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Sub-Clinical Iodine Deficiency Still Prevalent in Bangladeshi Adolescent Girls and Pregnant Women

[1,2]G. Ara, [2]A. Melse-Boonstra, [1]S.K. Roy, [1]N. Alam,
[1]S. Ahmed, [3]UH.F. Khatun and [1]T. Ahmed
[1]International Centre for Diarrhoeal Disease Research,
Bangladesh (ICDDR, B) Mohakhali, Dhaka, Bangladesh
[2]Division of Human Nutrition, Wageningen University, The Netherlands
[3]Institute of Public Health Nutrition (IPHN), Mohakhali, Dhaka, Bangladesh

Abstract: The major aim was to determine iodine status of adolescent girls and pregnant women in Bangladesh. Secondary objectives were to assess knowledge and practice on iodized salt use and to determine predictors of iodine status. A total number of 354 adolescent girls and 256 pregnant women were randomly selected from the six divisions of Bangladesh. Socio demographic information and iodine nutrition knowledge, weight and height were collected. Salt samples were collected from the household and spot urine samples were collected from the respondents. The median urinary iodine concentration of adolescent girls and pregnant women were 135 and 133 μg L^{-1}, respectively. Among adolescent girls, 37% had UIC <100 μg L^{-1} and among pregnant women, 56% had UIC < 150 μg L^{-1}. A significant correlation existed between the iodine concentration of the salt sample and UIC in both adolescent girls and pregnant women. Half of the households of both adolescent girls and pregnant women used inadequately iodized salt (<15 mg kg^{-1}). Adolescent girls had better knowledge on cause and prevention of goitre than pregnant women. The odds ratio of adolescent girls and pregnant women to be iodine deficient were 0.44 (95% CI, 0.39 to 0.95) and 0.55 (95% CI, 0.43 to 0.98) when they used adequately iodized salt.The results show that sub-clinical iodine deficiency is still present in Bangladesh, specifically in the divisions of Dhaka and Rajshahi. Salt iodization, use of packed salt and nutrition education should consistently be stimulated, monitored and improved in order to establish adequate access to dietary iodine for all people in Bangladesh.

Key words: Adolescent girl, pregnant women, iodine deficiency, urinary iodine concentration, Bangladesh

INTRODUCTION

Iodine Deficiency Disorders (IDD) have been recognized as one of the major public health problems in 130 countries, affecting a total of 740 million people (Hetzel and Delange, 2006). Though, outstanding measurable progress is being achieved through universal salt iodization, nearly 50 million people are estimated to still be affected by some degree of IDD-related brain damage (Hetzel and Pandav, 1996). Iodine deficiency during pregnancy has

Corresponding Author: Gulshan Ara, World Food Programme (WFP), IDB Bhaban, E/8-A, Rokeya Sharani, Agargaon, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh Tel: +880 2 8116344-48 Fax: +880 2 8113147

been associated with increased incidence of miscarriage, stillbirth and birth defects (ICCIDD, UNICEF, PAMM, AMI and WHO, 1994; Delange, 2000; Glinoer and Delange, 2000). Adolescent girls in iodine deficient areas were shown to have poorer school performance, lower IQs and a higher incidence of learning disabilities than matched girls from iodine-sufficient areas (Huda *et al.*, 1999; Azizi *et al.*, 1993, 1995).

A median Urinary Iodine Concentration (UIC) in the general population varying from 100 to 199 $\mu g\ L^{-1}$ is considered to reflect adequate iodine intake and an optimal status of iodine nutrition (ICCIDD, WHO and UNICEF, 2001) per capita consumption of salt in different countries usually varies from 5 to 15 g day^{-1} and most countries have fixed levels of 50 mg kg^{-1} iodine at the time of production (Sullivan *et al.*, 1995). Therefore, in Bangladesh the required level to meet the recommended iodine intake of 150 $\mu g\ day^{-1}$ was set at 15 $\mu g\ g^{-1}$ of salt (15 mg kg^{-1}) at household level.

