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THE ASSOCIATION BETWEEN ENERGY ADEQUACY LEVEL AND PHYSICAL ACTIVITY WITH NUTRITIONAL STATUS IN ADOLESCENTS AT WALISONGO HIGH SCHOOL, KETANGGUNGAN

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ABSTRACT

Growth during adolescence is rapid due to the development of muscle mass and fat tissue as well as hormonal changes that affect the nutritional needs of adolescents. An imbalance in nutrient intake compared to the recommended nutrient adequacy is a major problem in adolescent nutritional status. Weight loss and other nutrient deficiencies will occur if low energy intake is prolonged. However, lack of physical activity and excessive energy intake can lead to obesity. The purpose of this study was to determine how the nutritional status of adolescents and the level of energy adequacy and physical activity relate to each other at Walisongo Ketanggungan High School. This type of research uses a cross-sectional design. The number of samples taken with simple random sampling technique in this study was 152 people. Data collection of energy adequacy level using SQ-FFQ, physical activity data with PAL questionnaire, and nutritional status of respondents obtained from measurements of BW and TB. The results showed that most participants had an adequate level of energy sufficiency (65.1%) according to the Spearman Rank test, physical activity was mostly in the moderate category (63.8%), and the majority had good nutritional status (80.9%). The results of the Spearman Rank test showed that there was a significant correlation between the level of energy adequacy and nutritional status (p value = 0.045) and there was a significant correlation between physical activity and nutritional status (p value = 0.021). The conclusion is that there is a significant correlation between the level of energy adequacy and physical activity with nutritional status in adolescents at Walisongo Ketanggungan High School. It is recommended for the school to collaborate with the health department or local health center to make preventive and promotive efforts related to nutritional status problems through education about General Guidelines for Balanced Nutrition (PUGS).

KEYWORDS *Energy Adequacy Level, Physical Activity, Adolescents, Nutritional Status*

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INTRODUCTION

Adolescence is a transitional period between childhood and adulthood characterized by physical, psychosocial, cognitive, and behavioral growth. Their age ranges from 10 to 18 years (Ministry of Health of the Republic of Indonesia, 2014). The nutritional needs of adolescents can be influenced by hormonal changes and rapid muscle and fat tissue growth that occur during adolescence (Adriani M, 2012).

According to data from the World Health Organization (WHO, 2016), nutritional status is one of the public health problems, especially in developing countries. A survey on the prevalence of nutritional status conducted by WHO from 2010 to 2014 found that 48.8% of people worldwide had malnutrition. Data from the Basic Health Research (Riskesdas) 2018 shows that the nutritional status of adolescents aged 13-15 years in Indonesia is 8.7% malnutrition, with 1.9% severely underweight and 6.8% underweight. In addition, 8.1% of adolescents aged 16-18 years have malnutrition, with 6.7% being underweight and 1.4% severely underweight. Meanwhile, the prevalence of overweight and obesity is 16% in adolescents aged 13-15 years and 13.5% in adolescents aged 16-18 years (Ministry of Health of the Republic of Indonesia, 2018).

Both malnutrition and overnutrition are current nutritional issues in Indonesia, where their coexistence leads to double burden malnutrition. Double burden malnutrition is a problem of nutritional status that often occurs in society. The occurrence of malnutrition is caused by insufficient nutrient intake (Pujiati & Arneliwati, 2015). Meanwhile, overnutrition (obesity) occurs due to excessive calorie consumption, leading to fat accumulation in the body (Pramitya & Valentina, 2013).

The problem with nutritional status for adolescents is dominated by the imbalance between nutrient intake and the recommended amount of nutrients. Individuals with deficits in energy and protein intake experience adverse effects on their bodies, including obesity, chronic energy deficiency (CED), and anemia (Hafiza et al., 2021). One factor that increases the likelihood of obesity in adolescents is the shift from a conventional lifestyle to a sedentary lifestyle. Eating patterns that are higher in calories, fat, carbohydrates, and cholesterol, but lower in fiber, such as consuming fatty foods (Guo et al., 2012).

