ORIGINAL ARTICLE

THE INFLUENCE OF IODINE SUPPLEMENTATION INTO DRINKING WATER AS A COMPLEMENT TO IODIZED SALT IN SCHOOLCHILDREN IN A MOUNTAINOUS AREA OF CENTRAL JAVA, INDONESIA

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ABSTRACT

Iodine Deficiency Disorders (IDD) is still prevalent in Indonesia. Since 1994 the Government of Indonesia launched iodized salt as the sole method to eliminate IDD. Unfortunately, many parts of the country, particularly in mountainous area could not achieve the target due to some reasons.The objective of the present study was to ascertain that iodine supplementation into drinking water can fill the gap. It was a school-based, long-term trial of iodine supplementation into drinking water in schoolchildren aged 8-10 years. That drinking water contained 200µg iodine/L. Four hundred and forty one children in Ngargoyoso sub-district were included in the study. Drop method of water iodization was used. Goiter was determined by palpation. The reduction of Total Goiter Rate (TGR) indicates effectiveness of the supplementation.TGRdecreased from 51.9% (2010) to 34.3% (2011) to 25.2 (2012) consecutively. No dropout wasreported. It seems thatsevere IDD endemic area with abundance of drinking water from spring well would benefit from the supplementation.

***Keywords**: iodine supplementation, drinking water, schoolchildren, mountainous area, Central Java*

INTRODUCTION

Indonesia is the biggest archipelago in the world. It consists of more than 17,000 islands with around 240 million inhabitants and 54 million are living in iodine deficient area[1]. Many parts of the country are difficult to reach due to geographical reasons. It is easily understandable that iodized salt distribution within the country is uneven. Ngargoyoso sub-district, a mountainous area on the high slope of Mount Lawu has been known as an IDD pocket in Central Java.

In 1998, National Survey on Iodine Deficiency has confirmed the statement. While TGR nationally was 9.8% and 4.4% in Central Java, it was 17.1% in Ngargoyoso sub-district[2]. The sub-district is located on the high slope of Mount Lawu at an altitude between 650 and 1100 meters above the sea level. The most remote area has no access for car. After stopping iodized oil capsules in Ngargoyoso sub-district the TGR among schoolchildren increased steeply, from 17.1% in 1998 to 51.9% in 2010.Only 61% of households reported using iodized salt[3].

Our study group observed that since 2004 the health centre of Ngargoyoso sub-district removed iodized oil capsules from their budget. Since then people relied their iodine supply only upon iodized salt. Besides the increase of TGR, there was a low urinary iodine excretion among preschool children[4], and pregnant women[5]. It was not surprising that abortions and stillbirths were quite prevalent in the sub-district[4]. Iodine was also not detected in drinking water consumed by people[4]. To make things worse, some goitrogenic foods were consumed by schoolchildren[3]. However, drinking water is abundant. People get their drinking water from spring wells, free of charge. It is distributed directly to people homes via pipeline.

The objective of the study was to ascertain that iodine supplementation into drinking water can fill the gap left by using iodized salts in the community.The hypothesis was an iodine supplementation trial into drinking water can fill the gap until iodized salt completely works in Ngargoyoso sub-district.
The study was approved by Ethical Review Committee, School of Medicine, SebelasMaret University. The parents on behalf of their children were informed about the nature of the study and gave their informed consents.

MATERIAL AND METHODS

Population

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, integrated health posts and a health centre. The most remote area has no access for car. It consists of 9 villages with inhabitants about 30,000 people living from subsistent farming. People drink water from mountainous spring wells distributed via pipelines directly to their homes. Unfortunately, the water contains no iodine. Iodized salt is widely distributed in the

traditional market with higher price than non-iodized salt. Only 61% households used iodized salt for cooking. Since the 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 17.1% in 1998 to 32% in 2006 and 51.9% in 2010 after stopping the supply of iodized oil capsules.

Subjects

Ngargoyoso sub-district has 21 state-owned elementary schools with around 3000 pupils from year one to six. Only pupils from year two and year four (aged 8-10 years) were surveyed for goiter at the end of the year 2010, so that they can be followed up for the next three years iodine supplementation. It consists of 197 girls and 244 boys (n=441) with overall TGR at 51.9%. These pupils received Albendazole 400 mg as de-worming agentjust before supplemented with 100 µg iodine daily, six days a week.

