

Iron and iodine supplementation in school children in Ngargoyoso sub-district, Karanganyar regency, Central Java, Indonesia

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Abstract

Background:
Schoolchildren living in iodine deficient area are not only vulnerable to iodine deficiency, but also to other micro-nutrient deficiencies. Recent screening on hematologic status in Ngargoyoso sub-district showed very high prevalence of anaemia among school children.

Objectives:
The present study was designed to test hypothesis that adding iron to iodine supplementation will improve both iodine and hematologic status in schoolchildren living in IDD endemic area.

Methods:
Three hundred and sixty five school children from year three (± 8 years old) from 22 state-owned elementary schools in Ngargoyoso sub-district were clustered-randomly assigned into two groups. The first group (N=211)) received 60 mg elemental iron (200 mg FeSO4) twice weekly and 100 µg iodine (KIO3) daily via drinking water, for six weeks. The second group (N=154) received 60 mg elemental iron (200mg FeSO4) six days a week and 100 µg iodine (KIO3) daily via drinking water, for six weeks. Both groups received Albendazole 400 mg given in single dose, before starting supplementation. Hemoglobin concentration was measured using haematin-chloride (Sahli) method. Urinary iodine excretion (UIE) was measured using Method A (ammonium persulfate) in an accredited IDD Laboratory in Magelang, Central Java, Indonesia. Goitre prevalence was measured by palpation method. Total goitre rate (TGR) is the sum of grade 1 and grade 2. Statistical analysis was performed using SPSS for Windows release 17.0 (Chicago, IL, USA).

Results:
Before treatment 98.6% of schoolchildren (N = 365) were anemic (Hb<11,5 g/dl). Median urinary iodine excretion (UIE) was 248.5 µg/L, but 14.6% were below 100 µg/L. After six weeks supplementation hemoglobin concentration increased from 9.827 ± 0,719 g/dl in group one to 10.183 ± 0.742 g/dl, whereas in group two there was an increased in hemoglobin concentration from 9.645 ± 0.591 g/dl to 10.196 ± 0.611 g/dl. Median UIE also increased from 248.5 µg/L to 319 µg/L after six weeks supplementation. The proportion of schoolchildren with UIE less than 100 µg/L also decreased from 14.6% to 7.5%. The difference between groups was significant. Total goitre rate (TGR) was 9.3% at basal, and a follow up is needed.

Conclusion:
Adding iron to iodine supplementation via drinking water was effective in improving hemoglobin status and iodine intake among school children in Ngargoyoso sub-district, Karanganyar regency, Central Java Province, Indonesia.

Keywords: iron, iodine, hemoglobin, urinary iodine excretion.

1. Introduction

Ngargoyoso sub-district is an IDD pocket area in Central Java, Indonesia. Since 2010 we have been surveyed this area. Due to very high of total goiter rate (TGR) among schoolchildren (Suprapto et al, 2010), we started an iodine supplementation trial in schoolchildren in 2011 and followed by supplementation in preschoolers (Dewi et al, 2012). These supplementations showed improvement in TGR, urinary iodine excretion and IQ score. We focused on using water as a vehicle for iodine supplementation for some reasons i.e. drinking water in Ngargoyoso was abundant; it comes from mountainous spring wells and freely consumed by the people. Secondly, water iodization was successfully implemented in some countries such as Mali (Fisch et al, 1993) and Thailand (Pandav et al, 2000). Recently, we realized that anemia was also highly prevalent in Ngargoyoso sub-district, Central Java. Both deficiencies affect cognitive performance of schoolchildren deleteriously. Iron deficiency anemia reduced 5 IQ points (Walter, 2003), while iodine deficiency reduced 13.5 IQ points (Bleichrodt & Born, 1994). Iron deficiency anemia is still a public health problem in Indonesia. According to WHO classification (2011) the country has been faced with severe deficiency (>40%). Zimmermann et al (2000) found that goitrous schoolchildren with iron deficiency anemia were resistant to iodine supplementation. Whereas, Hess et al (2002) showed that treatment of iron deficiency anemia improved the efficacy of iodized salt.

Hess et al (2002) revealed that iron deficiency anemia reduces thyroid peroxidase activity in rats. Do schoolchildren in Ngargoyoso sub-district also need a double supplementation i.e. iron and iodine?

