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(RESEARCH ARTICLE)

The association between dietary patterns and physical activity with the nutritional status of children aged 10-12 years in Indonesia

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Abstract

Childhood obesity is a significant health concern globally. Obesity in children lead to various health problems in adulthood. Undernutrition also poses risks, affecting physical development and increasing susceptibility to illness. Both overnutrition and undernutrition are critical issues that impact children's longterm health. This research aimed to analyze the association between dietary patterns and physical activity with nutritional status of children aged 10-12 years at Ta'miriyah elementary school in Surabaya. This study is an observational research design with a cross-sectional approach. Data collected through interviews to assess the frequency food questionnaire, 1x24 hours food recall form, international physical activity questionnaire, and anthropometric measurement. Of the 66 children studied, 54.5% had good nutritional status based on BMI/age. However, 31.8% children were categorized as overweight and obese. Most childrens did not meet their recommended daily nutritional intake. Their diets lacked variety and low frequency of eating vegetables and fruits. While most children had moderate physical activity (84.8%), the duration was below WHO recommendations. This study found no relationship between nutritional intake and dietary patterns. However, there was a negative association between nutritional status and physical activity. Many children did not adhere to recommended dietary and physical activity guideline. The study concludes that nutritional status is not related to dietary patterns in this age group, but it is related with physical activity. These highlights the importance of promoting adequate physical activity to maintain optimal nutritional status in children.

Keywords: Dietary Pattern; Physical Activity; Nutritional Status; Children

1. Introduction

Nutritional status represents the balance between nutrient intake from food and the nutrients needed for the body's metabolism. Excessive and insufficient nutrition cause health problems with long-term consequences for children. For example, overnutrition can lead to obesity, thereby increasing the risk of type 2 diabetes mellitus [1]. In addition, undernutrition can cause a lack of fat and muscle reserves, increase susceptibility to disease and infection, and potentially interfere with brain development.

Nutrition remains a major health problem in Indonesia and globally. The Food and Agriculture Organization (FAO) reports that 768 million people worldwide suffered from malnutrition in 2020, an increase 18.1% from the previous year. The World Health Organization (WHO) identifies malnutrition as the leading cause of 3.1 million child deaths each year [2]. According to data from the Basic Health Research (Riskesdas) Indonesia, there has been an increase in obesity among children from 2007 to 2018 in Indonesia. In 2018, 6.8% of children aged 5-12 years were malnourished, and

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10.8% were overweight. East Java Province ranked fourth nationally for overweight and obesity in children aged 5-12 years [3].

Several factors contribute to nutritional status, such as diet, physical activity, environmental, psychological, and genetic factors. Diet can be described in terms of frequency, quantity, and type of food [4]. Studies show a strong correlation between dietary patterns and nutritional status, with a high percentage of children with good nutritional status having appropriate dietary patterns [5]. Dietary patterns that do not comply with balanced nutrition guidelines increase the likelihood of obesity [6]. Physical activity is also one of the factors that can affect person's nutritional status. A study shows that insufficient physical activity is a risk factor for obesity, with inactive children having a much higher risk of underweight than active children [7].

2. Material and methods

This study is an analytical observational study using a cross-sectional research design. The population in this study were children aged 10-12 years at Ta'miriyah Elementary School, Surabaya, Indonesia. The minimum sample size was 60 students. This sample was selected using simple random sampling. Data collection was conducted in November 2024.

2.1. Variables under study

- Nutritional status
- Physical activity
- Dietary pattern (energy intake, types of consumption, and food freqeuncy)

The data collection instruments used were a frequency food questionnaire, 1x24-hour food recall questionnaire, International Physical Activity Questionnaire (IPAQ), and anthropometric data (BMI/A). The 1x24-hour food recall questionnaire used to record the name, brand, time, and amount of food consumed. From the results of the 1x24-hour food recall, the amount of energy intake was classified into Insufficient (<80% of RDA), Adequate (80%-110% of RDA), and Excessive (>110% of RDA) [8]. The categories of nutritional status based on Body Mass Index for Age (BMI/A), as stated by the Ministry of Health of Indonesia [9].