The type of food and the amount of calories consumed determine the quality of a person's healthy eating pattern. Healthy foods consist of carbohydrates, fats, proteins, vitamins, and minerals (Mokoginta & Manampiring, 2016). Adolescents tend to consume foods that are high in energy, excessive sugar, low in fiber, and high in sodium. This is because these foods taste savory, crunchy, and delicious (Dieny, 2014).

Energy is the main nutrient needed by the human body; if energy is not available, the body's need for other nutrients such as protein and minerals will also be met (Setyandari & Margawati, 2017). Nutritional problems such as good nutrition, overnutrition, or malnutrition occur when there is an imbalance between energy needs and adequacy. If energy intake is less than energy needs, muscles will use

stored energy. Weight loss and deficiencies in other nutrients are caused by prolonged energy deficiency (Gibney, 2008). Achieving energy balance can be achieved if energy intake into the body is balanced with energy expenditure; for example, lack of physical activity can increase weight (Almatsier, 2016).

According to the Ministry of Health of the Republic of Indonesia (2018), unhealthy eating habits in adolescents affect the emergence of various nutritional problems such as chronic energy deficiency (CED) with a prevalence of 36.3%, nutritional anemia of 21.7%, obesity of 21.6%, and overweight prevalence of 13.6%. Imbalanced food consumption and nutritional needs, combined with infections from diseases, are factors causing nutritional problems in adolescents. To prevent nutritional problems, nutritional needs in adolescents should be met in line with the principles of a balanced diet. Through nutritional fulfillment, it is hoped to be able to improve or maintain optimal nutritional status in adolescents (Pratami, T, Laksmi, 2016).

Energy imbalance occurs due to lack of physical activity and balanced energy intake. The body stores this energy as fat reserves (Kurniasanti, 2020). One factor that influences a person's nutritional health is the level of physical activity they engage in. Low levels of physical activity result in weight gain. Lifestyle changes that occur in society, such as increased nutritional status, result from consuming high-calorie, high-fat, and high-cholesterol foods without sufficient activity. Overnutrition or obesity can occur due to an imbalance between food intake and physical activity levels. Low levels of physical activity make it easier for someone to become obese when compared to someone who engages in vigorous physical activity (Vertikal, 2012).

Physical activity is the expenditure of energy from within the body. A person is considered to have sufficient activity if they exercise for 30 minutes/day or 3-5 days/week (Ministry of Health of the Republic of Indonesia, 2017). The WHO states that insufficient physical activity can lead to overweight, obesity, musculoskeletal disorders, and non-communicable diseases. Therefore, physical activity is recommended for children and adolescents aged 5-17 years for a minimum of 60 minutes at moderate to vigorous intensity (WHO, 2017). A study by (Hamalding et al., 2019) found that a sedentary lifestyle with insufficient physical activity is associated with overweight or obese adolescents. Adolescents prefer to engage in passive activities, such as watching television, playing gadgets, and sleeping while listening to music.

A study by (Sutrio, 2017) found a correlation between adolescent nutritional status and their energy intake. Referring to the data above, it can be concluded that respondents with normal nutritional status and good energy intake have regular physical activity. In Brebes Regency, there are several nutritional status problems, according to the Brebes District Health Office, the prevalence of adolescent nutritional status is 81.22% good nutrition, 0.33% malnutrition, and 18.14% overnutrition.

From the above background description, the researcher wants to examine the correlation between adolescent nutritional status at Walisongo High School, Ketanggunan, and the adequacy of energy and physical activity levels.

RESEARCH METHOD

This study has a cross-sectional design and is a quantitative research type. The study was conducted at Walisongo Ketanggungan High School. This study involved 249 students from classes X and XI at Walisongo Ketanggungan High School. Simple random sampling method was used in this study. A list of 249 student names was created in Microsoft Excel, then randomized using the RAND program and adjusted to the sample size, which amounted to 152 people.

