

## Original Article

# Iodine deficiency disorders in Bangladesh, 2004-05: ten years of iodized salt intervention brings remarkable achievement in lowering goitre and iodine deficiency among children and women

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A survey was conducted to monitor the current status of iodine deficiency disorders in children aged 6-12 years and women aged 15-44 years in Bangladesh as measured by goitre prevalence and urinary iodine excretion. Conducted between September 2004 and March 2005, the survey followed a stratified multistage cluster sampling design to provide nationally representative data, with self-weighted rural-urban disaggregation. A total of 7233 children and 6408 women were examined for goitre and 4848 urine samples (2447 from children and 2401 from women) were analyzed for iodine. In addition, 5321 household salt samples were analyzed for iodine. In children, the total goitre rate (TGR) was 6.2%, compared to 49.9% in 1993 and the TGR among women was 11.7%, while in 1993 it was 55.6%. Prevalence of iodine deficiency (Urinary Iodine Excretion <100 µg/L) was 33.8% in children and 38.6% in women (compared to 71.0% and 70.2%, respectively in 1993). Iodine nutrition status in urban areas was considerably better than in rural areas. There was a clear inverse relationship between iodine deficiency and the coverage of households using adequately iodized salt (≥15 ppm). The findings of the survey revealed that Bangladesh has achieved a commendable progress in reducing goitre rates and iodine deficiency among children and women ever since the universal salt iodization programme was instituted 10 years ago. However, physiological iodine deficiency still persists among more than one-third of children and women, which points to the need for all stakeholders to redouble their efforts in achieving universal salt iodization.

**Key Words:** Iodine deficiency disorders, goitre rate, iodine deficiency, household coverage with adequately iodized salt, Universal Salt Iodization

## INTRODUCTION

Iodine deficiency disorders (IDD) are recognized as a major global public health problem. According to the latest estimates, about 2.5 billion people worldwide (38% of the world's population) have insufficient iodine intake, of which 313 million are in the South-eastern Asian region that includes Bangladesh.<sup>1</sup> Iodine deficiency is the single most preventable cause of neurological and intellectual impairment (cretinism) in the world. The Government of Bangladesh is officially committed to IDD elimination through national, as well as international, commitments. In 1989, the Government of Bangladesh passed a law making it mandatory that all edible salt be iodized. The law stipulates that all salt for human consumption must contain 45-50 parts per million (ppm) of

iodine at the time of production and not less than 20 ppm iodine at the time of retail, to ensure a minimum of 15 ppm iodine at the household level. Accordingly, a plan was undertaken to institute a Universal Salt Iodization

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(USI) in the country.

Little progress was made in salt iodization until the results of the first National IDD Survey in 1993 were published. The survey revealed a very high prevalence of total goitre (47.1%), visible goitre (8.8%), cretinism (0.5%), and biochemical iodine deficiency (68.9%) as indicated by a low urinary iodine excretion ( $<100 \mu\text{g/L}$ ).<sup>2,3</sup> Following the release of the survey findings, the Salt Bye-Law was passed in 1994 and substantial investments were made in the infrastructure for salt iodization. By 1995, all 267 registered salt factories in the country were equipped with Salt Iodization Plants (SIP) with UNICEF assistance, and iodized salt became available throughout the country by the beginning of 1995.

Two National USI Surveys were conducted to assess the progress in achieving USI, the first in 1996<sup>4</sup> and the second in 1999.<sup>5</sup> The surveys revealed that during the period 1996-9, the percentage of adequately iodized salt at household level ( $\geq 15$  ppm) was maintained at 54 to 55%. In 1999, the first follow-up National IDD Survey was conducted to measure progress in eliminating IDD.<sup>6</sup> This survey showed that the substantial investments in salt iodization and resulting increase in consumption of iodized salt by households resulted in a remarkable reduction in the prevalence of IDD. Between 1993 and 1999, the total goitre rate among the population fell from 47.1% to 17.8% and biochemical iodine deficiency fell from 68.9% to 43.1%.

As part of the roadmap to eliminate iodine deficiency in Bangladesh, a National IDD and USI Survey was again conducted in 2004-05 to monitor the latest situation. This report provides the key findings of the survey.

## METHODS

### *Survey Area and Population*

Data were collected from a random sample of households in Bangladesh between September 2004 and March 2005. The survey population comprised of boys and girls aged 6-12 years old and women aged 15-44 years old.

