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A Comparison of Iodine Nutritional Status among School Children in Rural and Urban West Bengal, India

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ABSTRACT

The iodine deficiency disorders (IDD) survey was conducted in a rural village Kotulpur of the Bankura district and an urban locality in Dakshineswar of the North 24-parganas district of West Bengal during the post-iodization phase. The prevalence of endemic goitre was found to be 22.7 percent in Kotulpur and 31.4 percent in Dakshineswar. The median urinary iodine level in Kotolpur was 8.25 g/dl, while in Dakshineswar it was 9.75 g/dl. Iodine levels were below 15 ppm in approximately 57 percent of salt samples from Kotolpur and approximately 62 percent of salt samples from Dakshineswar. The mean iodine level in Kotolpur's drinking water was 6.4±1.2 g/dl, indicating an iodine deficient zone, whereas the iodine content in Dakshineswar's drinking water was 22±3.8 g/dl, indicating an iodine sufficient zone. The mean urinary thiocyanate level in Kotolpur was 0.506 ± 0.181 mg/dl, while it was 0.741 ± 0.206 mg/dl in Dakshineswar. The current study found that endemic goitre was prevalent in both studied areas, regardless of state. This study confirms that existing goitre prevalence in both rural and urban areas could be due to insufficient iodine intake associated with the consumption of anti-thyroid foods and water.

Key words: *Endemic goitre, School children, Urinary iodine, Urinary thiocyanate*

Introduction

Iodine is an important micronutrient found in water, soil and plants. Man needs iodine to make thyroid hormones, essential for normal development of the brain and maintenance of body heat and energy. In iodine deficient environment, the people do not have enough iodine for thyroid hormone synthesis and the deficiency of iodine causes several important health consequences. The major consequences are goitre (enlargement of thyroid gland than normal), weakness and paralysis of muscles, mental defect, deaf mutism, stillbirth and miscarriages; as well as lesser degree of physical and mental function (Hetzel, 1987). Iodine deficiency also affects the socio-economic development of a community (Levin, 1987).

The northern part of West Bengal is mostly located in hilly sub-Himalayan classical conventional goitre-endemic belt in India (WHO/SEARO, 1985). Considering the consequences of iodine deficiency disorders (IDD), supplementation of iodine through edible salt had been introduced in entire West Bengal irrespective of hilly or plain since early nineties (Biswas *et al.*, 2002). The southern part of West Bengal is mainly plain, the lands are fertile and are drained by a number of rivers including the Ganga flowing through the north to south. A random study in a village of South 24-Parganas district on a population of 3814 covering all age-groups showed over-

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all goitre prevalence 44.5%, along with associated disorders, viz. feeble mindedness (49%), hypothyroidism (29%), stunted Growth (12%), deaf mute (6.6%), reproductive failure (18%) and stillbirth (4%) (Chandra *et al.,* 2003). In another study on iodine nutritional status among school children conducted in a rural area of Howrah district in the Gangetic West Bengal showed that inspite of adequate iodine intake as evidenced by urinary iodine level the total goitre prevalence was about 38% (Chandra *et al.,* 2004).

Reports on the iodine nutrition of the population in the other districts of southern West Bengal are not available. Therefore the present study has been undertaken to evaluate the thyroid gland functional status as evidenced by goitre prevalence in the children of age group (6-12 years) from both sexes, iodine nutritional status as evidenced by iodine excretion pattern through urine, consumption pattern of most common cyanogenic foods considered as dietary goitrogen, consumption pattern of iodized salt and bio-availability of iodine through drinking water in two different localities- one in urban and other in rural area of southern West Bengal.

Materials and Methods

Selection of population

Kotolpur, a rural area of Bankura district and Dakshineswar, an urban area of North 24-Parganas district were selected at random for the study. As iodine nutritional status of the school children represents the correct state of iodine deficiency in the general population (Dunn*et al.,*1993), random sampling from the population aged 6-12 years instead of the entire population was done (Perez*et al.,* 1960 and Thilly *et al.,* 1980) for the present study. In the area the student of both sexes and age group 6-12 years from the randomly selected school were chosen as target population.

Clinical goitre survey

All the students of recommended age group who were present on the day/days of survey were clinically examined for goitre by trained research staff. Goitre grading was done according to the recommended criteria of WHO/UNICEF/ICCIDD 1994 (grade 0: no goitre; Grade 1: thyroid palpable but not visible; and grade 2: thyroid visible with neck in normal position) (WHO/UNICEF/ICCIDD, 1994). The age of students was recorded from the school register and was rounded off to the nearest whole number. In this way 360 students in Kotolpur of Bankura district and 378 students in Dakshineswar of North 24-Parganas district were clinically examined for the enlargement of thyroid gland.

