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Full Length Research Paper

Impact of double fortified salt on iron and iodine deficient school children (6 to 12 years) of rural Vadodara

Sirimavo Nair[1]*, Ruchirang Goswami[2], MGR Rajan[3] and Vasudev Thakkar[2]

[1]Department of Foods and Nutrition, Faculty of Family and Community and Sciences, M.S. University of Baroda, Vadodara, India.

[2]Department of Biosciences, Sardar Patel University, Vallabh Vidyanagar, India.

[3]Nuclear Medicine Section, Bhabha Atomic Research Centre, Tata Memorial Hospital- Annexe Building, Parel, Mumbai, India.

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Iodine deficiency disorder (IDD) is a widespread health problem in developing countries. Double fortified salt (DFS) has been developed to combat two micronutrient deficiencies (iron and iodine) simultaneously; because, in many instances, these deficiencies co-exist. Iron component of the DFS helps to improve the hemoglobin (Hb) level. There is a simultaneous improvement in thyroperoxidase (TPO) activity and iodinated thyroglobulin (Tg) levels due to presence of iodine. The objective of this study was to assess the impact of DFS supplementation on salivary Tg and Hb levels in children of 6 to 12 years of age. The present study was conducted in rural areas of Vadodoara district. A total of 3125 children were screened for iodine deficiency by palpation and based on urinary iodine excretion (UIE). Their anthropometric measurements were recorded. The children (n= 54) with less UIE level (<100 µg/L UIE indicates iodine deficiency) were enrolled as subjects for the study, they were supplemented with DFS for two months. Biochemical estimations for salivary Tg, serum Tg, T4 and thyroid stimulating hormone (TSH) (by Radio Immuno Assay), Hb (by Drabkin's Method) and UIE (by micropipette method using ELISA reader) were carried out before and after the supplementation. All the data were subject to statistical analysis using SPSS software version 13.0. Mean salivary Tg values were reduced significantly by 4.45 ng/dl. Mean Hb value in post data improved by 0.5 ng/dl. Mean serum Tg was found to be 12.4 ng/dl which was in normal range. Supplementation of DFS with iron and iodine can combat these deficiencies simultaneously. DFS supplementation improves Hb and Tg levels in the subjects. Hence, DFS can be a powerful weapon in eliminating two micronutrient deficiencies.

Key words: Iron, iodine, thyroid, salivary thyroglobulin (Tg), double fortified salt (DFS), radio-immunoassay (RIA), urinary iodine excretion (UIE).

INTRODUCTION

Childhood malnutrition is a massive crisis in developing countries. Inadequate micronutrients in the diet lead to micronutrient-deficiency. Double fortified salt (DFS) has been designed with iron and iodine to control at least these two micronutrient deficiencies (Rao, 1994). DFS, when consumed regularly (for a minimum period of two months), improves the status of these two micronutrients in the human body (Malavika et al., 2007; Zimmermann et al., 2003, 2004). Iron present in DFS increases hemoglobin (Hb) level. Also, heme is prosthetic group of