Data collection

Iodine supplementation into drinking water

Drop method for water iodization was used. To provide 100 µg iodine/L drinking water, the procedure as described by Pandav et al[6]was followed i.e. 24 g of KIO_3(Merck, Germany) dissolved in 725 ml water. This solution is then poured into 24 plastic bottles of 30 ml. Two drops of the solution is added to 10 L of drinking water in a water dispenser. This provides 200 µg iodine/L of drinking water. Each pupil drinks a glass of water (250 ml) every school break; there are two school breaks every day. Thus a pupil would drink two glasses of water (500 ml) containing 100 µg iodine/day,six days a week. The supplementation started In January 2011 until December 2013.

Delivery of iodine supplement

Each school received one plastic bottle contained 30 ml iodine solution and two or four water dispensers (10 L each) for particular school participated in the trial (Figure 1). One school teacher took responsibility to provide two glasses of iodized water during school day for each student. Figure 2 showed pupils taking iodized water from water dispenser.

Figure 1: A school teacher drops iodine into drinking water. Photograph by Sunarto (2011)

Figure 2: Pupils are taking iodized drinking water. Photograph by Sunarto (2011)

Definition

Palpation of the thyroid gland

A trained doctor carried out the palpation of the thyroid gland. All of subjects were palpated every year. The pupil to be examined stands in front of the doctor and then asked to look up and fully extended his/her neck. The doctor palpated the thyroid gland by gently sliding her own thumb along the side of 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. Goiter was classified according to WHO classification[7] as the following: Grade 0, the thyroid neither palpable, nor visible; Grade 1, the thyroid is palpable, but not visible; when the neck in a normal position. Grade 2 is 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 goiter rate (TGR) is the sum of Grade 1 and Grade 2, divided by all children palpated. Figure 3 and Figure 4 showed palpable and visible goiter.

Figure 3 Palpable goiter. Photograph by Sunarto (2011)

Monitoring

A checklist was provided to the teacher to be filled including the number of children who took the supplement, complaints (if any), drop outs (and its reason), replacement of iodine solution and water dispenser (if necessary). The checklists were collected by staffs of Ngargoyoso Health Centre every week. Palpation of the thyroid gland was carried out by a trained doctor in December each year until 2013, for calculating the TGR.

Efficacy of iodine supplementation

Efficacy of this trial was determined by a reduction in TGR within three years.Acceptability was reflected by drop-out rates, and affordability was calculated as cost of daily supplementation including the water dispenser compared with monthly household expenditure at the same period.

Figure 4: Visible goiter. Photograph by Sunarto (2011)

RESULTS

About 197 girls and 244 boys of elementary school in Ngargoyoso sub-district participating in the supplementation trial. Analysis of the checklists revealed that all pupilsfollowed the trial till the end of the study. Some pupils reported got common illness and absent from school for some days, but continued taking iodized water after that. Total Goiter Rate (TGR) at the beginning of the study was 51.9%. At the end of year one (2011) TGR was 34.3%. TGR continued to decrease to 25.2% at the end of year two (2012) and 9.3% in 2013 (See Figure 5). The results of the study showed the effectiveness of iodine supplementation into drinking water among schoolchildren in reducing TGR. Drop-out rates often used as an indicator of acceptability of supplementation program. The study showed that none of the children withdrawn from the study for any cause. No side effects were reported. Zero drop-out was an excellent achievement of a program.

DISCUSSION

The government of Indonesia released the decentralization decree in 2004. It caused a very big impact on health budgeting. Since 2004, health budget has been allocated via district management. In 1998, overall TGR in Karanganyar district - where Ngargoyoso sub-district is located - was 4.4%. It was understandable if there was no budget allocated for IDD elimination program. However, at the same period TGR in Ngargoyoso sub-district was 17.1%[2].Iodized oil capsules has been stopped by Health Centre of Ngargoyoso since 2004. Furthermore, the capsule was officially banned in 2009 by The Department of Health, Republic of Indonesia. Now, IDD elimination program just relies on iodized salts.

