

Relations of Food Pattern and Physical Activity with Academic Achievement and Cognitive Function

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ABSTRACT

Introduction: The results of the initial survey showed that there were seven children with low food pattern and moderate physical activity was having a cognitive function and low academic achievement at school, and three children with good food pattern and moderate physical activity were having good cognitive and high academic achievement in school. This study was to determine the relations of food patterns and physical activity with academic achievement and cognitive function.

Methods: This study was a cross-sectional study that was conducted at Elementary School 2 Blangkeujeren, West Labuhanhaji Sub-district, South Aceh District from March 2017 to June 2017. This study used a total sampling design is 81 students. Subjects are all students in grade five (42 students) and six (39 students). Data were collected by using questionnaires include Food Frequency Questionary (FFQ), Food Recall 24 hours, Physical Activity Level (PAL). Last year's report card value and the Mini-Mental State Examination (MMSE) were used to assess cognitive children.

Results: The relationship between the type and the amount of macro and micronutrient intake obtained p-value<0.05. This study also showed a relationship between food patterns and cognitive function in children.

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Based on the research results, there is a relationship between physical activity and academic achievement ($p < 0.05$). There is a relationship between physical activity and cognitive function in children.

Conclusion: There is a relationship between food patterns, physical activity, academic achievement, and cognitive function.

Keywords: Cognition; micronutrients; child; students

Introduction

Based on Riskesdas 2010, 20.3% to 50% of school-age children and adolescents, and also an average of 36.7% of adults were not breakfasted in Indonesia. As many as 28.9% of school children simply consume drinks at breakfast, such as water, milk, or tea and 45.9% consume low-quality breakfast ¹.

The results of the study showed that the main problems for parents, especially difficulty mothers give breakfast to their children due to difficulty to wake up a child from sleep (59%), it is difficult to take the child to breakfast (19%) and do not to finish their breakfast (6%). Academic achievement is inseparable from learning activities, because learning is a process, while achievement is the result of the learning process. A person's cognitive intelligence is closely related to food pattern and physical activity ².

A food pattern will affect intelligence level and ability a person to get a lesson at school so that a person who has a good food pattern will have better capture power than a child with a bad food pattern. School-age children belong to a group that is vulnerable to nutrition. At this age of nutrient intake is needed to support growth and development. Poor and unbalanced food patterns will cause children to lose essential nutrients. Many parents do not realize that a balanced food pattern can provide benefits to cognitive function and academic achievement ³.

The results of the initial survey conducted at Elementary school Blankeujeren, West Labuhanhaji Sub-district, South Aceh District, on 10 children showed that there were 7 children (70%) with poor food pattern and regular physical activity was having a cognitive function and poor performance in school, and only 3 children (30%) with good food pattern and normal physical activity is having good cognitive and achievement function in school. The study aims to determine the relationship between food pattern and physical activity with academic achievement and cognitive function in students of grades five and six at Elementary School 2 Blangkeujeren, West Labuhanhaji Sub-district, South Aceh District.

Methods

This study was a cross-sectional study was conducted at Elementary School 2 Blangkeujeren, West Labuhanhaji Sub-district, South Aceh District from March 2017 to June 2017. This study used a total sampling design is 81 students. Subjects are all students in grade five (42 students) and six (39 students) at Elementary School 2 Blangkeujeren, West Labuhanhaji Sub-district, South Aceh District in 2017.

The subjects were students age 10-12 years old (n=75) and 13-15 years old (n=6). Data were collected using the questionnaire. Subjects were interviewed according to a questionnaire. The questionnaires included Food Frequency Questionary, Food Recall 24 hour Form, Physical Activity Level (PAL), and Mini-Mental Status Exam (MMSE).

Food Frequency Questionary. This is to evaluate the type of food include complete and incomplete. Complete is children who consume staple food, side dishes, vegetables, and fruits daily. Incomplete is children who do not consume staple food, side dishes, vegetables, and fruits in daily. The frequency of eating is measured using the Food Frequency form with the following categories: often (4-6 times/week), sometimes (1-3 times/week), rarely (1-2 times/month), and never.