*Corresponding author. E-mail: ruchirang@gmail.com

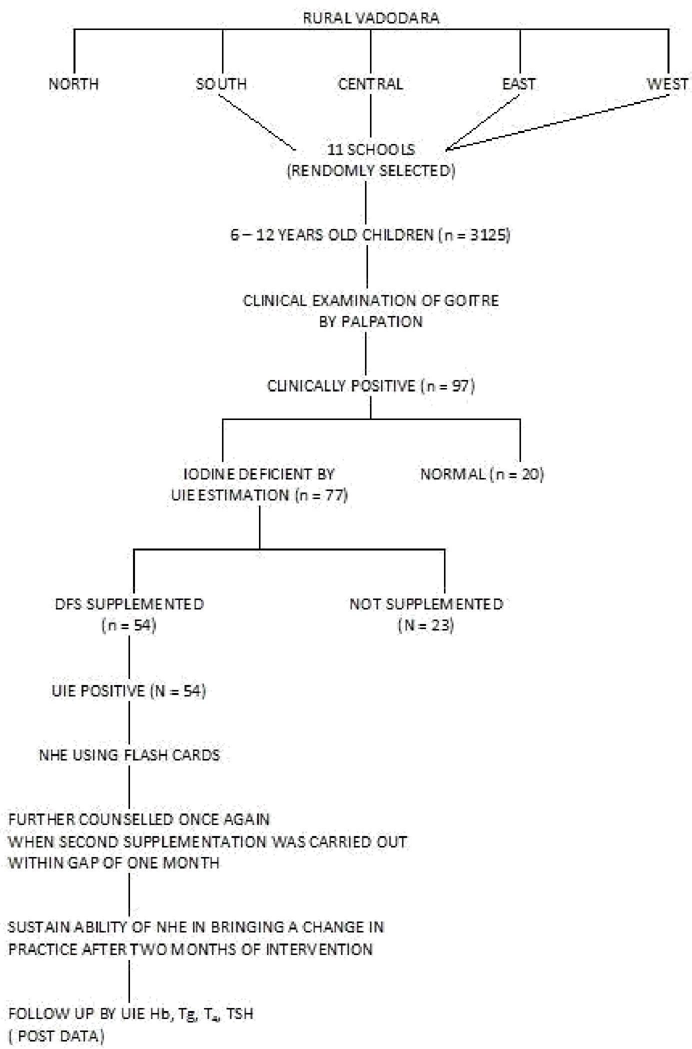

Figure 1. Schematic diagram of study design.

enzyme thyroperoxidase (TPO) which catalyzes iodination of thyroglobulin (Tg) at tyrosyl residues (Beard et al., 1998; Fayadat et al., 1999).

MATERIALS AND METHODS

Study area

The present study was carried out among the school children of ages 6 of 12 years in the rural Vadodara. Ten villages were randomly selected within and around Vadodara which were scattered in the East, West, North, South and Central zones. After an initial scanning by palpation method, 8 villages had the population which precipitated some form of goitre. These 8 villages were in 15 to 30 km of the radius. They were Channi, Karachiya, Mujpur, Padra, Mahuvad, Sokhada, Aajod, Goraj and Padra.

Sample size

Considering goitre prevalence of 10 and 95% confidence limit, 20% relative precision of estimate, the sample size required was calculated as follows:

Anticipated prevalence of goitre (p): 0.1;
Level of significance (z): 95% (1.96);
Relative precision (e): 20%;
Formula for sample size calculation = $(Z)^2 \times (1 - p)/(p) \times (e)^2$
Sample size (N) = $(1.96)^2 \times (1\text{-}0.1)/(0.1) \times (0.2)^2$ = 864 Children

The children screened were 3125. A sub-sample was arrived based on various classes of goiter along with UIE deficiency, and these subjects were supplemented (n=54) with DFS which had iron (1000 ppm) and iodine (40 ppm) (Figure 1). The goiter precipitation was classified by WHO/ICCIDD (1994).

Estimation of UIE

UIE estimation was done by micropipette method using enzyme-linked immunosorbent assay (ELISA) reader. The cut off value for median UIE are as follows: 100 or <100 µg/L: normal; 50.0 to 99.9 µg/L: mild iodine deficiency; 20.0 to 49.9 µg/L: moderate iodine deficiency; < 20.0 µg/L: severe iodine deficiency.

Estimation of haemoglobin in blood

Collection of blood sample

Venous blood was collected using an ethylenediaminetetraacetic acid (EDTA)-Vaccutainer for each subject and was analyzed by Cyanmet method.

Measurement of salivary Tg

Collection of saliva samples

Glass vials with screw caps (5 ml) were provided for saliva. Children were asked to rinse their mouth thoroughly with water to remove any food particles and then transfer saliva. These samples, after initial processing in the laboratory were analyzed by Radio Immuno Assay (RIA). All these analysis were carried out after the approval of ethical committee (Institutional Ethical Committee, ME54/55 as per ICMR guidelines).