According to the Bangladesh Small and Cottage Industries Corporation (BSCIC), over 99% of all the salt produced locally is now iodized (IPHN, BSCIC, UNICEF and ICCIDD, 1996). However, different surveys showed that, although, almost all salt factories produced iodized salt, the level of iodization does not meet the recommendation of the ICCIDD of 45-50 mg kg^{-1} at production level, which allows for losses during transport and storage (ICCIDD, UNICEF, PAMM, AMI and WHO, 1994).

Two National surveys on IDD have been carried out in Bangladesh the first in 1993 and a later follow-up survey in 1999. In these two surveys, children aged 5 to 11 years and adults aged 15 to 44 years were included according to WHO, UNICEF and ICCIDD (2001). The national IDD survey in 1999 revealed that 43.1% of the total population had biochemical iodine deficiency (urinary iodine <10.0 $\mu g\ L^{-1}$). Males had slightly better urinary iodine concentrations than females (IDD News letter, 2000). Although, some girls in the age range of 15 to 18 years were surveyed, no national figure exists separately for adolescents or for pregnant women.

The present study was carried out using the baseline data from a nationwide survey within the National Nutrition Programme (NNP). The aim of this study was to determine the iodine status of adolescent girls and pregnant women, to assess knowledge and practice on iodized salt use and to determine predictors of iodine status.

MATERIALS AND METHODS

The Bangladesh Integrated Nutrition Project (BINP) has been initiated by the Ministry of Health and Family Welfare, Government of Bangladesh in 1996. The objective of BINP was to reduce malnutrition among children and women in a comprehensive and effective way through community-based nutrition interventions. In 2004 the National Nutrition Programme (NNP) was launched, which is the largest nutrition initiative to reduce malnutrition in children, adolescents and women in Bangladesh. The experience of BINP and the available expertise with GO-NGO (Governmental Organization-Non Governmental Organization) collaboration has been utilized for NNP. The programme started in 44 new upazilas. One of the targets of NNP was to reduce the prevalence of severe iodine deficiency, indicated by a urinary iodine excretion of <30 ug dL^{-1}, by half of the previously reported prevalence of 40% in the population.

Sampling

The NNP baseline survey used a stratified two-stage random cluster sampling design to select approximately 5000 never married adolescent girls aged 13-19 years and

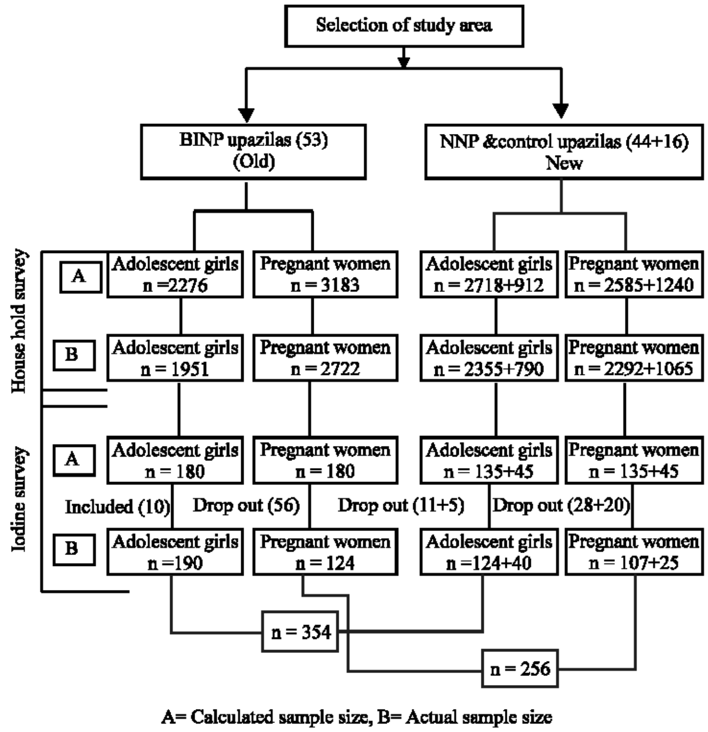

Fig. 1: Sampling profile

7000 pregnant women from 113 upazilas of Bangladesh for a household survey. They were grouped into BINP upazilas, NNP upazilas and control upazilas. The primary sampling units (PSUs) were formed by random selection of about 310 households in NNP upazilas and about 360 households in the BINP upazilas. A total number of 360 adolescent girls and 360 pregnant women were selected. From these, finally 354 adolescent girls and 256 pregnant women participated in the study (Fig. 1). The number of pregnant women was less than adolescents because of loss to follow up, mainly because they were moving to their parents' house for delivery. Pregnant women and adolescent girls were selected from different households. For this data analysis only cross sectional comparisons at baseline were done and therefore NNP and control upazilas were taken jointly. Better iodine status was expected in the BINP upazilas in view of the education on health and nutrition given in this area.

