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Research Article
Relation Between Food Consumption and Anemia in Children in Primary School in a Final Disposal Waste Area

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Abstract

Background and Objectives: Anemia is a public health problem in Indonesia. Iron deficiency is the most common cause of anemia in infants, preschool students, pregnant mothers, adolescents and the elderly. Therefore, it is time to review the current evidence of the relation between food consumption and anemia in primary school students, particularly in waste disposal areas, in which a high risk of anemia is caused by low income and the inability to purchase food high in iron. **Materials and Methods:** A cross-sectional study with 52 primary students was used as the sample. The primary data comprised hemoglobin levels, nutrient consumption as energy, protein, iron and vitamin C. **Results:** The number of anemic students remained high at 32.7%. Student's consumption of nutrients remained below the "Good" category, in which the energy consumption was 65.4%. Overall, 17.3% of students were at a moderately adequate level, 13.5% were less than adequate and 3.8% showed a deficit. Only 23.1% of the sample demonstrated a "Good" level of protein consumption, 25.0% were at a moderate level of adequacy and 32.7% were less than adequate. Of the students, 19.2% were in the deficit category. **Conclusion:** There is a significant relation ($p<0.05$) between energy consumption, protein consumption, iron consumption, vitamin C and anemia.

Key words: Anemia, food consumption, primary student, waste disposal area

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Anemia is a condition in which blood hemoglobin levels are below normal for one's age group[1]. The primary cause of anemia is a lack of iron consumption; thus, anemia is often called iron-deficiency anemia.

The consumption of food that is low in iron is a major determinant of anemia, particularly in nutritionally vulnerable groups such as infants, school children, adolescents, pregnant women, nursing mothers and the elderly. An Indonesian health survey in 2013 reported that the prevalence of anemia in children aged 5-12 years was 29%[2]. At that time, the high prevalence of anemia was labeled a public health problem.

Various studies stated that anemia causes physical growth disorders, low resistance to disease, decreased learning ability and concentration and weak performance in sports[3]. Sirajuddin and Masni[4] stated that the effects of anemia on elementary school students led to decreased ability and concentration when learning and inhibited the growth of both body cells and brain cells causing students to be pale, tired and lethargic, which in turn inhibits fitness and learning achievement.

In landfill areas in which worm infestation is high, children are prone to anemia. Worm infestation is exacerbated by the moist soil in a landfill.

In addition, income levels in landfill areas are generally low; thus, the ability to purchase food high in iron is also low, increasing the risk of anemia. One landfill in the province of North Sumatra is the final disposal waste area in the Terjun village Medan Marelan sub-district.

This landfill is the repository for garbage from the 23 districts in the city of Medan. Delivery of waste to the landfill is quite active from morning until nearly midnight. The incidence of anemia among primary school children in the area of the landfill is not yet known although the rate of anemia in North Sumatra province was 21.7% in 2013, according to Health Research Indonesia[2].

The level of food consumption for primary school children near the waste disposal area is unknown; studies are necessary to determine whether there is a correlation between food consumption and anemia in primary school children near the terminal disposal waste area.

MATERIALS AND METHODS

This study used a descriptive analytic design with a cross-sectional study. The sample population was all primary school children from grades 5 and 6, located near the landfill in Terjun village. There are two government primary schools, 067 and 773 and a primary school MIN Darul Ulum, with a total of 86 students. The inclusion criteria of the sample were that children were not suffering from the disease and indicated a willingness to be sampled by signing an informed consent. Fifty two children met the criteria.

Blood and hemoglobin levels were measured using the cyanmethemoglobin method using a blood hemoglobin photometer. Participants used a 24 h food recall to track food consumption. The results were analyzed by the nutri survey program to determine the levels of consumption of energy, protein, iron and vitamin C.

RESULTS

The majority of parents study as scavengers and laborers. The parents generally had low income levels; 38.5% of parents had income below the regional minimum wage.

Food consumption: Food consumption by primary school student is one of the factors that influences nutritional status and is an anemia status indicator. Anemia in this study is defined as anemia because of iron deficiency. The adequacy of food consumption was assessed by the adequacy of nutrient consumption: Energy, protein, iron and vitamin C.

The assessment of food consumption also included the composition of meals to determine the completeness of the diversity and composition of the food consumed.

Energy consumption: An analysis of the energy consumption of primary students revealed that only 65.4% had consumed sufficient energy; 17.3 and 13.5% had moderate and low levels of energy consumption, respectively. Of the participants, 3.8% fell into the deficit category of energy consumption. Adequate energy levels for primary school boys are 2100 and 2000 kcal for girls (Table 1).

Protein consumption: Table 2 indicates that only 23.1% of students consumed "Good" levels of protein, 25.0% had moderate levels of protein consumption and 32.7% were in the less than moderate category. As many as 19.2% of students had deficit protein consumption levels. Dietary allowances of protein are 56 g for males and 60 g for females.