### *Survey Design*

The two previous IDD Surveys in 1993 and 1999 were conducted zone-wise for flood, plain and hilly zones. However, studies now show that IDD can, and does, occur in many areas irrespective of geographical location.<sup>7</sup> The present survey was designed to provide nationally representative data and followed a stratified multistage cluster sampling design. This new survey design should not have affected the comparison of data collected in the present survey with previous surveys, because data were weighted to provide national estimates. There is a slight change in the age group of children from 5-11 years to 6-12 years, in line with WHO recommendations,<sup>7</sup> which is unlikely to have a significant effect on the analysis of trends over time in school-aged children.

### *Sample Size and Sampling Procedure*

The sample size needed to provide data representative at the national level was calculated using standard statistical formula. In summary, the minimum expected number of samples for the different indicators was as follows:

- a) 6400 households for all household indicators (3% precision, 95% confidence level, design effect = 6);
- b) 6400 children and 6400 women for goitre assessments and all other child/maternal indicators except UIE (3% precision, 95% confidence level, design effect = 6);
- c) 2400 urine samples from children and 2400 urine samples from women for UIE measurement (5% precision, 95% confidence level, design effect = 6).

### *Sampling Procedure*

In the first stage of sampling, 160 *upazilas* (sub-districts), which constituted the Primary Sampling Units (PSUs) were selected from the 507 *upazilas* in the country using probability proportional to size sampling (PPS). As the ratio of the rural to urban population is 76.6:23.4,<sup>8</sup> 123 clusters were selected from rural areas and 37 from urban areas, so that the sample was self-weighted for rural-urban differentials. In the second stage of sampling, one *mauza* or *mohalla* (smallest administrative units within rural and urban areas, respectively) was randomly selected from each of the selected PSUs by simple random sampling. In the third stage, 40 households (the Ultimate Sampling Units) were selected from each *mauza/mohalla* using systematic sampling for assessment of goitre in children and women and collection of data on household characteristics.

Twenty of the 40 households in each PSU were systematically sampled for collection of salt samples and 15 households were systematically sampled for collection of urine samples from children and women. If any of the 15 selected households did not have a child aged 6-12 years or a woman aged 15-44 years, the next surveyed household was selected for collection of urine samples. All data and salt samples were collected from households in rural and urban Bangladesh between September 2004 and March 2005.

### *Clinical Examination of Goitre*

Children aged 6-12 years and women aged 15-44 years were examined for thyroid enlargement by trained physicians using physical observation and palpation. Goitre was graded according to the criteria recommended by the Joint WHO/UNICEF/ICCIDD Technical Consultation Group.<sup>7</sup>

### *Salt and Urine Analysis*

A structured survey questionnaire was developed and field-tested before finalization to collect all information on households. Salt samples used for cooking in households were collected and transferred to air-tight containers and stored at room temperature in the laboratory until analysis. The iodine content of the salt samples was determined by iodometric titration. About 10% salt samples were cross-checked among four recognized laboratories in Dhaka for quality control.

Casual urine samples from the selected children and women were collected into wide-mouthed screw-capped plastic bottles that were previously washed with de-ionized water and dried. All samples were transported to the IDD laboratory at the Institute of Nutrition and Food Science (INFS), Dhaka University and stored at  $-15^{\circ}\text{C}$  until analysed by using the ELISA method of Ohashi et

**Table 1.** Total number of goitre examinations and urinary iodine measurements in IDD Survey, 2004-05

		Goitre examination			Urinary iodine measurement		
		Rural	Urban	Total	Rural	Urban	Total
Children	Girls	2752	825	3577	925	274	1199
	Boys	2820	836	3656	949	299	1248
	All	5572	1661	7233	1874	573	2447
Women	Non-pregnant	4747	1434	6181	1785	536	2321
	Pregnant	167	46	213	56	17	73
	All	4925	1483	6408	1847	554	2401

al.<sup>9</sup> Samples containing high (>300 µg/L) and low (<20 µg/L) values were repeated.

#### Data Management and Analysis

Data entry officers, under the guidance of the data manager/statistician, manually checked, edited and coded the questionnaires, and entered the data using an application software constructed using Visual Foxpro and Visual Basic. A programme was run to check for invalid data, which were then manually checked against the questionnaires before editing.

Data analysis was conducted by the data manager/statistician, under the guidance of the Chief Statistician, using SPSS Version 10.0. The data were weighted to provide divisional and national estimates using the Census 2001 population proportions. Confidence intervals (CI) of 95% for population level estimates were also determined.

