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RESEARCH

Anemia Status and Water Adequacy with Academic Performance of Obese Children in Bogor

Sanya Anda Lusiana[1 (corresponding author)], Budi Setiawan[2], Faisal Anwar[2]
[1]Department of Nutrition, Health Polythecnic of Jayapura, Indonesia
[2]Bogor Agricultural University, Bogor, Indonesia

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ABSTRACT

Abstract: The objective of this study was to analyze the association between anemia status and water adequacy with academic performance of obese students in elementary schools in Bogor City. The design of this study was cross-sectional and it was conducted in February 2014 until April 2015 in six state and private elementary schools with upper-middle socio-economic level. A total of 204 5th grade obese students and students with normal nutritional status were selected as participants using simple random sampling method. Differences between variables were analyzed by Mann-Whitney test. Correlation between variables was analyzed by chi-square test and logistic regressions test. The results showed that there were significant differences in pocket money and water adequacy between obese and normal students. Anemia anemia status and water adequacy were significantly related to academic performance ($p<0.05$). Factors affecting student academic performance were energy adequacy level, vitamin C adequacy level, anemia status and water adequacy. This study showed a low density of micronutrient intake in obese and normal students. One of the attempts to achieve good academic performance in elementary school children is by paying attention to their dietary intake, particularly vitamin and Fe. Water consumption, especially plain water, also needs to be noticed by the parents. In order to get better results and make a comparison, further studies can be conducted in different locations and other factors (infectious diseases, lifestyle, and intelligence quotient) should be included.
Keywords: academic performance, water adequacy, anemia status, elementary school students, obesity

INTRODUCTION

The main key of success of long-term national development can be seen from human resource development. One of efforts to create high-quality human resources is by giving attention to nutrition, health and education aspects in school-aged children (Kustiyah, 2005). Better access to education needs to be balanced with good health status and adequate nutrition, so that the school-aged children can maximize their potential to get maximum academic performance (Khomsan, 2012).

A habit of eating high-calorie foods in children without balanced nutrient intakes can lead to overweight within a certain period and eventually lead to obesity (Herlianty, 2003). The prevalence of overweight and obesity in children aged 6-12 years in Indonesia reached 9.2% in 2010 (Kemenkes, 2010) and increased to 18.8% in children aged 5-12 years in 2013 (Kemenkes, 2013). Obesity rate in urban areas is 10.4%, higher than rural areas (8.1%) (Kemenkes, 2010). A total of 7.7% of elementary school children in Bogor City were overweight (Hermina, 2007). A study by Madanijah et al. (2013) showed that 18.79% of elementary school children in Bogor City were overweight.

Great academic performance becomes one of human resource quality indicators in the field of education. Academic performance is affected by internal and external factors. One of the internal factors is physiological factor. Physiological aspects are related to physical condition of students. Weak organ conditions or illness can degrade the cognitive quality so that the students will not be able to recall the materials being studied. Therefore, they have to consume nutritious foods to stay healthy (Syah, 2014). Another physiological aspect that affects the academic performance is water adequacy. Studies on drinking habits and fluid intake in school children are still scarce. Mild dehydration, the loss of body fluids by 1-2 %, can lead to cognitive impairment, poor concentration, and reduced physical capacity (Jequier and Constant, 2010). This is also reinforced by a review of study which states that the loss of fluid by 1% can degrade the cognitive ability and learning concentration (Lieberhman, 2007).

Another problem faced by school children which also influences a child's academic performance is iron deficiency anemia. Anemia is often associated with cognitive, mental, and motor functions (Olney et al., 2009). It can cause the decrements in learning concentration (Muchtar, 2000), fatigue, lethargy, dizziness, impaired growth, decreased immune system, impaired cognitive function and slow psychomotor development (Lubis et al., 2008). Study on Mexican school children proved that anemic children had lower cognitive score by 1.28 point than non-anemic children (Kordas et al., 2004). Study on 5,398 children aged 6-16 years in USA reported that math scores of those with iron deficiency anemia were lower than the normal ones (Halterman et al., 2001).