Iron consumption: An analysis of iron consumption among primary students revealed that only 28.8% consumed adequate amounts of iron and 71.2% of students did not achieve adequacy. Adequacy levels of iron for primary student are 13 mg for boys and 20 mg for girls (Table 3).

Table 1: Energy consumption in primary school students

	Boys		Girls		Total	
Energy consumption	n	%	n	%	n	%
Good	11	50.0	23	76.7	34	65.4
Moderate	7	31.8	2	6.7	9	17.3
Less	3	13.6	4	13.3	7	13.5
Deficit	1	4.5	1	3.3	2	3.8
Total	22	100.0	30	100.0	52	100.0

Table 2: Protein consumption in primary school students

	Boys		Girls		Total	
Protein consumption	n	%	n	%	n	%
Good	8	36.4	4	13.3	12	23.1
Moderate	6	27.3	7	23.3	13	25.0
Less	4	18.2	13	43.3	17	32.7
Deficit	4	18.2	6	20.0	10	19.2
Total	22	100.0	30	100.0	52	100.0

Table 3: Iron consumption in primary school students

	Boys		Girls		Total	
Iron consumption	n	%	n	%	n	%
Met the adequacy level	7	31.8	8	26.7	15	28.8
Did not meet the adequacy level	15	68.2	22	73.3	37	71.2
Total	22	100.0	30	100.0	52	100.0

Table 4: Vitamin C consumption in primary school students

	Boys		Girls		Total	
Vitamin C consumption	n	%	n	%	n	%
Met adequate levels	6	27.3	8	26.7	14	26.9
Did not meet adequate levels	16	72.7	22	73.3	38	73.1
Total	22	100.0	30	100.0	52	100.0

Vitamin C consumption: Analysis of primary student's vitamin C consumption revealed that only 26.9% consumed adequate levels of vitamin C; 73.1% consumed inadequate levels. Adequate levels of vitamin C for both boys and girls in the primary grades are 50 mg (Table 4).

Meal composition: The composition of meals illustrates the diversity of the types of food consumed. A healthy and balanced diet comprises four types of food: Staple foods, side dishes, vegetables and fruit. Any meal that includes these four types is considered a complete meal. Conversely, when food consumption comprises 3 or fewer types of foodstuffs, the meal is deemed incomplete. Consuming complete meals contributes to the intake of all types of nutrients required for healthy living.

Table 5 indicates that fewer than half (48.1%) of primary students consumed full meals and 51.9% of primary student consumed incomplete meals.

Anemia status: Anemia status is based on hemoglobin levels in the blood. If the hemoglobin levels are below normal, the primary student is considered to be anemic and when the blood hemoglobin levels are equal to or above normal levels, the primary student is not anemic.

Table 5: Food consumption in primary school students

Food consumption	n	%
Complete	25	48.1
Incomplete	27	51.9
Total	52	100.0

Table 6: Anemia status in primary school students

Anemia status	n	%
Anemia	17	32.7
Non-anemia	35	67.3
Total	52	100.0

Table 6 indicates that anemia in school children is high at nearly 35%, suggesting that anemia is associated with low consumption of iron.

Relation between energy consumption and anemia status: According to Table 7, more primary students who consumed adequate amounts of energy were not anemic (85.3%) than anemic (14.7%). Students who consumed less energy

Table 7: Relation between energy consumption and anemia status

	Anemia status						
	Anemia		Non-anemia		Total		
Energy consumption	n	%	n	%	n	%	p-value
Good	5	14.7	29	85.3	34	100.0	0.001
Less	12	66.7	6	33.3	18	100.0	
Total	17	32.7	35	67.3	52	100.0	

Table 8: Relation between protein consumption and anemia status

	Anemia status						
	Anemia		Non-anemia		Total		
Protein consumption	n	%	n	%	n	%	p-value
Good	10	52.6	9	47.4	19	100.0	0.044
Less	7	21.2	26	78.8	33	100.0	
Total	17	32.7	35	67.3	52	100.0	

Table 9: Relation between iron consumption and anemia status

	Anemia status						
	Anemia		Non-anemia		Total		
Iron consumption	n	%	n	%	n	%	p-value
Good	12	54.5	10	45.5	22	100.0	0.01
Less	5	16.7	25	83.3	30	100.0	
Total	17	32.7	35	67.3	52	100.0	

Table 10: Relation between vitamin C consumption and anemia status

	Anemia status						
	Anemia		Non-anemia		Total		
Vitamin C consumption	n	%	n	%	n	%	p-value
Good	6	19.4	25	80.6	31	100.0	0.029
Less	11	52.4	10	47.6	21	100.0	
Total	17	32.7	35	67.3	52	100.0	

were more likely to be anemic (66.7%) than not anemic (33.3%). An analysis of the relation between energy consumption and anemia status indicated a significant correlation ($p<0.05$).