The food frequency questionnaire used to determine the types of food consumed and the frequency of eating by children, which was obtained from the total score of the FFQ questionnaire and divided into three categories. Physical activity categories were assessed based on the IPAQ questionnaire results, referring to the total MET-minutes/week value, and were divided into three categories: Light (<600 MET-minutes/week), Moderate (600-3000 MET-minutes/week), and Heavy (>3000 MET-minutes/week) [10]. Analysis of the relationship between variables using Spearman's test and Fisher's exact test.

3. Results

According to table 1, most of the respondents were male (36 children) and aged 11 years (33 children). In accordance with the guidelines from the World Health Organization (WHO) and recommendations from the Ministry of Health of the Republic of Indonesia and the Indonesian Pediatric Society (IDAI), children and adolescents aged 5–17 years are advised to engage in moderate to vigorous physical activity for at least 60 minutes every day throughout the week. In addition, the WHO also recommends that children aged 5–17 years engage in vigorous physical activity for at least 3 days a week [11]. Based on Table 1, most respondents in this study did not meet these recommendations.

Table 1 Sample characteristics

Characteristic	**Total**	
	(n=66)	%
Sex		
Boys	36	54.5
Girls	30	45.5
Age		
10 years	32	48.5
11 years	33	50
12 years	1	1.5
Duration of Physical Activity		
≥60 minutes/day	15	22.7
<60 minutes/day	51	77.3
≥3 days/week	23	34.8
<3 days/week	43	65.2

Table 2 Distribution of nutritional status (BMI/Age) based on age and gender

Sample's Characteristics	**Nutritional Status (BMI/Age)**										**Total**	
	Severe underweight		Underweight		Normal weight		Overweight		Obesity			
	N	%	N	%	N	%	N	%	N	%	N	%
Age												
10 years	1	1.5%	5	7.6%	16	24.2%	3	4.5%	7	10.6%	32	48.5%
11 years	2	3%	0	0%	20	30.3%	10	15.2%	1	1.5%	33	50%
12 years	1	1.5%	0	0%	0	0%	0	0%	0	0%	1	1.5%
Total	4	6.1%	5	7.6%	36	54.5%	13	19.7%	8	12.1%	66	100%
Gender												
Boys	2	3%	4	6.1%	15	22.7%	10	15.2%	5	7.6%	36	54.5%
Girls	2	3%	1	1.5%	21	31.8%	3	4.5%	3	4.5%	30	45.5%
Total	4	6.1%	5	7.6%	36	54.5%	13	19.7%	8	12.1%	66	100%

Table 3 showed the majority of respondents were at normal weight (54.5%). However, 45.5% of respondents still had nutritional problems, with the highest percentage being overweight (19.7%), followed by obesity (12.1%). The distribution of respondent's energy intake was classified as insufficient in 42 people (63.6%), adequate in 15 people (22.7%), and excessive in 9 people (13.7%). The majority of respondents in this study had a not varied dietary pattern based on types, consisting of 43 people (65.2%), while those with diet with a variety of foods, consisting of staple foods, animal or vegetable side dishes, vegetables, and fruits, consisted of 23 people (34.8%).

Most respondents had an adequate frequency in the staple food, animal side dish, and vegetable side dish groups. In the staple food category, 36 children (54.5%) consumed staple foods with adequate frequency to meet their daily energy

needs. In contrast to vegetable consumption, the majority of children consumed vegetables with low frequency (43.9%). Similarly, in fruit consumption frequency, most respondents (45.5%) consumed at low frequency. Moderate physical activity levels were reported by 56 children (84.8%). Meanwhile, the remaining children had mild physical activity levels (2 children, 3%) and vigorous physical activity levels (8 children, 12.2%).

