Original Article

Persistence of iodine deficiency in a Gangetic flood-prone area, West Bengal, India

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In 2000, India revoked the ban on production and sale of non-iodised salt. We conducted a study in the north 24 parganas district in the state of West Bengal to assess the prevalence of goitre, status of urinary iodine excretion (UIE) level and to estimate iodine content of salts at the household level. We surveyed 363 school children aged eight to ten years selected using a multistage cluster sampling technique. We estimated goitre prevalence and urinary iodine excretion (UIE) using methods and criteria recommended by the World Health Organization. We estimated the iodine content of salt samples collected from the households of the study subjects using spot iodine testing kit. Of the 363 children, 73 (20%) had goitre. The median UIE was 160 μg/l (normal: ≥ 100 μg/l) and only 6% children had a level below 50 μg/l. Only 253 of 363 salt samples (70%) were sufficiently iodised. The combination of high goitre prevalence with normal median urinary excretion indicates that the North 24 Parganas district is in transition from iodine deficient to iodine sufficient state. However, the persistence of non-iodised salt consumption indicates that an intensification of universal salt iodisation program is needed.

Key Words: goitre, iodine deficiency, total goitre rate (TGR), urinary iodine excretion (UIE), iodine content of the salt, cross-sectional study, India.

Introduction

Iodine deficiency is one of the most common preventable causes of mental retardation in the world today.[1] People living in areas affected by severe iodine deficiency disorders may have an intelligence quotient of up to about 13.5 points below that of those from comparable communities in areas where there is no iodine deficiency.[2] In 1999, the World Health Organization (WHO) estimated that 130 of its 191 member states had a significant iodine deficiency disorders (IDD) problem. A total of 740 million (13%) of the world's population is affected by goitre.[2] Goitre is usually a manifestation of severe iodine deficiency. Thus, it is expected that a greater proportion of the population suffer from IDD and in particular, from some degree of mental retardation.

In India, an estimated 167 million people are at risk for IDD.[3] Of those, 54 million have goitre, two million suffer from cretinism and 6.6 million children have neurological deficits.[3] In 1999, 275 of the 457 districts in the country were surveyed for IDD. Of those 275, 235(85%) were identified as endemic.[4] Even in developed countries a decline in iodine nutrition status has been observed e.g. Australia, since reduction in availability/intake of iodised salt.[5-7]

Universal iodisation of salts is the most effective and cheapest available intervention available. WHO, the United Nations Children's Fund (UNICEF) and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) recommend it. A cost benefit analysis in India quantified the ratio between cost and economic benefits as 1:3, which further justifies the necessity of a universal salt iodisation program in India.[8] In 1962, the Government of India initiated a National Goitre Control Program (NGCP), primarily aiming at covering endemic population with iodised salt. In 1992, the Government of India intensified organized efforts with the change of NGCP to National Iodine Deficiency Disorders Control Program (NIDDCP) to reflect broader aspects of iodine deficiency. It led to the initiation of compulsory salt iodisation in 1998. The compulsory salt iodisation program included a ban on the sale of non-iodised salt. The ban on non-iodised salt went against a number of local business interests. In the year 2000 it was revoked considering 'compulsion in such matters of individual choice undesirable'.[9]

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Table 1. Indicators recommended by WHO, ICCIDD and UNICEF for tracking progress towards eliminating iodine deficiency disorders

Indicators	Goal (%)
1. Thyroid size	
In school children 6-12 years age:	
- Proportion with enlarged thyroid, by palpation or ultrasound	<5
2. Urinary iodine	
- Proportion below 100 µg/L	<50
- Proportion below 50 µg/L	<20
3. Salt iodisation	
- Proportion of households consuming effectively iodised salt	>90

In a context where iodisation is not universal, the progress of programs to prevent iodine deficiency need to be monitored using standard quantifiable indicators recommended by WHO, UNICEF and ICCIDD [10] (Table 1). Of the 19 districts of the state of West Bengal, only two, Malda and Birbhum were surveyed recently using recommended indicators and methodology. The prevalence of goitre was reported to be 11.3% and 12.6% respectively.[11,12] The North 24 Parganas, the largest district of the state, is flood-prone and located in the Gangetic basin. As increased erosion of soil in river valleys and flood-prone area leads to greater degree of leaching of iodine, thus, it is potentially vulnerable to iodine deficiency disorders. We conducted a study in the North 24 Parganas district to estimate the magnitude of iodine deficiency disorders and the present status of salt iodisation at household level.