The technique for collecting data on energy adequacy levels used the Semi Quantitative Food Frequency (SQ-FFQ) questionnaire over the past three months, while data on physical activity were obtained using the Physical Activity Level (PAL) questionnaire within a 24-hour period. Nutritional status was measured based on anthropometric measurements of body weight using a digital weighing scale and height obtained from microtoise measurements, which were then categorized using the BMI/U indicator.

The analysis of the data for both variables used the Kolmogorov-Smirnov normality test, which showed that the data were not normally distributed ($p \leq 0.05$). Therefore, in this study, the statistical test used was the Spearman Rank test, and if $p < 0.05$, there was a correlation between variables, but if $p > 0.05$, there was no correlation between variables.

RESULT AND DISCUSSION

Table 1. Frequency Distribution of Respondents Characteristics

Respondents Characteristics	**N**	**%**
Age of Respondents		
14	3	2
15	55	36,2
16	64	42,1
17	29	19,1
18	1	0,7
Education Level of Fathers		
Primary School	110	72,4
Secondary School	42	27,6
Education Level of Mothers		
Primary School	122	80,3
Secondary School	30	19,7
Father Occupation		
Farmer	38	25
Trade	31	20,4
Contraction Worker	17	11,2
Labourer	10	6,6
Self Employed	7	4,6
Bussinessman	30	19,7
Pedicab Riders	19	12,5
Mother Occupation		
Housewife/unemployed	45	29,6

Farmer	26	17,1
Trade	32	21,1
Buruh	20	13,2
Self Employed	16	10,5
Household Assistant	13	8,6
Parents Income		
<Rp.1.500.000/month	73	48
Rp.1.500.000-Rp.2.500.000/month	72	47,4
>Rp.2.500.000/month	7	4,6
TOTAL	**152**	**100**

In Table 1, it can be seen that the age of the respondents is dominated by 16 years old, with a percentage of 42.1% obtained from a total of 152 students. Adolescence occurs between the ages of 12-19 years, during which there is a transition between childhood and adulthood. Adolescents are categorized as vulnerable to nutrition because adolescence involves many changes, such as growth and maturation of reproductive organs, which affect the higher nutritional needs for development.

The results of the study on the educational level of the respondents' parents show that the majority have completed primary education consisting of elementary school or equivalent and junior high school or equivalent. About 72.4% of the respondents' fathers completed primary education, while for the respondents' mothers, the percentage of those who completed primary education was 80.3%. From this, it can be concluded that the majority of the last educational attainment of both parents of the respondents is elementary school or equivalent and junior high school or equivalent. Based on research by Lamijan & Roesminingsih (2013), there is a strong influence on the growth and development of a child between adequate parental education and knowledge about nutrition. Parents who are well-educated and have a better understanding of nutritional information will pay more attention to what their children should eat. Parents' desire for their children to grow as well as possible without experiencing nutritional deficiencies that will slow down their growth and development.

In terms of the occupation of the respondents' parents, the majority of the respondents' fathers work as farmers, accounting for 25%, and the majority of the respondents' mothers work as housewives, accounting for 29.6%. From these findings, it is concluded that the majority of the respondents' parents work as farmers and housewives, with uncertain incomes, which affect the nutritional status of children due to their insufficient income. Parents' occupations play an important role in the nutritional status of children. The type of parents' occupation affects their ability to meet the family's nutritional needs because parents' jobs are related to taking care of the family. The purchasing power of parents for food will be determined by their income from their jobs. Parents with higher incomes will be able to provide enough food for their children. Furthermore, by utilizing the high purchasing power of parents, they will be able to improve food security at the family level.

The majority of the respondents' parents' combined income is <Rp. 1,500,000/month, accounting for 48%. It is concluded that the combined income of both parents is still below the UMK (Regional Minimum Wage) of Brebes Regency,

which is Rp. 2,018,837. To meet the nutritional needs of children with various nutritious foods, an indirect factor is the family's income level. The income level can determine the type of food that families want to buy. Because income determines purchasing power, family income can affect the availability of family food for good food intake.