This decision was supported by median urinary iodine excretion reported nationally[8],where Indonesia is classified as a country with a threat of Iodine Induced Hyperthyroidism (IIH). However, analysis of Indonesian national survey in 1998 (TGR of 9.8%) and 2003 (TGR of 11.1%) showed that an

increased goiter prevalence in one-third of the districts of the country[9]. As stated above, Indonesia is the biggest archipelago in the world. It would be wise to carry out a public health program based on local condition. Ngargoyoso sub-district is located on the high slope of Mount Lawu, Central Java, at an altitude between 650 and 1100 meters above the sea level. It has some asphalt roads, traditional markets, some electricity and a health centre. The most remote area has no access for car. People drink water from spring wells, unfortunately it contains almost no iodine.Within the year of 2010 till 2013.

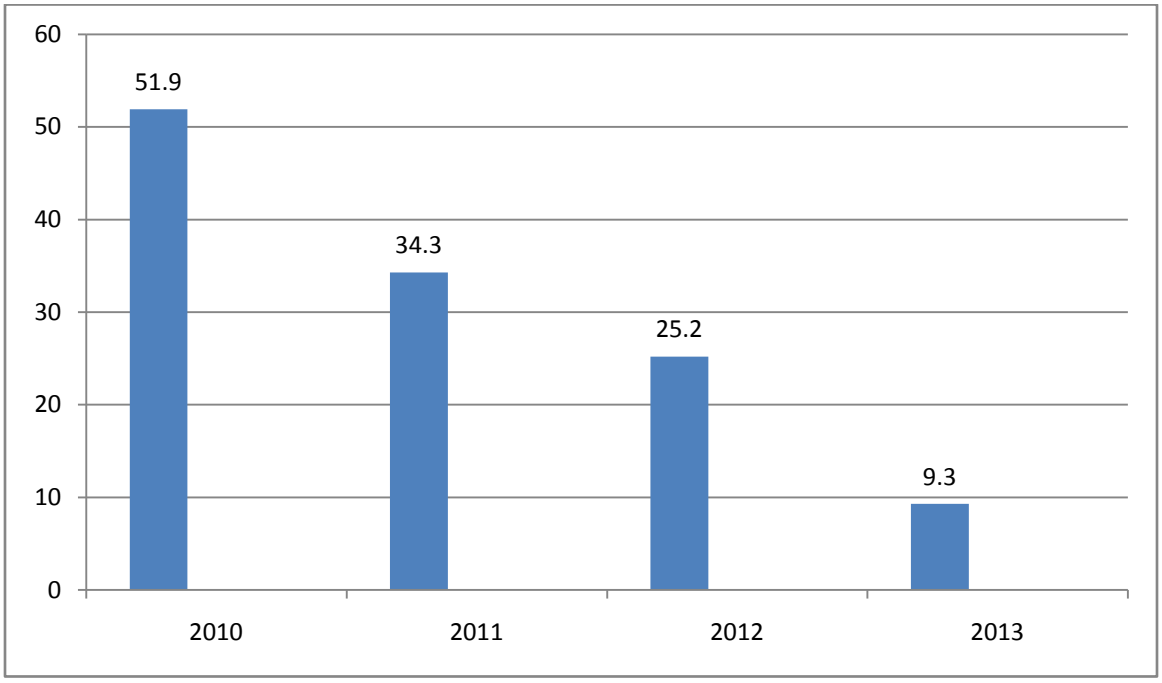

Figure 5. TGR among schoolchildren in Ngargoyoso sub-district 2010-2013.

The IDD Study Group of SebelasMaret University collected data from Ngargoyoso sub-district with the following results: Median Urinary Iodine Excretion (UIE) less than 100 µg/L among preschool children was 23.34% (n=317)[4],maternal UIE < 150 µg/L was 54.4% (n=126)[5], abortion rate was 13.1/1000 live birth and stillbirth rate was 32.7/1000 live births[5]. Household consumption of iodized salts was of 61%, far below national target (>90%)[4]. Therefore, an urgent iodine supplementation was warranted. Iodine supplementation into drinking water in preschool children improved cognitive performance[6]and water iodization reduced TGR substantially in school children within three years i.e. from 51.9% to 9.3%. Water iodization has been used in several countries with good results. In Mali, Fischet al[10] developed a controlled iodine release system based on silicone.