Statistical analysis

All results were analyzed using SPSS software version 13.0.

RESULTS

The subjects had mild (25.9%), moderate (57.4%) to severe (16.7%) levels of goiters (p<0.001). It was observed that the mean urinary iodine concentration was 44.4 µg/L which increased to 110.2 µg/L after DFS supplementation for 2 months (Figure 2). Thus, this indicates that there was a shift from moderate iodine deficiency to normal. Generally, all thyroid function tests hormonal assays were carried out. It was of our interest to use a non-invasive approach. Our study revealed significant difference in baseline and post-supplementation values of salivary Tg (p <0.001). Mean salivary Tg was reduced from 6.28 to 1.83 ng/dl.

Increase in Hb was observed at the end of supplementation period. Mean base line level was 11.1 g/dl which increased to 11.6 g/dl after supplementation (p < 0.001) (Figure 3). After supplementation period, serum Tg was analyzed. It was found that

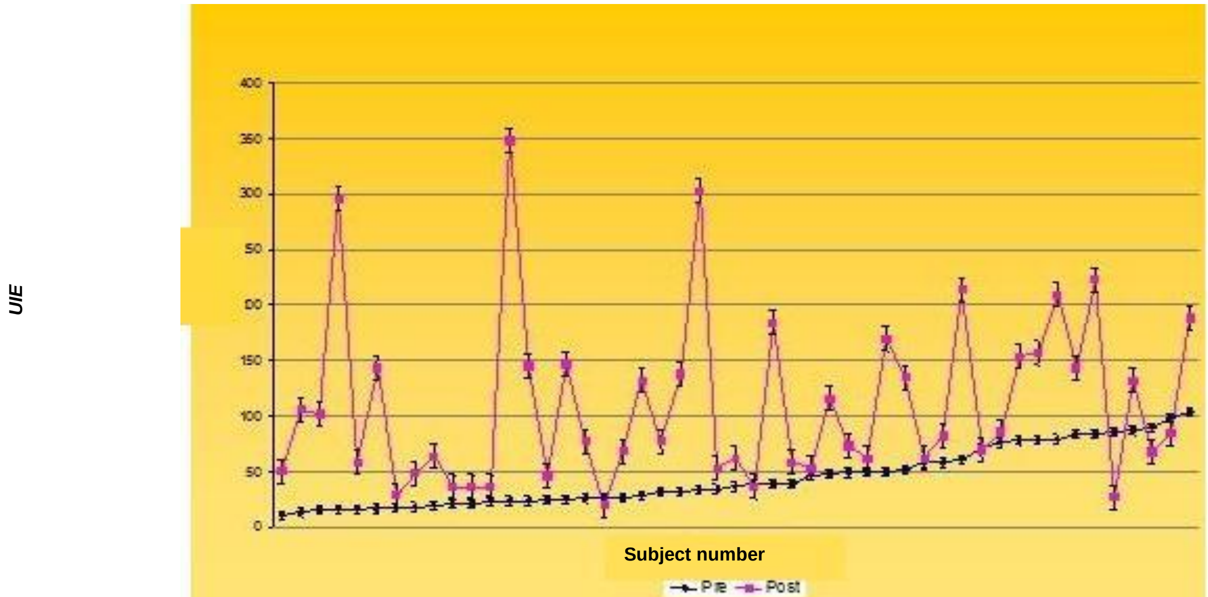

Figure 2. Distribution of UIE before and after DFS supplementation.