Table 2. Frequency Distribution Based on Energy Source Type

Food sources of energy	Energy content per 100 grams	Average consumption weight	Energy intake (kcal)	Number of students who consumed (n)	%
White rice	130,0	127,63	165,9	152	100
Instant noodles	437,4	217,88	952,6	152	100
Chicken meat	284,9	95,53	95,5	152	100
Tempe	199,1	96,03	191,2	152	100
Granulated sugar	387,0	19,90	77,0	152	100
Coconut oil	862,1	29,40	253,5	152	100
Chicken egg	155,1	257,89	399,9	147	96,71
White bread	273,9	150,50	412,2	136	89,47
Batagor	152,0	48,50	73,7	132	86,84
Beef meatballs	370,0	112,73	417,0	131	86,18
Fish dumplings	71,0	224,80	159,6	120	78,94
UHT milk	60,0	97,77	58,7	116	76,31
Egg martabak	319,1	52,38	167,1	113	74,34
Donut	400,1	46,67	186,7	112	73,68
Rice vermicelli	381,0	18,67	71,1	109	71,71
Cassava	131,0	20,29	26,6	109	71,71
Coconut milk	106,1	40,55	43,0	104	68,42
Potato	93,0	19,00	17,7	103	67,76
Pop ice	439,8	40,75	179,2	72	47,36
Good day	450,5	28,58	128,8	61	40,13

Based on the results of the SQ-FFQ interviews conducted, students consume high-energy foods sourced from rice, bread, cassava, potatoes, instant noodles, and others. In addition, respondents also consume high-energy foods sourced from animal and plant-based dishes as well as snacks. A total of 152 students (100%) consume rice at 127.63 grams per day, instant noodles at 217.88 grams per day, chicken meat at 95.53 grams per day, tempeh at 96.03 grams per day, granulated sugar at 19.90 grams per day, and coconut oil at 29.40 grams per day.

Research conducted by Wardlaw & Smith (2007) states that adolescents generally prefer and choose high-calorie foods that originate from carbohydrates. High carbohydrate consumption, which increases calorie intake, supports the occurrence of adolescents with excess nutrition.

This is in line with research by Rokhmah et al. (2016), which states that consuming low-nutrient snacks such as crackers, candy, and packaged foods is one of the causes of adolescent energy deficiency. Most of these snacks are not only low in calories but also low in nutrients, which can disrupt appetite. A study investigating Indonesian habits, views, and trends in snack consumption found that people consume snacks more often than staple foods (Mondalez, 2020).

Table 3. Distribution of Respondents Based on Energy Intake.

Variable	Mean	Std. Deviation	Minimum	Maximum
Energy Intake (kcal)	2139,20	358,24	1422,2	3884,4

Based on Table 3, the average energy intake is 2139.30 kcal. Meanwhile, the average energy requirement for adolescents is 2050-2650 kcal per day. Using the SQ-FFQ questionnaire and direct interviews with respondents, energy consumption by respondents is calculated and compared with individual nutritional adequacy figures (AKG)..

Table 4. Distribution of Respondents Based on Energy Adequacy Level

Variable	Mean	Std. Deviation	Minimum	Maximum
Energy Adequacy Level (%)	103,23	16,20	73,23	156,19

It can be seen from Table 4 that the energy adequacy level has a mean of 103.23%, so it can be concluded that the energy adequacy level (103.23%) falls into the sufficient category (80-110%). According to WNPG (2014), the percentage of energy adequacy levels is grouped into three categories: deficient (<80% AKG), sufficient (80-110% AKG), and excess (>110% AKG). The respondents' energy adequacy levels can be seen in Table 5:

Tabel 5. Distribution of Respondents Based on Energy Adequacy Level

Category	N	%
Deficient (<80% AKG)	8	5,3
Adequate (80-110% AKG)	99	65,1
Excessive (>110% AKG)	45	29,6
Total	**152**	**100**

Table 5 shows that 99 students at SMA Walisongo Ketanggungan, accounting for 65.1%, have a good energy adequacy level (80-110% AKG), resulting from the foods consumed being in line with their needs. Meanwhile, 8 students (5.3%) have insufficient energy adequacy levels (<80% AKG), due to the respondents not eating according to recommendations, i.e., having 3 main meals and 2 snacks.

