Indian J Physiol Pharmacol 2004; 48 (2) : 219–224

IODINE NUTRITIONAL STATUS OF SCHOOL CHILDREN IN A RURAL AREA OF HOWRAH DISTRICT IN THE GANGETIC WEST BENGAL

AMAR K. CHANDRA*, SMRITIRATAN TRIPATHY, DISHARI LAHARI AND SANJUKTA MUKHOPADHYAY

Endocrinology and Reproductive Physiology Laboratory,
Department of Physiology,
University College of Science and Technology,
University of Calcutta
92, Acharya Prafulla Chandra Road,
Kolkata – 700 009

(Received on June 23, 2003)

Abstract : The objective of the study was to assess the status of iodine nutrition in an area of Howrah district where iodine deficiency disorders (IDD) were reported despite the introduction of iodised salt for general use. A total of 969 school children in the age group 6–12 years of both sexes were clinically examined for goitre. On the spot 242 urine samples were collected from the children to study the iodine and thiocyanate excretion pattern and 108 edible salt samples were collected from the homes of the children to measure iodine level. Drinking water samples were collected to evaluate the bioavailability of iodine in the region. The total goitre prevalence was 37.6% (Grade 1: 32.6%; Grade 2: 4.9%). The median urinary iodine level was 35 μg/dL, 12.5% urine samples had iodine level below 10 μg/dL and no sample was found to contain iodine below 5 μg/dL. In 51.9% salt samples iodine level was below 15 ppm and the iodine level in the drinking water was about 82 μg/L. The people of the area consume foods from the vegetables of the *Brassica* family and mean thiocyanate level was 0.747 ± 0.21 mg/dL. The findings of the present study indicated that as per clinical criteria of WHO/UNICEF/ICCIDD, IDD is a severe public health problem though apparently there is no biochemical iodine deficiency. Overall results indicate that factors other than iodine deficiency may have a role in the persistence of endemic goitre in the post salt-iodisation in this region.

Key words : endemic goitre IDD school children urinary iodine urinary thiocyanate goitrogens

INTRODUCTION

Iodine deficiency disorders (IDD) are now considered as a major public health problem all over the world. Its major manifestations are goitre, mental defects, deaf mutism, stillbirth and miscarriages, weakness and paralysis of muscles as well

*Corresponding Author : E-mail address : amark_chandra@yahoo.co.in

as lesser degree of physical and mental dysfunction (1). In India, a nation wide goitre survey conducted by ICMR reported that out of 282 studied districts 241 were endemic for IDD (2). In the post-salt iodisation phase endemic goitre has been reported from many new areas (3, 4, 5). IDD is now not restricted to the classical hilly sub-Himalayan goitre endemic belt in India. It has also been reported from the sub-Himalayan flat lands (tarai), plains (specially those subjected to annual flooding), riverine areas, deltas and even in costal regions (6). The northern part of the State of West Bengal is hilly and located in the classical iodine deficient goitre endemic belt of India (7), while its major southern region is in the Gangetic basin where the land is plain, fertile and thickly populated. In a study of the village Madhabnagar in South 24-Parganas on a population of 3814 covering all age groups, we showed that total goitre rate was 44.5% while the other associated disorders were also prevalent: feeble mindedness (49%), hypothyroidism (29%), stunted growth (12%), deaf mute (6.6%), reproductive failure (18%) and stillbirth (4%). Females were found more affected by IDD than males (8). Reports on the status of iodine nutrition of the people in this region are not available. Therefore the present work was undertaken to evaluate the state of iodine nutrition, distribution of iodine through iodised salt, bioavailability of iodine, consumption pattern of goitrogenic foods that generally interfere with iodine nutrition in a randomly selected area from the IDD affected region of West Bengal.

METHODS

Selection of population

Howrah is one of the most thickly populated districts in Gangetic West Bengal. Most of its population lives in rural areas from which Rospur village under Amta-I Community Development Block was selected at random. As the iodine nutritional status of school children represents the state of iodine deficiency in the general population (9), random sampling from the population aged 6–12 years instead of the entire population was done (10, 11). Students of both sexes and age group 6–12 years from all the five schools in the area were chosen as the target population. The clinical goitre survey, evaluation of urinary iodine excretion, iodine content in edible salt samples are the common indicators to evaluate the iodine nutritional status in a region (12). To evaluate consumption pattern of the most common dietary goitrogen of cyanogenic origin, urinary thiocyanate concentration is also measured (13).