Materials and Methods

We conducted a cross sectional survey during August-October 2004 among school children aged eight to ten years. WHO recommended using school children of this age group to assess IDD because of their high vulnerability to disease, their easy accessibility and the representativeness of their age group in the community.[10] High school enrolment and low drop out rates in the district of North 24 Parganas [13] justified this school-based approach. We followed a multistage cluster sampling methodology to select the study participants.[10] First, we enlisted all the villages and wards (defined geographical area in urban locality) in the district with their respective population according to the 2001 census and sampled the clusters with a probability proportional to size. Second, we enlisted all the primary schools in each identified cluster and selected one using simple random sampling technique. Third, from the sampling frame of all children between eight to ten years of age in the identified school in a cluster, we selected the study children through a simple random sampling technique. This approach maximized the chance to select an equal number of children in each age group.

We estimated the sample size using the *Right Size software*[14], anticipating a prevalence of goitre of 15%, aiming for a precision of ± 5% with a confidence interval of 95%, a rate of homogeneity at 0.02 and a cluster size of 30. The calculated sample size was 330 individuals to be selected from 11 clusters with an anticipated design effect of 1.58. Considering 10% of non-response, the final sample size was 363 school children aged eight to ten years (i.e., 33 children per cluster). We used a pre-tested instrument for data collection. We informed the identified school at least one week before the day of survey to ensure a maximum attendance of students. We briefed the teachers and students about the activities to be undertaken. We trained the investigators prior to data collection to minimise inter-observer variation.

A team from the department of community medicine, R. G. Kar Medical College, Kolkata assessed the presence of goitre by standard palpation method and graded the goitre according to the criteria jointly recommended by WHO, UNICEF and ICCIDD.[10,15] This classification identifies three stages: Grade 0: Goitre neither visible nor palpable; Grade I: A mass in the neck, palpable but not visible when the neck was in normal position, consistent with an enlarged thyroid and moved upwards in the neck as the subject swallowed and Grade II: A swelling in the neck, visible when the neck was in a normal position and was consistent with an enlarged thyroid when we palpated the neck. The overall prevalence of goitre at grades I and II constituted the Total Goitre Rate (TGR).

We collected on-the-spot urine samples from all the study subjects in screw-capped plastic bottles to estimate the current level of iodine intake. We stored them at $4^{o}C$ until analysis. The biochemistry laboratory of Burdwan Medical College, West Bengal estimated the urinary iodine excretion (UIE) levels using the wet digestion method[16] and expressed the result in µg/L urine. We asked all study subjects to bring 20 gm of salt routinely consumed in their households in auto-sealed polythene pouches. We estimated the iodine content in parts per million (ppm) of salt samples using a spot testing kit [2].

We analysed the data collected using Epi Info 6.04d [17]

Table 2. Goitre prevalence by age and sex, North 24 Parganas district, West Bengal, India (n=363)

Age (Years)	Boys					Girls					Total	
	Number	Goitre grade			TGR	Number	Goitre grade			TGR	Number	TGR
		0	I	II	(%)		0	I	II	(%)		(%)
8	75	62	13	0	17	50	41	4	5	18	125	18
9	62	50	11	1	19	66	50	13	3	24	128	22
10	49	41	6	2	16	61	46	9	6	25	110	21
All	186	153	30	3	18	177	137	26	14	23	363	20

Table 3. Urinary iodine excretion level among children 8-10 years of age, North 24 Parganas district, West Bengal, India (n=358)

Urinary iodine excretion level (µg/L)	Children (n=358)	
	Frequency	%
< 20	2	0.6
20-49	19	5.3
50-99	79	22.1
≥100	258	72.0

and performed univariate analysis to examine the association between the outcome and exposure variables. We used the Yates corrected chi-square (χ^2) test and considered '*P*' values less than 0.05 statistically significant. In addition, we conducted two separate multiple linear regression analysis using *Epi Info 2002*[18] to examine the independent association of selected factors with actual values of UIE as the continuous variable and salt iodine level and logistic regression model with the categorical outcome variable, UIE level above and below 100 µg/L. The covariates considered for assessing the association were age, sex, religion and place of residence.

