Amerta Nutrition
e-ISSN: 2580-1163 (Online)
p-ISSN: 2580-9776 (Print)
Sholikhah and Rahma | Amerta Nutrition Vol. 8 Issue 2 (June 2024). 239-247

RESEARCH STUDY
English Version
OPEN ACCESS

The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency

Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik

Desty Muzarofatus Sholikhah[1]*, Amalia Rahma[2]

[1]Undergraduate Nutrition Study Program, Faculty of Sports and Health Sciences, Surabaya State University, Indonesia
[2]Undergraduate Nutrition Science Study Program, Faculty of Health Sciences, Muhammadiyah University Gresik, Indonesia

ARTICLE INFO

Received: *15-09-2023*
Accepted: *17-01-2024*
Published online: *07-06-2024*

Correspondent:
Desty Muzarofatus Sholikhah
desty.muzarofatus@gmail.com

DOI:
10.20473/amnt.v8i2.2024.239-247

Available online at:
https://e-journal.unair.ac.id/AMNT

Keywords:
Energy Intake, Macronutrients, Nutritional Status, School Children, Gresik Regency

ABSTRACT

Background: School-age children are vulnerable to nutritional and health problems. Several factors that can directly influence a child's nutritional status are nutritional intake, which includes energy and macronutrient intake, level of physical activity, and incidence of illness.
Objectives: This research analyzes the relationship between energy intake and macronutrients with the nutritional status of Muhammadiyah elementary school children in Gresik Regency.
Methods: This research was an observational analytical study with a cross-sectional study design. Using purposive sampling, 231 children from five Muhammadiyah elementary schools in Gresik Regency were taken as research samples. The research was carried out from May to June 2023. Research variables include energy intake, intake of macronutrients, and nutritional status. Data collection used the interview method with 2x24-hour food recall, FFQ (Food Frequency Questionnaire), and measuring body weight and height to assess nutritional status based on BMI-for-age (Body Mass Index-for-age). All research data were analyzed using the Spearman test.
Results: The result showed there is a relationship between energy intake (p-value=0.000) and protein (p-value=0.000) with nutritional status, but there is no relationship between the intake of fat (p-value=0.253) and carbohydrates (p-value=0.821) with nutritional status of Muhammadiyah elementary school children in Gresik Regency.
Conclusions: Intake of energy and macronutrients, especially protein, is related to the nutritional status of school children in Gresik Regency. Healthy food and snacks need to be provided in school canteens to support the nutritional status of school-age children.

INTRODUCTION

School-age children are generally aged 6 to 12 years[1,2]. This age group needs to get good nutritional aid to support physical, mental, and emotional growth and achieve normal nutritional status so that children can grow healthily, be more active, and excellent[3]. Nutritional status can be referred to as the body's condition resulting from the use and activity of nutritional substances from daily food consumption. Normal nutritional status can be obtained when food consumption and expenditure are balanced, if this condition is not achieved, it can cause nutritional problems, both undernutrition and overnutrition[4,5]. One group that is prone to experiencing nutritional problems is school children[5,1].

A nutritional problem that often occurs in school-age children is obesity. Globally, 124 million children are obese[6]. A study stated that the highest incidence of overweight and obesity in children occurs in Asia[7]. In Indonesia, there has also been an increase in the incidence of overweight and obesity from 2013 to 2018; the 2018 Basic Health Research (Riskesdas) states that the nutritional status (BMI-for-age) of children aged 5-12 years is overweight and obese at 10.8% and 9.2%, while in 2013 it was 10.8% and 8.8%. On the other hand, there are still school children with poor nutritional status. In 2013, 4.0% of children aged 5-12 were categorized as very thin, and 7.2% were underweight. These results are lower when compared to the malnutrition status in 2018; namely, 2.4% were very thin, and 6.8% were included in the underweight category. Based on a comparison of nutritional problems in school-aged children, it is known that obesity cases are currently increasing[8].

Obesity can occur when a person's daily intake exceeds the calorie value. The incidence of nutritional problems starting in school-age children. It is due to being overweight which increases the risk of metabolic diseases

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*

in the future, such as diabetes mellitus, hypertension, and other cardiovascular diseases[3,1,9]. Conditions of overweight and obesity can also affect the quality of life and economic status of the family as a result of decreased productivity and poor health status. However, malnutrition in school children also causes several problems, such as disrupting learning ability and concentration, causing a decrease in performance at school, being susceptible to infectious diseases, and causing suboptimal physical growth. This will also affect their health in the future[1,3,5,10,11].

Good nutritional status in children can be achieved when there is energy balance in the body[3]. Energy can be produced from consuming macronutrient sources, including carbohydrates, protein, and fat; each of these nutrients can provide different energy values[1]. Protein plays a role in building body cells and supporting children's growth. Lack of protein consumption can inhibit growth, make them susceptible to infectious diseases, and reduce nutritional status. Additionally, carbohydrates and fats can provide energy quickly to support children's activities. However, excessive fat consumption can store body fat and cause excess weight in children[1,3].

Several other factors that can determine the nutritional status of school children include daily eating patterns, physical activity, environmental factors, and sleep patterns[12]. Children who often skip breakfast and prioritize snacks without paying attention to nutritional value in the long term can experience malnutrition[1,3]. Lifestyle changes and increased consumption of instant foods and snacks high in fat and sugar and low in fiber can cause overweight and obesity in children[1,9]. Riskesdas data from 2018 shows that 97.9% of children over ten years are deficient in consuming vegetables and fruit, 56.4% consume sweet foods and drinks daily, and 41.2% are recorded as liking fatty foods. Some of these risky eating patterns can support the increase in obesity in school-aged children[8].