Physical activity is measured using Physical Activity Level (PAL) instrument with the categories: light (sedentary lifestyle) with score PAL 1.40-1.69, moderate (active or moderately active lifestyle) with score PAL 1.70-1.99 and heavy (vigorous or vigorously active lifestyle) with score PAL 2.00-2.40. Instruments used academic achievement is the value of report cards of the school year 2017/2018. Academic achievement is categorized into high is score 75 – 100 and low is score ≤ 75 .

Measurement of the cognitive function uses a mini-mental state examination (MMSE). MMSE includes orientation, attention-concentration, memory, language, and constructional in 30 points. The score contains score >23 is normal, score 18-22 is probable cognitive impairment, and score <17 is definite cognitive impairment.

Univariate analysis was used to describe the characteristics of the basic data of the study. Chi-Square (X²) test was used to the relation between 2 variables.

Results

From 81 subjects, 70 children (86.4%) had consumed incomplete on type of food and 11 children (13.6%) had consumed complete food consisted of staple food and a side dish or staple food, side dish, and vegetables. The carbohydrate adequacy level in the good category was 23.45% and the less category was 76.54%. Meanwhile, the protein adequacy level of children in the good category was 19.75% and the less category was 80.25% (Table 1).

Subjects have the Fe sufficiency level in the good category was 9.88% and the low category was 90.12%. Subjects who have probable cognitive impairment were 50.6% and definite cognitive impairment was 3.7% (Table 1).

All children consume staple food (i.e. rice) was 4-6 times/week. Furthermore, the staple food that children like to consume is noodles (65.4%) with a frequency of 1-3 times/week. The most consumed side dishes come from animal protein, namely eggs (43.2%) was 4-6 times/week. Fish was consumed as much as 76.5% 1-3 times/week. The type of vegetable that is mostly consumed by children is mustard greens with a frequency of 4-6 times/week as much as 39.5% (Table 2).

Table 1. Characteristic of students

1	Food pattern based on the type of food in children		
Type of food	n (81)	%	
complete	11	13.6	
incomplete	70	86.4	
2	Distribution of macronutrient in children		
Adequacy of carbohidrat	n (81)	%	
less	62	76.54	
good	19	23.45	
over	0	0	
Adequacy of protein	n (81)	%	
less	65	80.25	
good	16	19.75	
over	0	0	
3	Distribution of micronutrient in children		
Adequacy of Fe	n (81)	%	
less	73	90.12	
good	8	9.88	
4	Distribution of physical activity in children		
Physical activity	n (81)	%	
light	21	25.9	
moderate	46	56.8	
heavy	14	17.3	
5	Distribution of academic achievements in children		
Academic achievement	n (81)	%	
high	35	43.2	
low	46	56.8	
6	Distribution of cognitive functions in children		
Cognitive function	n (81)	%	
normal	37	45.7	
probable cognitive impairment	41	50.6	
definite cognitive impairment	3	3.7	

There are 86.4% of children who eat incomplete foods have low academic achievement was 55.6% and 13.6% of children who eat complete foods that have high academic achievement was 30.9%. The results of statistical tests using the chi-square test showed a relationship between types of food and academic achievement ($p=0.001$). (Table 3)

From 76.6% of children who have less carbohydrate adequacy, 56.8% had low academic achievement. Meanwhile, 23.5% of the children with good carbohydrate adequacy had high academic achievement as much as 23.5% in table 3.

From 80.2% of children with less protein adequacy have low learning achievement as much as 56.8%. Meanwhile, children with good protein adequacy had high learning achievement as much as 19.8% (Table 3).