Relation between protein consumption and anemia status: According to Table 8, of students who consumed "Good" amounts of protein, 52.6% were anemic and 47.4% were not anemic. Of the students who consumed less protein, 78.8% were non-anemic and 21.2% were anemic. The results indicate a significant relation between protein consumption and anemia ($p<0.05$).

Relation between iron consumption and anemia status: According to Table 9, of students who consumed adequate amounts of iron, 54.5% were anemic and 45.5% were not anemic. Of the students who consumed less than sufficient iron, 83.3% were not anemic and 16.7% were anemic. An analysis of the relation between iron consumption and anemia status showed a significant correlation ($p<0.05$).

Relation between vitamin C and anemia status: Table 10 indicates that of the students who consumed adequate vitamin C, 80.6% were not anemic and 19.4% were anemic. Of the students who consumed less than adequate vitamin C, 52.4% were anemic and 47.6% were not anemic. An analysis of the relation between vitamin C and anemia indicated a significant correlation ($p<0.05$).

Relation between meal composition and anemia status: According to Table 11, of students who consumed complete meals, 84.0% were not anemic and 16.0% were anemic. Of students who consumed incomplete meals, 48.1% were anemic and 51.9% were not anemic. An analysis of the relation between eating complete meals and anemia status showed a significant correlation ($p<0.05$).

Table 11: Relation between meal composition and anemia status

	Anemia status						
	Anemia		Non-anemia		Total		
Meal consumption	n	%	n	%	n	%	p-value
Complete	4	16.0	21	84.0	25	100.0	0.030
Incomplete	13	48.1	14	51.9	27	100.0	
Total	17	32.7	35	67.3	52	100.0	

DISCUSSION

An analysis of the relation between energy consumption and anemia status suggested a significant correlation ($p<0.05$). Of the students who consumed adequate amounts of energy, more were not anemic (85.3%) than anemic (14.7%). Of the students whose consumption placed them in the less-than-adequate energy categories, 66.7% were anemic and 33.3% were not anemic.

The level of energy consumption for most students was adequate; more than 50% of the students consumed sufficient calories. Most large energy needs are met by macro-nutrients. If the macro-nutrient requirements are fulfilled, the macro-nutrient requirements will also be met. One macro-nutrient is iron. If iron intake is sufficient but energy consumption remains less than adequate, iron does not provide the maximum health benefits.

The prevalence of anemia in medical students is 59%. This percentage is related to dietary habits and the quality of food served in the hostel; the majority of medical students reside in institution hostels[5].

In the metabolism of nutrients, macro-nutrients that should be prioritized first. Based on this, fewer students who consumed sufficient energy were anemic than were non-anemic. Students who did not consume sufficient energy were more likely to have anemia. The energy sources in student's food comprised primarily rice, noodles, bread, crackers or fried food.

An analysis of the relation between protein consumption and anemia status revealed a significant correlation ($p<0.05$). Of students who consumed adequate protein, 52.6% were anemic and 47.4% were not anemic. Of the students who consumed less than adequate protein, 78.8% were not anemic and 21.2% were anemic.

Protein is one of the macro-nutrients that can affect the adequacy of micro-nutrients. The existence of macro-nutrients is an indicator of the micro-nutrient, indicating that if the macro-nutrient requirements are met, the micro-nutrient requirements will also have been properly fulfilled. Anemia is indicated by blood hemoglobin levels. The nutrients composing blood hemoglobin are iron; thus, consuming less iron can lead to low blood hemoglobin levels.

Low hemoglobin is the cut-off point for iron deficiency anemia. Food sources of iron are animal products that also contain large amounts of protein. Thus, when protein intake is low, iron intake is generally low, affecting the occurrence of anemia because of low blood hemoglobin levels. Conversely, when students consume foods high in protein, the consumption of iron will also be high so that the blood hemoglobin levels are also high and there is no anemia.

Protein intake for students remains "Less than good"; only 23% of students consumed "Good" amounts of protein. In addition to the consumption of protein, students fall into "Moderate" and "Less" categories of protein adequacy; 19% of students were deficient in protein consumption. Sources of protein for students included grilled meatballs, eggs and fish.

The food consumption log indicated that meat consumption was rare and that the consumption of protein, grilled meatballs, eggs, fish, was relatively scant and did not meet the student's protein requirements. Only 23% of the students consumed adequate amounts of protein.

In this study, Khan *et al.*[6] observed that the overall prevalence of anemia was 39% with a preponderance among female students (56%) compared with male students (22%). Males as well as females belonging to the Hindu religion, having low socio-economic status, hailing from urban areas and involved in study that required moderate physical activity had a higher prevalence of anemia[6].