Respondents only eat 1-2 times a day without snacks. And a total of 45 students (29.6%) fall into the excess category (>110% AKG), due to excessive food intake.

Excessive energy intake not accompanied by energy utilization such as physical activity can potentially lead to obesity. This change in lifestyle, accompanied by an increase in family prosperity, also affects a person's eating habits. Eating habits will shift towards consuming foods high in sugar, fat, and salt but low in fiber and vitamins, resulting in an imbalanced diet. Fat tissue accumulation occurs when energy intake and expenditure are imbalanced for an extended period (Maffeis et al., 2001). Excessive food consumption increases energy intake, while low physical activity decreases energy expenditure (D'Addesa et al., 2010).

Energy balance will be achieved when the energy consumed is equal to the energy utilized in the form of physical activity. This condition will lead to a more ideal body (Wiarto, 2013). Meanwhile, if someone is unable to meet their nutrient intake, especially energy nutrients, it can trigger chronic energy deficiency (KEK) and anemia due to iron deficiency. Adolescents often experience nutritional problems such as KEK and anemia (Waryana et al., 2019).

Table 6. Distribution of Respondents Based on Type of Physical Activity

No.	Type of Physical Activity	Average time/day (minutes)	n	%
1.	Sleeping	446,44	152	100
2.	Watching TV, playing mobile games, and chatting	331,18	152	100
3.	Light activities during breaks (reading novels, magazines, etc.)	22,13	82	53,9
4.	Eating and drinking	23,94	152	100
5.	Sitting activities (attending school, studying, doing homework or assignments)	449,01	152	100
6.	Riding a motorcycle	22,54	110	72,3
7.	Cleaning the house, washing clothes and dishes by hand	17,98	57	37,5
8.	Mopping the floor, cleaning and watering the yard and plants, cleaning household furniture, cleaning windows, and ironing clothes	19,42	61	40,1
9.	Light exercise (running, aerobics)	40,09	52	34,2
10.	Cooking	16,69	59	38,8

According to the research findings, the types of physical activities commonly performed by students include sleeping, watching TV and using mobile phones, attending school, and doing homework. The duration of sleep is 7.5 hours/day, while for watching TV and using mobile phones, it is around 6.5 hours/day, and for attending school and doing homework, it is 7.5 hours/day. Dedeh et al. (2010) suggest

that adolescents engage in sports such as football, volleyball, basketball, swimming, jogging, and cycling, as well as beneficial and healthy physical activities such as making beds, sweeping, mopping, and gardening.

According to Kumala et al. (2019), high screen time duration affects changes in eating patterns, thus also affecting a person's nutritional status. The American Academy of Pediatrics and WHO (2019) recommend a screen time activity for ages > 13 years of 2 hours/day. Screen time is the duration spent engaging in activities in front of gadget screens (Houghton et al., 2015). This activity can then lead to changes in a person's nutritional status by increasing energy intake because some people only sit and lie down to watch TV and play games. This leads to a lack of physical activity, contributing to increased BMI, especially in adolescents (Cameron et al., 2016). Frequent screen time activities also cause other health problems, such as insomnia. This is triggered by disruptions in hormonal responses due to artificial light from screen time. Excessive light from screen time is one of the causes of insufficient sleep and increased energy intake (Laurson et al., 2014).

According to (Suni & Rehman, 2023), the recommended sleep duration for adolescents is 8-10 hours per night. It can be concluded that students have inadequate sleep duration (< 8-10 hours/day). Inadequate sleep duration leads to hormonal imbalances in the blood, namely an increase in ghrelin hormone that suppresses hunger and a decrease in leptin hormone that can trigger hunger at night, leading to excess weight gain (Damayanti et al., 2019).