Other studies showed that the average score of natural science subject of the anemic subjects was significantly lower than the non-anemic subjects (Hidayati et al., 2010).

This study aimed to analyze the association between anemia status and water adequacy with academic performance of obese elementary school children in Bogor City.

METHODS

Design, Time, and Location

This study was part of the study by Ekawidayani et al. in 2013 funded by Neys-van Hoogstraten Foundation (NHF) entitled "Overweight among school children: Its causes and effects on physical fitness, anemia, and academic performance". The design of this study was cross-sectional and it was conducted in February 2014 until April 2015 in six state and private elementary schools with upper-middle socio-economic level, namely Polisi 1 State Elementary School, Polisi 4 State Elementary School, Polisi 5 State Elementary School, Bantarjati 9 State Elementary School, At-Taufiq Elementary School, and Pertiwi Elementary School.

Sample Size and Sampling Method

Participants in this study were obese students and students with normal nutritional status from the 5th grade. The number of participants in this study was calculated based on α=5% ($Z\alpha$=1.96), d=0.05, prevalence of overweight elementary school children in Bogor City (p)=18.79%7, q=(1-p), and the number of 5th grader population in six elementary schools (N) = 822 students. The formula used in this study was as follows (Lemeshow et al., 1990): The number of students observed in this study were 204 and they were selected using simple random sampling method.

Data Type and Collection Methods

Types of data collected in this study were in the form of primary and secondary data. Primary data collected consisted of parental characteristics, students' characteristics, hemoglobin (Hb) level, and recall of food and beverages consumed for 3x24 hours. These data were collected through direct observation, interview using a questionnaire, anthropometric measurements, and blood sampling. Secondary data included data on general description of study location and academic performance acquired from students' exam results.

Student Characteristic Measurement

Students' characteristics were collected by a validated questionnaire. The questionnaire was validated by reliability and validity tests. The questionnaire consisted of age, sex and allowance. The gender was classified as boy and girl while the allowance was classified as < 9000 IDR/day, and ≥ 9000 IDR/day.

Anthropometric Measurement

Anthropometric data was assessed by using standard procedure. Height was measured by using microtoise with 0.1 cm accuracy. The participant was weighed by using digital scale with 0.1 kg accuracy. The measurement tools were calibrated every day before use. Weight and height data were assessed to determine body mass index (BMI) of participants. BMI of each participant was calculated using Z-score. Statistical analyses performed in this study were descriptive and inferential statistics. Based on the criteria determined by Indonesian Ministry of Health, the participants with +1<SD≤+2 and > +2 SD BMI-for-age were classified as obese and those with -2<SD≤+1 BMI-for-age were classified as normal (Kemenkes, 2013).

Hemoglobin Measurement

Hemoglobin measurement method was first submitted to Faculty of Medicine, University of Indonesia to acquire ethical clearence. The method was approved and the number series are 222/H2.FI/ETIK/2014. Hemoglobin was measured using hemocue with cyanmethemoglobin method and the blood were collected from a finger-prick. The procedure was performed by a medical personnel from Bogor Agricultural University.

Energy Density and Nutrient Intake

Dietary energy density was defined as total amount of energy contained in 100 gram of a food consumed (Barclay, 2008). Dietary energy density score was calculated using dietary energy density (DED) method which compares the total amount of energy intake with total weight of food (kcal/g) (Wang et al., 2013). DED was categorized as follows: high (4-9 kcal/g of food), moderate (1.5-4 kcal/g of food), low (0.6-1.5 kcal/g of food) and very low (0-0.6 kcal/g of food) (Rolls, 2009). The lower the score, the better the nutritional quality of the food and vice versa.