Results

All 363 selected study subjects agreed to participate in the study. Of them 125 (34%), 128 (35%) and 110 (31%) were eight, nine and ten years of age, respectively. The mean age was 8.9 years (Standard deviation: 0.8) and 177 (49%) were girls. Of the 363 study subjects, 237 (65%) were Hindu, while the 126 others (35%) were Muslim. Among the participants 198 (54%) lived in rural areas. The TGR in the district was 20% (73/363; 95% CI = 17%–23%) with visible goitre rate of five percent (17/73). The prevalence of goitre did not differ significantly by age and sex (Table 2). The TGR did not differ between Hindu (51/237, 21.5%) and Muslim (22/126,17.5%, *P* = 0.4). There was no difference of the TGR by zone of residence (22% in rural area versus 17% in urban area, *P* = 0.3).

Out of 363 urine samples, we discarded five because of contamination. Thus, we estimated the urinary iodine excretion levels on 358 samples. The median urinary iodine excretion level was 160 µg/L; almost identical in boys (150µg/L) and girls (160 µg/L). Of the 358 children, only two (0.6%) had urinary iodine levels in the range of severe iodine deficiency (<20µg/L), while 19 (5.3%) were in the range of moderate (20 to 49µg/L) and 79 (22.1%) in the range of mild iodine deficiency (50 to 99 µg/L) (Table 3). Compared with girls (39/175; 22%), a higher proportion of boys (61/183; 33%) had UIE level below 100 µg/L (*P*=0.02). A higher proportion of children residing in rural area (63/195, 32.3%) had UIE values under 100 µg/L compared to urban area (37/163, 22.7%; *P* =0.04). The UIE values did not differ by age and religion. The logistic regression model indicated that the variables that were significantly associated with UIE level below 100 µg/L in univariate analysis (i.e., sex and the place of residence) were no longer significant when adjusted for the other variables. However, when we considered the actual values of UIE as the continuous variable and carried out a multiple regression analysis, rural children had significantly lower UIE values compared with their urban counterparts (Coefficient: 1.95; S.E.: 0.77; F-test: 6.45; *P* value: 0.01).

Table 4. Iodine content of salt at household level (n=363), North 24 Parganas district, West Bengal, India

Iodine content (ppm)	Hindu (n=237)	Muslim (n=126)	Total (n=363)
	No (%)	No (%)	No (%)
Nil	13 (6)	24 (19)	37 (10)
<15	38 (16)	35 (28)	73 (20)
≥15	186 (78)	67 (53)	253 (70)

ppm= parts per million

Of the 363 salt samples tested, 37 (10%) had no iodine and 253 (70%) had iodine levels within normal range (i.e 15 ppm or above). The proportion of households consuming adequately iodised salts was higher among Hindu than Muslim (78% versus 53%, *P*<0.001, Table 4), but did not differ according to the area of residence. In multiple linear regressions, religion was the only variable significantly associated with the salt iodine level (coefficient: -6.13; S.E.: 1.10;F-test: 30.97; *P* value: <0.0001).