Iodine and thiocyanate in urine

To evaluate the state of iodine nutrition of the locality, spot casual urine samples were collected from 40 children irrespective of their thyroid status from the clinically examined enrolled students at a definite interval maintaining proportionate representation from the entire population of the studied school(s) Following ICCIDD/UNICEF/WHO criteria (Dunn*et al.,*1990) in wide mouth screw capped plastic bottles adding a drop of toluene to inhibit bacterial growth and minimize bad odour. Iodine concentrations in urine were determined by the arsenite method following dry ashing in the presence of potassium carbonate (Karmarkar *et al.,* 1986). Thiocyanate content in the urine was measured from the urine samples analysis by the method of Aldridge (Aldridge, 1945) as modified by Michajlovskij and Langer (Michajlovskij and Langer, 1958).

Iodine in salt and water

Dietary sources of iodine are food, water and iodized salt. To evaluate the iodine content of salt available in the locality, 35 marked air tight plastic containers were distributed at random to the students of studied school in each locality, and they were asked to bring edible salt samples from their households the next day.The salt samples were kept at room temperature in the laboratory and iodine content was measured within a week following iodometric titration method (Indicators for Trackling Progress in IDD Elimination, 1994). Ten drinking water samples from each locality were collected at random and kept at 4ºC until iodine concentrations were measured using the method of Karmarkar *et al.* (1986).

Results

Overall, 738 school children were clinically examined for goitre from a rural and an urban area. The prevalence of goitre in rural area Kotolpur was 22.7% where as in urban area Dakshineswar 31.4%. Most of the goitres were palpable but visible goitre was also found (Table 1 and 2)

To evaluate the state of iodine nutrition of the locality, spot casual urine samples were collected from 40 children irrespective of their thyroid status from the clinically examined enrolled students at a definite interval maintaining proportionate representation from the entire population of the studied school(s) Following ICCIDD/UNICEF/WHO criteria (Dunn *et al.*, 1990). The median urinary iodine level in the rural area Kotolpur was 8.25 µg/dl where as in urban area Dakshineswar it was 9.75 µg/dl. In kotulpur 30.0% urine sample had iodine level less than 5 µg/dl and 60% urine sample less than 10 µg/dl. In Dakshineswar 35% urine sample had iodine level less than 5 µg/dl and 50% urine samples had iodine level less than 10 µg/dl (Table 3).

To monitor the iodine content of edible salt available in the areas, 35 marked airtight plastic containers were distributed among the school children of both areas at random and results showed that 57% and 62% salt samples had iodine level less than the recommended level of 15 ppm in Kotolpur and Dakshineswar respectively (Table 4).

Iodine content in water in a region truly reflects the bioavailability of iodine. Ten samples of drinking water were collected at random from each area from the available sources. The mean value of iodine level in drinking water of Kotulpur and Dakshineswar were 6.4±1.2µg/dl and 22±3.8 µg/dl respectively. According to Zeltser *et al.* (1992)

Table 1. Age specific goitre prevalence in the school children of Kotulpur in Bankura district.

Age	Total number of children examined	Number of children with goitre		
		Grade 1	Grade 2	Total (1+2)
6	55	06 (10.9%)	-	06 (10.9%)
7	43	09 (20.9%)	-	09 (20.9%)
8	47	10 (21.2%)	01 (2.1%)	11 (23.4%)
9	65	18 (27.6%)	02 (3.0%)	20 (30.7%)
10	52	16 (30.7%)	01 (1.9%)	17 (32.6%)
11	53	08 (15.0%)	03 (5.6%)	11 (20.7%)
12	45	07 (15.5%)	01 (2.2%)	08 (17.7%)
	360	74 (20.5%)	08 (2.2%)	82 (22.7%)

(Parentheses indicate percentage)

Table 2. Age specific goitre prevalence in the school children of Dakshineswar in North 24-Parganas district.

Age	Total number of children examined	Number of children with goitre		
		Grade 1	Grade 2	Total (1+2)
6	46	10 (21.7%)	-	10 (21.7%)
7	50	13 (26.0%)	02 (4.0%)	15 (30.0%)
8	49	11 (22.4%)	01 (2.0%)	12 (24.4%)
9	61	27 (44.2%)	03 (4.9%)	30 (49.1%)
10	66	22 (33.3%)	03 (4.5%)	25 (37.8%)
11	57	16 (28.0%)	01 (1.7%)	17 (29.8%)
12	49	08 (16.3%)	0 (4.0%)	10 (20.4%)
	378	107 (28.3%)	12 (3.1%)	119 (31.4%)

(Parentheses indicate percentage)

Table 3. Urinary iodine and thiocyanate excretion pattern of the studied school children

Sl. No.	Study areas	Urinary iodine levels (µg/dl)			Urinary thiocyanate (USCN) level mg/dl Mean ±SD
		Median	% Urine samples with <10 µg/dl	Urine samples % with <5 µg/dl	
1	Kotulpur	8.25	60	30	0.506±0.181
2	Dakshineswar	9.75	50	35	0.741±0.206

Number of urine samples from each area- 40
Total urine samples- 80

Table 4. Iodine content of salt samples and drinking water from the study areas.

