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Factors Associated with Iron Deficiency in Elementary School Children

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Abstract

BACKGROUND: Iron deficiency is the leading cause of iron deficiency anemia and is a health problem for children in developing countries. School-age children are susceptible to iron deficiency because children's growth and development require iron. Although iron is needed for children's growth and development, iron also plays a role in cognitive function. Many factors cause iron deficiency in children.

AIM: This study aims to determine the most dominant factor causing iron deficiency in elementary school children.

METHODS: The design of this study was case-control, with a sample of elementary school children aged 9–12 years in the Tuah Negeri Subdistrict. After examining the serum iron, children were grouped into two groups, namely, iron deficiency and normal. Each group consists of 85 children, and the total sample is 170 children. Measurement of serum iron levels was done by spectrophotometric method, while data on children's characteristics were obtained through questionnaires. In addition, nutritional status measurements were also carried out to determine whether the child was stunted, measurements based on TB/U, and Z-score was calculated using Anthro 1.02 software. Finally, the data were analyzed by univariate, bivariate, and multivariate using Statistical Package for the Social Sciences version 22.

RESULTS: Based on the child characteristics data, 60% of children aged >10–12 years, 54.1% were female, and 23.5% of children were stunted. Data on the characteristics of parents obtained 67.6% of mothers and 74.1% of fathers with low education; 84.1% of mothers and 55.3% of fathers work as farmers, and 54.7% have low economic status. Bivariate results showed that two characteristic variables, namely, economic status ($p = 0.003$) and nutritional status ($p < 0.001$), were significantly related to the incidence of iron deficiency in children. The results of multivariate analysis showed that children with low economic status were at risk of 2.361 times ($p = 0.011$) of having an iron deficiency while stunting children were at risk of 6.785 times ($p < 0.001$) of having iron deficiency.

CONCLUSION: Stunting is the dominant factor associated with iron deficiency in elementary school children in Tuah Negeri Sub-district.

Background

Iron deficiency is a public health problem that often occurs in developing countries. It is estimated that 2/3 of children and adolescents have iron deficiency, and 25% of preschool children have iron deficiency anemia. The WHO data (2011) state that two billion people in the world suffer from iron deficiency anemia. Approximately 50% of cases of anemia are caused by iron deficiency. In Africa, the incidence of iron deficiency anemia in school children reaches 64.3–71% [1], [2], while in Indonesia, based on the results of Basic Health Research in 2013; it is 29% [3].

Iron deficiency anemia occurs when a decrease in hemoglobin levels accompanies iron deficiency. Iron is obtained from food intake and absorbed in the upper gastrointestinal tract. Low iron intake results in limited absorption of iron that the digestive system can absorb. If there is an imbalance between intake and needs, there will be iron deficiency. Anemia does not occur at this stage, but serum ferritin levels and serum transferrin saturation levels decrease. If this condition is not overcome, it will continue to the next stage, namely, iron deficiency anemia [4]. According to the Miniero *et al*. (2018), 30% of cases of iron deficiency that are not treated will develop into iron deficiency anemia [5].

Iron deficiency anemia results in not optimal cognitive development. It is difficult to concentrate, so that children's learning achievement will decrease. The brain requires a lot of iron because the oxidation metabolism that occurs in the brain is higher than in other organs. Therefore, iron must be transferred to brain cells with good regulation because iron availability is very influential on brain function [6]. Children with

iron deficiency tend to have low cognitive function and academic achievement [7].

The prevalence of anemia in school children in Indonesia is still relatively high. In addition to behavior and diets that are low in iron sources, the problem of poverty, which generally occurs in rural and or mountainous areas, is a contributing factor to the high rate of iron deficiency anemia [8]. The results of Riskesdas 2013 show iron deficiency anemia in school-age children in rural areas by 31% [3].