In this report, a urinary iodine excretion (UIE) of <100 µg/L is termed 'iodine deficiency' and a UIE <20 µg/L is termed 'severe iodine deficiency'. Household salt was defined as iodized if it contained ≥5 ppm, and as adequately iodized if it contained ≥15 ppm.

#### Ethical considerations

The study protocol along with its ethical issues was approved by a Project Coordination Committee (PCC) comprised of representatives from the government (Ministry of Health and Family Welfare and the Ministry of Indus-

tries), the International Council for Control of Iodine Deficiency Disorders (ICCIDD), departments of Dhaka University and the donor agency (UNICEF). Because no invasive intervention was involved in the survey, formal institutional ethical clearance was not felt necessary by the PCC.

However, informed verbal consent was obtained from each respondent before conducting the survey in the household for clinical assessment of goitre, collection of casual urine samples and for collection of salt samples consumed in the household. For ethical reasons, all information obtained from the respondents were kept confidential and used for scientific purpose only.

## RESULTS

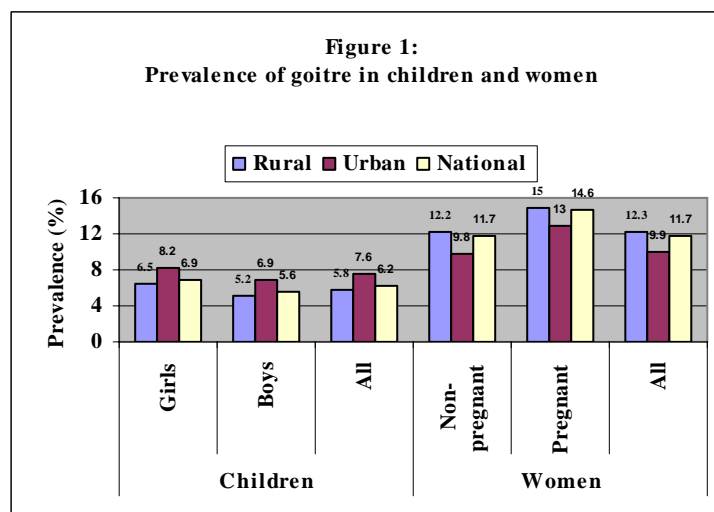
### Total Number of Goitre Assessments and Urinary Iodine Measurements

Table 1 shows that a total of 7233 children were examined for goitre, 5572 (77.0%) in rural areas and 1661 (23.0%) in urban areas. The girl:boy ratio was 49.5:50.5. A total of 6408 women were examined for goitre, 4925 (76.9%) in rural areas and 1483 (23.1%) in urban areas. Of these women, 213 (3.3%) were pregnant at the time of the survey.

A total of 2447 urine samples were collected from children, 1874 (76.6%) in rural areas and 573 (23.4%) in urban areas. The girl:boy ratio was 49.0:51.0. A total of 2401 urine samples were collected from women, 1847 (76.9%) in rural areas and 554 (23.1%) in urban areas. Of these women, 73 (3.0%) were pregnant at the time of the survey. Thus, all target sample sizes for goitre examinations (children, 113.0%; women, 100.1%) and urine iodine measurements (children, 101.9%; women 100.0%) were met.

### Prevalence of Goitre

The total goitre rate (TGR) was 6.2% among children (95% CI, 5.6 - 6.8) and 11.7% among women (95% CI, 10.9 - 12.5) (Figure 1). In children, the prevalence of Grade 1 goitre (4.7%) was over three times the prevalence of Grade 2 goitre (1.5%), while in women the prevalence of Grade 1 goitre (6.5%) was only slightly higher than Grade 2 goitre (5.2%).



**Figure 1.** Prevalence of goitre in children (6-12 years) and women (15-44 years) by area of residence in Bangladesh, 2004-05

**Table 2.** Proportion of households consuming iodized ( $\geq 5.0$  ppm) and adequately iodized ( $\geq 15$  ppm) salt in rural and urban areas of Bangladesh, 2004-05

Iodine (ppm)	Rural (%) (n = 2706)	Urban (%) (n = 815)	National (%) (n = 3521)
Iodized ( $\geq 5.0$ ppm)	77.9	92.8	81.4
Adequately iodized ( $\geq 15$ ppm)	45.2	71.0	51.2

**Table 3.** Median urinary iodine excretion ( $\mu\text{g/L}$ ) in children (6-12 y) and women (15-44 y) by area of residence in 2004-05.

