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Original Article

Effect of iron treatment on nutritional status of children with iron deficiency anemia

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Abstract

Background Iron has been shown to improve growth in children with iron deficiency anemia (IDA), as indicted by increases in height and weight. Frequently, malnutrition and iron deficiency coexist.

Objective To determine the effect of iron treatment on nutritional status in children with IDA.

Methods A randomized placebo-controlled clinical trial was conducted at Bilah Hulu, a subdistrict of Labuhan Batu, North Sumatera, Indonesia, between November 2006 and February 2007. Iron deficiency anemia was diagnosed if there anemia was present along with MCHC <31%, RDW index >220 and Mentzer index >13. Elementary school children (8–12 years old) with IDA were randomly assigned to either receive a daily therapy of 6 mg iron/kg/day or a placebo for three months. Nutritional status was evaluated by anthropometric assessment before and after intervention.

Results From 300 subjects recruited, there were 111 (37.2%) with iron deficiency anemia; 108 of them completed the therapy. After intervention, the iron and placebo groups had different mean hemoglobin concentrations (P <0.05), but there was no significant difference in mean weight and height gain between the two groups.

Conclusion A significant increase in hemoglobin concentration was seen when iron was given, but did not affect weight and height increase in the subjects. **[Paediatr Indones. 2009;49:160-4]**.

Keywords: *nutritional status, iron deficiency anemia, anthropometric*

The assessment of nutritional and growth status is an essential part of clinical evaluation and care in the pediatric setting. Attention to nutritional status is particularly important because children are undergoing complex growth and development processes.[1] Iron deficiency continues to be the most common nutritional cause of anemia worldwide. It has been estimated that 4–5 billion people in the world suffer from iron deficiency anemia (IDA), with 90% of cases occurring in developing countries, leading to higher morbidity and mortality rates.[2] IDA is most frequently found in infants, children, and adolescents; this is due to high nutrient requirements because of high growth rates in conjunction with dietary deficiencies.[3] In Indonesia, the 1995 Survey of Households showed that 40.5% of infants and 47.3% of school children suffered from IDA. Survey of elementary school children (7-15 years) showed that half of all types

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of anemia are caused by iron deficiency.[4] Several additional studies also show that prevalence of IDA is 47%–64% in school children aged 5 - 14 years old with protein-calorie malnutrition.[5]

Many studies found different results for the effect of iron supplementation on children's body weight (wt) and body height (ht) or nutritional status. In 1998, Chwang *et al*[6] gave 10 mg ferrous sulfate to Indonesian school children for 12 weeks and found increased growth after intervention. Similarly, in 1999 in Thailand, Sungthong *et al*[7] reported that iron supplementation for 16 weeks had a significant effect on height increase in school children. Dijkhuizen *et al*[8] gave iron supplements to infants for six months in Indonesia in 1999, and showed that there was a significant increase in growth.[8] We aimed to determine the effect of iron supplementation on weight and improved nutritional status in school children with IDA.

Methods

This was a randomized placebo-controlled clinical trial. The study was carried out for three months from November 2006 until February 2007 in five elementary schools in Bilah Hulu, a subdistrict of Labuhan Batu in North Sumatra, Indonesia. The subjects were elementary school children aged from 8 to 12 years old. Blood specimens were taken to determine the hemoglobin level, mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), red blood cell (RBC) level, and red–cell distribution width (RDW) index.

According to World Health Organization criteria (1975), anemia was diagnosed in children aged 6 to 14 years old when the hemoglobin level was lower than 12 g/dl. A diagnosis of IDA was made when the anemia was accompanied by a MCHC <31%, RDW >220, and the Mentzer index >13. We excluded subjects with other blood diseases, severe malnutrition, renal disorders, other chronic infections (helminthisis, nephritis, nephrosis), neurological disorders, and severe anemia.

