5	0.001	0.503
Enough	20	47.6	8	19.1	0	0	28	66.7		
More	2	4.8	3	7.1	5	11.9	10	23.8		
Protein Intake										
Less	5	11.9	2	4.8	0	0	7	16.7	0.002	0.459
Enough	20	47.6	6	14.3	2	4.8	28	66.6		
More	0	0	4	9.5	3	7.1	7	16.7		

Discussion

Relationship of Physical Activity with Adolescent Nutritional Status

Physical activity is described as the total amount of time spent on activities of daily living, work and school activities, recreational and sports activities, as well as other activities that increase the body's energy expenditure. Physical activity level (PAL) is of important research interest in public health, as having sufficient PAL is associated with higher health-related quality of life(10). The results showed a value of p = 0.001 i.e. Ha was accepted and Ho was rejected. This means that there is a significant relationship between physical activity and the nutritional status of adolescents at Junior High School 2 Long Bagun, Mamahak Besar Village, Long Bagun District, Mahakam Ulu Regency.

The results of this study were corroborated by univariate trials that showed from 10 light physical activities there was a good nutritional status of 4.7%, nutrition over 9.5% and obesity by 9.5%. Of the 32 moderate physical activities, there was a good nutritional status of 54.7%, more nutrition of 19.1% and obesity of 2.4%. This research is in line with the study of Khoerunisa and Istianah (2021) in Bogor, Indonesia which shows a significant relationship between physical activity and nutritional status of adolescents(11). One of the factors that shape a person's nutritional status is by doing physical activity. Doing regular physical activity has a positive impact on the body, in addition to making the body healthy and fit, there are other benefits of these activities, which can improve a person's nutritional status. We found moderate physical activity was identical to good nutritional status in adolescents of Junior High School 2 Long Bagun. However, this study is not in line with a study in Surabaya that suggests physical activity with nutritional status is not associated with a value of p = < 0.068 (12).

The process of collecting adolescent activity data is by using the IPAQ test questionnaire. Based on the results of questionnaires carried out by physical activity respondents, most of the categories are moderate, namely 32 respondents and 10 respondents in the light category. This happens because most students participate in extracurricular activities at school such as football, volleyball, badminton and

table tennis. In addition, most students also go to school on foot and other physical activities are done at home while helping parents with homework.

Lack of physical activity is identified as the leading risk for all four deaths worldwide, accounting for about 6% of the world's mortality events. A person who lacks physical activity causes the body to use less energy stored in the body. Therefore, if excess energy consumption is not balanced with appropriate physical activity then it can sustainably lead to obesity. The easiest and most common way to increase energy expenditure is to do physical exercise or bodywork (12). The Bell et al (2019) cohort study found strong evidence that physical activity is associated with better mental well-being or reduced symptoms of mental health disorders in adolescents. However, a protective relationship was found between physical activity and the emotional problems subscale of SDQ. This suggests that physical activity has the potential to reduce symptoms of depression and anxiety in adolescents. Future cohort study designs should allow for repeated measurements to fully explore the temporal nature of any relationship (13).

Evidence suggests that greater amounts of physical activity and higher intensity are associated with a range of health benefits, including cardiorespiratory fitness, muscle fitness, bone health, and cardiometabolic health. Evidence also suggests that physical activity reduces the risk of developing depression, and physical activity interventions reduce depressive symptoms in children and adolescents with and without major depression. Physical activity has a positive effect on cognitive function and academic outcomes (school performance, memory and executive function) in children and adolescents. Physical activity is also associated with fat loss in children and adolescents. Zero findings were generally observed in studies examining the relationship between physical activity and motor skill development. No or very limited evidence is available to infer an association between physical activity and adverse events, prosocial behaviour, or sleep. The overall quality of physical activity evidence was rated "moderate" (14).

The Relationship of Energy Intake with Adolescent Nutritional Status

Energy intake is obtained based on the average daily consumption of adolescents. Data collection of energy intake was carried out using the method of recording the food recall questionnaire 2 x 24 hours. The results showed that there was a significant relationship between energy intake and nutritional status of adolescents of Junior High School 2 Long Bagun with p-value = 0.001. Based on the results of the recall carried out by respondents, most of the categories are sufficient, namely 2, 8 respondents, 4 respondents in the less category, and 10 respondents in the category more than the needs of RDA. This happens because most teenagers tend to consume carbohydrates not according to the exchanger and the composition of the food does not vary. This research is in line with the study of Khoerunisa and Istianah (2021) in Bogor, Indonesia, which found a significant relationship between energy intake and the nutritional status of adolescents(11).