		Rural	Urban	National
Children	Girls	126	208	149
	Boys	154	256	176
	All	141	229	163
Women	Non-pregnant	122	226	139
	Pregnant	142	291	158
	All	123	230	140

Figure 1 also shows that the TGR in children was slightly higher in urban areas (7.6%) than in rural areas (5.8%), while TGR in women was higher in rural areas (12.3%) than in urban areas (9.9%). The reason for the different urban-rural pattern in children and women is not known. The TGR was slightly higher in girls (6.9%) than boys (5.6%), and higher in pregnant women (14.6%) than in non-pregnant women (11.7%).

The prevalence of goitre was  $<5\%$  in children in 93 (58%) of the sampled *mauza/mohalla* and  $<5\%$  in women in 49 (31%) of the *mauza/mohalla*. The prevalence of goitre was  $\geq 15\%$  in children in 12 (8%) of the sampled *mauza/mohalla* and  $\geq 15\%$  in women in 53 (33%) of the *mauza/mohalla* (data not shown).

**Table 4.** Epidemiological criteria for assessing the severity of IDD based on the prevalence of goitre and median urinary iodine excretion in school-aged children<sup>7</sup>

	Optimal	Mild	Moderate	Severe
Total goitre rate (TGR)	0.0-4.9%	5.0-19.9%	20.0-29%	$\geq 30\%$
Median urinary iodine ( $\mu\text{g/L}$ )	100-199	50-99	20-49	$< 20$

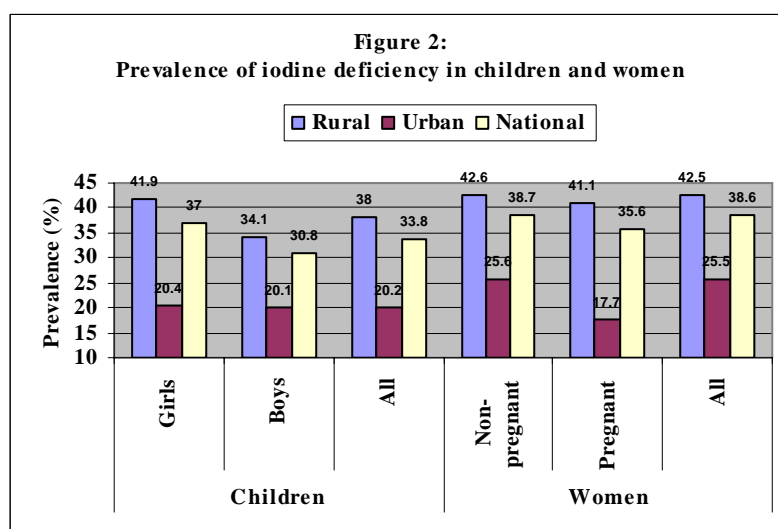
Note: Median urinary iodine above 200  $\mu\text{g/L}$  indicates risk of iodine-induced hyperthyroidism within 5-10 years following the introduction of iodized salt in populations characterized by long standing iodine deficiency and rapid increment in iodine intake.

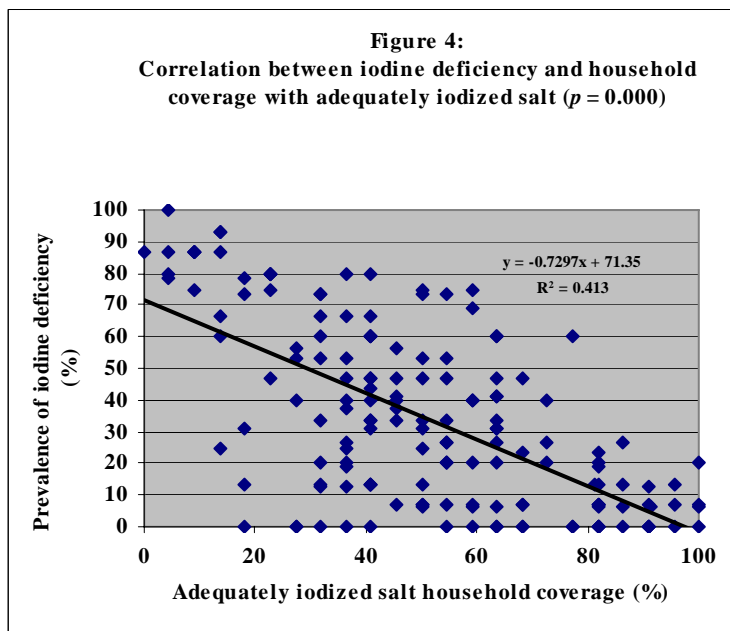
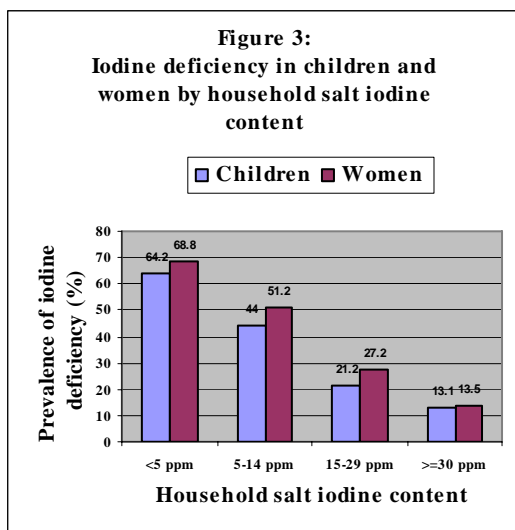
#### Households Consuming Iodized and Adequately Iodized Salt