Clinical goitre survey

The clinical examination of each child was conducted by palpation method for goitre and grading was done according to the criteria recommended by the joint WHO/UNICEF/ICCIDD (Grade 0, no goitre; Grade 1, thyroid palpable but not visible; and Grade 2, thyroid visible with the neck in normal position) (12).

Iodine in urine

To evaluate the state of iodine nutrition in the studied area, urine samples were collected at random from 242 subjects in wide mouth screw capped plastic bottles. A drop of toluene was added to inhibit bacterial growth. Iodine was determined by the arsenite method following dry ashing in presence of potassium carbonate (14).

Thiocyanate in urine

Urinary thiocyanate (SCN) concentration was measured in the same urine samples using the method of Aldridge (15) and modified by Michajlovskij and Langer (16). To identify the source of thiocyanate, people of the area were interviewed regarding the consumption of cyanogenic foods.

Iodine in salt and water

The sources of dietary iodine are water, food and iodised salt available commercially in the studied area. Iodine content in water in a region truly reflects the bioavailability of iodine. To cover the entire study area 30 samples of drinking water were collected from only source, shallow tube wells (150–200 feet depth), at random in screw capped plastic bottles, kept at 4°C and iodine content was measured using the method of Karmarkar et al (14).

Iodine content of at least 35 salt samples collected at random from a locality provides a valid estimate of the iodine content of the salt samples of the localities (17). To monitor the iodine content of salt samples available in the area, 108 air - tight plastic containers were distributed at random to the students and they were asked to bring samples of edible salt from their homes the next day. The salt samples were kept at room temperature in the laboratory and iodine content was measured, within a week using the iodometric titration method (18).

RESULTS

In all 969 school children of both sexes were clinically examined for goitre prevalence and total goitre rate (TGR) was 37.6 per cent. Age-specific goitre prevalence is given in Table I. A progressive increase

TABLE I: Age specific goitre prevalence in the school children of Rospur, District Howrah.

Age (yrs.)	*Total number of children examined*	*Number of childrren with goitre*		
		Grade 1	*Grade 2*	*Total (1+2)*
6	126	18 (14.3%)	3 (2.4%)	21 (16.7%)
7	141	36 (25.5%)	5 (3.5%)	41 (29.1%)
8	152	40 (26.3%)	4 (2.6%)	44 (28.9%)
9	128	64 (50.0%)	8 (6.2%)	72 (56.3%)
10	144	56 (38.9%)	12 (8.3%)	68 (47.2%)
11	132	50 (37.9%)	6 (4.5%)	56 (42.4%)
12	146	52 (35.6%)	10 (6.8%)	62 (42.5%)
	969	316 (32.6%)	48 (4.9%)	364 (37.6%)

(Parentheses indicate percentage)

in goitre prevalence was found from the age of 6 years till the age of 9 years followed by a small decline from 10 years to 12 years. Most of the goitres were palpable or Grade-1 (32.6%) but visible goitre or Grade-2 was also prevalent (4.9%) in the study sample.

Urinary concentration of iodine and thiocyanate is shown in Table II. Of the 242 samples analysed, 12.5% had iodine excretion level below 10 µg/dL however, no sample contained less than 5 µg/dL. The mean and median urinary iodine (UI) value were 39.87 ± 18.04 µg/dL and 35 µg/dL respectively. Besides mean and median UI level to understand the lower and upper ranges the results are also expressed in 25% and 75% values that were 25 µg/dL and 43.7 µg/dL respectively further indicating that even the lower values are more than 10 µg/dL or almost no population have deficiency in iodine intake. The mean and median thiocyanate excretion levels were 0.747 ± 0.21 mg/dL and 0.658 mg/dL respectively. Like UI value, the urinary thiocyanate levels are also expressed in 25% and 75% values that were 0.48 mg/dL and 0.95 mg/dL respectively indicating that the entire studied population are exposed to thiocyanate load. The individual iodine and thiocyanate ratio (µg/mg) in the samples was determined and it was found to be 54.47 ± 22.67 with a median value of 53.88.

TABLE II : Urinary iodine and thiocyanate concentration levels in school children (n = 242) at Rospur, District Howrah.