Table 3 Variable distribution

Variable	**Total**	
	(n=66)	%
Nutritional Status		
Severe underweight	4	6.1
Underweight	5	7.6
Normal weight	36	54.5
Overweight	13	19.7
Obesity	8	12.1
Physical Activity		
Mild	2	3
Moderate	56	84.8
Vigorous	8	12.2
Energy Intake		
Insufficient (<80% RDA)	42	63.6
Adequate (80-110% RDA)	15	22.7
Excessive (>110% RDA)	9	13.7
Types of Consumption		
Varied	43	65.2
Not varied	23	34.8
Food Frequency		
Staple foods		
Low	24	36.4
Adequate	36	54.5
High	6	9.1
Animal-based side dishes		
Low	24	36.4
Adequate	34	51.5
High	8	12.1
Plant-based side dishes		
Low	18	27.3
Adequate	35	53
High	13	19.7
Vegetables		

Low	29	43.9
Adequate	33	50
High	4	6.1
Fruits		
Low	30	45.5
Adequate	29	43.9
High	7	10.6

The nutritional status of children aged 10–12 years at Ta'miriyah Elementary School in Surabaya was not related to diet, but was significantly and negatively correlated (r = -0.429) with physical activity.

Table 4 The association between nutritional status and food frequency

Food frequency	**Nutritional Status (BMI/Age)**					**Total**	**p-Value and r-Value**
	Severe underweight	Underweight	Normal weight	Overweight	Obesity		
Staple foods Low	1 (1.5%)	2 (3%)	14 (21.2%)	5 (7.6%)	2 (3%)	24 (36.4%)	*p* = 0.527 r = 0.079
Adequate	3 (4.5%)	3 (4.5%)	19 (28.8%)	6 (9.1%)	5 (7.6%)	36 (54.5%)	
High	0 (0%)	0 (0%)	3 (4.5%)	2 (3%)	1 (1.5%)	6 (9.1%)	
Animal-based side dishes							
Low	2 (3%)	2 (3%)	15 (22.7%)	3 (4.5%)	2 (3%)	24 (36.4%)	*p* = 0.382
Adequate	1 (1.5%)	3 (4.5%)	16 (24.2%)	8 (12.1%)	6 (9.1%)	34 (51.5%)	r = 0.109
High	1 (1.5)	0 (0%)	5 (7.6%)	2 (3%)	0 (0%)	8 (12.1%)	
Plant-based side dishes							
Low	0 (0%)	1 (1.5%)	12 (18.2%)	4 (6.1%)	1 (1.5%)	18 (27.3%)	*p* = 0.470
Adequate	3 (4.5%)	3 (4.5%)	20 (30.3%)	5 (7.6%)	4 (6.1%)	35 (53%)	r = 0.09
High	1 (1.5)	1 (1.5%)	4 (6.1%)	4 (6.1%)	3 (4.5%)	13 (19.7%)	
Vegetables Low	2 (3%)	2 (3%)	17 (25.8%)	5 (7.6%)	3 (4.5%)	29 (43.9%)	*p* = 0.406
Adequate	2 (3%)	3 (4.5%)	17 (25.8%)	8 (12.1%)	3 (4.5%)	33 (50%)	r = 0.104
High	0 (0%)	0 (0%)	2 (3%)	0 (0%)	2 (3%)	4 (6,1%)	

Fruits Low	1 (1.5%)	3 (4.5%)	19 (28.8%)	4 (6.1%)	3 (4.5%)	30 (45.5%)	p = 0.375 r = 0.111
Adequate	3 (4.5%)	2 (3%)	12 (18.2%)	8 (12.1%)	4 (6.1%)	29 (43.9%)	
High	0 (0%)	0 (0%)	5 (7.6%)	1 (1.5%)	1 (1.5%)	7 (10.6%)	