The iodine content of household salt by area of residence is shown in Table 2. Nationally, 81.4% of household salt was iodized (iodine content  $\geq 5$  ppm), and 51.2% of household salt was adequately iodized (iodine content  $\geq 15$  ppm). The coverage of iodized salt was considerably higher in urban areas (92.8%) than rural areas (77.9%). Similarly, the coverage of adequately iodized salt was considerably higher in urban areas (71.0%) than rural areas (45.2%). Only 1.3% of household salt was found to contain excessive iodine ( $\geq 100$  ppm)(data not shown).

#### Urinary Iodine Excretion

The median UIE was 163  $\mu\text{g/L}$  in children and 140  $\mu\text{g/L}$  in women (Table 3). In urban areas, the median UIE in children (229  $\mu\text{g/L}$ ) was about 60% higher than in rural areas (141  $\mu\text{g/L}$ ), while the median UIE in women of urban areas (230  $\mu\text{g/L}$ ) was about 85% higher than in rural areas (123  $\mu\text{g/L}$ ). These differences reflect the higher coverage of iodized ( $\geq 5$  ppm) and adequately iodized household salt ( $\geq 15$  ppm) in urban areas than rural areas shown in Table 2. Median UIE in boys (176  $\mu\text{g/L}$ )

**Figure 2.** Prevalence of iodine deficiency (urinary iodine excretion  $<100$   $\mu\text{g/L}$ ) in children (6-12 years) and women (15-44 years) by area of residence in Bangladesh, 2004-05



**Figure 3.** Prevalence of iodine deficiency in children (6-12 years) and women (15-44 years) by household salt iodine content in Bangladesh, 2004-05

**Figure 4.** Scatterplot of the prevalence of iodine deficiency in children (6-12 years) in each mauza/mahalla by adequately iodized salt ( $\geq 15$  ppm) household coverage in Bangladesh, 2004-05

was over 15% higher than in girls (149  $\mu\text{g/L}$ ), and that in pregnant women (158  $\mu\text{g/L}$ ) was about 14% higher than in non-pregnant women (139  $\mu\text{g/L}$ ).

### Iodine Deficiency

The prevalence of iodine deficiency (UIE  $< 100$   $\mu\text{g/L}$ ) was 33.8% in children (95% CI, 31.9-35.7) and 38.6% in women (95% CI, 36.7-40.5) (Figure 2). Moderate deficiency (UIE  $< 50$   $\mu\text{g/L}$ ) affected 15.8% of children and 16.9% of women, and severe deficiency (UIE  $< 20$   $\mu\text{g/L}$ ) affected 4.0% of children and 4.5% of women. Almost 10% of children and women had excessive iodine excretion (UIE  $\geq 500$   $\mu\text{g/L}$ ) (data not shown).

Figure 2 also shows that the prevalence of iodine deficiency in rural children (38.0%) was almost double the prevalence in urban children (20.2%). A similar pattern was observed in women (42.5% vs. 25.5%). In both children and women, the prevalence of severe deficiency was also higher in rural areas than in urban areas, while excessive UIE was more pronounced in urban areas than in rural areas. The prevalence of iodine deficiency was slightly higher in girls (37.0%) than boys (30.8%), and slightly higher in non-pregnant women (38.7%) than pregnant women (35.6%). These urban-rural, girl-boy, and non-pregnant-pregnant differentials reflect the findings for UIE.