Eating patterns in school-age children can be formed due to several factors, including support factors from the family, socio-economics, school environment, friendships, family education, and economics[3,13]. Education on nutrition implemented in the family can produce good eating patterns in children. However, environmental and friendship factors can also influence dietary imbalances; the number of places providing fast food can affect children's eating patterns, leading to obesity[3,14]. Foods that obese children often consume are chocolate, soft drinks, and fast food, which tend to have a high calorific value but do not contain many significant nutrients, especially vitamins and minerals, which are needed a lot by children. Hence, they do not only have an impact on obesity but can also cause micronutrient deficiencies[15].

Education in Indonesia has an important role in improving children's nutritional status. A third of a child's time is spent at school, so all types of food consumed by a child at school are determinants of the child's nutritional status. According to the 2018 Riskesdas data, the rates of overweight and obesity in children aged 5-12 years in East Java are higher than the national figures, namely 12.48% and 11.08%. On the other hand, it was still found that 2.23% were in the very thin category, and 5.81% were underweight. Thus, there is a need for further studies regarding food intake and nutritional status in school children, especially in the East Java Region[16].

Several previous research results stated that the level of energy, protein, and fat intake was related to the status of school-age children at Ketabang 1 State Elementary School (SDN), Surabaya City[9]. The same research results were also obtained from SDN 1 and 2 Sambirejo, that the energy and protein adequacy level was related to the nutritional status of school-aged children[17]. Other research also gave the same results, namely that there was a significant relationship between energy, fat, protein, and carbohydrate intake and the nutritional status of school children at SDN Pacarkembang 1 Surabaya, with 69.7% of children having normal nutritional status and the remainder being obese[18]. The same research also found that 48.2% of school children included obese nutritional status at full-day schools in areas near urban areas[18].

Gresik Regency is an industrial area close to urban areas such as Surabaya. The easy access to contemporary food and snacks, fast food, and soft drinks, which children tend to like, can affect the nutritional status of school children[19]. Based on the initial survey, it was discovered that the school did not provide lunch packages, so nutritional intake, especially at school, was obtained from food supplies from home and several canteens provided by the school. If children's daily intake of food and snacks is not equivalent to their needs, it can impact energy imbalance and affect their nutritional status. There is a need for research related to nutritional intake, especially macronutrients, and the nutritional status of school children at Muhammadiyah Elementary School, Gresik Regency, because children spend a lot of time at school, including eating time. In addition, food intake depends more on the student's own choices. Therefore, this research examined the relationship between energy and macronutrient intake and the nutritional status of children at Muhammadiyah Elementary School, Gresik Regency.

METHODS

This research used an analytical observational design with a cross-sectional study conducted in May-June 2023. This research involved five Muhammadiyah elementary schools in Gresik Regency, namely Muhammadiyah Elementary Schools 1, 2, and 3 Gresik, Muhammadiyah Elementary School 2 GKB, and Muhammadiyah Elementary School Manyar. In this study, a total of 231 students were taken as samples through purposive sampling. The students had to meet the inclusion criteria, namely being registered as active students at the school where the research was conducted, students in grades IV, V, and VI, willing to be research respondents as proven by signature by their parents on the consent form, and completed the questionnaire thoroughly from the interview. Meanwhile, the exclusion criteria were students absent from school, students who were not there when the research was conducted, and students who had not completed the questionnaire.

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*

The data collected in this research is primary data. The variables measured in the study included energy and macronutrient intake (protein, fat, and carbohydrates) as measured by 2×24-hour food recall, estimated food record and FFQ, and nutritional status based on the BMI-for-age index. Counting energy and macronutrient intake using a 24-hour food recall form and a food photo book was carried out twice, namely once on weekdays and once on weekends. Confirmation was carried out with parents/guardians using the estimated food record form that had been given—information on the day and date of filling, as well as procedures for filling. The results of measuring energy and macronutrient intake were calculated using a Nutrisurvey. It calculated the average number and then compared the results with the Nutritional Adequacy Rate (AKG) table for the 10-12 year age group through body weight correction so that the data was comparable to the needs of each respondent[20].

The energy adequacy figure for school-aged boys is 2000 kcal and 1900 kcal for girls, the protein adequacy rate for boys is 50 grams and 55 grams for girls, the fat adequacy rate for boys and girls is 65 grams, while the carbohydrate adequacy rate in boys 300 grams and in girls 280 grams[20]. The average intake of respondents is compared with nutritional adequacy based on the RDA table through body weight correction so that each respondent's healthy adequacy figure can be higher or lower than the adequacy figure in the RDA table. The comparison results are presented in percentage form and classified based on the 2012 Food and Nutrition National Widyakarya (WNPG) category to determine energy and macronutrient intake, which is classified as a severe deficit (<70% of the requirement figure), moderate deficit (70-79% of the requirement figure), mild deficit (80-89% of the requirement figure), average (90-119% of the requirement figure), and excess (≥120% of the requirement figure)[21]. Meanwhile, FFQ measurements are used to determine the types of food that are often consumed[22]. The food categories included in the FFQ form are staple food sources, which consist of nine kinds; animal side dish sources, which include 12 types; vegetable side dish sources, which consist of seven kinds; vegetable sources, which consist of 18 kinds, 13 kinds of fruit sources, and 20 kinds of snacks taken from snacks sold in the school area and surrounding areas.