Table 5 The association between nutritional status and energy intake

Energy Intake	**Nutritional Status (BMI/Age)**					**Total**
	Severe underweight	Underweight	Normal weight	Overweight	Obesity	
Insufficient (<80% RDA)	2 (3%)	2 (3%)	25 (37.9%)	6 (9.1%)	7 (10.6%)	42 (63.6%)
Adequate (80-110% RDA)	1 (1.5%)	2 (3%)	9 (13.6%)	3 (4.5%)	0 (0%)	15 (22.7%)
Excessive (>110% RDA)	1 (1.5%)	1 (1.5%)	2 (3%)	4 (6.1%)	1 (1.5%)	9 (13.6%)
Total	4 (6.1%)	5 (7.6%)	36 (54.5%)	13 (19.7%)	8 (12.1%)	66 (100%)
p = 0.670						
Coeficient correlations (r) =-0.053						

Table 6 The association between nutritional status and variation of consumption

Types of Consumption	**Nutritional Status (BMI/Age)**					**Total**
	Severe underweight	Underweight	Normal weight	Overweight	Obesity	
Not varied	3 (4.5%)	5 (7.6%)	25 (37.9%)	6 (9.1%)	4 (6.1%)	43 (65.2%)
Varied	1 (1.5%)	0 (0%)	11 (16.7%)	7 (10.6%)	4 (6.1%)	23 (34.8%)
Total	4 (6.1%)	5 (7.6%)	36 (54.5%)	13 (19.7%)	8 (12.1%)	66 (100%)
p = 0.205						

Table 7 The association between nutritional status and physical activity

Physical activity	Nutritional Status (BMI/Age)					Total
	Severe underweight	Underweight	Normal weight	Overweight	Obesity	
Mild	0 (0%)	0 (0%)	0 (0%)	1 (1.5%)	1 (1.5%)	2 (3%)
Moderate	2 (3%)	3 (4.5%)	32 (48.5%)	12 (18.2%)	7 (10.6%)	56 (84.8%)
Vigorous	2 (3%)	2 (3%)	4 (6.1%)	0 (0%)	0 (0%)	8 (12.1%)
Total	4 (6.1%)	5 (7.6%)	36 (54.5%)	13 (19.7%)	8 (12.1%)	66 (100%)
p = 0.001						
Coeficient correlations (r) = -0,429						

4. Discussion

Based on SSGI 2022 data, 10.8% of children aged 5-12 years are overweight and 9.2% are obese, meaning that 1 in 5 children aged 5-12 years are overweight or obese [12]. The results of this study show a similar pattern, with 31.8% still experiencing nutritional problems, especially overweight and obesity. This means that 3 out of 10 children are overweight or obese. The proportion of overweight and obesity in this study is higher than the national data, even though the scope of the study is more limited. These results indicate that the prevalence of overweight and obesity in children remains a problem that requires attention and early intervention to prevent long-term impacts on children's health and development.

According to the gender distribution and nutritional status in Table 2, the proportion of males and females is relatively balanced, although there are slight differences. In this study, the number of boys who were overweight and obese was higher than that of girls. At the onset of adolescence, testosterone levels in boys begin to increase due to the activation of the hypothalamic–pituitary–gonadal axis. Testosterone stimulates muscle mass growth and increases physical strength, which in turn increases the basal metabolic rate (BMR). In addition, the influence of testosterone on the limbic system can encourage exploratory behavior. These factors contribute to a tendency toward higher physical activity [13]. Higher physical activity can increase energy requirements and be followed by increased eating patterns [14]. If eating patterns exceed the basic requirements of children according to their age, the excess energy causes overnutrition or obesity. However, each individual has different biological characteristics, so the factors influencing overweight and obesity are not only determined by gender but are also influenced by genetic factors, physical activity, lifestyle, parental education level, and sedentary lifestyle [15].

4.1. Energy Intake

The results of this study indicate that there is no relationship between nutritional status and dietary patterns based on quantity. During pre-adolescence, children often exhibit picky eating habits, which can lead to dietary imbalances. Children who tend to avoid certain types of food have inconsistent meal portions because they only choose foods that they like. These findings are supported by previous research stating that there is no significant relationship between nutritional status and protein, carbohydrate, fiber, or physical activity intake, meaning that total macronutrient intake is not related to nutritional status [16]. These results are also reinforced by a other study, which states that high energy intake is not necessarily directly related to poor nutritional status or obesity if the types of food consumed are dominated by foods that are less nutritious, and the factors of physical activity and the metabolic condition of children are not taken into account [17].