Detailed data (not given here) show that the prevalence of iodine deficiency was  $< 20\%$  in children in 60 (38%) of the sampled mauza/mohalla and  $< 20\%$  in women in 54 (34%) of the mauza/mohalla. The prevalence of iodine deficiency was  $\geq 80\%$  in children in 15 (9%) of the sampled mauza/mohalla and  $\geq 80\%$  in women in 17 (11%) of the mauza/mohalla.

### Public Health Significance of IDD in Bangladesh

Table 4 shows the international criteria for assessing the public health significance of IDD in a population using the prevalence of goitre and median UIE in school children.<sup>7</sup>

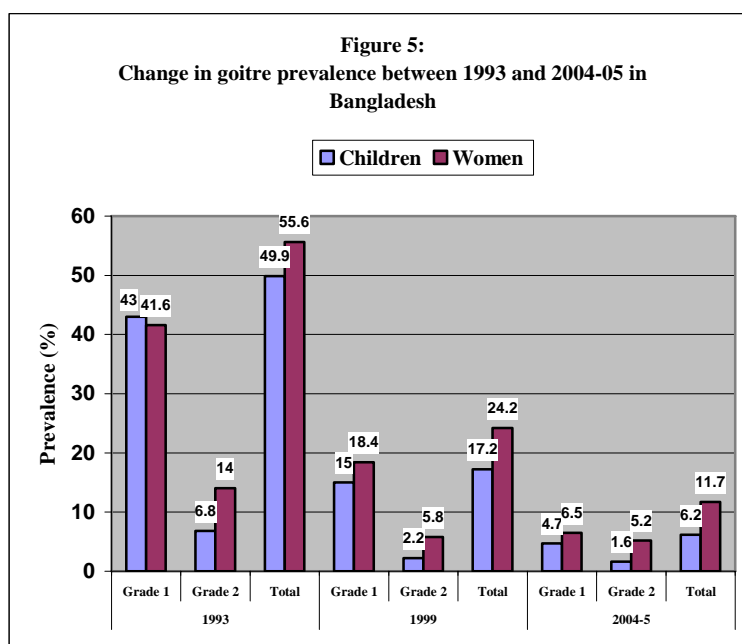
According to this criteria, the prevalence of goitre in Bangladeshi school-aged children falls within the 'mild' category (5.0-19.9%) for establishing IDD severity, while the median UIE falls within the 'optimal' category (median UIE 100-199  $\mu\text{g/L}$ ).

### Relationship between Iodized Salt Coverage and Iodine Deficiency

Figure 3 shows the prevalence of iodine deficiency (UIE  $< 100$   $\mu\text{g/L}$ ) among children and women by the iodine content of the subjects' household salt. As the iodine content of household salt increases, the percentage of subjects with iodine deficiency decreases. This analysis clearly illustrates that children and women residing in households that consume inadequately iodized salt have inadequate iodine status.

This is more substantiated by a clear and significant inverse relationship observed between the coverage of adequately iodized household salt and the prevalence of iodine deficiency in children and women. Figure 4 shows the example for children. Similar picture is seen for the women. The coverage of adequately iodized salt explains 41% of the variation in iodine deficiency in both children and women.

There was also a close match between high prevalence of IDD (goitre and iodine deficiency) in children and women in the PSUs (clusters) and low coverage of ade-



**Figure 5.** Change in goitre prevalence among school-aged children and 15-44 years old women between 1993 and 2004-05 in Bangladesh

Note: Age of children in 1993 and 1999 surveys was 5-11 years; age of children in 2004-05 survey was 6-12 years. The 1993 data are the lowest values from the range of values in hilly, flood-prone and plain zones.

quately iodized household salt. Northern districts of the country in Rajshahi and Dhaka Divisions were particularly badly affected by a high prevalence of IDD (data not shown).

#### **Change in IDD Status in Bangladesh between 1993 and 2005**

**Table 5.** Median urinary iodine excretion (UIE) and prevalence of iodine deficiency (UIE <100 µg/L) in school-aged children and women (15-44 y) in 1993, 1999 and 2004-05 (%)

			1993	1999	2004-05
Children	Girls	Median UIE (µg/L)	27.5 - 60.9	121	149
		Iodine deficiency (%)	75.7	44.0	37.0
		Boys	Median UIE (µg/L)	37.9 - 90.5	131
		Iodine deficiency (%)	67.3	41.0	30.8
	All	Median UIE (µg/L)	33.4 - 77.5	126	163
		Iodine deficiency (%)	71.0	42.5	33.8
Women	Median UIE (µg/L)	27.5 - 57.1	112	140	
	Iodine deficiency (%)	70.2	45.6	38.6	

Notes: Age of children in 1993 and 1999 surveys was 5-11 years; age of children in 2005 survey was 6-12 years. In 1993, the survey was done zone wise (hilly, flood-prone and plains) and the national estimate of median urinary iodine was not calculated. The 1993 data are the range of values in hilly, flood-prone and plain zones.