The nutritional status of respondents was obtained by measuring their weight and height twice by two different meters to increase the accuracy of the measurement results. Body weight was measured using an Omron digital weight scale, while height was measured using a microtoice with an accuracy of 0.1 cm. After that, calculate the BMI (body mass index) based on age and classify it into five categories according to the World Health Organization (WHO), namely poor nutrition (<-3 SD), undernutrition (-3 SD to <-2 SD), malnutrition good (-2 SD to 1 SD), over nutrition (>1 SD to 2 SD), and obesity (>2 SD)[23]. This research has received approval from the research ethics commission of the Faculty of Health, Muhammadiyah University of Gresik, with number 239/KET/II.3.UMG/KEP/A/2023.

RESULTS AND DISCUSSION

Respondents in this study were students in grades IV, V, and VI from five Muhammadiyah elementary schools in Gresik Regency. The respondents involved were students who met the inclusion criteria. Table 1 provides an overview of respondent's characteristics, including gender, age, and class group of respondents, as well as pocket money. It is known that more than half of the respondents were male students, 53.7%, with the largest number coming from class IV (42.2%), and almost half were 11 years old (45%). On average, respondents received pocket money exceeding or equal to the average (56.3%), and the middle pocket money of respondents is IDR 14,500. Pocket money can impact student's purchasing power for snacks at school. An increase in pocket money will follow an increase in purchasing on snacks at school. Higher pocket money can allow children to buy and consume the snacks they like, generally without paying attention to their nutritional content[24]. If the snacks consumed are of poor quality and do not meet their dietary needs, it will interfere with their main meal, affecting the nutritional status of school children[24,25]. Survey results from BPOM show that snacks for school children can contribute 31.1% energy and 27.4% protein[1]. The food often found in the school environment is close to street food, fast food, or other foods high in sugar and fat and low in vitamins, minerals, and fiber[25].

Table 1. Frequency distribution of characteristics of Muhammadiyah elementary school children in Gresik Regency, East Java, Indonesia.

Respondent Characteristics	Amount (n=231)	Percentage (%)
Gender		
Man	124	53.7
Woman	107	46.3
Age		
Ten	91	39.4
Eleven	104	45
Twelve	36	15.6
Class		
IV	98	42.4
V	93	40.3
VI	40	17.3
Pocket money		
<Rp 14.500	101	43.7
≥Rp 14.500	130	56.3

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*

Respondent Characteristics	Amount (n=231)	Percentage (%)
Energy Consumption Rate		
Heavy deficit	29	12.6
Moderate deficit	15	6.5
Mild deficit	28	12.1
Good	153	66.2
More intake	6	2.6
Protein Consumption Rate		
Heavy deficit	23	10.0
Moderate deficit	8	3.5
Mild deficit	14	6.1
Good	63	27.3
More intake	123	53.2
Fat Consumption Rate		
Heavy deficit	21	9.1
Moderate deficit	18	7.8
Mild deficit	9	3.9
Good	79	34.2
More intake	104	45
Carbohydrate Consumption Rate		
Heavy deficit	72	31.2
Moderate deficit	34	14.7
Mild deficit	33	14.3
Good	45	19.5
More intake	47	20.3
Nutritional Status Category (BMI/U index)		
Severely thinness	5	2.2
Thinness	4	1.7
Normal	115	49.8
Overweight	53	22.9
Obese	54	23.4

The level of energy and nutrient consumption in school children is obtained from intake from home and supplemented by the consumption of snacks at or outside school. Energy and macronutrient intake in this study was brought based on the results of a 2×24-hour food recall. This information was then confirmed with the student's parents using an estimated food record form and compared with the AKG table through correction for the respondent's body weight. It can be seen in Table 1.

Adequate energy intake for boys aged 10-12 years based on the AKG table is 2000 kcal/day, while for girls aged 10-12 years, it is 1900 kcal/day[20]. Table 2 shows that most respondent's energy intake is in a good category, namely 153 respondents (66.2%) with an average intake of 2195 kcal/day. The percentage of energy intake is included in the good category if it reaches 90-119%[21]. Energy intake is obtained from macronutrient sources, including protein, fat, and carbohydrates. The body requires energy for metabolic processes, physical activity, and to support the growth and development of children and other functions[4]. Insufficient energy intake in school-aged children can cause them to experience malnutrition, impacting their physical growth and cognitive development. On the other hand, excessive energy intake, not accompanied by good energy expenditure from physical activity, increases the risk of overweight in children. Both deficiencies and excesses of energy are not good if they occur in school-aged children[1,3].

The macronutrient that is often known as a building block is a protein. This nutrient has the main function of forming and supporting body growth as a component for creating antibodies, hormones, and enzymes; it also can be a source of energy when carbohydrate and fat sources are insufficient in the body. Protein can be grouped into two, namely animal and vegetable. This grouping is based on its source[1]. Protein adequacy for boys aged 10-12 years is 55 grams/day, while for girls of the same age, it is 50 grams/day[20].