Discussion

The WHO, UNICEF and ICCIDD recommended that if more than five percent of school children between 6 and 12 years of age suffer from goitre, the area should be classified as endemic to iodine deficiency.[10] The present study estimated a total goitre prevalence rate of 20%. Thus, the North 24 Parganas district is still endemic for iodine deficiency. Various studies in other districts of the state and other states of the country also reported similar observations of high goitre prevalence.[11,12,19-21]

WHO, UNICEF and ICCIDD recognize urinary iodine excretion as the most important marker to detect current iodine deficiency. The recommended median urinary iodine excretion level is 100 µg/L or more, and not more than 20% of the samples should have urinary iodine level of 50 µg/L or less.[10] Our study suggests that the present iodine nutrition status in the district is satisfactory. Similar findings were reported in the Malda (150 µg/L) and Birbhum (124 µg/L) districts of the state of West Bengal[11,12] and in earlier studies in other states of India.[19-21]

The univariate analysis suggested that boys were more likely to have a UIE below 100 µg/L than girls. The proportion was also significantly higher among rural children compared with their urban counterparts. Rural population are less likely to access iodised salt for many reasons, including lack of awareness, poverty and poor geographical access to iodised salt. The analysis of salt samples indicated that more than two third (70%) of the children were consuming adequately iodised salt. This proportion is well below the recommended goal (>90%).[10] Other studies in the two districts of the state also reported similar findings.[11,12] Two factors may explain the insufficient iodisation in the present study. These include: (a) the lack of awareness in the community regarding the impact of iodine deficiency disorders and the role of iodised salt to prevent them and (b) the absence of ban on the production and sale of non-iodised salt. These two factors may affect the poor more. Furthermore, the proportion of households consuming adequately iodised salts was significantly lower among Muslim compared to Hindu. This suggests that they are more vulnerable to iodine deficiency. Factors that may explain this increased vulnerability to iodine deficiency among Muslim include a lower socio-economic status and a lower level of education than Hindu.[22, 23]

In the context of IDD elimination, the status of the recommended indicators needs to be interpreted in combination. In the present study of school children, the high goitre prevalence suggests moderate endemicity of IDD. In contrast, the median urinary iodine value being well above 100µg/L indicates that there is no current iodine deficiency in the district. Hence, the district North 24 Parganas is in transition from iodine deficient to iodine sufficient state. However, the persistence of non-iodised salt consumption indicates that an intensification of the universal salt iodisation program is needed. Sustained monitoring and intensified awareness generation activities, with particular emphasis to the vulnerable section of the community, are keys to eliminate iodine deficiency disorders in the district. Since this study was conducted, Government of India announced their decision to reinstate the ban on production and sale of non-iodised salt from 15 August 2005. Additional data regarding the vulnerability of the poor to iodine deficiency disorders would allow formulating better prevention policy. In this context, we propose further study to address the equity in access to universal salt iodisation among different strata of population in respect to their socio-economic characteristics and level of awareness about iodine deficiency disorders. This study is being prepared and will be conducted in the North 24 Parganas district in 2005.

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印度西孟加拉Gangetic flood-prone地區持續碘缺乏

公元2000年，印度廢除禁止生產與銷售未加碘食鹽的規定。我們評估西孟加拉州北部的24個伯爾格納縣的居民甲狀腺腫盛行率、尿液碘排出量(UIE)狀況並估計在家戶中使用的食鹽碘含量。我們採用多步驟叢集抽樣法選取並調查363名年齡在8-10歲間的學童。我們採用世界衛生組織所建議的甲狀腺腫盛行率及尿液碘排出量的分析方法與標準。我們使用spot iodine 檢驗套 件估計從研究 對象 的家 戶中收集來的食鹽樣本的碘含量。363名兒童中有73名(20%)有甲狀腺腫的情形。UIE中位數為160μg/L (正常值：≥100μg/L)，只有6% 的兒童其UIE 濃度低於 50μg/ L。363個食鹽樣本中只有253個(70%)加了足夠的碘。這種高甲狀腺腫盛行率及正常的中位數尿液碘排出量的綜合狀況，顯示24個北伯爾格納縣正由碘缺乏轉變成碘足夠的區域。然而持續攝取未加碘鹽指出有必要加強全球食鹽加碘。

關鍵字：甲狀腺腫、碘缺乏、總甲狀腺腫率(TGR)、尿液碘排出量(UIE)、食鹽碘含量、橫斷性研究、印度。