Another study concluded that there was a significant correlation between anemia and protein intake. Students who were anemic numbered 71.1, 63.2% of the students had low protein intake[7].

An analysis of the relation between iron consumption and anemia status revealed a significant correlation ($p<0.05$). Only 28% of students consumed adequate amounts of iron. This result is evident from the low intake of food sources of iron, including meat, fish, eggs, liver or animal products and vegetables that are high in iron.

In addition to the small amounts of iron-rich food consumed, student's food logs indicated that students rarely consumed meat at all.

Students consumed vegetables more often than animal foods. Animal foods are more expensive than vegetable foods and were rarely consumed because the majority of the student's parents had low incomes. Of the students who consumed adequate amounts of iron, 54.5% were anemic and 45.5% were not anemic. Of the students who consumed less adequate amounts of iron, 83.3% were not anemic and 16.7% were anemic. The largest component of blood hemoglobin is iron; thus, low iron consumption results in lower levels of blood hemoglobin, causing anemia in students. Conversely, when the consumption of iron is sufficient, hemoglobin levels in the blood are also sufficient and students do not have anemia. Thus, there is a significant correlation between the consumption of iron and anemia status.

Research on junior high school students in Brebes indicated a correlation between iron intake and hemoglobin levels ($r = 0.564$ and $p<0.05$)[8]. Of the 71.1% of students who were anemic, 68.4% reported a low protein intake, indicating a significant correlation between anemia and iron intake[7]. In adolescent girls, 60.8% did not consume sufficient iron. There is a clear correlation between the level of iron consumption and anemia[9].

An analysis of the relation between vitamin C consumption and anemia status indicated a significant correlation ($p<0.05$). Only 28% of students consumed sufficient vitamin C. The rate of consumption of vitamin C was thus relatively low. Student's recall of food consumption indicated that consumption of food sources of vitamin C such as vegetables and fruits was slight and relatively rare. Because students in general do not like vegetables, those foods were rarely consumed.

Fruit was also rarely consumed but not because of the aversion factor; fruit is expensive and the student's parents had little purchasing power.

Vitamin C enhances iron absorption to optimize the iron absorption process. When students consume iron-rich food when also consuming inhibitors of iron absorption, the iron cannot be optimally absorbed or utilized by the body. Thus, iron levels in the body will be inadequate. Inhibitors of iron absorption include pitat, tannin, cabbage, egg plant and caffeine and oxalate in tea and coffee.

Of students who consumed sufficient vitamin C to fall into the "Good adequacy" category, 80.6% were not anemic and 19.4% were anemic. Of students who fell into the "Less adequacy" category, 52.4% were anemic and 47.6% were not anemic. Thus, there was a significant association between vitamin C and anemia status. Research on junior high school students in Brebes revealed a correlation between vitamin C intake and hemoglobin levels ($r = 0.564$ and $p<0.05$)[8]. Of the 71.1% of students who were anemic, 86.8% had low protein intake. There was a significant correlation between anemia and vitamin C intake[7].

An analysis of the relation between meal composition and anemia status showed a significant correlation ($p<0.05$). Of the students who completed food logs, 84.0% were not anemic and 16.0% were anemic. Students whose food logs were incomplete had relatively the same amounts of anemia and non-anemia, 48.1 and 51.9%, respectively.

A well-balanced diet comprises four different food groups: Staple foods, side dishes, vegetables and fruits. When students consume foods from fewer than 4 different groups, those students are not eating a complete diet. Conversely, when the 4 types of foods are consumed, that diet is considered to have a complete food composition.

Consuming all of the food groups enhances the fulfillment of macro-nutrient and micro-nutrient requirements. Thus, consuming incomplete meals can lead to a deficiency in one or more nutrients. Approximately 50% of the students in the study ate meals that were incomplete.

Meals were incomplete primarily because vegetable and fruit groups were rarely consumed. This lack implies nutritional deficiencies in iron and iron-uptake enhancers, which resulted in anemia in primary students. Thus, there is a significant correlation between the composition of meals and anemia status.

CONCLUSION

The number of students with anemia remained high at 32.7%. Student consumption of nutrients remained below the "Good" category. "Good" energy consumption was present in 65.4% of students, "Moderate adequacy" in 17.3%, "Less than adequate" in 13.5% and "Deficient" in 3.8%. Only 23.1% of students were in the "Good adequacy" category of protein consumption, 25.0% in "Moderate adequacy", 32.7% in "Less than adequate" and 19.2% in the deficient category:

- "Good" levels of iron consumption were present in only 28.8% of students
- "Good" levels of vitamin C consumption were present in 26.9%
- There is a significant relation ($p<0.05$) between energy consumption and anemia status, protein consumption and anemia status, consumption of iron and anemia status and consumption of vitamin C and anemia status

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