Data Collection

Data collection period was from February 2004 to June 2004. Informed consent was obtained form the head of household. The study was approved by the Research Review Committee (RRC) of ICDDR, B (International Centre for Diarrhoeal Disease Research in Bangladesh). Trained female interviewers visited the households and interviewed the never married adolescent girls and pregnant women with a structured questionnaire to collect data on age, education and household possessions of durable items, health and nutrition. Socio-economic status was estimated by level of education, as measured by the number of years of schooling and by household possessions. The long-term status of a household is indicated by wealth index. Wealth included in the index ranged from the possession of items such as bed, table, chair, almirah, radio, television, bike, motorbike, land owned, wall material of the main dwelling unit and type of toilet used (Gwatkin *et al*., 2000).

Knowledge about the cause of goiter was assessed by the question What are the major causes of goitre and the multiple answer categories were not eating enough food/not eating enough fruits/not eating vegetables/not eating iodized salt/not eating iodine rich food. Proper knowledge was defined by the same way. The knowledge about prevention of goitre was assessed by the question How can goitre can be prevented and the multiple answer categories were eating enough rice/eating enough fruits/eating vegetables/eating iodized salt/eating iodine rich food proper knowledge was again defined as eating of iodized salt/ eating iodine rich food. Knowledge of the consequences of eating iodized salt was also assessed and divided into positive effect and negative effect. The interviewers were trained by nutritionists to measure weight, height and MUAC of the adolescents by Uniscales, locally-made height scales and TALC (Teaching Aid at Low Cost) tape, respectively.The WHO standard protocol was followed for anthropometric measurements.

Nutritional status of adolescents was compared with WHO growth reference for school-aged children and adolescents (De Onis *et al*., 2007). Height-for-age z-scores below-2SD were used to measure wasting and stunting in adolescents girls.

Salt samples of current use by the household members were collected (approximately 50-100 g) and Iodine content of salt was determined by iodometric titration in the laboratory of the Institute of Public Health Nutrition (IPHN). Spot urine samples were collected from the respondents. The samples were collected in disposable cups and were transferred to clean, dry, wide-mouthed and screw-capped plastic bottles. Then the urine samples were carried in carton boxes and brought to the ICCIDD Laboratory of the Institute of Nutrition and Food Sciences, University of Dhaka. The samples were stored in a freezer at -20°C until analysis. Urinary iodine was measured by APDM (Ammonium Persulfate Digestion on Microplate) method (Ohashi *et al*., 2000).

Data Analysis

The SPSS version 12.00 (Inc. Chicago, USA) was used to analyze the data. Summary statistics were generated including frequencies, means with standard deviations, or medians with 25th and 75th percentiles. According to WHO criteria, subjects were defined as iodine deficient if their UIC was less than 100 $\mu g\ L^{-1}$ for adolescent girls and less than 150 $\mu g\ L^{-1}$ for pregnant women. Mann Whitney U and Kruskal Wallis tests were used to compare the UIC between BINP and NNP upazilas and between different divisions. Prevalences were compared using Chi-square testing. Spearman correlation coefficient was calculated between the iodine content of salt used in the household and urinary iodine concentration. Prevalence ratios were calculated to determine the potential predictors of outcome variables. Statistical significance was accepted at 5% probability level.