The device then placed in wells so that it can release a certain amount of iodine. Urinary iodine excretion was increased significantly in test villages compared with control village. The disadvantage of the system is that the elastomer should be replaced each year. Elnagaret al[11]found a reduction of goiter prevalence with iodination of water in four villages in Sudan after two years supplementation. Water iodization has also been used in some trials in different countries[12-14]. The drop method was used in our study for two reasons. First, it is easy to carry out. No equipment is needed. Second, the water must be boiled to kill *E. coli* before supplemented with iodine. Drop method has also been used in Thailand successfully[8].TGR was used as an outcome measure in this study because it is cheap and applicable under condition in rural areas of Ngargoyoso sub-district. In rural areas where people usually have low education level, a reduction of TGR gives a better impression than urinary iodine excretion, although the latter is more sensitive.

Visible goiter is easily seen, and if it disappears people feel they get the “evidence”. Elnagaret al[11]also used goiter prevalence in Sudan to measure the effectiveness of iodination of water. Zimmermann et al[15] concluded that the 1994 palpation criteria provide an accurate estimate of goiter prevalence in areas of severe IDD, such as Ngargoyoso sub-district. It is also more acceptable and affordable than thyroid ultrasound[15]. In Malaysia, Foo et al[16]observed that in the screening

of children for thyroid enlargement the use of local reference is more favorable than WHO/ICCIDD-recommended thyroid volume reference in the assessment of IDD.It seems that palpation of the thyroid is still valuable in the screening of IDD, especially in severely endemic area. However, to be sustainable an iodization program should include community participation and also local resources should be used optimally. Drinking water is always available all the year from natural spring wells.

It is free for all people in the sub-district. Thus, drinking water is an ideal vehicle for iodine supplementation for them. Water is a dietary necessity and is consumed daily by all people[11]. Elnagar et al[11]suggests if a specific source of drinking water can be identified like in Ngargoyoso sub-district, water iodination may be appropriate at the village level. Pandavet al[6] evaluated water iodization program in Thailand. They used three outcome measures to be evaluated i.e. cost per beneficiary, cost per µg iodine consumed daily and cost per goiter person years averted. They found that the cost per µg iodine consumed daily was US$ 0.01. Our study revealed that the cost of iodine supplement and water dispensers was US$ 0.00067per person per day or US$ 0.24/person/year. It is similar with the cost of iodized oil, although higher than iodized salt[13]. When it is compared with household expenditure in the sub-district at the same period i.e. US$ 75/month, it can be assumed that people can afford the iodine supplement. Even, without subsidy from the government. However, it is difficult to calculate the cost of TGR reduction per year, because at the same time people consumed iodized salt.

Although only 61% households in Ngargoyoso sub-district in 2010 consumed iodized salt for cooking[4], recent data compiled at country level showed an increase from 62.3% (2007) to 77.1% (2013)[17]. This increase of consumption may in part explain the decrease of TGR from 25.2% (2012) to 9.3% (2013). Of course, the safety and convenience of iodine supplementation into drinking water must be a serious concern. Iodine did not change the color and taste of the water. During the trial no side effects were reported. Some minor ailment, such as common cold experienced by the pupils, but they continued taking the supplement. It is assumed that the iodine supplementation into drinking water can be accepted by the school children. Community participation will emerge if the people convinced that the program was effective, safe and within reasonable cost. The main limitation of this supplementation study was that iodine intake from other sources (iodized salts, salted small fish etc) consumed by schoolchildren in the study area have not been calculated. Due to ethical consideration it is unwise to conduct a randomized placebo control trial in a severe endemic IDD area like Nagrgoyoso sub-district, Central Java. With the present study design confounding factors could not be eliminated.

CONCLUSION

Iodine supplementation into drinking water is effective, acceptable and affordable for people in Ngargoyoso sub-district, Central Java, Indonesia. It seems that iodine supplementation program into drinking water can fill the gap left by iodized salts in the study area.

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