Different results were found in a study, which stated that nutritional consumption is closely related to the nutritional status of school children [18]. According to the WHO, the nutritional status of children is greatly influenced by a balanced diet, daily activity patterns, and a family and social environment that supports healthy eating behaviors [19]. Several factors, such as varying eating habits, individual metabolism, physical activity levels, or genetic factors also play a role in children's nutritional status. This can be seen in Table 5, where the majority of children with good nutritional status

have insufficient energy intake (<80% of RDA). Even though energy intake is low and meal frequency is relatively low, nutritional status can still be categorized as good if individual energy requirements are relatively low or there are sufficient body energy reserves to meet metabolic needs. Based on the above considerations, dietary patterns based on quantity are not the sole determinant of nutritional status in children aged 10–12 years at Ta'miriyah Elementary School in Surabaya.

4.2. Food Frequency

Based on table 4, most respondents have a diet with sufficient frequency of staple foods, animal-based side dishes, and plant-based side dishes. This indicates that children's energy and protein needs are relatively met. However, there are still some children who do not consume staple foods with sufficient frequency, which can lead to a lack of daily energy intake. In contrast, the majority of respondents consume vegetables and fruits less frequently. The low consumption of vegetables and fruits is caused by several factors, one of which is the habit of children in their pre-adolescence to choose foods based solely on their preferences. This condition is in line with previous studies which state that children of this age often have fruit and vegetable intake below the recommended amount [20].

In this study, the frequency of vegetable and fruit consumption was not associated with the nutritional status of children aged 10-12 years at Ta'miriyah Elementary School in Surabaya. Vegetables and fruits contain more micronutrients, such as vitamins, minerals, and fiber, rather than macronutrients (carbohydrates, protein, and fat). The energy content of vegetables and fruits is lower than that of staple foods and side dishes, so that high frequency of consumption of vegetables and fruits does not directly affect an improvement in nutritional status. This is in line with the theory that nutritional status is more influenced by energy from macronutrient intake than by micronutrients [21]. Furthermore, the anthropometric index used in this study, BMI/Age, better represents macronutrient intake. Therefore, the frequency of vegetable and fruit consumption does not always correlate with nutritional status based on anthropometry.

It was found that there was no significant relationship between nutritional status and eating patterns based on frequency in children aged 10–12 years at Ta'miriyah Elementary School in Surabaya. These results are in line with previous studies that stated that there is no relationship between eating patterns (frequency) and nutritional status in children [22]. Children who eat three times a day do not necessarily have good nutritional status, and vice versa. This means that eating frequency alone is not sufficient to determine nutritional status because the quality and nutritional content of food also play a role. Research conducted by Mufidah, R. & Soeyono, R.D. (2021) is in line with this study. According to them, there are other factors that affect nutritional status, such as infectious diseases, physical activity, and socioeconomic status [23]. In a similar study, found that diet is only one of several factors that influence nutritional status [24]. These results are in line with previous findings showing that nutritional status is not influenced solely by diet.

Another study found a significant relationship between meal frequency and the nutritional status of school-age children. In this study, children who ate more than three meals a day tended to have good nutritional status because meal frequency was also accompanied by an increase in the quality of consumption in the form of foods. These differences in results are likely due to differences in respondent characteristics, school environment, and parental education levels. In addition, the study included a nutritional education intervention prior to the study, which made children and parents more aware of the content and type of food consumed, not just the frequency[25].