The results of the research by Flora *et al*. (2019) regarding the distribution of stages of iron deficiency anemia in elementary school children in Tuah Negeri District found that 15.4% of children had anemia without iron deficiency, 33% of children had iron deficiency, 37.4% of children had iron deficiency anemia, and only 14.3% of children did not have iron deficiency or iron deficiency anemia. Many factors cause iron deficiency and iron deficiency anemia [9]. This study aims to analyze the dominant factors causing iron deficiency in elementary school children in Tuah Negeri District.

Methods

The design of this study was cross-sectional, with a sample of elementary school children aged 9–12 years in Tuah Negeri District. Previously, blood was taken for measurement of serum iron. Measurement of serum iron levels was carried out by the spectrophotometric method. Based on the results of iron measurements, children are grouped into two groups, namely, iron deficiency and normal. Each group consists of 85 children, and the total sample is 170 children.

Furthermore, data on child characteristics (age, gender, and nutritional status) and parental characteristics (education, occupation, and economic status) were collected. Measurement of nutritional status based on TB/U, Z-score was calculated using Anthro 1.02 software. The measurement results were categorized into stunting and normal. Data were analyzed univariate, bivariate, and multivariate using Statistical Package for the Social Sciences version 22. This study has received ethical approval from the Ethics Commission of the Faculty of Public Health, Sriwijaya University. 170/UN9.1.10/KKE/2021.

Results

Data on the characteristics of children and parents (Table 1) show that 60% of children aged >10–12 years, 54.1% are female, and 23.5% of children are stunted. Data on the characteristics of parents obtained 67.6% of mothers and 74.1% of fathers with low education; 84.1% of mothers and 55.3% of fathers work as farmers, and 54.7% have low economic status.

Table 1. Frequency distribution of elementary school children in Tuah Negeri district

Frequency distribution	n	%
Age		
9–10 year	68	40
>10–12 year	102	60
Gender		
Male	78	45.9
Female	92	54.1
Mother's Education		
Low	115	67.6
High	55	32.4
Mother's Occupation		
Employed	143	84.1
Unemployed	27	15.9
Father's Education		
Low	126	74.1
High	44	25.9
Father's Occupation		
Farmer	94	55.3
Not Farmer	76	44.7
Economic Status		
Low	93	54.7
High	77	45.3
Nutritional Status		
Stunting	40	23.5
Normal	130	76.5

The results of bivariate analysis (Table 2) regarding the characteristics of children and parents with the incidence of iron deficiency, it was found that there was no significant relationship between age (p = 0.754), gender (p = 0.124), mother's education (p = 0.140), mother's occupation (p = 0.834), father's education (p = 0.726), and father's occupation (p = 0.537) with the incidence of iron deficiency. Only two variables, namely, economic status (p = 0.003) and nutritional status (p < 0.001), were significantly related to the incidence of iron deficiency in elementary school children.

Table 2: Relationship between child characteristics and serum iron status

Children characteristics	Serum iron status				p
	Deficiency		Normal		
	n	%	n	%	
Age					
9–10 year	33	48.5	35	51.5	0.754
>10–12 year	52	51.0	50	49.0	
Gender					
Male	34	43.6	44	56.4	0.124
Female	51	55.4	41	44.6	
Mother's Education					
Low	62	53.9	53	46.1	0.140
High	23	41.8	32	58.2	
Mother's Occupation					
Employed	13	48.1	14	51.9	0.834
Unemployed	72	50.3	71	49.7	
Father's Education					
Low	64	50.8	62	49.2	0.726
High	21	47.7	23	52.3	
Father's Occupation					
Farmer	49	52.1	45	47.9	0.537
Not Farmer	36	47.4	40	52.6	
Economic Status					
Low	56	60.2	37	39.8	0.003
High	29	37.7	48	62.3	
Nutritional Status					
Stunting	33	82.5	7	17.5	0.000
Normal	52	40.0	78	60.0	

Based on the results of multivariate analysis (Table 3), it was found that economic status (p = 0.011) and nutritional status (p < 0.001) were related to serum iron status. Children with low economic status

are 2.361 times at risk for iron deficiency and stunting children are 6.785 times at risk for iron deficiency. Stunting is the most dominant factor associated with iron deficiency in children.