FAO (2001) states that the level of physical activity is categorized into three categories: light activity (1.40-1.69), moderate (1.70-1.99), and heavy (2.00-2.40). The level of physical activity of respondents can be seen in Table 7:

Table 7. Distribution Based on Physical Activity

Category	**N**	**%**
Light	55	36.2
Moderate	97	63.8
Total	**152**	**100**

From the research results on students at SMA Walisongo Ketanggungan, it can be seen in Table 7 that 97 students (63.8%) have moderate physical activity. Meanwhile, 55 students (36.2%) have a light physical activity category because respondents only engage in daily activities such as lying down, watching TV, playing games for a considerable duration, and studying. Additionally, it is known that more respondents are either picked up or drive themselves to school. In this regard, the low level of physical activity is consistent with advancing technology. For example, advancements in transportation technology have reduced the number of people walking. As a result, people become more reliant on motor vehicles. A cross-cultural study on obesity found that video games also lead to less physical activity. The less physical activity, the more sedentary lifestyle (Al-Nakeeb et al., 2012).

Pekik (2006) states that adolescents or school-age children generally have moderate physical activity. This is because studying is a frequent activity. Research by Ferinawati & Mayanti (2018) states that, compared to students who engage in heavier physical activity, more students spend time on light physical activities. This

is due to the fact that, as students, they do not have parental roles that require them to impose heavy activity burdens on their children.

Table 8. Distribution of Respondents Based on Nutritional Status

Variable	Mean	Std. Deviation	Minimum	Maximum
Nutritional Status	-0,60	1,00	-2,94	2,35

The research findings in Table 8 indicate that the average ± SD nutritional status of the respondents is -0.60 SD, meaning that the majority of respondents have a normal nutritional status, with a minimum value of -2.94 SD falling into the undernutrition category and a maximum value of 2.35 SD falling into the obesity category, with a standard deviation of 1.00. The frequency distribution of respondents can be seen in Table 9:

Table 9. Distribution of Respondents Based on Nutritional Status

Category	N	%
Underweight	22	14,5
Normal weight	123	80,9
Overweight	6	3,9
Obesity	1	0,7
Total	**152**	**100**

In Table 9, it is found that 123 respondents (80.9%) have good nutritional status, 22 respondents (14.5%) have undernutrition status, 6 respondents (3.9%) have overnutrition status, and only 1 respondent (0.7%) is obese. As shown by the nutritional status monitoring data from the Ministry of Health in 2018, 1.6% of people are considered severely thin, 6.7% are thin, 91.0% are considered normal, and 0.7% are considered overweight (Balitbangkes, 2018).

The nutritional problems that occur in students at SMA Walisongo Ketanggungan are primarily undernutrition issues. This occurs when the amount of energy intake and other nutrients does not meet the requirements. Imbalance of nutrients in adolescents increases the risk of degenerative diseases, respiratory disorders, and heart disease similar to older people. On the other hand, poor nutritional status increases the likelihood of diseases, especially infectious diseases, and disrupts the absorption process of nutrients in the intestines (Irdiana & Nindya, 2017).

Several factors influencing the nutritional level of adolescents include genetic factors, lifestyle factors, and environmental factors. In terms of genetic factors, parents who are overweight are more likely to have overweight children or vice versa. Then, lifestyle and dietary patterns of adolescents, such as paying attention to physical appearance, will affect the amount of food and nutrients they consume. The environment can also influence adolescent behavior, which also affects the amount of food and nutrients consumed (Serly et al., 2015).

Table 10. Relationship between Energy Adequacy Level and Nutritional Status

	$\bar{x}$ ± SD	r_s	P
Energy Adequacy Level	103,23 ± 16,20	0,163	0,045

Nutritional Status (Z-Score)	-0,60 ± 1,00

From the Spearman Rank test results, a correlation coefficient (r) value of 0.163 with a p-value of 0.045 was obtained, since the p-value < 0.05 then H0 is rejected. Thus, it can be concluded that there is a significant relationship between nutritional status and energy sufficiency level. The characteristics of the relationship between variables can be described by referring to the correlation coefficient value. In the table above, a correlation coefficient of 0.163 indicates that the strength of the relationship between the two variables is strong, while the coefficient sign indicates the direction or form of the correlation. A positive sign in the correlation coefficient value indicates that the relationship type is positive, meaning that if the energy sufficiency level improves, then the nutritional status of adolescents will also improve and may even lead to obesity.