The results of the research (Table 1) show that for more than 50% of the total number of respondents, the protein intake of Muhammadiyah Elementary School students in Gresik Regency was in the over category, namely 123 respondents (53.2%) with an average intake of 74.13 grams. Protein intake is included in the excessive category if it is ≥120%[21]. In this study, respondents' protein intake mainly came from animal protein. As the results of the FFQ show, the most consumed protein is chicken, with a percentage of 17% consuming it more than once per day, 42% consuming chicken once per day, and the rest consuming eggs more often. Apart from that, protein is obtained from milk intake, which is consumed daily. The FFQ results stated that as many as 25% of respondents drank packaged liquid milk such as Ultra High Temperature (UHT) milk more than once per day, 10% consumed milk once per day, and others consumed it 4-6 times per week, 1-3 times per week, and so on. The results of the FFQ for Muhammadiyah Elementary School students in Gresik Regency are presented in Figure 1.

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*

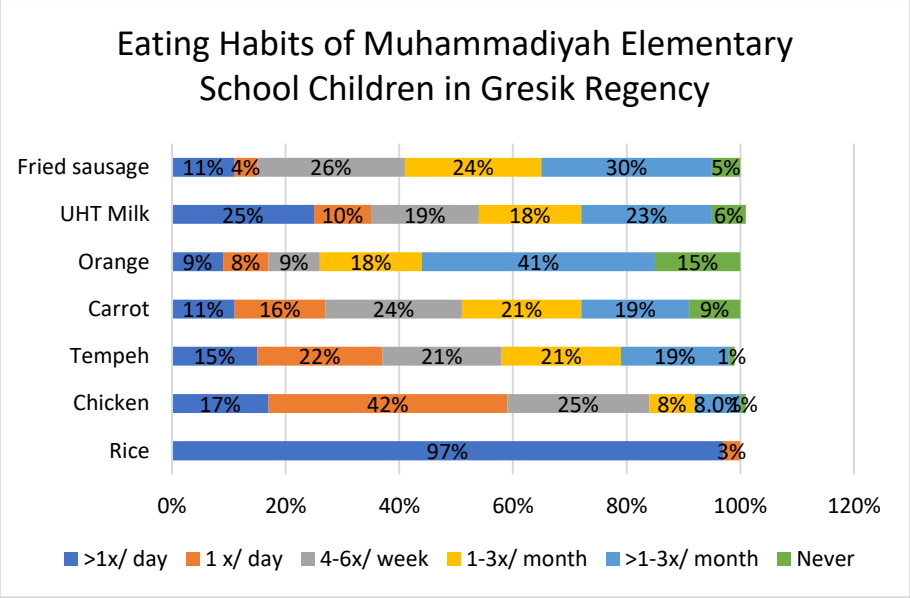

Figure 1. Eating Habits (FFQ) of Muhammadiyah Elementary School Children in Gresik, East Java, Indonesia

A good source of protein is generally one that contains complete amino acids, so the body more easily absorbs it, which can be found in animal protein[1]. However, high consumption of animal protein is generally accompanied by fat content[4]. Apart from needing animal protein, school-age children also need vegetable protein to complement the benefits of animal protein, such as tofu, tempeh, and nuts[3].

According to the FFQ results, it is known that the vegetable protein respondents often consume tempeh. As many as 15% of respondents consumed tempeh more than once per day, 22% consumed tempeh once per day, and so on. Tempeh is a source of vegetable protein with raw materials originating from soybeans. This type of bean has the best biological value when compared to other sources of vegetable protein[4]. These two types of protein are good for school-age children's consumption because apart from functioning for growth, protein also works to help intelligence and replace damaged cells in the body[26].

Fat is a macronutrient that can produce the highest caloric value, 9 kcal per 1 gram of fat. Apart from having energy, fat is also needed by the body to help it absorb fat-soluble vitamins (A, D, E, K)[3]. According to balanced nutrition guidelines, fat is required as much as 25% of the total daily energy requirements[1]. Adequate fat for boys and girls aged 10-12 years is 65 grams/day[20].

Table 1 presents the fat intake of children at Muhammadiyah Elementary School in Gresik Regency. Notably, 45% of respondent's fat intake was classified as more, and 27.3% was included in the good category with an average of 88.17 grams daily. The source of fat intake is obtained from animal protein, which tends to be consumed in excess, especially when processed by frying, such as fried chicken, fried chicken with flour, which tends to require more oil in the frying process and can be obtained from snacks which also tend to be processed by frying. The type of snack that respondents consume more often is fried sausage. As many as 11% of respondents consume fried sausage more than once per day, 4% consume it once per day, and 26% consume it 4-6 times per week (Figure 1).

This research obtained results consistent with those carried out in elementary schools in Java and outside Java, indicating that most school children's fat intake was in the more-than-normal category[20,27]. Excessive fat consumption can trigger weight gain and can lead to overweight and obesity in children. That can increase the risk of dangerous metabolic diseases in the future, such as coronary heart disease, hypertension, diabetes mellitus, and others[1]. Intake of unsaturated fats, commonly known as good fats, is more needed by school-age children to support brain function and reduce inflammation, thereby lowering the risk of illness[3].

Apart from protein and fat, this study also examined carbohydrate intake in Muhammadiyah Elementary School students in Gresik Regency. Carbohydrates, as a class of macronutrients, serve as the body's main energy source for activities or other functions[3]. Carbohydrate adequacy based on the AKG table for boys aged 10-12 months is 300 grams/day, while carbohydrate adequacy for girls of the same age is 280 grams/day[3]. Table 2 shows that as much as 31.2% is included in deficit carbohydrate intake, but as much as 20.3% is included in excess carbohydrate intake. The average carbohydrate intake per day is 291.7 grams. The level of carbohydrate intake in respondents this time is similar to previous research, indicating that most school children tend to have a deficit in carbohydrate intake[28].