Table 3: Multivariate analysis results

Variable	p	OR	95% CI for Exp (B)	
			Lower	Upper
Economic Status	0.011	2.361	1.218	4.578
Stunting	0.000	6.785	2.754	16.713

Discussion

This study indicates that stunting is the most dominant factor associated with iron deficiency in elementary school children in Tuah Negeri District. Low economic status affects the adequacy of iron intake in children. Insufficient food intake will lead to hidden hunger or nutritional problems that are not visible due to a lack of micronutrients, such as iron. Children more often consume foods high in carbohydrates, but low in food ingredients such as animal side dishes, vegetables, and fruit [10]. In general, iron in meat, chicken, and fish has high biological availability, iron in cereals and beans has biological availability. Most vegetables' moderate in iron, especially those containing high oxalic acid, such as spinach, have low biological availability. Therefore, the daily food combination is crucial and must consist of iron sources derived from animals and plants [11].

Iron is one of the essential micronutrients that affect growth. One of them is as a component of the ribonucleotide reductase enzyme, which participates in DNA synthesis, which works indirectly on tissue growth that can affect growth [12]. In addition, iron is a cytochrome component that can participate in the production of adenosine triphosphate and protein synthesis affecting tissue growth [2]. Iron deficiency will impact the body's immune ability, so infectious diseases can easily enter the body. Iron deficiency anemia and prolonged infectious diseases will impact the linear growth of children or stunting [13]. The results of this study are in line with the results of research conducted by Ayoya *et al*. which stated that there is a relationship between the incidence of stunting and the incidence of iron deficiency anemia. Stunting toddlers have a 2 times greater risk of developing iron deficiency anemia than non-stunted toddlers [14]. The results of Flora *et al.*'s study also showed a decrease in serum iron levels in children who were stunted compared to children who were not stunted (34.33 ± 12, 73 μg/dL vs. 42.79 ± 19.45 μg/dL), There was a significant difference (p = 0.011) in the mean serum iron level between stunted and non-stunted children [15]. Damayanti *et al.*'s research also stated that there was a significant relationship between the level of iron adequacy and stunting [13].

The prevalence of stunting in school-age children (6–12 years) in Indonesia is 30.7% [3]. The high prevalence of stunting shows that nutritional problems in Indonesia are chronic problems related to poverty, low education, inadequate services, and environmental health. Many interrelated factors can directly influence nutritional problems by infectious diseases and lack of nutritional intake in quality and quantity, while indirectly influenced by the reach and quality of health services, inadequate child care patterns, environmental sanitation, and low food security at the household level [16]. The data on the characteristics of parents in this study showed that 67.6% of mothers and 74.1% of fathers had low education; 84.1% of mothers and 55.3% of fathers work as farmers, and 54.7% have low economic status. This condition affects the availability of food at the household level, which impacts the incidence of stunting in the Tuah Negeri District.

Stunting reflects poor linear growth. This condition has accumulated since the pre- and post-natal period caused by poor nutrition and health. Stunting an early age will negatively affect intelligence, psychomotor development, fine motor skills, and neurosensory integration [17]. School children are generally in a period of very rapid and active growth; a well-nourished, balanced, and diverse diet will ensure adequate nutrition [18].

This study describes the condition of iron status in children from Fe serum level examination; however, this study did not measure iron intake. Measurement of iron intake can describe the amount and type of iron consumed by children, thus the amount of iron consumed and iron serum in the body could have been compared.

Conclusion

Stunting is the dominant factor associated with iron deficiency in elementary school children in Tuah Negeri District. Stunting children are at risk of 6.785 times (p = 0.000) greater iron deficiency than children who are not stunted.

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