4.3. Variation of Consumption

The results of this study indicate that there is no significant relationship between nutritional status and variation of consumption in children aged 10–12 years at Ta'miriyah Elementary School in Surabaya. This is supported by previous studies which state that there is no relationship between food type and nutritional status in elementary schools. If the diet type is not varied, but healthy food consumption is in line with requirements, good nutritional status will be achieved. A varied or non-varied type of food, if the food selection is inappropriate, unhealthy, and excessive or insufficient in quantity, will also cause nutritional problems [22]. Different results were found in another study which stated that a good diet will result in good nutritional status and a poor diet will also result in poor nutritional status [26].

A varied diet consists of staple foods, animal and plant-based side dishes, vegetables, and fruits. The diversity of food types consumed affects nutritional quality and nutrient completeness. Students often buy snacks or food in the canteen based on what they like without considering the nutritional value, such as instant noodles and seblak. The results of the food frequency questionnaire show that many children do not consume enough vegetables and fruits. As a result, the nutritional content of the food they consume is incomplete. Picky eating habits can reduce the variety of foods consumed. Children can still get enough energy and protein from monotonous foods, even if they are nutritionally

unbalanced. For example, they may frequently consume foods high in carbohydrates or fat, but low in vegetables, fruits, and protein. This condition is likely due to the BMI/Age indicator representing macro nutritional status, so it does not directly describe the quality of micro nutrient consumption.

4.4. Physical Activity

Based on table 7, there is a relationship between nutritional status and physical activity in this study. A negative correlation coefficient (r) value means that an excessive improvement in nutritional status is associated with a decrease in physical activity. This is in line with the study by Taufik et al. (2024), which found a significant relationship between physical activity levels, energy intake, and protein intake with the nutritional status of children aged 12–15 years. Regular physical activity has a positive impact on the body. Moderate to vigorous physical activity helps establish a balanced diet and optimal nutritional status [27]. This statement is consistent with the findings in table 7, where children with moderate levels of physical activity are more likely to have good nutritional status compared to those with low or high levels of physical activity. Another supporting study conducted at Al-Falaah Ciputat Islamic Elementary School in 2020 showed that there is a significant influence between physical activity and the nutritional status of students [28]. In addition, other studies also mention that doing physical activity regularly can maintain optimal nutritional status. Regular physical activity of moderate intensity can reduce fat accumulation.

The results of this study show that many respondents engage in moderate to vigorous physical activity, but not regularly every day. This indicates a gap between health recommendations and the actual behavior of respondents. This non-compliance can increase the risk of future health problems such as overweight, obesity, and metabolic disorders [29]. Regular physical activity is an important factor in maintaining good nutritional status. This is in line with research by Sukianto et al. (2020), which states that low frequency of physical activity is associated with an increased risk of obesity [30]. In line with this, other studies show that an increase in the amount and intensity of physical activity is associated with various health benefits, including improved cardiorespiratory, muscular, bone, cardiometabolic, and cognitive outcomes [11].

Limitations

The limitation of this study is that the questionnaires were only administered on weekdays, not on weekdays and weekends, so the results do not fully represent children's daily dietary patterns. In addition, the collection of primary data through questionnaires allows for recall bias because it is subjective and highly dependent on the respondents' ability to accurately remember and report the types and amounts of food consumed.

5. Conclusion

There is a association between physical activity and nutritional status. However, this study found no association between dietary patterns and nutritional status in children aged 10-12 years at SD Ta'miriyah Surabaya. The nutritional status of respondent based on BMI/U shows that the majority are well-nourished. However, the number of respondent who are overweight and obese is still high, in line with the national trend. Most of the respondents' dietary patterns did not meet their daily nutritional needs according to the Recommended Dietary Allowance (RDA), their diets were not varied, and they did not eat enough vegetables and fruits. The majority of children engaged in moderate-vigorous physical activity, but the duration did not meet WHO recommendations.

Compliance with ethical standards

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Disclosure of Conflict of interest

All Authors have no conflict of interest in this research.

Statement of ethical approval

This research has received ethical approval from the Health Research Ethics Committee of Faculty of Medicine, Universitas Airlangga on October 11, 2024, number 123/EC/KEPK/FKUA/2024.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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