RESULTS

Table 1 provides the details of the socio-demographic characteristics of the adolescent girls and pregnant women. Overall, 346 adolescent girls and 254 pregnant women participated in the study. Eighty eight percent of adolescent girls and more than 60% of pregnant women passed secondary level of education. The vast majority of households of adolescent girls and pregnant women were poor by considering the ownership of household durables. Half of the households (50%) of both adolescents and pregnant women did not have agricultural

Table 1: Socio demographic characteristics of adolescent girls and pregnant women

Characteristics	Adolescent girls (n = 346)	Pregnant women (n = 254)
Age (Mean±SD)	15.1±1.6	24±5.0
Educational status (%)		
Primary	12	32
Secondary	88	66
Above Secondary	-	2
Asset index (%)		
Lowest	25.4	25
Second	16	27
Middle	25.4	15.2
Fourth	18.1	20
Highest	16.2	13.2
Ownership of agricultural land (decimal) (%)		
Landless	46.2	47.6
0.1 to 10.00	4.4	2.6
11.00 to 15.00	3.2	3.2
16.00 thru 20.00	2.8	1.6
21.00 thru 33.00	4.1	6.9
34.00 and above	39.3	38.1

Table 2: Median urinary iodine concentration by programme upazila and division

	Adolescent girls n = 346				Pregnant women n = 254			
	37% Overall subclinical iodine deficiency				56% Overall subclinical iodine deficiency			
Programme	UIC (Median) (25th and 75th percentile)	p-value	% (<100 μg L^{-1})	p-value	UIC (25th and 75th percentile)	p-value	% (<150 μg L^{-1})	p-value
Upazila								
NNP	125 (54.7, 262.4)	0.16[a]	42	0.078[c]	149 (77.10,298)	0.00[a]	51	
BINP	148 (81.9, 276.7)		50		125 (50.07, 214.27)		62	0.06[c]
Division								
Barisal	116 (79.1, 195.3)		39		191 (99.0, 314.0)		44	
Chittagong	276 (207.0,448.2)		3		149 (71.1, 217.0)		56	
Dhaka	95 (41.1, 176.9)	0.00[b]	50	0.00[c]	112 (42.1, 196.5)	0.02[b]	50	0.22[c]
Khulna	406 (186.0, 514.3)		10		127 (58.2, 306.0)		54	
Rajshahi	82(40.0, 143.0)		62		76 (50.1, 173.1)		68	
Sylhet	163 (67.3, 266.1)		32		130 (83.1, 258.2)		67	

[a]Within group Mann Whitney U test, [b]Within group Kruskal Wallis test, [c]Within group Chi-square test, NNP: National Nutrition Programme, 2004-2010, BINP: Bangladesh Integrated Nutrition Project, 1995-2002

land. The majority (70%) of the pregnant women had 1 to 3 children. One fourth of pregnant women did not have any children; only a few women (5%) had seven to eight children.

The overall prevalence of iodine deficiency was 37% in adolescent girls and 56% in pregnant women (Table 2). The median urinary iodine concentration in adolescent girls was 125 μg L^{-1} (25th and 75th percentile, 54.7 and 262.4) in NNP uapazilas and 148 μg L^{-1} (25th and 75th percentile, 82 and 277) in BINP upazilas. There was no significant difference between the two programme areas. The median UIC in adolescents differed significantly between divisions ($p<0.01$) with the highest UIC found in Khulna division (406 μg L^{-1}; 25th and 75th percentile, 186 and 514 μg L^{-1}), intermediate in Chittagong (276; 207 and 448 μg L^{-1}) and the lowest in Rajshahi division (95; 40 and 143 μg L^{-1}). The median UIC of pregnant women of NNP and BINP upazilas were 149 μg L^{-1} (25th and 75th percentile, 77, 298) and 125 μg L^{-1} (25th and 75th percentile, 50.1, 214), respectively. In contrast to UIC in adolescents, in pregnant women the NNP upazilas showed significantly higher ($p<0.05$)urinary iodine excretion than BINP upazilas. It also varied significantly ($p<0.05$) between the 6 divisions. In Barisal division, the highest UIC of pregnant women was observed (191, 99 and 314 μg L^{-1}) and lowest was in Rajshahi (76, 50 and 173 μg L^{-1})