Sl. No.	Study areas	Iodine content in salts (ppm)			Iodine content in drinking water µg/L
		<15	15-29	>30	
1	Kotulpur	20	05	10	6.4±1.2
2	Dakshineswar	22	02	11	22.0±3.8

Number of salt samples from each area- 35
Total salt samples- 70
Number of drinking water samples from each area- 10
Total drinking water samples- 20

Kotulpur may be considered as iodine deficient zone but Dakshineswar may be considered as iodine sufficient Zone (Table 4).

The urine samples that were analyzed for urinary iodine were further tested for quantitation of thiocyanate and thus 40 urine samples from each area were analyzed for thiocyanate and mean thiocyanate levels of Kotulpur and Dkshineswar were 0.506±0.181 mg/dl and 0.741±0.206 mg/dl respectively.

Discussion

Goitre survey was conducted under the present investigation to evaluate the thyroid status among the school children from a rural and an urban area revealed that thyroid problem was found prevalent even in the plain region of West Bengal both in rural and urban areas indicating that the studied region was affected by endemic goitre. According to WHO/UNICEF/ICCIDD (WHO/UNICEF/ICCIDD, 1994) recommended criteria, a prevalence rate 5.0-19.9% is considered as mild; 20.0-29.9% is considered as moderate and a prevalence rate of above 30.0% is considered as severe public health problem. The overall goitre prevalence in the rural area Kotulpur was 22.7% indicating that IDD is a moderate public health problem in the studied area and the goitre prevalence in the urban area Dakshineswar was 31.4% indicating that IDD is a severe public health problem in the studied area.

Urinary iodine is the most important biochemical indicator that indicates current state of iodine nutrition also used as a valuable indicator for the assessment of IDD because 90% body's iodine is excreted through urine. The indicator of iodine deficiency elimination is a median value for urinary iodine (MUI) concentration of 100 µg/l, i.e., 50% of the samples should be above 100 µg/l, and not more than 20% of samples should be below 50 µg/l (17). In two studied areas MUI was less than 10µg/dl (Table 3) suggesting that as per WHO/UNICEF/ICCIDD there is mild iodine deficiency.

According to WHO/UNICEF/ICCIDD 90% of the house hold should get iodized salt at the level of 15 ppm (ICCIDD/UNICEF/WHO, 2001) but the study shows that about 43% in rural area and 37% in urban area house hold consume iodized salt at level of 15 ppm (Table 4). Zeltser *et al.* (1992) have categorized that the iodine 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 iodine deficient zone having iodine level 20 µg/l of water. According to the criteria, the rural study area considered as moderate iodine deficient zone but urban area had no environmental iodine deficiency as evidenced by iodine content in drinking water (Table 3).

The consumption pattern of cyanogenic plant foods (such as cabbage, radish, cauliflower, mustered etc) was also evident from the urinary excretion pattern of thiocyanate. In India many cyanogenic plant foods are used as common vegetables and thus IDD may persist in many regions in spite of adequate iodine intake (Delange *et al.*, 1982; Kochupillai, 1992 and Chandra and Ray, 2002). Indian cyanogenic plant foods have potent anti-thyroid activity and intake of extra iodine cannot counteract their effect (Chandra *et al.*, 2004). In post salt iodization phase, it is reported that thiocyanate have an important role in goitre formation especially among poor children in India (Marwaha *et al.*, 2003). In the studied areas the thiocyanate was found present in almost all the studied urine samples analyzed (Table 3). So, thiocyanate or thiocyanate precursors present in cyanogenic plant foods that they consumed may not be ruled out.

Conclusion

This study found that endemic goitre of mild to se-

vere severity is common in the plain region of southern West Bengal, regardless of rural or urban status. The bioavailability of iodine in drinking water was found to be inadequate in the rural area but adequate in the studied urban area. The iodine content of edible salt available in the studied areas was lower than the recommended level, and people consumed cyanogenic foods containing thiocyanate precursors with antithyroid activity. As a result, inadequate iodine intake associated with cyanogenic food consumption may play a role in the persistence of goitres among children in the studied areas.

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