2. Subjects and Methods

2.1. Study location

The study took place in the rural area of Ngargoyoso sub-district on the high slope of Mount Lawu, Central Java, Indonesia, at an altitude between 650 and 1100 meters above the sea level. It has some asphalt roads, traditional markets, some electricity, 58 integrated health posts and a health center. The most remote area has no access for car. It consists of 9 villages with inhabitant about 30.000 people living from subsistent farming. People drink water from mountainous spring wells via pipelines directly to their homes. The water contains no iodine. Iodized salt is widely distributed in the markets with higher price than un-iodized one. Only 61% households used iodized salt for cooking. Since the year 2004 iodized oil has been withdrawn from Indonesia IDD elimination program, including in the study area. Total goiter rate (TGR) in Ngargoyoso sub-district increased steeply from 29% in 1996, to 32% in 2006, and 51.9% in 2010 after stopping the supply of iodized capsules. There were 22 state-owned elementary schools with ±3000 students in the sub-district. All schools were included in the study.

2.2. Subjects

Three hundred and sixty five school children at year three (8 years old) were participated in the study. Cluster random sampling was used to allocate school children into two groups. Group I received 60 mg elemental iron (200 mg $FeSO_4$) twice weekly + 100 µg iodine (KIO_3) in drinking water daily, whereas Group II received 60 mg elemental iron (200 $FeSO_4$) six days/wee + 100 µg KIO_3 in drinking water daily. KIO_3 was used as it does not change the color, taste and odor of the drinking water.

2.3. Study protocol

List of all (22 schools) state-owned elementary school in Ngargoyoso sub-district was used as baseline data. Then, the schools were numbered and used as clusters. Cluster random sampling technique was used to allocate the schools into two groups. Both groups received 400 mg Albendazole in single dose, just before starting the supplementation. The first group (N=211) was given one iron tablet twice weekly + iodized drinking water daily. The second group (N=164) received one iron tablet six days a week + iodized drinking water daily. Students of year three (± 8 years old) was chosen because in 2011 they were anemic (Hb<11.5 g/dl). Two doctors in charge at Ngargoyoso Health Center undertook palpation of the thyroid gland. Both of them have been trained in thyroid palpation at Research and Development Center on IDD, Magelang, Central Java, Indonesia. Teachers were recruited to ensure that the iron and iodine supplements were taken by the students.

2.3. Hemoglobin measurement.

Three hundred and sixty five students were taken their capillary blood for hemoglobin measurement with hematin-chloride (Sahli) method. Blood samples and the measurements were conducted at schools by a trained laboratory assistant. Results were reported in g/dl.

2.4. Urinary iodine measurement

Three hundred and sixty five students were asked to collect their urine at basal and six week after supplementation of iodine supplementation. Urinary iodine excretion (UIE) was measured using Method A-ammonium persulfate digestion (WHO, 2007). Casual urine samples were taken without preservative and refrigeration in plastic bottles (50 ml with sealed cap) in the morning before starting the class hour, and then sent to IDD laboratory at Magelang, Central Java on the next day. Results were reported in µg/L urine.

2.5. Palpation of thyroid

The student to be examined stands in front of the doctor and the asked to look up and fully extend his/her neck. The doctor palpates the thyroid by gently sliding her own thumb along the side of the trachea between the cricoids cartilage and the top of the sternum. Both sides of trachea are checked. The size and consistency of the thyroid gland are carefully noted (WHO, 2007). Goitre is graded according to the classification as follow:

Grade 0 No palpable or visible goitre.

Grade 1 A goitre is palpable, but not visible, when the neck is in the normal position.

Grade 2 A swelling in the neck that is clearly visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated.

Total goitre rate is the sum of grade 1 and grade 2.

Result was reported in % of the subjects examined.

2.6. Anthropometric measurements

Weight was recorded on a calibrated mechanical bathroom scale to the nearest 0.1 kg (Krups, Ireland) after zeroing for each measurement. Children were lightly clothed and had removed their footwear. Height was recorded using a microtoise (Statumeter™, Indonesia) and measured to the nearest 0.1 cm. Each child stood with his buttocks, heels and back against the wall and his head in the Frankfurt plane. Mean of weight and height were calculated using SPSS 17.0 (Chicago, IL,USA).