	Iodine (I) (µg/dL)	*Thiocyanate (SCN) (mg/dL)*	*I/SCN ratio (µg/mg)*
Mean ± SD	39.87±18.04	0.747±0.216	54.472±22.677
25% value	25.0	0.480	25.46
Median value	35.0	0.658	53.88
75% value	43.75	0.950	68.19

(12.5% of urine samples had urinary iodine levels <10 µg/dL and none of the samples measured <5 µg/dL)

Iodine content in edible salt fortified with iodine was measured and it was found that all the salt samples tested had iodine. However, 51.9% salt samples had iodine level below 15 ppm (i.e. below the adequate level of 15 ppm), 18.5% salt samples had iodine level above 15 ppm but below 30 ppm and 29.6% salt samples had iodine level more than 30 ppm. Iodine content in drinking water of the studied region was determined from the different tube wells in the localities and the mean iodine value was 81.7 ± 3.4 µg/L.

DISCUSSION

Prevalence of endemic goitre in school children is the most widely accepted marker to evaluate the severity of IDD in a region. On the basis of its prevalence WHO/UNICEF/ICCIDD (17) recommended criteria to understand the severity of IDD as a public health problem in a region. According to these criteria, a prevalence rate of 5.0–19.9% is considered as mild; 20.0–29.9% is considered as moderate and a prevalence rate of above 30% is considered as a severe public health problem. Using this criterion, it is apparent that IDD is a severe public health problem in the region examined.

Median urinary iodine level indicates the state of iodine nutrition of a study area when it is based on at least 40 urine samples taken at random (19). A median urinary iodine concentration of 10 µg/dL and when not more than 20% of the samples are below 5 µg/dL in an area indicates no iodine deficiency (17). In the area under study as per the above recommendation there is no biochemical iodine deficiency. To study the bioavailability of iodine, the iodine content in the drinking water was estimated. Zeltser et al (1992) have categorised the iodine deficient zones – as the severe deficient zone having iodine less than 4 µg/L of water; moderate deficient zone with iodine level 4–10 µg/L of water and the relative deficient zone having iodine level 20 µg/L of water (20). Therefore, it was found that there was no iodine deficiency in the region. In addition the people of the region consumed iodised salt even though the iodine content of the salt samples was not found satisfactory. This information further supports the view that intake of iodine of the population was sufficient enough to meet the need for thyroid hormone synthesis.

The dietary practise amongst the people of the area was also investigated to examine the involvement of dietary goitrogens that may interfere in iodine nutrition. It was found that the people consume a number of cyanogenic plants (cabbage, cauliflower, radish, mustard, turnip, beans etc. of *Brassica* family). The consumption of cyanogenic food was evident from the urinary excretion pattern of SCN. Available literature suggests that development of goitre does not necessarily depend upon the consumption of large quantities of food containing SCN precursors but is critically related to the balance between the dietary supplies of iodine and thiocyanate (21). The dietary supplies of I^- and SCN are determined from the urinary I^-/SCN ratios (µg/mg). The ratio is higher than 7 under normal conditions and endemic goitre develops when it reaches a critical threshold of about 3 (22). The individual I^-/SCN ratios in the study area were well above the critical level 7 yet the possibility of the involvement of thiocyanate can not be ruled out because the precursors of thiocyanate such as goitrin and isothiocyanates may have antithyroidal/antithyroid peroxidase activity and excess iodine supplementation has no effect under this condition (23). Though iodine deficiency is the primary determinant in the development of endemic goitre but there are other environmental factors in the etiopathogenesis of endemic goitre. Studies are in progress to identify the causative factor viz chlorates, pertechnetates, periodate, nitrates, and perchlorates in the persistence of this severe public health problem from the region.

ACKNOWLEDGEMENTS

We gratefully acknowledge the co-operation received from the staff and students of the five schools in Rospur village. Special thanks are also due to Dr. Prabal Ray, Diamond Harbour S.D. Hospital for his suggestions in many aspects of the study.