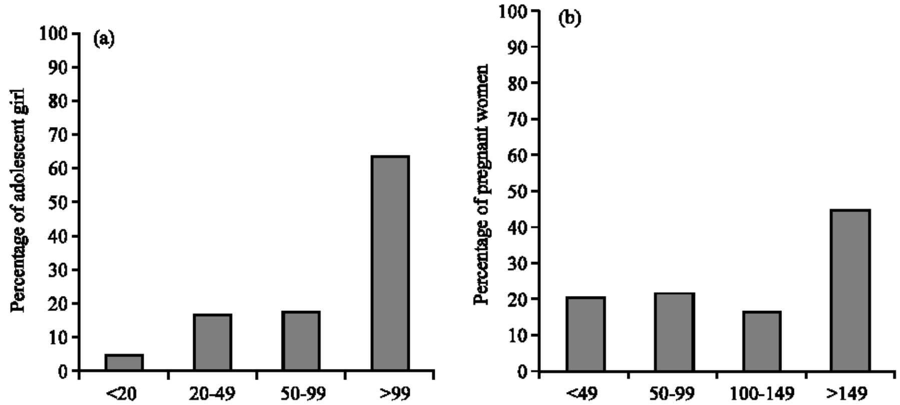

Fig. 2: (a) Status of iodine nutrition of adolescent girl according to urinary iodine concentration (μg L^{-1}) and (b) Status of iodine nutrition of pregnant women according to urinary iodine concentration (μg L^{-1})

Table 3: Urinary iodine concentration (median) and salt iodine level according to different level of salt iodine of adolescent girls and pregnant women

Salt iodine level (mg kg^{-1})	Adolescent girls Median, 25th and 75th percentile UIC (μg L^{-1}) (n =346)	p-value	Pregnant women Median, 25th and 75th percentile UIC (μg L^{-1}) (n =254)	p-value
0-15	110 (46.5,194)		91(49.0, 163)	
15-30	116 (75.0, 358)	0.00[a]	142 (77.1, 277)	0.00[a]
30-45	174 (84.0, 293)		203 (90.0, 338)	
45 and above	196 (111, 415)		235 (99.0, 379)	
Correlation coefficient	0.28[b]	0.00	0.33[b]	0.00

[a]Within group Kruskal Wallis test; [b]Spearman correlation between salt iodine and UIC

division. The UIC in the other divisions ranged from 127 to 149 μg L^{-1}. Prevalence of deficiency both in adolescents and pregnant women was slightly lower in NNP (42 and 51%) in comparison to BINP upazilas (50 and 62%). The difference was almost significant (p = 0.07 and p = 0.06, respectively). Variation in prevalence of iodine deficiency between divisions ranged from 3% in Chittagong through 62% in Rajshahi in adolescent girls. The divisional distribution of this prevalence among pregnant women was not statistical significantly different it ranged from 44-67%.

According to urinary iodine concentration classified by the WHO cut off points (optimal iodine concentration >99 μg L^{-1}; mild deficiency 50-99 μg L^{-1}; moderate deficiency 20-49 μg L^{-1} and severe deficiency <20 μg L^{-1}) the level of iodine deficiency was severe in 4% of the adolescent girls. Mild to moderate deficiency existed in 33% of the girls (Fig. 2a). One fifth (20%) of pregnant women had severe iodine deficiency. There were 37% women who demonstrated mild to moderately low levels of urinary iodine (Fig. 2b).

A positive relationship was observed between iodized salt intake and urinary iodine excretion (r = 0.28 in adolescent girls and 0.33 in pregnant women, p<0.01). The higher the salt iodine content, the higher the urinary iodine concentration was (p for trend <0.01) (Table 3). Based on the required amount of 15 μg of iodine per g of salt (ppm), an equal percentage of households of both adolescent girls and pregnant women were consuming inadequately iodized salt. More than 60% of households in Rajshahi division were consuming salt with low iodine content. More households of pregnant women in Chittagong and Khulna division were consuming low iodine content salt than the households of adolescent girls (Table 4).