We randomized subjects by simple randomization to either receive iron therapy or placebo. Iron therapy was given daily; a capsule containing 40 mg of ferrous sulfate (a dosage of 6 mg/kg body weight) was given 3 times a day, giving a total dosage of 120 mg/day. The placebo was a capsule containing saccharum lactis that was also given three times daily. Both the iron and placebo capsules had the same size and color, and capsules were consumed daily in the presence of the subjects' teachers and parents for three months.

Anthropometrical measurements of weight and height were carried out before and after intervention. Weight was measured using a Camry weight meter (sensitivity up to 0.5 kg) and height was measured using stadiometer/MIC microtoise (sensitivity up to 0.5 cm). Nutritional status was determined using the NCHS-WHO anthropometric reference based on the Z-score (standard deviation or SD) as a threshold. [9] Nutritional status was classified based on the indexes of weight and height i.e., severe malnutrition if the value was less than -3 SD, moderate malnutrition if it was between $\geq$-2 SD and $\leq$- 3 SD, mild malnutrition if it was between $\geq$– 1SD and <– 2 SD, normal if between $\geq$– 1 SD and $\leq$+ 1 SD, overweihht if between >+ 1 SD and $\leq$+ 2 SD, and obese if $\geq$ 2 SD.

Data were processed using SPSS for WINDOW 13.0 (SPSS Inc. Chicago). We used the independent t-test to determine whether changes in laboratory and anthropometric measurements were statistically significant after intervention. The test was considered significant when $P<0.05$.

Results

Out of 300 school children, we identified 111 children with IDA (37.2%). All of these 111 children were recruited and were randomly allocated into two groups; 55 children were given iron and 56 children were given the placebo. There were no difference on basic characteristics of subjects in both groups **(Table 1).** Only 108 children completed the three month study, 2 subjects in the treatment group and 1 subject in placebo group dropped out.

After the 3 month intervention the hemoglobin levels in both groups increased, i.e., from 10.09 (SD 1.27) g/dl to 12.94 (SD 0.72) g/dl in treatment group, and from 10.11 (SD1.40) g/dl to 11.67 (SD 0.75) g/dl. However there was no significant improvement of the nutritional status between the iron and the placebo groups (**Tables 2 and 3)**.

Table 1. Subject characteristics

Characteristic	Iron group	Placebo group
Age (years); mean (SD)	9.73 (1.2)	9.84 (1.3)
Sex , male / female	29 / 26	28 / 28
Hemoglobin, mean (SD) g/dl	10.09 (1.27)	10.11 (1.40)
MCHC, mean (SD) %	29.90 (0.67)	29.92 (0.56)
Mentzer index, mean (SD)	17.49 (3.00)	16.79 (3.51)
RDW index ; mean (SD)	265.84 (52.42)	251.49 (35.36)
Level of mother's education, n		
- Elementary school or less	31	35
- Junior & senior high school	23	20
- University	1	0
Family income, n		
≤ Rp 400.000,-	26	12
Rp 401.000,- - Rp 800.000,-	32	35
> Rp 801.000,-	7	9
Nutritional status		
Obese	2	1
Overweight	8	5
Normal	31	36
Mild malnutrition	12	10
Moderate malnutrition	2	4

Table 2. The difference in nutritional status before and after intervention

Parameter	After intervention		P
	Iron	Placebo	
n	53	55	
Nutritional status n ; %			0.74
- Obesity	1	1	
- Overweight	7	5	
- Normal	35	38	
- Mild malnutrition	7	10	
- Moderate malnutrition	3	1	

capabilities, lower living standards with a higher incidence of malnutrition, inadequate sanitation, higher morbidity, lower intake of mammalian protein, and parasitic infestation.[5] Children with IDA have a lower body weight and are shorter than children without IDA.[6]