#### *Prevalence of goitre*

Figure 5 shows that the total goitre rate (TGR) in both children and women has fallen remarkably in the last decade. Between 1993 and 2004-05, TGR decreased from 49.9% to 6.2% in children, and from 55.6% to 11.7% in women. In both children and women, the absolute fall in TGR between 1993 and 1999 was considerably greater than between 1999 and 2005. Nevertheless, the fall between 1999 and 2005 was almost two-thirds of the 1999 level in children and over one-half of the 1999 level in women. Most of the change in TGR in all population groups was due to a fall in Grade 1 rather than Grade 2 goitre. This is particularly true for the period 1999 to 2005, during which there was negligible change in the prevalence of Grade 2 goitre.

#### *Iodine deficiency*

Table 5 shows that median UIE increased between 1993 and 2005 among both children and women, and there was a concomitant decrease in iodine deficiency. Like goitre, most of the increase in UIE and decline in iodine deficiency occurred between 1993 and 1999. In children, UIE increased from 54 µg/L in 1993 to 126 µg/L in 1999 and further to 162 µg/L in 2005, and accordingly iodine deficiency decreased from 71.0% in 1993 to 42.5% in 1999 and then to 33.8% in 2005. Boys had better iodine status than girls at each survey. In women, UIE increased from 47 µg/L in 1993, to 111 µg/L in 1999 and to 140 µg/L in 2005, while iodine deficiency decreased from 70.2% in 1993 to 45.6% in 1999 and to 38.6% in 2005.

## **DISCUSSION**

Bangladesh has achieved a commendable progress in reducing prevalence of goitre and iodine deficiency among school-aged children and women of reproductive age in

ten years of universal iodized salt intervention initiated in the mid-90's. Major percentage change in TGR in all population groups was due to a fall in Grade 1 goitre. Most of the children were born after iodized salt became widely available in Bangladesh, which explains the lower prevalence of goitre, particularly Grade 2 goitre, in children compared with women. Some Grade 2 goitres are irreversible, even when dietary intake is adequate for iodine, hence the persistence of Grade 2 cases in the women who developed goitre before the introduction of salt iodization. It is reassuring to find that salt iodization has been effective in maintaining the prevalence of Grade 2 goitre at a very low level in children.

As mentioned in the Methods section, there is a slight change in the age group of children from 5-11 years in the previous surveys (1993 and 1999) to 6-12 years, in line with WHO recommendations.<sup>7</sup> Although this is unlikely to have a significant effect on the analysis of trends over time in school-aged children, the present study has some limitations in making a direct comparison.

The finding that the prevalence of goitre in Bangladeshi school-aged children falls within the 'mild' category (5.0-19.9%), while the median UIE falls within the 'optimal' category (median UIE 100-199 µg/L),<sup>7</sup> can be explained. Urinary iodine excretion is a more sensitive indicator of iodine nutrition status because it reflects recent iodine intake. Thyroid size reflects iodine nutrition over months or years, and changes in goitre prevalence lag behind changes in iodine status. For this reason, goitre can persist among school children (and also adult women) even when they have attained iodine sufficiency as indicated by median UIE concentration.<sup>7</sup>

Although iodine deficiency, as measured by UIE <100 µg/L, among children and women has decreased during the last 10 years, prevalence is still enormous, over one-third. Moreover, in 2005, the prevalence of severe iodine deficiency (UIE <20 µg/L) was 4.0% in children and 4.5% in women. Bangladesh thus has still a long way to go with the universal salt iodization programme to eliminate iodine deficiency. All stakeholders need to redouble their efforts in strengthening the on-going Control of Iodine Deficiency Disorders (CIDD) programme, with more vigilance in monitoring and supervision.