This is in line with the research conducted by Purwanti et al. (2015), stating a correlation between energy intake and BMI/U, with a correlation coefficient (r) = 0.844, which means a strong relationship between the two variables with a positive correlation direction. Another study by Sutrio (2017b) also found similar results, indicating a correlation between energy intake and nutritional status. This means that if the energy intake consumed is in line with the needs, then the nutritional status should also be good. If the energy intake possessed by the respondents does not meet their needs, they will tend to have undernutrition status or underweight, and similarly, if the energy intake is excessive, it will cause overweight or obesity. This explains that energy intake affects a person's nutritional status.

Within the body, every individual has energy, which is the most important substance for humans for basal metabolism, daily activities, temperature regulation, and growth. Energy is highly needed during adolescence. This is because during adolescence, physical growth is the fastest phase after infant growth (Evans et al., 2015). This energy is obtained from carbohydrates, proteins, and fats from the consumption of foods containing macronutrients that function as energy sources through metabolic processes. Carbohydrates and proteins in food provide 4 kcal of energy per gram. Meanwhile, 1 gram of fat provides 9 kcal of energy (Qamariyah & Nindya, 2018).

According to Almatsier (2001), adolescents need good food intake to meet their body's needs, but if the food intake consumed is insufficient, it results in the body experiencing decreased energy yield and a deficiency of nutrients. Insufficient intake consumed by an individual causes this nutrient deficiency. Therefore, the body's glycogen reserves will be used to produce energy. However, if this continues for a long time, the body will become thinner and deficient in nutrients absorbed by the body. This weakens the body's immunity and increases the risk of disease. Conversely, excess weight or obesity is the result of body fat formation from excess energy.

The body receives carbohydrates, fats, and proteins as sources of energy. After not being used, they are stored as glucose through the appropriate process where each nutrient must become glucose. Glucose undergoes glycolysis to produce acetyl-CoA, which can be used when energy is needed. Acetyl-CoA is then converted into fatty acids, which are stored as triglycerides in adipose tissue. If glucose

undergoes glycolysis and enters the Krebs cycle, adenosine triphosphate (ATP) is formed. However, if glucose is not processed to produce energy during glycolysis, it means there is excess glucose and will be stored as glycogen during glycogenesis. In the process called lipogenesis, glycogen that fills the cells is converted into fat (Samodra & Musfira, 2021).

Lipogenesis converts acetyl-CoA into fat. This allows energy to be stored as fat (Imamah & Muti'ah, 2020). Because their fat cells are not fully filled, people with many fat cells will have a larger body weight and always feel hungry. This process is what causes a person's weight to increase (Samodra & Musfira, 2021).

Table 11. Relationship between Physical Activity and Nutritional Status

	$\bar{x}$ ± SD	r_s	P
Physical Activity Level (PAL)	1,65 ± 0,09	-0,187	0,021
Nutritional Status (Z-Score)	-0,60 ± 1,00		

The test results using Spearman's Rank obtained a correlation coefficient value of approximately -0.187 and a p-value of 0.021. Since the p-value is less than 0.05, H0 is rejected. Therefore, it can be concluded that there is a significant relationship between physical activity and nutritional status. The characteristics of the relationship between variables can be described through the correlation coefficient value. The correlation coefficient value explains the level of strength or closeness of the correlation, and the sign of the coefficient explains the direction or form of the correlation. The correlation coefficient in the table above, which is -0.187, indicates a weak level of relationship strength between the two variables. The negative sign in the correlation coefficient value explains that the type of relationship is in the opposite direction, meaning that as physical activity increases, the nutritional status of an individual also increases.