2.7. Supplements

To provide 100µg iodine/L drinking water, the following procedure was used: 24 g of KIO_3 diluted with adding 725 ml distillated water. This solution is then poured into 24 plastic bottles of 30 ml each. Two drops of this solution is added to 10 L of drinking water. This provides 200µg iodine per liter of drinking water (Pandav et al, 2000). The drinking water was kept in ten liter pots. Each student provided a glass of 250 ml. They were asked to drink two glasses every day during break time. The supplement does not change the color, taste and odor of the drinking water. Iron supplements were given twice weekly to group one and six days a week in group two. Iron tablet (60 mg elemental iron presented in 200 mg $FeSO_4$, non sugar coated) were given in the morning,

2.9 Statistical analysis

Results were expressed as the mean ± standard deviation. To see the difference between baseline and post-treatment in each group a paired *t*-test was used. For comparison between groups an independent *t*-test was used. All statistical analysis was performed using SPSS for Windows, release 17.0 (Chicago, IL, USA).

2.10 Ethical considerations

The study was approved by the Ethical Review Committee, School of Medicine, Sebelas Maret University. The students, the parents and the head masters were informed about the nature of the study and agreed to participate and gave informed consents..

3. Results

Subject characteristics shown in Table 1. Surprisingly, the total goitre rate in the present study (2013) was much lower than our last report (Suprapto & Dewi, 2012). With TGR of 9.3% Ngargoyoso sub-district now can be classified as mild IDD endemic area. Median urinary iodine excretion was 248.5 µg/L and classified as above the requirement (WHO, 2007), although 14.6% students still have UIE <100 µg/L. Iodine supplementation within six weeks increased median UIE to 319 µg/L and reduced schoolchildren with low iodine intake (UIE<100 µg/L) to 7.5%. On the contrary, almost all schoolchildren (98.6%) in Ngargoyoso sub-district were anaemic (Hb<11.5 g/dl). Six weeks iron supplementation either twice weekly or six days a week increased haemoglobin concentration significantly (Table 2). Paired-t test showed significant increase in both groups, but the increment was higher in group two (six days a week). However, the prevalence of anaemia only slightly decreased from 98.6% to 97.4%.