The main benefit of carbohydrates is that they can provide energy for the brain to support its performance. When the brain does not work optimally, it can interfere with children's concentration on learning. Insufficient carbohydrate intake can also make the body weak due to hypoglycemia. That can reduce learning achievement in school children[28]. A lack of varied intake of carbohydrate sources can cause insufficient intake of carbohydrate sources. It is known that as many as 97% of school children consume rice more than once as a source of carbohydrates (Figure 1) but have yet to meet the adequate level of carbohydrates they should (Table 1).

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*

Rice is a source of cereal carbohydrates that is easy to find in Indonesia, including in Gresik Regency. Consuming sufficient amounts of carbohydrate sources, besides providing an energy source, can also save other nutrients such as protein. Therefore, protein can maximize its functions as a source of building blocks. The research results show that carbohydrate sources are obtained from vegetables and fruit apart from rice. Figure 1 shows that carrots are often consumed; 11% of respondents consume them more than once daily, and 16% consume carrots daily. Meanwhile, the fruit consumed frequently by respondents is citrus, with 9% of them consume it more than once and 8% consuming it once a day. Vegetables and fruit tend to be consumed less by children compared to the standard. This condition is similar to the results of the Systematic Review[29]. It proves the results of Riskesdas in 2018 that children over ten years old are recorded 97.9% in less consumption of vegetables and fruit[8].

The level of macronutrient intake in children influences nutritional status. Excessive intake can increase excess weight, resulting in overweight and obesity. On the other hand, a lack of nutritional intake can result in malnutrition in children. Almost half (49.8%) of the respondents had good nutritional status, but there were still those who fell into the overweight and obese categories, namely 22.9% and 23.4% respectively (Table 1). These percentages are higher than the national overweight and obesity figures in 2018, namely 10.8% and 9.2%, and higher than the overweight and obesity figures in East Java, namely 12.48% and 11.08%[16], respectively. Overweight and obesity can occur when many fat deposits are in the body, leading to a bodyweight exceeding the ideal body weight. Both overweight and obesity have an impact on body health, which can result in various types of cardiovascular diseases in the future[30], including metabolic disorders such as diabetes mellitus[11]. Besides physical impacts, obesity in children will also have a psychological effect. Children who are overweight tend to have low self-esteem and lack self-confidence[6]. Even so, 2.2% are classified as malnourished, and 1.7% are underweight. It indicates that multiple nutritional problems still exist in developing countries[31]. The relationship between energy and macronutrient intake and the nutritional status of Muhammadiyah Elementary School children in Gresik Regency is presented in Table 2.

Table 2. The Relationship of Macronutrient Intake Level and Nutritional Status of Children at Muhammadiyah Elementary School in Gresik Regency, East Java, Indonesia

Intake Level	Nutritional Status (BMI/U index)										p-value
	Severely thinness (<-3SD)		Thinness (-3SD sd <-2 SD)		Normal (-2 SD sd +1 SD)		Overweight (+1 SD sd +2 SD)		Obese (> +2 SD)		
	n	%	n	%	n	%	n	%	n	%	
Energy											
Heavy deficit	2	6.89	1	3.45	24	82.75	2	6.89	0	0.00	0.000
Moderate deficit	0	0.00	2	13.33	7	46.67	1	6.67	5	33.33	
Mild deficit	1	3.57	1	3.57	19	67.86	1	3.57	6	21.43	
Good	2	1.30	0	0.00	65	42.48	45	29.41	41	26.80	
More intake	0	0.00	0	0.00	0	0.00	4	66.67	2	33.33	
Protein											
Heavy deficit	2	8.69	4	17.39	17	73.91	0	0.00	0	0.00	0.000
Moderate deficit	0	0.00	0	0.00	7	87.50	1	12.50	0	0.00	
Mild deficit	0	0.00	0	0.00	13	92.85	0	0.00	1	7.15	
Good	0	0.00	0	0.00	45	71.43	6	9.52	12	19.05	
More intake	5	4.00	0	0.00	33	26.40	46	36.80	41	32.80	
Fat											
Heavy deficit	0	0.00	1	4.76	19	90.48	0	0.00	1	4.76	0.253
Moderate deficit	1	5.56	0	0.00	8	44.4	5	27.78	4	22.22	
Mild deficit	1	11.11	0	0.00	6	66.67	1	11.11	1	11.11	
Good	0	0.00	3	3.80	27	34.18	22	27.85	27	34.18	
More intake	3	2.88	0	0.00	55	52.88	25	24.04	21	20.19	
Carbohydrate											
Heavy deficit	5	6.94	2	2.78	38	52.78	16	22.22	11	15.28	0.821
Moderate deficit	0	0.00	0	0.00	18	52.94	7	20.59	9	26.47	
Mild deficit	0	0.00	0	0.00	12	36.36	7	21.21	14	33.33	
Good	0	0.00	1	2.22	5	11.11	22	48.89	17	37.78	
More intake	0	0.00	1	2.12	42	89.36	1	2.13	3	6.38	

Table 2 shows a relationship between energy and protein intake and the nutritional status of Muhammadiyah Elementary School children in Gresik Regency with a p-value of <0.000 for each. It is known that 153% of them are in the good group regarding carbohydrate intake. By this number, 42.48% of them are in the nutritional status category, 29.41% are overweight, and 26.80% are obese. The energy intake category is good if it reaches a percentage of 90-119%, meaning that if energy intake exceeds 100%, it is still considered good intake if it does not exceed 119%[21]. If it happens further, it can become an energy imbalance and cause overweight

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*

or obesity[32]. This incident is the same as the research results from SDN Dukuhsari, Sidoarjo Regency, and SDN Ketabang 1, Surabaya City, which show a significant relationship between energy intake and nutritional status[9,33].