Table 2. Distribution of type of food and eating frequency

Type of food	Eating frequency							
	4-6 times/week		1-3 times/week		1-2 times/week		Never	
	N	%	N	%	N	%	n	%
Rice	81	100	0	0.0	0	0.0	0	0.0
Noodles	22	27.2	53	65.4	6	7.4	0	0.0
Bread	19	23.5	18	22.2	44	54.3	0	0.0
Egg	35	43.2	46	56.8	0	0.0	0	0.0
Tofu	41	50.6	35	43.2	5	6.2	0	0.0
Tempeh	25	30.9	47	58	6	11.1	0	0.0
Fish	19	23.5	62	76.5	0	0.0	0	0.0
Shrimp	18	22.2	60	74.1	3	3.7	0	0.0
Chicken meat	0	0.0	16	19.8	65	80.2	0	0.0
Beef	0	0.0	3	3.7	66	81.5	12	14.8
Spinach	23	28.4	36	44.4	22	27.2	0	0.0
Kale	18	22.2	36	44.4	22	27.2	9	11.1
Mustard greens	32	39.5	19	23.5	24	29.6	6	7.4
Carrot	31	38.3	37	45.7	13	16	0	0.0
Guava	42	51.9	19	23.5	20	24.7	0	0.0
Papaya	21	25.9	36	44.4	24	29.6	0	0.0
Orange	19	23.5	34	42	28	34.6	0	0.0
Chiki/crackers	41	50.6	26	32,1	14	17,3	0	0.0
Candy	37	45.7	43	53,1	1	1,2	0	0.0
Biscuits	31	38.3	24	29,6	26	32,1	0	0.0

There were 90.1% of children with less iron adequacy have low academic achievement was 56.8%. Meanwhile, children who have good Fe adequacy had high academic achievement as much as 9.9%. Statistically using Fisher's Exact Test with p-value is 0.001 (Table 3).

There were 13.6% of children consume complete food have normal cognitive function as much as 12.3%. Meanwhile, 86.4% of children who consumed incomplete food had 50.6% probable cognitive impairment. This was statistically using the chi-square test with $p = 0.004$ in table 4.

Table 3. The relationship between food types, macronutrient, micronutrient, physical activity, and academic achievement

The relationship between food types and academic achievement					
Type of food	Academic achievement				p-value*
	High		Low		
	N	%	N	%	
Complete	10	12.3	1	1.2	0.001
Incomplete	25	30.9	45	55.6	
The relationship between macronutrient (carbohydrate) and academic achievement					
Carbohydrate adequacy	Academic achievement				p-value*
	High		Low		
	N	%	N	%	
Less	16	19.8	46	56.8	0.000
Good	19	23.5	0	0	
The relationship between macronutrient (protein) and academic achievement					
Protein adequacy	Academic achievement				P-value*
	High		Low		
	N	%	N	%	
Less	19	23.5	46	56.8	0.000
Good	16	19.8	0	0	
The relationship between micronutrient (Fe) and academic achievement					
Adequacy of Fe	Academic achievement				P-value*
	High		Low		
	N	%	N	%	
Less	27	33,3	46	56,8	0.001
Good	8	9,9	0	0	
The relationship between physical activity and academic achievement					
Physical Activity	Academic achievement				P-value*
	High		Low		
	N	%	N	%	
Light	13	16	8	9.9	0.005
Moderate	21	25.9	25	30.9	
Heavy	1	1.2	13	16	

From 76.5% of children with less carbohydrate adequacy, the majority had probable cognitive impairment as much as 49.4%. Meanwhile, 23.5% of children with good carbohydrate adequacy had normal cognitive function as much as 22.2% (Table 4).

From 25.9% of children doing the light physical activity, the majority have high academic achievement as much as 16% and 56.8% of children who do moderate physical activity majority have high academic achievement as much as 30.9% (Table 4).

Table 4. The relation based on food pattern, macronutrient, micronutrient, physical activity with cognitive function