4. Discussion

Soil transmitted helminthiasis is highly prevalent among school children, even in urban area like Jakarta, the capital of Indonesia (Sasongko, 2000). *Ascaris lumbricoides* and *Trichuris trichiura* infections are common in schoolchildren/ Bad personal hygiene was blamed as the main cause. We give 400 mg Albendazole in single dose before iron supplementation to all schoolchildren in order to ensure that the supplementation will be effective. Albendazole was used in eradicating soil transmitted helminths in Indonesia and has been proven effective. Different iron supplementation schedules has been proposed by WHO (Stoltzfus & Dreyfuss (1998);WHO, 2011). In this study, we compared twice weekly and six days a week iron supplementation in schoolchildren with mild anemia in iodine deficient environment. Results showed that iron does not influence iodine supplementation and *vice versa*. Six days a week iron supplementation better than twice weekly in terms of hemoglobin increments. In pregnant women, twice weekly iron supplementation was more effective than daily iron supplementation because of lesser side effects and better absorption. Recently WHO (2011) promotes intermittent iron supplementation once a week in schoolchildren. We argued that such schedule would not be enough to combat iron deficiency anemia in Ngargoyoso sub-district. It seems that daily iron supplementation must be given until the prevalence of anemia reduced below national level. At present, Indonesia still be classified as a country with severe public health problem of iron deficiency anemia (de Benoist at al, 2006). Iron tablet used in this study was not sugar coated. Some students disliked it, and some got nausea, vomiting and diarrhea. For better acceptance, we recommend sugar coated iron tablets in the community supplementation programs. Iron deficiency anemia reduced cognitive function in schoolchildren in Indonesia (Soemantri et al (1985), and combating iron deficiency anemia would increase cognitive function (Soewondo et al, 1989; Sesadri & Gopaldas, 1989). Iron deficiency anemia reduced 5 IQ points (Walter, 2003). In the present study, we did not measure cognitive function of schoolchildren in Ngargoyoso sub-district. However, a follow up study will include the measurements. In Thailand, Thurlow et al (2006) found that anemic infants treated with iron would have lower cognitive function at 9 years old. The implication of this findings suggests that periodic iron supplementation in children living in countries with high prevalence of anemia is warranted. At least, intermittent iron supplementation as recommended by WHO (2011) should be conducted. Iron deficiency anemia and iodine deficiency are two among others nutrition problems in Indonesia (Atmarita, 2005). Indonesia iodine deficiency elimination program has not been very successful (Goh, 2001). There was an increase of TGR from 9.8% to 11.1% after an intensive national intervention program conducted between 1998 to 2003. Atmarita (2005) showed that about half of the districts in Indonesia remained endemic, even some districts became worst. In the present study, we found that the total goiter rate (TGR) was 9.3% in Ngargoyoso sub-district, Central Java. It is much better than in the year of 2010 (51.9%) and 2011 (34.8%). After two years iodine supplementation in schoolchildren in this area we could reduce TGR significantly. Our concern is how to maintain the progress, because iodine supplementation in schoolchildren is not the government priority. The Department of Health of Indonesia rely its IDD eradication program on iodized salt. In Africa, Zimmermann et al (2000) found that anemic goitrous schoolchildren were resistant to iodine supplementation. Indeed, Hess et al (2002a) showed that treating iron deficiency anemia would improve the efficacy of iodized salt. It has been shown that iron deficiency reduced the activity of thyroid peroxidase (Hess et al, 2002b). The activity of this enzyme is required in trapping and binding iodine to tyrosine molecules in thyroid glands (Visser, 2008). Therefore, double supplementation among anemic schoolchildren living in IDD endemic area such as Ngargoyoso sub-district, Central Java would give a better result. Eftekhari et al (2006) also found that double supplementation of iron and iodine increased both iron status and thyroid hormone parameters. Sattarzadeh & SZotkin (1999) showed that in adult there was no interference between iron and iodine absorption. Our results showed an increase in both hemoglobin concentration and median UIE. It seems that iron and iodine supplementation could be given simultaneously. Six days a week iron supplementation is better than twice weekly in increasing hemoglobin concentration (0.550 ± 0.195 g/dl *versus* 0.355 ± 0.123 g/dl, $p<0.001$), although after six weeks iron supplementation the prevalence of anemia was still very high (97.4%). Median UIE in Ngargoyoso sub-district, Central Java in the present study was higher than the requirement (248.5 µg/L before supplementation and 319.0 µg/L after six weeks iodine supplementation). This result showed an improvement in iodine intake in the sub-district after two years study in schoolchildren. It seems that consumption iodized salt increased due to emerging awareness of the importance of iodine in improving cognitive functioning. Dewi et al (2012) revealed that iodine supplementation in preschoolers in Ngargoyoso sub-district, Central Java increased 8.8 IQ points after 12 weeks supplementation. If this true, people in the sub-district can now rely on iodized salt alone, although 7.5% schoolchildren in Ngargoyoso sub-district still had UIE<100 µg/L at the end of the study. In summary, the present study revealed that based on TGR, Ngargoyoso sub-district has moved from severe IDD endemic to mildly endemic, and a replete area if UIE was used as the sole parameter of iodine intake. However, iron deficiency anemia was highly prevalent (97.4% at the end of the study). We recommend to conduct six days a week iron supplementation in schoolchildren in Ngargoyoso sub-district to reduce the prevalence of anemia and periodic albendazole treatment to all schoolchildren due two bad personal hygiene in rural area.

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Table 1 Characteristics of schoolchildren participated in the study (N= 365).

Variables		
Age (years)		± 8
Sex :	Boys	167
	Girls	198
Height (cm)		122.2 ± 6.02
Weight (kg)		22.57 ± 3.71
% anemia (Hb<11.5 g/dl)		98.6
Median UIE (µg/L)		248.5
% UIE < 100 µg/L		14.6

Table 2. Results of six weeks iron and iodine supplementation on hemoglobin concentration and median UIE

Variable	**Group I** (**+ iron twice weekly)**	**Group II** (**+ iron six days a week)**	**p**
Hemoglobin (g/dl)	10.183 ± 0.742	10.196 ± 0.611	< 0.05
Median UIE (µg/L)	292.0	361.0	<0.05