Nutrient density was calculated by comparing the nutrient intake with energy intake (kcal) and the result was then multiplied by 1000 kcal. Nutrient density was determined using the standard from the previous study (Drewnowski, 2005) and the scores were then categorized by FAO's standard. The scores of protein intake density were divided into three categories as follows: low (< 20 g/1000 kcal), adequate (20-40 g/1000 kcal) and high (> 40 g/1000 kcal). Vitamin A intake density scores were categorized as adequate (700-1000 µg/1000 kcal) and inadequate (< 700-1000 µg/1000 kcal). Intake density scores of vitamin C were categorized as adequate (50-60 mg/1000 kcal) and inadequate (< 50-60 mg/1000 kcal). Iron intake density scores were divided into two categories as follows: adequate (7-40 mg/1000 kcal) and inadequate (< 7-40 mg/1000 kcal) (WHO, 1998; Drewnowski, 2005).

Water Adequacy

Individual water adequacy level per day was calculated by comparing the individual total fluid intake with the fluid requirement of each individual in a day and presented in the form of percentage (%). Individual requirement per day was calculated based on the actual body weight (ABW) (Astuti et al., 2014). In calculating the nutrient requirement level (NRL), the maximum score was truncated at 100 in order to minimize the compensation between low and high scores mathematically because different nutrients could interact with one another but could not substitute each other biologically (Adyas, 2011).

Academic Performance

Academic performance is an important school output and a measurement tool for student's cognitive abilities. There are various ways to determine the academic performance but the most commonly used is written test (Widayati, 2009). In this study, the academic performance was assessed from the average score of three subjects (Mathematics, Natural Sciences, and Indonesian Language) representing the numeracy, logical reasoning and language skills.

Data Processing and Analysis

Data were processed through several stages, namely editing, coding, processing, and cleaning. Age and sex was input to generated z-scored using World Health Organization growth references. Inferential statistics consisted of Mann-Whitney test to analyze the differences in allowance, anemia status, water adequacy, and academic performance between obese and normal students; and logistic regression test to analyze the factors affecting academic performance of obese students. The results considered to be significant if $p<0.05$.

RESULTS

Characteristics of Students

Table 1. Distribution of obese and normal students' characteristics

Variable	Obese	Normal	Total	p-value
Age (years)				
▪ < 12	2 (2.0%)	4 (66.7%)	6 (2.9%)	
▪ ≥ 12	100 (98.0%)	98 (96.1%)	198 (97.1%)	
- Pocket money (Rp/day)				
▪ ≥ 9,000	65 (63.7%)	48 (47.1%)	113 (55.4%)	
▪ < 9,000	37 (36.3%)	54 (52.9%)	91 (44.6%)	0.017*
Mean±SD	10580 ± 6052	8402 ± 3697		

*Significant at α<5%

Most of the obese students (98%) and normal students (96.1%) were ≥ 12 years (98.0%). Children aged 6-12 years undergo a more stable growth and development period than infants and under-five children. Their physical growth seems slower but their motor, cognitive and socio-emotional development starts to mature. This period is indicated by puberty where girls experience it first than the boys and they also experience growth spurt; thus, various nutritional problems such as obesity is more common in this age (Brown et al., 2011).

Student's pocket money in this study was defined as daily pocket money used by students to buy snacks and did not include money spent for transportation (public transport only). Obese students had more pocket money than normal students. Most of them (63.7%) had at least Rp 9.000,- while more than half of normal students (52.9%) had less than Rp 9.000,-.

There was no significant difference in age but there was a significant difference ($p<0.05$) in pocket money between obese and normal students, as presented in Table 1. This was presumably due to bigger amount of pocket money in obese students than normal students. Giving large amounts of pocket money allowed the children to buy energy-dense foods and beverages (Suryaalamsyah, 2009). These results were consistent with the study by Karimah (2014) which showed that the average pocket money of overweight children was greater than normal children.