A mismatch between consumption patterns can result in a lack or excess of nutrients entering the body. Besides depending on food intake, the energy balance can be supported by energy expenditure from physical activity. A child being active in daily activities can keep expenditure levels to balance body mass index and reduce the risk of being overweight. The benefits of physical activity are to help use up accumulated fat mass in the body and strengthen muscle mass, thereby preventing excessive fat deposits in the body[34,35].

Apart from requiring adequate physical activity and participation, adding and strengthening muscle mass also requires support from adequate nutritional intake, especially protein. Table 2 shows that more than half of respondents fall into the category of excessive protein intake, including 36.80% overweight, 32.80% obese, and 26.40% well-nourished. The previous research indicates a significant relationship between protein intake and nutritional status at SDN Dukuhsari Sidoarjo Regency and SDN Ketabang 1 Surabaya City[9,32].

Protein is a very important nutrient and plays a role in the growth period, including for school-aged children. However, excessive protein intake can also have an impact on being overweight. If the body has excess protein, it will be stored as fat[4]. The source of protein that the body has consumed will be held in the form of muscle if supported by sufficient activity. Still, if there is no balancing activity, it will automatically be stored in the form of triglycerides, which increase fat mass and obesity[36]. The results of several studies also state that excess protein intake will be stored as fat by the body[37,38]. If it happens, it is necessary to increase physical activity, so that weight increases due to increased muscle mass to support a child's growth.

Fats and carbohydrates are important macronutrients for school-age children besides protein. However, if both are consumed inappropriately, whether more or less than what they are needed, it will also cause nutritional problems. Based on Table 2, it can be seen that there is no relationship between fat and carbohydrate intake and the nutritional status of Muhammadiyah Elementary School children in Gresik Regency, with p-values of 0.253 and 0.821, respectively. The results of this study are the same as previous research, namely that fat and carbohydrate intake is not significantly related to nutritional status in elementary school children at SDN 1 Tempuran Karawang, SDN 1 Pangkajene, and SDN 126 Palembang[39],[12],[27]. Almost half of the respondents had excessive fat intake (104 respondents). By this number, 52.88% of them were included in good nutrition; this figure is greater than overweight (24.04%) and obesity (20.19%). Excessive fat intake comes from animal or protein processed by frying. Apart from that, high-fat snacks can also increase the amount of fat intake. It is known that the snacks frequently consumed by respondents are sausages, which, apart from containing fat, they also have high levels of sodium that impact body health if consumed excessively[40].

Foods containing fat generally improve the taste and do not easily make someone feel full, causing people's desire to continue consuming them. Fat can accumulate in unlimited amounts in the body, so if it is not balanced with good oxidation activity from physical activity, it will be stored in the body and cause excess weight[41]. If children with good nutritional status often consume excessive sources of fat, they may at risk of becoming overweight[41]. Besides, carbohydrate intake can also be converted into fat if it is consumed excessively. It is known that carbohydrate intake is quite varied, namely 89.36% are included in excessive carbohydrate intake and have good nutritional status, but as many as 38 respondents (52.78%) with good nutritional status included in severe deficit carbohydrate intake. The results of the food recall found that some children liked noodles or nuggets as a complement to white rice, some liked macaroni snacks, and others. However, some children say they do not like rice, they are already full of protein sources, such as chicken, eggs, or milk. Carbohydrates need to be consumed in sufficient quantities, so they are not hurt the body. Apart from being a source of glucose, carbohydrates also play a role in maintaining healthy intestinal function, especially non-starchy carbohydrates (fiber)[4].

The results of this research provide an overview of the nutritional intake and status of children at school age in location that are close to urban areas. This overview can be used as a reference in preparing nutrition programs, especially for school-age children. However, several factors related to children's nutritional status still need to be studied further, especially other variables influencing being overweight, such as physical activity level, sleep patterns, school supplies, the type and number of snacks chosen daily, and other factors. Further studies are needed to prevent nutritional problems in the school-age group, especially in the Gresik Regency area.

CONCLUSIONS

There was a significant relationship between energy and protein intake and the nutritional status of school children, but fat and carbohydrate intake with nutritional status did not produce a significant relationship at Muhammadiyah Elementary School, Gresik Regency. There is a need for further research regarding several factors that are closely related to children's nutritional status, especially variables that influence overweight, such as physical activity level, sleep patterns, school supplies, the type and amount of snacks consumed every day, and other factors. It is necessary to provide healthy food containing complete nutrition in school canteens to meet the nutritional needs of school children, as well as reduce snacks that are high in energy, sugar, and fat, such as fast foods.

ACKNOWLEDGEMENTS

The author would like to express her gratitude to the schools where the research occurred, namely SD Muhammadiyah 1, 2, and 3 of Gresik District, SD Muhammadiyah 2 GKB, and SD Muhammadiyah Manyar.

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*

Thanks are also expressed to all respondents and parties who have assisted in this research.

Conflict of Interest and Funding Disclosure

All authors have no conflict of interest regarding this article.