Carbohydrates are a source of energy for the body, this substance is found in foods derived from plants such as rice, corn, cassava, sago, wheat, taro and others. Carbohydrates function as a provider of energy or calories to meet the needs of body activities and also to maintain body temperature. Excess carbohydrate intake will be stored in the form of fat in the body. The energy that enters through food must be balanced with one's energy needs. If this is not achieved, there will be a shift in balance towards negative or positive. The state of a person's weight can be used as one of the clues as to whether a person is in a state of balance, excess, or lack of energy(15).

This is because the body needs an adequate supply of all nutrients to grow properly. Therefore, adolescents need adequate food both in terms of quality and quantity. The more varied or diverse the food consumed, the more fulfilled the adequacy of nutrients which can further have an impact on nutritional status and health(16). Adolescence is a period of physical growth and maturation of very fast organs, so to meet the need for adequate nutritional intake. Energy nutrients are needed to sustain life, perform physical activities and support growth(16). Macro- and micronutrient deficiencies are often referred to as hidden hunger and have global health impacts on adolescents because their manifestations are less visible and usually begin to appear when the condition is severe and has caused serious health impacts(6). Micronutrient deficiencies can adversely affect not only the health of adolescents today, but also their future health, and the health of the next generation(4). This study is not in line with research that found no significant relationship between nutritional status and energy intake in adolescents at Pesantren Darul Aman Gombara(17).

The Relationship of Protein Intake with Adolescent Nutritional Status

The results showed that there was a significant relationship between protein intake and the nutritional status of adolescents in Junior High School 2 Long Bagun in 2023 with an analysis of p-value

(0.00 2) and r-value (0.450) = a strong relationship. This result is corroborated by the distribution of variables that show the majority of children with adequate protein consumption patterns tend to have good nutritional status, namely 20 adolescents (47.6%). This finding is comparable to previous studies that showed there was a significant relationship between the level of protein deficiency and the nutritional status of respondents of SMP IT Iqra Kota Bengkulu in 2020 with p-value = 0.035 (18).

Adolescence can be said to be a second chance to pursue growth if you experience a nutritional deficit early in life. In this phase, the growth rate occurs rapidly because adolescence is a transition from childhood to adulthood. Therefore, adolescent girls need adequate nutrition in terms of quantity and quality to cope with rapid growth and other health risks that increase nutritional needs(19). Protein can affect growth and development because these nutrients have a distinctive function that cannot be replaced with other nutrients, namely building and maintaining cells and body tissues. The fulfilment of protein intake will affect nutritional status and the process of growth and development in adolescents to be more optimal (11). Protein needs in adolescents are influenced by the amount of protein needed to maintain existing body tissues(15).

While based on the results of interviews most subjects in the consumption of food sources of protein every day obtained from animal protein and vegetable protein such as tofu, tempeh, chicken eggs, chicken meat, fish, and nuts. Lack of protein in the long term can interfere with various processes in the body and reduce the body's resistance to disease. If a person's protein intake is sufficient and can be said to be good, then his nutritional status will also be good. This is mentioned in WNPG (2004) a person's nutritional status is influenced by the amount and quality of food consumed and the condition of a person's body. In its calculation, food consumption is more emphasized on energy and protein needs. Because if the nutritional needs of energy and protein have been met, the needs of other nutrients will be easier to meet. Public health is closely related to their diet. Diet can be interpreted as a set of foods that are consumed in a day and are susceptible to changes by various factors, such as physiological, environmental, psychological, and social(20).

The findings suggest significant positive correlations between all three dietary factors and nutritional health. These results offer valuable insights for designing interventions and programs to improve adolescent nutrition: 1) Promote Physical Activity (Encourage participation in extracurricular sports and physical education classes. Advocate for creating safe walking and cycling routes near schools), 2) Balanced Diet Education (Integrate nutritional education into the curriculum, emphasizing a balanced diet rich in various food groups), 3) Dietary Monitoring Tools (Develop tools for adolescents to track their daily energy and protein intake), 4) Parental Involvement (Engage parents in promoting healthy eating habits at home through workshops and educational materials), 5) School Canteen Regulations (Implement regulations in school canteens to promote healthy food choices and limit unhealthy options).

Conclusion

There was a significant relationship between physical activity, energy intake, and protein intake with the nutritional status of adolescents at Junior High School 2 Long Bagun. The results of physical activity research are expected to be a reference for the school to increase extracurricular sports hours to 2 times per week so that students can be more intense in physical activity, and it is hoped that students can take extracurricular activities seriously and actively and so that the physical activity carried out is more measurable and feels the benefits. Furthermore, energy intake and protein intake are expected to be input to the school cafeteria to provide a more diverse and nutritious menu of food and snacks following the principles of a balanced menu at school.

Conflicts of Interest: The authors declare no conflict of interest.

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