Characteristics of Students' Families

Table 2. Distribution of obese and normal students' family characteristics

Variable	Obese	Normal	Total	p-value
Family size				
▪ Small family (≤ 4 people)	45 (44.1%)	47 (46.1%)	92 (45.1%)	0.888
▪ Big family (≥ 5 people)	57 (55.9%)	55 (53.9%)	112 (54.9%)	
Paternal education				
▪ < Senior high school	28 (27.5%)	22 (21.6%)	50 (24.5%)	0.416
▪ ≥ Senior high school	74 (72.5%)	80 (78.4%)	154 (75.5%)	
Maternal education				
▪ < Senior high school	31 (30.4%)	41 (40.2%)	72 (35.3%)	0.187
▪ ≥ Senior high school	71 (69.6%)	61 (59.8%)	132 (64.7%)	
Paternal occupation				
▪ Private employee	77 (75.5%)	87 (85.3%)	164 (80.4%)	0.112
▪ Civil servants	25 (24.5%)	15 (14.7%)	40 (19.6%)	
Maternal occupation				
▪ Unemployed	55 (53.9%)	57 (55.9%)	112 (54.9%)	0.888
▪ Work	47 (46.1%)	45 (44.1%)	92 (45.1%)	
Parental income				0.551
≥ Rp 9,000,0000/month	36 (35.3%)	31 (30.4%)	67 (32.8%)	
< Rp 9,000,0000/month	66 (64.7%)	71 (69.6%)	137 (67.2%)	

Characteristics of students' families consisted of family size, parental education, occupation and income. Family size of most of the obese students (55.9%) and normal students (53.9%) were categorized as big. According to the previous study, overweight and/or obese were associated with small family size (Alemu et al., 2014). This was probably due to the large number of family members that would affect the distribution of food received by each person. Paternal education of most students in this study, either obese or normal students, was in the category of "at least senior high school graduates"; 56.9% and 57.8%, respectively. Maternal education of most students, either obese or normal students, was also in the same category as paternal education; 69.6% and 59.8%, Education determines of how big the contribution of parental knowledge in observing the nutritional status of their children. According to the study by Fikawati and Syafiq (2007), nutritional knowledge or nutrition-related information are expected to increase along with educational level. Parental occupation has a huge effect on children's eating behavior (Suhardjo, 2005). Type of parental occupation will have a huge impact on income. This shows that occupation can affect eating behavior indirectly through income. The results of this study showed that most of obese students (75.5%) and normal students (85.3%) had a father working in private sector. Most of obese students (53.9%) and normal students (55.9%) had mothers who did not work outside the home or know as housewives. There was a tendency that working mothers would have obese children. Work would affect the interaction with children. Busy parents usually paid less attention to their children so that their children's nutrient intake was less controlled (Karimah, 2014). If the mother also acted as a breadwinner in the family, she would spend most of her time outside the house. This would make her feel guilty to their children, especially the meal preparation. Working mothers would often buy food outside for their children and usually the choice was limited to fast food (WHO, 2000). Based on mean total income of both parents, parental income was categorized as high (≥ Rp 9,000,000,-/month) and low (< Rp 9,000,000,-/month). Most of obese students (64.7%) and normal students (69.6%) had parents with a total income of less than Rp 9,000,000/month). There was a tendency that low-income parents had obese children. This finding was supported by the previous study indicating that the prevalence of overweight and obesity in school children in Delhi, India was higher in high-income group than moderate-income and low-income groups (Kaur et al., 2008).

All characteristics of students' families (in obese and normal students) had no significant association with nutritional status of the students (Table 2). These results were consistent with the study by Karimah (2014)

which showed that family characteristics had no significant association with nutritional status of obese and normal students.