REFERENCES

1. Hetzel BS. An overview of the prevention and control of iodine deficiency disorders. In: Hetzel BS, Dunn JT, Stanbury JB editors. The prevention and control of iodine deficiency disorders. Elsevier, Amsterdam 1987; p. 7–31.
2. ICMR task force study. Epidemiological survey of endemic goitre and endemic cretinism. *Indian Council of Medical Research*, New Delhi, 1989.
3. Chandra AK and Ray I. Evaluation of the effectiveness of salt iodization status in Tripura, northeast India. *Indian J Med Res* 2002; 115: 22–27.
4. Kochupillai N. Neonatal hypothyroidism in India. *Mount Sinai J of Medicine* 1992; 59: 111–115.
5. Pandav CS, Malik A, Anand K, Pandav S, Karmarkar MG. Prevalence of iodine deficiency disorders among school children of the national capital territory of Delhi. ICCIDD, Regional office of South Asia and Pacific, New Delhi, 1996.
6. Clugston GA, Dulberg EM, Pandav CS, Tilden RL. Iodine Deficiency Disorders in South East Asia. In: Hetzel BS, Dunn JT, Stanbury JB editors. *The prevention and control of iodine deficiency disorders.* Elsevier, Amsterdam 1987; p. 273–308.
7. WHO/SEARO. Iodine deficiency disorder in Southeast Asia. SEARO Regional Health, New Delhi, 1985; paper No. 10.
8. Chandra AK, Tripathy S, Mukhopathyay S, Lahari D. Studies on endemic goitre and associated iodine deficiency disorders (IDD) in a rural area of the Gangetic West Bengal. *Indian J Nutr & Dietet* 2003; 40: 53–58.
9. Dunn JT, Crutchfield HE, Gutekunst R, Dunn AD. Iodine deficiency disorders and urinary iodine levels. In: Methods for measuring iodine in urine. The Netherlands: ICCIDD/UNICEF/WHO Publication 1993; 7–10.
10. Perez C, Scrimashw NS, Munaz JA. Technique of endemic goitre surveys; In endemic goitre. *WHO, Geneva* 1960; 369–383.
11. Thilly CH, Delange F, Stanbury JB. Epidemiologic surveys in endemic goitre and cretinism. In: Stanbury, Hetzel, Endemic goitre and endemic cretinism: iodine nutrition in health and disease. Wiley, New York 1980; p. 157–184.
12. WHO/UNICEF/ICCIDD. Indicators for assessing Iodine Deficiency Disorders and their control through salt iodization. WHO/NUT/94.6, 1994.
13. Queriodo O, Delange F, Dunn T, Fierro-Benitez R, Ibbertson HK et al. Defination of endemic goitre and cretinism, classification of goitre size and severity of endemias, and survey techniques. In: Dunn JT, and Medeiros-Neto GA, ed. Endemic goitre and cretinism: Continuing threats to world health. Pan American Health Organization, Washington DC, USA, Sci. Publ. 1974; 292: 267–272.
14. Karmarkar MG, Pandav CS, Krishnamachari KAVR. Principle and procedure for iodine estimation. A laboratory manual, New Delhi, *Indian Council of Medical Research* 1986.
15. Aldridge WN. The estimation of micro quantities of cyanide and thiocyanate. *Analyst* London, 1945; 70: 474–475.
16. Michajlovskij N, Langer P. Studien uber Benziehungen Zwischen Rhodanbildung und Kropfbildender Eigenschaft Von Nahrungsmitteln. In: Gehalt einiger Nahrungs Mittel an praformierten Rhodanid. *Z Physiol Chem* 1958; 312: 26–30.
17. Indicators for Tracking Progress in IDD Elimination. In: *IDD Newsletter* 1994; 10: 37–41.
18. Titration methods for salt iodine analysis. In: Monitoring Universal salt iodization programme (Editors: Sullivan KM, Houston E, Gorestein J, Cervinskas J). UNICEF/ICCIDD/PAMM/WHO, 1995; p. 11.
19. Dunn JT, Van der Haar F. Detection of iodine deficiency. In: A practical guide to the correction of Iodine Deficiency. Technical Manual No. 3. The Netherlands : ICCIDD/UNICEF/WHO Publication, 1990; 13–20.
20. Zeltser ME, Aldarkhanov BA, Berezhnaya IM, Spernasky GG, Bazarbekova RB, et al. Iodine deficiency and its clinical manifestation in Kazakhastan. *IDD Newsletter* 1992; 8(1): 5–6.
21. Delange F, Vigneri R, Trimachi F, Filetti S, Pezzino V et al. Etiological factors of endemic goitre in north eastern sicily. *J Endocrinol* 1978; *Invest* 2: 137–142.
22. Delange F, Bourdoux P, Colinet E et al. Nutritional factors involved in the goitrogenic action of cassava. In: Delange F and Ahluwalia R editors. *Cassava Toxicity and thyroid and thyroid research and public health issues,* 1982; 17–26.
23. Gaitan E. Goitrogens in food and water. *Annu Rev Nutr* 1990; 10: 21–39.