Malnutrition or nutritional deficiency is the most important problem in Indonesia. It is reported that low birth weight infants, malnutrition during infancy, and lack of catch-up growth result in stunting and malnutrition in many school children (36.1%).[11] The coexistence of protein energy malnutrition and iron deficiency is the leading nutritional problem in Indonesia. Some studies conducted in Indonesia showed a high prevalence of IDA and malnutrition.[6,11] In 1997, Soemantri *et al*[5] reported that the prevalence of IDA along with mild malnutrition was 47%-64% among 5-14 year old children from a lower socioeconomic background. In contrast, the prevalence of IDA in children from a moderate socioeconomic background was 38%–67% and was only 20% in those from a higher socioeconomic class.[5]

In this study, 300 school children underwent a blood test. We determined that 37.2% were suffering from IDA. Sixty seven children (60.3%) from the total subjects had good nutritional status according to the anthropometric measurements. The results of this study were different from the previous study, because the children with IDA recruited as subjects in our study had good nutritional status.

Table 4. Weight and height before and after intervention

	Wt1 (kg)	Wt2 (kg)	P	Ht1 (cm)	Ht2 (cm)	p
Iron	26.98 (SD 6.51)	25.78 (SD 5.93)	0.24	129.21 (SD 7.62)	129.49 (SD 7.51)	0.34
Placebo	25.78 (SD 5.93)	26.01 (SD 5.96)		127.79 (SD 8.82)	127.99 (SD 8.81)	

Wt1: Weight before intervention, Wt2: Weight after intervention, Ht1: Height before intervention, Ht2: Height after intervention

Discussion

Iron is required for hemoglobin synthesis; hemoglobin has roles in oxygen storage and transportation. Iron is also a component of myoglobin, which carries oxygen in muscle tissues. Therefore, iron deficiency has a damaging impact on growth and development in children, can also reduce immunity, and decrease concentration during learning.[2,10]

The high prevalence of IDA in Indonesia is due to multiple and complex factors such as limited financial

In Indonesia, there are two main factors that contribute to anemia. The first is that foods containing lower amounts of bioavailable iron such as rice, cereal, grains, and vegetable are eaten in large quantities, whereas meat, liver and fish that have larger amounts of bioavailable iron are consumed less. The second factor is the relatively high prevalence of parasitic infestation.[5]

Research in Central Java concluded that the average intake of energy, protein and iron by children in rural regions is only a half or two-thirds of the

Indonesian Recommended Dietary Allowances.[6] Based on the characteristics of the subjects in our study, we found 70% of the subjects had monthly household revenues of less than Rp. 600,000. In addition, majority of the mothers were poorly educated (the highest education was primary school) and on average, their hemoglobin level were 10.1 g/dl.

The ideal treatment for IDA is iron therapy and as a result of this treatment, the hemoglobin level returns to normal and there is an increase in iron storage. It is very important to treat the causes of IDA, particularly by increasing the intake of food containing sufficient energy, protein and iron or by preventing parasitic infestation.[4]

In this study, the hemoglobin level increased significantly in both groups after therapy. Prior to iron therapy, we also provided thorough guidance on nutrition to the parents, children and teachers about foods that contain large amounts of iron as well as information about other factors that increase and reduce iron absorption. Information about good sanitation was also provided as it is important for the prevention and treatment of IDA.

Unfortunately, the iron profile (serum iron, total iron binding capacity/TIBC, serum ferritin, transferin saturation, and free erythrocyte porphyrin/FEP) was not examined as it was too expensive. Chwang *et al*[6] concluded that ferrous sulfate supplements for school children for 12 weeks resulted in increased or improved growth. Sungthong *et al*[7], in 1999, carried out research in Thailand and found that supplementation with iron for 16 weeks showed a meaningful increase in the height of school children. Our data showed that there was no significant difference in the average weight and height in the groups before and after therapy.

The limitations of our study include that we did not evaluate the eating habits of our subjects in detail. Furthermore, the morbidity rate of the children recruited as subjects was unknown, and examination for and treatment of parasitic infestations was not carried out. Based on this study, in the future we suggest supplementing with iron for a longer period and with more subjects.

In conclusion, the iron therapy significantly increased hemoglobin levels in the subjects, but there is no significant difference in mean weight and height.

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