Energy Density and Nutrient Intake

Table 3. Dietary energy density and nutrient intake distribution in obese and normal students

Dietary energy density (DED) and nutrient intake	Obese	Normal	Total	p-value
Energy				
▪ High DED (1.5-9 kcal/g food)	77 (75.5%)	60 (58.8%)	137 (67.2%)	0.011*
▪ Low DED (0-1.5 kcal/g food)	25 (24.5%)	42 (41.2%)	67 (32.8%)	
Protein intake				
▪ Low (< 20 g/1000 kcal)	11 (10.8%)	7 (6.9%)	18 (8.8%)	0.323
▪ Adequate (≥ 20 g/1000 kcal)	91 (89.2%)	95 (93.1%)	186 (91.2%)	
Vitamin A intake				
▪ Inadequate (< 700 – 1000 µg RE)	97 (95.1%)	95 (93.1%)	192 (94.1%)	0.552
▪ Adequate (700 – 1000 µg RE)	5 (4.9%)	7 (6.9%)	12 (5.9%)	
Vitamin C intake				
▪ Inadequate (< 50-60 mg)	96 (94.1%)	99 (97.1%)	195 (95.6%)	0.306
▪ Adequate (50-60 mg)	6 (5.9%)	3 (2.9%)	9 (4.4%)	
Iron intake				
▪ Inadequate (< 7-40 mg)	82 (80.4%)	85 (83.3%)	167 (81.9%)	0.586
▪ Adequate (7-40 mg)	20 (19.6%)	17 (16.7%)	37 (18.1%)	

*Significant at α <5%

Most of the students, either obese (75.5%) or normal (58.8%), included in the category of high DED. A habit of eating high energy density foods made the body have extra energy so that the energy intake in the body exceeded the requirement unwittingly, resulting in an increase in fat deposits in the body. That kind of habit would facilitate the occurrence of obesity (Avihani and Sulchan, 2013). Nutrient intake density of an individual or household was associated with and indicating the nutrient adequacy level of the person or household. Therefore, good nutrient intake density would indicate a good nutrient adequacy level and likewise. On the contrary, inadequate or low nutrient intake density would indicate a low nutrient adequacy level (Drewnowski, 2005). Protein density in most students, either obese students (89.2%) or normal students (93.1%), was adequate. Meanwhile, vitamin A, vitamin C, and iron intake densities in obese students (95.1%, 94.1%, and 80.4%, respectively) and normal students (93.1%, 97.1%, and 83.3%, respectively) were categorized as low. Study on the Pakistani living in the UK showed that the protein intake density tended to be adequate while the micronutrient densities, such as calcium, iron, vitamin B12, vitamin A and vitamin C in urban area were relatively lower; thus, it would affect the nutritional status of the children and the risk of degenerative diseases (Hakeem et al., 2002). Based on the results of chi-square test, there was no significant association between protein, vitamin A, vitamin C, and iron densities with nutritional status of the students.

Chi-square test showed that there was a significant association between energy density and nutritional status of obese and normal students ($p<0.05$) whereas the protein, vitamin A, vitamin C, and iron densities had no significant association with nutritional status of obese and normal students. The percentage of obese students who consumed high energy density foods was greater than normal students. Excessive consumption of high energy density foods contributed to the increase in total energy intake that might affect body weight, resulting in an increase in body mass index (BMI) (Howarth et al., 2006; Mendoza et al., 2007).

Anemia Status

Table 4. Anemia status distribution in obese and normal students

Anemia status	Obese	Normal	Total	p-value
Anemic (Hb < 12 mg/dL)	18 (17.6%)	19 (18.6%)	37 (18.1%)	0.856
Non-anemic (Hb ≥ 12 mg/dL)	84 (82.4%)	83 (81.4%)	167 (81.9%)	
Mean±SD	13.0 ± 1.0	12.8 ± 1.0		

Anemia is a condition in which the number of red blood cells or the concentration of oxygen carrier in the blood (Hb) is insufficient to meet physiological needs of the body, which vary for each age group and sex (Kemenkes, 2013). Table 4 showed that most of obese and normal students did not have anemia. The results of

Mann-Whitney test also indicated that there was no significant difference in anemia status between obese and normal students. These results were consistent with the previous study38.