The relationship of food pattern based on the type of food and cognitive function							
type of food	cognitive function						
	normal		probable cognitive		definite cognitive		p-value*
	n	%	n	%	n	%	
complete	10	12.3	1	1.2	0	0	
incomplete	26	32.1	41	50.6	3	3.7	
The relationship between carbohydrate adequacy and cognitive function							
carbohydrate adequacy	cognitive function						
	normal		probable cognitive		definite cognitive		p-value*
	n	%	n	%	n	%	
less	19	23.5	40	49.4	3	3.7	
good	18	22.2	1	1.2	0	0	
The relationship between protein adequacy and cognitive function							
protein adequacy	cognitive function						
	normal		probable cognitive		definite cognitive		p-value*
	n	%	n	%	n	%	
less	21	25.9	41	50.6	3	3.7	
good	15	18.5	1	1.2	0	0	
The relationship between Fe adequacy and cognitive function							
adequacy of Fe	cognitive function						
	normal		probable cognitive		definite cognitive		p-value*
	n	%	n	%	n	%	
less	31	38.3	39	48.1	3	3.7	
good	6	7.4	2	2.5	0	0	
The relationship between physical activity and cognitive function							
physical activity	cognitive function						
	normal		probable cognitive		definite cognitive		p-value*
	n	%	n	%	n	%	
light	12	14.8	9	11.1	0	0	
moderate	24	29.6	21	25.9	1	1.2	
heavy	1	1.2	11	13.6	2	2.5	

Discussion

We examined the relationship between food patterns and physical activity with academic achievement and cognitive function. The food pattern in this study was described based on the type of food, the amount of food, and the frequency of eating. Most of the subjects who ate an incomplete food had low academic achievement.

Based on the results, there is a relationship between food patterns and academic achievement in this study, this is probably based on the knowledge of parents in fostering a balanced food pattern in children so that it affects children's academic achievement. Food pattern is a reference that provides information about the kinds and amounts of food items eaten by one person each day and is a characteristic (habit) of eating for a particular group. Eating habits are the behavior of humans or groups of people in meeting their eating needs, including attitudes, beliefs, and food choices. Eating habits will affect a child's body. The growth and development of children reach their peak when the children enter elementary school age.

According to Piaget, elementary school children are categorized as vulnerable to nutrition. At this age, nutritional intake is needed to support children's growth and development. Children need nutrients and energy to concentrate on academic tasks at school and their high physical activity³.

Breakfast contributes to a third of the required nutritional intake. However, many children have the habit of skipping breakfast before they go to school for various reasons. Breakfast has many health benefits for growing children which can improve performance while learning in class⁴. A bad and unbalanced food pattern will cause losing the opportunity to get essential nutrients from food. A good food pattern and physical activity are associated with an increase in children's academic achievement². Breakfast is very important for children and adolescents because it has a negative impact on children's cognitive function when skipping breakfast so that it affects children's academic achievement⁵. The research was conducted by Ptomey et.al concluded that breakfast can be associated with increased academic achievement in elementary school children⁶.

There were 90.1% of children have less Fe adequacy, the majority had probable cognitive impairment as much as 48.1%. Fe is one of the micronutrients that has a role in improving the cognitive function of children, Fe/zinc is one of the micronutrients are associated with the growth and development of the brain⁷. If there is a deficiency of Fe will affect brain development, especially the first 2 years of life⁸. This is maybe why in this study the majority of subjects with Fe adequacy had probable cognitive impairment. Nyaradi et al said that consume enough micronutrients affects brain development, which can lead to increased academic achievement in children⁹. Meanwhile, according to Medina et al that the effect of zinc/Fe intake on cognitive function status was insufficient and inconsistent⁷.

Physical activity and exercise have positive benefits on children's cognitive because there is an increase in blood and oxygen flow to the brain so that the possibility of increasing concentration when learning in classroom¹⁰.

According to Donnelly et al, that increased physical activity does not have a negative impact on cognitive and academic achievement. Changing in brain structure and function lead to cognitive progress caused by physical activity among school-aged children¹¹. Optimal and sustainable glucose levels are needed so that children can have full concentration on learning and do not get easily tired or sleepy in the classroom. Stable glucose levels in the blood are excellent for learning, memory, and cognitive function. if there is a lack of glucose (hypoglycemic condition), it can affect the condition of the brain so that it can affect cognitive performance.¹².

The research limitation is this research only applies to the research population of grade 5 and 6 students at Elementary School 2 Blangkejeren, West Labuhanhaji Sub-district, South Aceh District in 2017.

Conclusion

There is a relationship between food patterns, physical activity, academic achievement, and cognitive function.

Conflicts of Interest

There are no conflicts of interest with the parties involved in this research activity

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