Table 4: Inadequately iodized salt in households of adolescent girls and pregnant women by division

Inadequately iodized salt by division (%) (<15 mg kg^{-1})	Adolescent girls n = 346	Pregnant women n = 254
Barisal	50	42
Chittagong	25	53
Dhaka	50	41
Khulna	27	55
Rajshahi	70	60
Sylhet	24	27
All	43	45

Table 5: Knowledge and practice of iodized salt among adolescent girls and pregnant women

	Adolescent girl			Pregnant women		
Type of salt used	Packed salt n = 247 (30¶)	unpacked salt n = 95 (50¶)	p-value	Packed salt n = 163 (57*)	unpacked salt n = 50 (66*)	p-value
Know about goitre (%)	87	61	0.05[a]	78	74	0.34[a]
Knowledge about cause of goitre						
Having proper knowledge (%)	51	26	0.00[a]	30	26	0.47[a]
Knowledge about goitre prevention						
Having proper knowledge (%)	53	28	0.00[a]	29	28	0.39[a]
Perception of impact of iodized salt during pregnancy (%)						
Positive effect	-	-		83	82	0.00[a]
Negative effect	-	-		17	18	

¶Percentage of deficit in adolescent girls, *Percentage of deficit in pregnant women, [a]Within group chi-square test

Table 5 shows the practice of packed salt use by knowledge level about goiter. Among the households of the 342 adolescent girls, 28% used unpacked salt and among the households of the 213 pregnant women 23% used unpacked salt. Prevalence of iodine deficiency was 30% in adolescents who used packed salt and 50% in adolescents who did not use packed salt. Surprisingly, a high prevalence of iodine deficiency was observed in pregnant women who used packed salt (57%) as well as those who used unpacked salt (66%). Analysis of questions concerning the knowledge on cause and prevention of goitre showed that more girls who used packed salt had proper knowledge (51%) than those who used unpacked salt (26%). On the other hand, only 30% of packed salt users and 26% of unpacked salt users among pregnant women had proper knowledge on cause and prevention of goitre. More than 80% of pregnant women responded that iodized salt had a positive effect during pregnancy, regardless whether they used packed or unpacked salt.

As shown by the odds ratios in Table 6, the risk of iodine deficiency in adolescent girls significantly increased by geographical region and decreased by use of packed salt, use of adequately iodized salt and adequate nutritional status. The risk of sub-clinical iodine deficiency in Dhaka and Rajshahi division were 5 to 7 times higher as compared to Chittagong division. Well-nourished adolescent girls had 40% less risk of being deficient than wasted adolescent girls. The risk of being iodine deficient during pregnancy was lower when adequately iodized salt was used or when the household asset index was higher and risk increased with age. Risk for iodine deficiency was not different between divisions in pregnant women.

DISCUSSION

The present study showed more progress is needed to correct the IDD situation in Bangladesh. The study results revealed that adolescent girls and pregnant women in two out of the six divisions, Dhaka and Rajshahi, are iodine deficient. In total, 37% adolescent girls and more than fifty percent of pregnant women were subclinically iodine deficient. Analysis

Table 6: Determinants for having a low urinary iodine excretion in Bangladeshi adolescent girls and pregnant women

Adolescent girls		Pregnant women	
Independent variable	OR (95% CI)	Independent variable	OR (95% CI)
Region		**Region**	
Chittagong (Ref)	1	Barisal (Ref)	1
Khulna	1.4 (0.33-6.25)	Khulna	1.17 (0.50-2.22)
Barisal	3.94* (1.01-12.32)	Chittagong	1.09 (0.54-2.21)
Sylhet	3.34* (1.07-10.56)	Sylhet	1.15 (0.65-2.03)
Dhaka	5.37** (1.72-16.72)	Dhaka	1.33 (0.78-2.26)
Rajshahi	7.00** (2.31-21.07)	Rajshahi	1.31 (0.66-2.60)
Programme Area		**Programme Area**	
NNP (Ref)	1	NNP (Ref)	1
BINP	1.24 (0.81-2.92)	BINP	1.27 (0. 79-2.04)
Type of salt used		**Type of salt used**	
Unpacked salt (Ref)	1	Unpacked salt (Ref)	1
Packed salt	0.53* (0.34-0.84)	Packed salt	0.86 (0.67-1.25)
Amount of iodine		**Amount of iodine**	
In adequately iodized (Ref)	1	In adequately iodized (Ref)	1
Adequately iodized	0.44* (0.39-0.95)	Adequately iodized	0.55** (0.43 - 0.98)
Level of education		**Year of schooling**	
Primary (Ref)	1	Illiterate (Ref)	1
Secondary	1.11 (0.55-2.29)	1-5 years	1.14 (0.68-1.90)
		>6 years	1.05 (1.61-1.82)
Asset index		**Asset index**	
Lowest (Ref)	1	Lowest (Ref)	1
Second	1.78 (0.85- 3.75)	Second	0.88 (0.18-2.6)
Middle	1.44 (0.71- 2.91)	Middle	0.95 (0.21-4.2)
Fourth	1.20 (0.63- 2.30)	Fourth	0.54* (0.15-0.86)
Highest	0.67 (0.33- 1.38)	Highest	0.39** (0.58-0.90)
Ht-age- Z sore		**Age**	
≤-2 (Ref)	1	35 and above years (Ref)	1
≥-2.01	0.86 (0.54-1.37)	30-34 years	0.89 (0.55-3.8)
Wt –age –Z score	25-29 years	0.77(0.75-2.3)	
≤-2 (Ref)	1	18-24 years	0.47 * (0.13-0.99)
≥-2.01	0.59* (0.39-0.99)	≤17 years	0.35** (0.12-0.65)
		No of pregnancy	
		1 (Ref)	1
		2-3	0.93 (0.56-1.54)
		>4	1.08 (0.50-2.35)