Some sub-groups in the population, notably in urban areas, fall within the 'more than adequate' category for median UIE (200-299 µg/L).<sup>7</sup> In populations characterized by longstanding iodine deficiency and rapid increment in iodine intake, median values for UIE above 200 µg/L are not recommended because of the risk of iodine-induced hyperthyroidism. However, this adverse condition is believed to occur only during the first 5-10 years following the introduction of iodized salt.<sup>10,11</sup> Iodized salt was introduced in Bangladesh over 10 years ago. Beyond this period of time, median values up to 300 µg/L have not demonstrated side-effects, at least not in populations with adequately iodized salt.<sup>7</sup>

Interestingly, in both children and women, there is a significant close match between iodine deficiency and the coverage of households consuming adequately iodized salt, meaning that children and women residing in households that consume adequately iodized salt have adequate iodine status. This is in line with the observation that the

median urinary iodine excretion (UIE) of children and women increased and the percentage of children with UIE <100 µg/L decreased with the increase in iodine content of household salt.

Likewise, there was a close match between high prevalence of IDD (goitre and iodine deficiency) in children and women in the PSUs (clusters) and low coverage of adequately iodized household salt. Northern districts of the country in Rajshahi and Dhaka Divisions are particularly badly affected by a high prevalence of IDD. The same parts of the country were found to be severely affected by iodine deficiency (measured as high goitre prevalence) some 40 years ago.<sup>12</sup> Special studies need to be undertaken to find out the root causes of this longstanding iodine deficiency problem in this region of the country.

All indicators of iodine nutrition status, except goitre in children, show that children and women living in urban areas have considerably better iodine status than those living in rural areas. This is due to better availability and higher consumption of iodized salt, sold as 'packet' salt, in urban than rural areas (data not shown in this paper).

The virtual elimination of IDD will contribute to the achievement of several of the Millennium Development Goals (MDGs) in Bangladesh by increasing learning ability, school performance and income-earning potential, and lowering the rates of stillbirths, miscarriages, pregnancy complications, neonatal deaths and other clinical outcomes of iodine deficiency. These MDGs include the eradication of extreme poverty and hunger (MDG #1), achievement of universal primary education (MDG #2), reduction in child mortality (MDG #4) and improvement in maternal health (MDG #5). Among the countries in the Asia Pacific region, China, Vietnam, Thailand and Indonesia are good examples of those who have invested enormous effort and resources in IDD elimination programs and are now reaping the social and health benefits of these investments.<sup>13,14</sup> Bangladesh should follow suit.

#### DEDICATION

This paper is dedicated to the memory of Late Professor Quazi Salamattullah, a leader and a committed ally in the fight to eliminate iodine deficiency disorders in Bangladesh. He gave technical guidance to the design of the present survey and supervised all laboratory analyses, when a debilitating and finally fatal illness befell him.

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**AUTHOR DISCLOSURES**

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## Original Article

## Iodine deficiency disorders in Bangladesh, 2004-05: ten years of iodized salt intervention brings remarkable achievement in lowering goitre and iodine deficiency among children and women

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### 2004 至 2005 年孟加拉碘缺乏之疾病：碘鹽介入十年顯著降低兒童和婦女甲狀腺腫及碘缺乏

調查孟加拉 6-12 歲兒童及 15-44 歲婦女碘缺乏疾病之現況，以甲狀腺腫之盛行率與尿液碘排泄量來評量。研究時間為 2004 年 9 月至 2005 年 3 月，自加權城鄉中採用分層多階段叢集，抽取具代表全國性之樣本。共有 7233 位兒童及 6408 位婦女接受是否有甲狀腺腫之檢查，其中共有 4848 位受試者有收集尿液（兒童 2447 位，婦女 2401 位）檢測其碘含量。並分析 5321 家戶使用之食鹽含碘量。發現孩童總甲狀腺腫率（TGR）為 6.2%，相對於 1993 年為 49.9%；婦女 TGR 為 11.7%，1993 年為 55.6%。碘缺乏（尿液中碘排出量 $<100 \mu\text{g/L}$ ）之盛行率，孩童為 33.8%，而婦女為 38.6%（於 1993 年分別為 71.0% 和 70.2%）。碘之營養狀況都市地區大幅優於鄉村地區。家庭使用碘鹽（ $>15 \text{ ppm}$ ）則明顯和碘缺乏呈現負相關。調查結果顯示，孟加拉自十年前實施全面食鹽加碘計劃，至今已達成可嘉許的成就，即降低兒童及婦女之甲狀腺腫及碘缺乏疾病。然而仍然有超過三分之一之兒童及婦女生理性缺碘之情況存在，這點需要所有相關工作者加倍努力，完成全民食鹽加碘。

**關鍵字：**碘缺乏疾病、甲狀腺腫比率、碘缺乏、家戶碘鹽普及率、全面食鹽加碘