Water Adequacy

Table 5. Distribution of water adequacy in obese and normal students

Water adequacy	Obese	Normal	Total	p-value
Inadequate (<90%)	18 (17.6%)	19 (18.6%)	37 (18.1%)	0.856
Adequate (≥ 90%)	28 (27.5%)	43 (42.2%)	71 (34.8%)	
Mean±SD	80.1 ± 36.9	88.4 ± 39.5		

***** Significant at α <5%

Water adequacy level indicates how much water consumption can meet individual requirement of water. The greater the adequacy level, the more fulfilled the requirement. Inadequate water intake can lead to fluid imbalance. In mild dehydration, consuming adequate water will make the hydration condition returns to normal. If the cellular dehydration occurs within a few minutes, then the person will feel thirsty. If the thirst is not addressed by consuming water, the volume of blood plasma will decrease (Astuti et al., 2014).

Total water content in the body of obese people is lower than non-obese people because the water content in adipose cells is lower than the one in muscle cells; thus, obese people is more prone to dehydration than non-obese people. In obese people, even though the dehydration has happened, but the signs are not clear. Therefore, we must assess the state of dehydration in obese people carefully. Water requirement for obese patients should be two cups more than the total water in normal condition. It is based on the previous study indicating that drinking more plain water increases oxidation (fat burning) (Santoso et al., 2011). Mann-Whitney test results showed that there was a significant difference ($p<0.05$) in water adequacy between obese and normal students (Table 5). Previous study also showed that there was a significant difference in water adequacy between obese and normal students (Prayitno, 2012).

Academic Performance

Table 6. Distribution of academic performance in obese and normal students

Academic performance	Obese	Normal	Total	p-value
Poor (<60%)	43 (42.2%)	54 (52.9%)	97 (47.5%)	0.124
Good (≥60%)	59 (57.8%)	48 (47.1%)	107 (52.5%)	
Mean±SD	60.8 ± 9.9	60.0 ± 10.2		

Academic performance in this study was acquired from the average score of three subjects (Mathematics, Natural Sciences, and Indonesian Language) representing numeracy, logical reasoning and language skills. There were 57.8% obese students who had good academic performances whereas normal students with good academic performances were only 47.1%. Results of Mann-Whitney analysis showed that there was no significant difference in academic performance between obese and normal students (Table 6). This result was consistent with the previous study28 due to the notion which stated that the academic performance of overweight or obese students was lower than students with normal nutritional status, which was related to children's intelligence levels and brain structure. Obesity could affect the structure and function of frontal lobes. Obese people had a lower brain volume. Gray matter volume in obese people was lower so that working capacity of the brain would decrease (Brooks et al., 2013).

Anemia Status and Academic Performance

Table 7. Association between anemia status of obese and normal students and their academic performance

Anemia status	Academic performance				p-value
	Poor		Good		
	n	%	n	%	
Obese students					
▪ Anemic (<12 g/dl)	2	11.1	16	88.9	0.024*
▪ Non-anemic (≥12 g/dl)	1	1.2	83	98.8	
Normal students					
▪ Anemic (<12 g/dl)	3	15.8	16	84.2	0.153
▪ Non-anemic (≥12 g/dl)	5	6.0	78	94.0	

***** Significant at α <5%

Anemia has a huge impact such as the high risk of maternal and child mortality, poor physical and cognitive development in children, and low work productivity in adults (WHO, 2008). Table 7 showed the results of chi-square test in which there was a significant association between anemia status of the obese students and academic performance. These results were consistent with the previous study (Hidayati et al., 2010). There was an association between overweight and decrements in short-term memory function in children aged 8-12 years (Hartini and Winarsih, 2014).