The dependent variable equals to 0 if UIC was =< 100 µg L^{-1} for adolescent girl and =<150 µg L^{-1} for pregnant women, 1 otherwise. The independent variables-region, programme area, type of salt, amount of iodine, education level, asset index, ht –age-score, wt-age-score, age of pregnant women and no. of pregnancy *p<0.05, **p<0.01 (compared with reference category)

of salt samples from the households shows that a proper level of iodine in the salt is not being maintained we found that almost half of the households were still consuming table salt containing an inadequate iodine concentration (<15 µg g^{-1}). Pregnant women were more vulnerable to iodine deficiency than adolescent girls. Deficiency of iodine in the environment is the major cause of iodine deficiency in Bangladesh. During the IDD survey conducted in 1993 and 1999, the whole country was divided into three ecological zone i.e. hilly, flood prone and plain area. Flood prone and hilly areas seemed to be high-risk zones for iodine deficiency. In the present survey, results are presented on country as well as division level. The distribution of median urinary iodine excretion significantly differed from division to division in both groups. The prevalence of iodine deficiency also differed between divisions among adolescent girls. The situation of adolescent girls is satisfactory in Chittagong and Khulna division. This may be related to consumption of sea fish as both of these divisions are situated at the coast. Rajshahi and Dhaka, both flood prone zones, still seemed to be the zones most at risk, since the highest prevalences of iodine deficiency were observed in these divisions (62 and 50%, respectively). In these two divisions, consumption of packed salt was also relatively low. The heavy rainfall and annual flooding consistently wash off soil iodine and the cumulative yearly loss of iodine from the soil in these zones make these divisions extremely vulnerable to iodine deficiency. In case of pregnant women we observed a different situation. Though the median UIC significantly varied between divisions, the prevalence of iodine deficiency in pregnant women was overall similar in all divisions. This may be explained by the increased demand for iodine during pregnancy (Zimmermann, 2007) by which the effects of iodine deficiency become evident even in geographical areas of borderline iodine supply (Mezosi *et al*., 2000).

As there are no reference values for the median urinary iodine concentration during pregnancy, we used different cut off points for sub-clinical iodine deficiency for adolescent and pregnant women. Hormonal changes and metabolic demands during pregnancy result in alterations in the biochemical parameters of thyroid function (Hollowell *et al*., 2002). By considering the increased demand we used cut off points of below 150 μg as sub-clinical iodine deficiency during pregnancy.

In spite of extensive international efforts to implement effective IDD programmes, there is evidence from different studies in India, Nicobar andaman and South Africa that a very low level of public awareness exists regarding the beneficial effect of iodine (Mohapatra *et al*., 2001, Mallik *et al*., 2003; Jooste *et al*., 2005). In all these studies a uniformly low level of IDD awareness in the general public has been demonstrated. Data regarding IDD knowledge from the present study have also yielded unsatisfactory results. Still one third of households use unpacked salt. Especially pregnant women had insufficient knowledge about cause and prevention of goitre. Poor iodine nutrition knowledge may be the result of inadequate representation in the school curriculum, less importance in nutritional knowledge provided by the existing nutrition programme in the locality and little media reporting. To solve this IDD communication gap, which appears to inhibit the transfer of this message to the consumer level, better educational and public health communication strategies are required.