Based on the research results, students with light physical activity mostly engage in daily activities such as eating, studying, drinking, lying down, and using their smartphones for a long duration. This is consistent with the study conducted by Rudiyanto et al. (2023), which found a correlation between physical activity and nutritional status with a correlation coefficient of -0.395, indicating a significant correlation between the two variables. The research results indicate that the duration of focus on gadget screens in rural and urban areas affects adolescent physical activity, whether significantly or insignificantly.

Similar research was also conducted by Huda et al. (2022), who proposed a specific relationship between physical activity and nutritional status in adolescents because when they only engage in light physical activity, their nutritional status tends to increase. This is also supported by the research of Suyasmi et al. (2018), which states that physical activity factors greatly affect the BMI of adolescents. The advancement of technology has a negative impact on adolescents because it makes them lazier to engage in activities. The lack of physical activity in adolescents is due to the preference for playing games and watching TV, which are more

appealing. High BMI tends to affect adolescents who engage in less physical activity (Suyasmi et al., 2018).

Another reason for the high prevalence of light physical activity is because many respondents prefer to use motorcycles to go to school rather than walk, even though the distance between home and school is quite short. This condition leads to a decrease in the frequency of physical activity. Regular physical activities such as brisk walking or jogging in the morning/evening reduce fat accumulation, thus reducing the risk of obesity in individuals and maintaining optimal nutritional status (Serly et al., 2015).

The lack of physical activity has a significant impact on nutritional status. The less time spent on sufficiently strenuous activities, the higher the risk of obesity. The more physical activities performed, the more calories burned, resulting in a more ideal body (Soraya et al., 2017). However, with individuals consuming high-calorie foods and beverages, lack of physical activity, and increased sedentary lifestyle, the body tends to accumulate excess calories, leading to obesity (Thompson et al., 2005).

Physical activity includes all types of body activities, which is one of the efforts to balance and distribute the expenditure and absorption of nutrients, especially energy sources in the body, so that the body can maintain a normal nutritional status (Harahap et al., 2020). Adolescents greatly need physical activity for their bodies because they are in a stage of development and growth. Physical activity is considered good if a person engages in at least moderate activity for a minimum of 150 minutes or 75 minutes for vigorous activity. If these activities are carried out regularly, it will have a positive impact on health (Sibarani, 2021). Higher levels of exercise and physical activity are considered important for protecting individuals from diseases. The risk of cardiovascular disease starts from childhood to adulthood, so it should not be ignored, and preventive measures must be taken in a timely manner (Aires et al., 2011). This is because cardiovascular diseases depend on decreased levels of physical activity and increased sedentary lifestyles in adulthood (Kvaavik et al., 2009).

ATP is the fastest source of energy available for muscle contraction and is obtained from consumed food and various chemical reactions in the body. ATP is found in muscle fibers as an energy source during muscle contraction. ATP is converted to adenosine diphosphate (ADP) during activity, which produces energy for muscle contraction. Generally, for muscle contraction, there are two main ways of providing energy: anaerobic (without oxygen) and aerobic (with oxygen). Aerobic energy (oxidative system) is obtained through the supply of carbohydrates, fats, and proteins (Sandi, 2019).

Muscle mass is a very important body tissue for increasing strength, functioning in sports and daily activities, and regulating metabolism. Physical activity and food intake are two factors that can affect muscle mass growth (Zahida et al., 2018). There is a correlation between body weight and muscle mass, with weight gain proportional to muscle mass growth, which means that higher body weight equals higher muscle mass (Siska & Amrizal, 2020).

CONCLUSION

In this study, nutritional status was positively correlated with the level of energy adequacy. The results of the Spearman Rank test show on the variable level of energy adequacy with nutritional status namely p-value = 0.045 (p-value < 0.05) and on the variable physical activity with nutritional status namely p-value = 0.021 (p-value < 0.05).

Students are advised to be more careful in eating food and participating in regular physical activity to maintain good nutritional levels and avoid health risks. However, it is recommended that schools collaborate with the health office or puskesmas to carry out preventive and promotive efforts related to nutritional status issues through education about PUGS (General Guidelines for Balanced Nutrition).

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