Water Adequacy and Academic Performance

Table 8. Association between water adequacy of obese and normal students and their academic performance

Water adequacy	Academic performance				p-value
	Poor		Good		
	n	%	n	%	
Obese students					
▪ Inadequate (<90%)	40	54.1	34	45.9	0.021*
▪ Adequate (≥90%)	8	28.6	20	71.4	
Normal students					
▪ Inadequate (<90%)	34	57.6	25	42.4	0.267
▪ Adequate (≥90%)	20	46.5	23	53.5	

* Significant at α <5%

Results of chi-square test in Table 8 showed that there was a significant association between water adequacy of obese students and their academic performance. These results were consistent with the previous studies (Taylor et al., 2005; D'Anci et al., 2006).

Cognitive impairment emerges as a result of dehydration, based on parts of the brain that is most vulnerable to the effects of dehydration. The more the dehydration level increases, the more parts of the brain are impaired. It has an impact not only on cognitive function, but also on task processing, decreased function and eventually, the quality of life (Hardinsyah et al., 2009).

DISCUSSION

Factors Affecting Academic Performance of Obese Students

Logistic regression analysis showed that the adequacy level of energy and vitamin A, anemia status and water adequacy had significant effects on academic performance of the obese elementary school students.

Obese students with excessive energy adequacy level were 1.337 times at higher risk of having poor academic performance (OR=1.337; 95%CI 2.536-2.933). The imbalance between energy intake (in the form of food) and energy expenditure (in the form of physical activity), such as in obesity cases, is also suspected to affect children's cognitive development. Energy and nutrient adequacy can affect the academic performance because inadequate energy and nutrient intakes will impair the brain development. Eating behaviors affects the academic performance, indicating that students will be easier to concentrate if they have good eating behaviors; thus, they will get satisfying and maximum academic performance (Masdewi et al., 2011).

Inadequate vitamin A intake would hinder the academic performance of obese students (OR=0.044; 95%CI 0.002-0.935). Vitamin is one of nutrients functioning in the formation of red blood cells and mobilization of body iron stores in synthesizing Hb. Impaired iron and Hb metabolism can lead to decreased learning ability and productivity (Almatsier, 2009). Vitamin A deficiency is closely related to the incidence of anemia in school-aged children. These facts are in line with the observation results in this study; that is, vitamin A adequacy level has an indirect effect on academic performance (Jus'at et al., 2013).

Logistic regression analysis for anemia status showed that anemia status increased the risk of poor academic performance in obese students (OR= 2.132; 95%CI 3.090-3.741). This result was consistent with the previous study (Widayati, 2009). Anemia, indicated by low Hb level, leads to a decrease in the ability of red blood cells in binding oxygen. Without a sufficient supply of oxygen, brain cells cannot develop and function optimally.

Obese students who had inadequate water intake were 1.299 times at higher risk of having poor academic performance than students with adequate water intake (OR= 1.299; 95% CI 2.014-2.611). Water consumption affected short-term memory and there was an association between dehydration and cognitive abilities (Fadda et al., 2012). The generated regression model was as follows:

$$Log\ \frac{F}{1-F} = -5.876 + 4.648 \text{ energy adequacy level } -3.123 \text{ vitamin A adequacy level } + 2.096 \text{ anemia status } + 1.209 \text{ water adequacy}$$

CONCLUSION

Student's characteristic that was significantly different was pocket money. Characteristics of students' families (in obese and normal students) had no significant association with nutritional status. This study showed the low micronutrient density in obese and normal students. Anemia status was not significantly different between obese and normal students while water adequacy was significantly different between obese and normal students. Anemia status and water adequacy in obese students had a significant association with academic performance. Factors affecting the academic performance of obese students were energy adequacy level, vitamin A adequacy level, anemia status, and water adequacy.

Based on the results of this study, one of the efforts to achieve good academic performance in elementary school-aged children is by paying attention to their dietary intake, particularly in meeting the need for vitamin and iron, which not only prevents obesity, but also anemia. Water consumption also needs to be noticed by the parents, especially the consumption of plain water. In addition, in order to get better results and make a comparison, the further studies can be conducted in different locations, such as between schools in cities and regencies, as well as take notice to other factors which have not been observed in this study (infectious diseases, lifestyle, intelligence quotient).

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