It has been shown previously that except for geographical and ecological conditions, households with low socioeconomic indexes are most vulnerable to be exposed to insufficiently or non iodized salt (Jooste *et al*., 2001). In present study we found that ecological variation (division to division) is a strong predictor of sub-clinical deficiency. Present study highlights a significant effect of using packed and adequately iodized salt in reducing the risk for iodine deficiency. We considered both packed salt use and adequately iodized salt as outcome variables because it shows that the salt industries in Bangladesh are not iodizing salt as per law. Remarkable differences were observed in iodine content of salt in the various divisions. Seventy percent of the households of adolescent girls and sixty percents of households of pregnant women in Rajshahi division were consuming salt with inadequate iodine content.

Present study demonstrated that the prevalence of sub-clinical iodine deficiency in Bangladeshi pregnant women is not dependent on environment or different divisions. Perhaps it is mostly dependent on metabolic reasons of increased demand. Use of packed salt was not related whereas use of adequately iodized salt was associated with adequate UIC in pregnant women. We also found that low socio economic status as indicated by less household possessions was accountable for poor iodine nutrition status. Pregnant women of young age (<17 years and 18 to 24 years) had less risk of being iodine insufficient. Although, association was observed among socio economic status and age with iodine deficiency in pregnant women, hardly it can be said that these factors were really attributable for poor iodine status rather than metabolic alteration.

In the present study urinary iodine concentration of was categorized according to WHO, UNICEF and ICCIDD (2001). We again categorized it to observe the excess excretion, approximately 20% adolescent girls (>300 g L^{-1}) (WHO, UNICEF and ICCIDD, 2001) and 10% of pregnant women (> 500 g L^{-1}) (Hollowell *et al*., 2002) excreted excessive amount of urinary iodine (data not shown). The question of side effects of high iodine intake of this population emphasizes the urgent need for careful monitoring of iodized salt production and IDD status. Excess iodization of salt is expensive and unnecessarily inflates the cost of USI programs. High intakes of iodine are associated with increased thyroid volume, suggesting adverse effects on thyroid function (Chen and Zou, 2004). So, decreasing the concentration of iodine in salt should be considered.

Huge international efforts to eliminate IDD world wide and outstanding progress achieved towards this goal in many countries, but a report from UNICEF in 2007 suggests that global progress against iodine deficiency is slowing. As a result of universal salt iodization in Bangladesh, the prevalence of goitre is decreasing and urinary iodine level is improving (iodine survey 1993 and 1999). But our data shows that sub-clinical iodine deficiency is still present in the country. The results obtained from the present survey show salt iodization in Bangladesh is still far from satisfactory. New strategies should be developed to strengthen salt iodization including increased political commitment, advocacy and capacity building of the salt industry all over the country for production and quality assurance, adoption and enforcement of appropriate regulations/legislation. Proper monitoring systems at production, retail and community levels should be established in vulnerable areas especially in Rajshahi and Dhaka division. Ministry of Health and family welfare should give special attention in these two divisions; if consumption of iodized salt alone is not enough to eliminate the subclinical iodine deficiency during pregnancy, iodine supplementation (Zimmermann, 2007) may be taken into account. Different study in Europe Denmark (Zimmermann *et al*., 2004) and Germany (Buhling *et al*., 2003) Hungary (Nohr *et al*., 1993) demonstrated that the median UI concentration were significantly higher in pregnant women receive iodine containing supplements than who were not supplemented. In addition, routine data should be collected on UIC of school children. Consumers should be encouraged to use the readily available packed salt instead of unpacked salt. Organizations directly or indirectly involved in salt iodization including UNICEF, BSCIC, Bangladesh Standards Institution and the Salt mill Owners Association should be alerted about the magnitude of the problem so that curative measures can be taken and ensured.

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