Author Contributions

DM: conceptualization, investigation, methodology, supervision, writing–review and editing, writing–original draft; AR: conceptualization, investigation, methodology, supervision, writing–review and editing.

REFERENCES

1. Hardinsyah; Supariasa, I. D. N. *Ilmu Gizi Teori & Aplikasi*. (Penerbit Buku Kedokteran EGC, 2017).
2. Riani, Syafriani & Syahrial. Pengaruh Kreasi Singkong Sebagai Pangan Jajanan Anak Sekolah Terhadap Pemenuhan Kebutuhan Energi dan Zat Gizi Anak Sekolah Dasar Kabupaten Kampar Tahun 2019. *J. NERS* **3**, 13–21 (2019).
3. Adriani, Merryana & Wirjatmadi, B. *Peranan Gizi dalam Siklus Kehidupan*. (Kencana Prenada Media Grup, 2014).
4. Almatsier, S. *Prinsip Dasar Ilmu Gizi*. (PT Gramedia Pustaka Utama, 2016).
5. Anugraheni, D. D. & Mulyana, B. Kontribusi Bekal Makanan dan Total Energi terhadap Status Gizi pada Anak Sekolah Dasar The Contribution of Packed Lunch and Energy Total to Nutritional Status in Elementary School Students. *Amerta Nutr.* 52–57 (2019) doi:10.20473/amnt.v3.i1.2019.52-57.
6. Spinelli, A. *et al.* Prevalence of severe obesity among primary school children in 21 European countries. *Obes. Facts* **12**, 244–258 (2019).
7. Zhang, X. *et al.* Prevalence of overweight and obesity among primary school-aged children in Jiangsu Province, China, 2014-2017. *PLoS One* **13**, 2014–2017 (2018).
8. Balitbangkes RI. Laporan Nasional Riset Kesehatan Dasar 2018. *Badan Penelitian dan Pengembangan Kesehatan* 674 at http://labdata.litbang.kemkes.go.id/images/download/laporan/RKD/2018/Laporan_Nasional_RKD2018_FINAL.pdf (2018).
9. Ermona, N. D. N. & Wirjatmadi, B. Hubungan Aktivitas Fisik Dan Asupan Gizi Dengan Status Gizi Lebih Pada Anak Usia Sekolah Dasar Di Sdn Ketabang 1 Kota Surabaya Tahun 2017. *Amerta Nutr.* **2**, 97 (2018).
10. Wilkinson, J. Comparison of packed school lunches of boys and girls in primary schools in East London. 1–213 (2015).
11. A, B. D. & M, R. Nutritional status impacting academics among school children in selected schools of North Chennai. *J. Diabetol.* **14**, 161–165 (2023).
12. Asmin, A., Arfah, A. I., Arifin, A. F., Safitri, A. & Laddo, N. Hubungan Pola Makan Terhadap Status Gizi Anak Sekolah Dasar. *FAKUMI Med. J. J. Mhs. Kedokt.* **1**, 54–59 (2021).
13. Muhsen, K. *et al.* Intake at School Age with Obesity in 10- to 12-Year-Old. *MDPI Nutr.* **13**, 2106 (2021).
14. Oktaria, R. Intervensi Pendidikan Gizi Terhadap Body Mass Index (Bmi) Pada Anak Usia Sekolah Dengan Obesitas: A Systematic Review. *J. Ilmu-Ilmu Kesehat.* **9**, 27–37 (2023).
15. Caballero, B., Vorkoper, S., Anand, N. & Rivera, J. A. Preventing childhood obesity in Latin America: an agenda for regional research and strategic partnerships. *Obes. Rev.* **18**, 3–6 (2017).
16. Riskesdas. *Laporan Provinsi Jawa Timur RISKESDAS 2018*. *Kementerian Kesehatan RI* (2018).
17. Nagari, R. K. & Nindya, T. S. Tingkat Kecukupan Energi, Protein Dan Status Ketahanan Pangan Rumah Tangga Berhubungan Dengan Status Gizi Anak Usia 6-8 Tahun. *Amerta Nutr.* **1**, 189 (2017).
18. Qamariyah, B. & Nindya, T. S. Hubungan Antara Asupan Energi, Zat Gizi Makro dan Total Energy Expenditure dengan Status Gizi Anak Sekolah Dasar. *Amerta Nutr.* **2**, 59 (2018).
19. Hasanah, Z., Sholikhah, D. M. & Supriatiningrum, D. N. Hubungan Pengetahuan Gizi, Body Image Dan Konsumsi Makanan Cepat Saji Dengan Status Gizi Remaja Putri Di Sma Kecamatan Gresik. *Ghidza Media J.* **4**, 45 (2022).
20. Kemenkes RI. *Peraturan Menteri Kesehatan RI Terkait Angka Kecukupan Gizi yang Dianjurkan untuk Masyarakat Indonesia*. (Kemenkes RI, 2019).
21. Hardinsyah, Sulaeman A, Soekatri M, R. H. Ringkasan Angka Kecukupan Gizi (AKG) yang Dianjurkan Bagi Orang Indonesia Tahun 2012. *Widyakarya Nas. Pangan dan Gizi* 1–26 (2012).
22. Supariasa, I. D. N. *Penilaian Status Gizi*. (Penerbit Buku Kedokteran EGC, 2016).
23. Kemenkes RI. *Peraturan Menteri Kesehatan RI tentang Standar Antropometri Anak*. *Kemenkes RI* vol. 2507 1–9 (2020).
24. Rosyidah, Z., Ririn Andrias, D. & Gizi Kesehatan Fakultas Kesehatan, D. Jumlah Uang Saku Dan Kebiasaan Melewatkan Sarapan Berhubungan Dengan Status Gizi Lebih Anak Sekolah Dasar. 1–6 (2013).
25. Desi, D., Suaebah, S. & Dwi Astuti, W. Hubungan Sarapan, Uang Saku dengan Jajanan Di SD Kristen Immanuel II Kubu Raya. *J. Vokasi Kesehat.* **4**, 103 (2018).