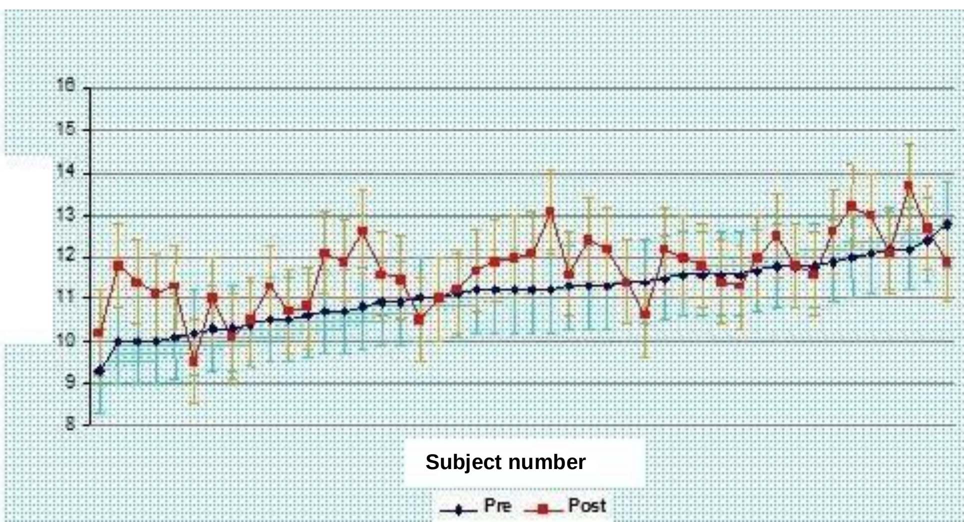

Figure 3. Distribution of Hb before and after DFS supplementation.

100% subjects had normal values of serum Tg.

DISCUSSION

The aforementioned results clearly indicate that, intake of DFS singly can contribute to the overall improvement in the iron and iodine status of an individual.

Marked reduction in mean values of salivary Tg (difference 4.455 ng/dl) was a sign of improvement in subjects. The advantage of the non-invasive approach is that all types of population can be considered. We found that instead of collecting serum, this approach would be highly beneficial due to the fact that even a drop of blood could be considered as a boon to them. This change was observed majorly due to impact of DFS. Iron presence in DFS improves the activity of enzyme TPO (because iron is a co-factor of the enzyme) (Hess et al., 2002).

Function of TPO is to enhance iodination of Tg polypeptide. Since iodine is available from DFS, iodination of Tg polypeptide occurs smoothly. Iodinated Tg polypeptide being precursor to thyroid hormones, is used up in the hormone formation, bringing T_3 and T_4 levels to normal. Hence, a decrease in salivary Tg value ($p < 0.01$) observed could be accounted for the same. The serum Tg value is an appropriate indicator for iodine status as reported by Breil et al. (2001). Thus, viewing the details, it is suggestive that an improvement in Hb level of 0.5 g/dl which was observed in our study though not anticipated in a short span of two months, could be because of various reasons such as less cases of infections, good absorption of iron, good iron stores, high intake of staple food-Bajra (pearl millet) which is a rich source of iron (8 mg iron in 100 g) and appreciable intake of vitamin C rich fruits like Zizyphus and Gooseberry which enhances iron absorption. As a part of the study, mothers were intervened for inclusion of iron-rich foods in their diet like green leafy vegetables and vitamin-C rich fruits. There can be an interference of phytates, though the results are commendable with an overall increase on 0.5 g/dl. Overall, this increase contributes to 4.5% of rise in Hb levels amongst the population.

The DFS supplementation study reflects on general improvement of the health status of a subject (Zimmermann et al., 2002). It is evidenced from the results that a consistent supply of DFS in the diet can improve the iron status along with iodine status of school children. Salivary Tg proved to be a good non-invasive indicator which can be used in field and can be applied to conduct large population size. Hence, it is essential and suggestive, that any government should strategically think and use DFS as an immediate solution to combat these two micronutrient deficiencies. If this is gained, half of the battle against malnutrition is won.

Conclusion

DFS can be a feasible and effective strategy to control two micronutrient deficiencies (iron and iodine).

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