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*

26. BPOM. Pedoman Pangan Jajanan Anak Sekolah untuk Pencapaian Gizi Seimbang Bagi Orang Tua, Guru dan Pengelola Kantin. *Direktorat Stand. Prod. Pangan Deputi Bid. Pengawas. Keamanan Pangan Dan Bahan Berbahaya Badan Pengawas Obat Dan Makanan Republik Indones.* 37 (2018).
27. Maesarah, Dajafar, L. & Adam, D. Pola Makan dan Kejadian Obesitas pad Anak Sekolah Dasar di Kabupaten Gorontalo. *Ghidza J. Gizi dan Kesehat.* **3**, 55–58 (2019).
28. Abresa, P. Asupan Zat Gizi Makro , Makanan Jajanan , dan Aktivitas Fisik dengan Status Gizi Anak SD. *J. Pustaka Padi* **2**, 1–7 (2023).
29. Khan, D. S. A. *et al.* Nutritional Status and Dietary Intake of School-Age Children and Early Adolescents: Systematic Review in a Developing Country and Lessons for the Global Perspective. *Front. Nutr.* **8**, (2022).
30. Yusuf, K., Wahyuni, F. & Rate, S. Lifestyle with the Incidence of Overweight in Elementary School Children in Pangkep Regency in 2020. *Lifestyle with Incid. Overweight Elem. Sch. Child. Pangkep Regency 2020.* **13**, 146–154 (2021).
31. Eze, J. N., Oguonu, T., Ojinnaka, N. C. & Ibe, B. C. Physical growth and nutritional status assessment of school children in Enugu, Nigeria. *Niger. J. Clin. Pract.* **20**, 64–70 (2017).
32. Saavedra, J. M. & Prentice, A. M. Nutrition in school-age children: a rationale for revisiting priorities. *Nutr. Rev.* **81**, 823–843 (2023).
33. Zuhriyah, A. Konsumsi Energi, Protein, Aktivitas Fisik, Pengetahuan Gizi dengan Status Gizi Siswa SDN Dukuhsari Kabupaten Sidoarjo. *J. Gizi Univ. Negeri Surabaya* **01**, 45–52 (2021).
34. Farpour-Lambert, N. J. *et al.* Physical Activity Reduces Systemic Blood Pressure and Improves Early Markers of Atherosclerosis in Pre-Pubertal Obese Children. *J. Am. Coll. Cardiol.* **54**, 2396–2406 (2009).
35. Liu, B., Liu, X., Wang, Q., Yan, W. & Hao, M. Nutritional status, food consumption, lifestyle, and physical fitness in rural and urban elementary school children in Northeast China. *Front. Nutr.* **9**, (2022).
36. Suryandari, B. D. & Widyastuti, N. Hubungan Asupan Energi dengan Obesitas Pada Remaja. *Progr. Stud. Ilmi Gizi Fak. Kedokt. Univ. Diponegoro* **4 (2)**, 492–298 (2015).
37. Pramono Dwi Sasmito. Hubungan Asupan Zat Gizi Makro (Karbohidrat, Protein, Lemak) Dengan Kejadian Obesitas Pada Remaja Umur 13-15 Tahun di Propinsi DKI Jakarta (Analisis Data Sekunder Riskesdas 2010). *Nutr. Diaita* **7**, 8 (2015).
38. Mestuti H, K. & Fitranti, D. Y. Faktor Risiko Kejadian Overweight Pada Anak Stunting Usia Sekolah Dasar Di Semarang Timur. *J. Nutr. Coll.* **3**, 134–141 (2014).
39. Gurnida, D. A. *et al.* Korelasi antara tingkat kecukupan gizi dengan indeks massa tubuh siswa sekolah dasar kelas 4, 5, dan 6. *Padjadjaran J. Dent. Res. Students* **4**, 43 (2020).
40. Juliana, maulida., R. S. Nasution & and Nuzlia, C. Analisis Kandungan Nitrit Pada Produk Daging Olahan Menggunakan Spektrofotometri UV-Vis. *J. Amin.* **2**, 71–78 (2020).
41. Dewi, P. L. P. & Kartini, A. Hubungan Pengetahuan Gizi, Aktivitas Fisik dan Asupan Energi, Asupan Lemak dengan Kejadian Obesitas pada Remaja SMP. *J. Nutr. Coll.* **6**, 257 (2017).

Copyright ©2023 Faculty of Public Health Universitas Airlangga
Open access under a CC BY – SA license | Joinly Published by IAGIKMI & Universitas Airlangga

How to cite: *Sholikhah, D. M., & Rahma, A. (2024) The Relationship between Energy and Macronutrient Intake with Nutritional Status of Muhammadiyah Elementary School Children in Gresik Regency: Hubungan Asupan Energi dan Zat Gizi Makro dengan Status Gizi Anak Sekolah Dasar Muhammadiyah di Kabupaten Gresik. Amerta Nutrition, 8(2), 239–247.*