Prevalence of Iodine Deficiency Disorders among Dongria Kondh Primitive Tribal Community in Niyamgiri Mountain area of Rayagada District, Orissa

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Abstract

Iodine Deficiency Disorders (IDD) is a major public health problem in India including Orissa. Following the National IDD control program, the state of Orissa enforced universal salt iodization, under which the entire population is to receive exclusively iodized salt. No systematic survey has been carried out to assess the iodine status of tribal communities, who are the socioeconomically deprived and nutritionally vulnerable sections of the society.

The present study was undertaken to evaluate the IDD in children and to assess community awareness and perception of iodized salt in Niyamgiri hill region of Rayagada district, which is the abode of Dongria Kondh, a primitive tribal group. The survey adopted the 30-cluster sampling and surveillance indicators as suggested by WHO/ UNICEF/ICCIDD consultation. A total of 623 school-age children of 6-12 years were examined clinically for goiter and iodine contents of urine and drinking water samples measured by standard methods.

The total goitre rate was 24% (grade-1, 16.7%; grade-2, 6.9%), girls had significantly higher prevalence than boys. Median urinary iodine excretion level was found to be 38 mg/l, of which 51.7% and 41.9% of children respectively had urinary iodine <100 and <50 mg/l. The iodine concentrations for water samples were in the range of 1.48-2.89 ìg/l. Only, 9.9% household edible salt samples had stipulated iodine content of $\geq$15 ppm by titration method. Less than 10% of respondents interviewed had correct knowledge of the cause of goitre and use of iodized salt. The prevalence of IDD was a moderate public health problem with poor community knowledge and environmental deficiency of iodine. This indicates the need of effective monitoring and intensive IEC to ensure accessibility of quality iodized salt at affordable price in remote tribal pockets as an essential public health responsibility in attaining the goal of sustainable IDD elimination.

Introduction

Iodine is an essential trace element for synthesis of the thyroid hormones; thyroxine (T_4) and triiodothyronine (T_3) are necessary for normal growth, development and functioning of the brain and body (Glinoer, 2003). In normal adults, the daily requirement of iodine is 150mg, while the production rate of T_4 and T_3 is approximately 100 µg and 30 µg respectively. All the T_4, but only about one-fifth of the T_3 is produced by the thyroid gland and the remainder of the T_3 is produced through the extra thyroidal deiodination of T_4. A minimum of 70 µg of iodine is thus needed daily to produce these two hormones in the thyroid gland (Bernal and Nunez, 1995). Iodine is supplied through diet, 90% of this normally comes from food, and the rest from water. Diet deficient in iodine is associated with a wide spectrum of illnesses, collectively called iodine deficiency disorders (IDD) (Hetzel, 1987). These include goiter of all ages, hypothyroidism, cretinism, congenital anomalies, neurological dysfunction, impaired reproduction, still birth and spontaneous abortion (Delange, 2001; de Benoist et al, 2004; de Benoist et al, 2003). Communities living in iodine-deficient environments lead major block to their human and social development (Hetzel, 1997). Correction of the iodine deficiency indicated a major contribution to human development. Iodine deficiency remained as the first important preventable cause of mental retardation, brain damage and diminished IQ in the world even today (Qian et al, 2005; Anderson et al, 2005). Among all interventions, salt iodization is proven to be the cost-effective sustainable strategy for eliminating IDD (WHO, 1997; Houston, 1999).

Iodine deficiency constitutes a major public health problem in India (Padav and Kochupillai, 1982). As of now no single state is free from ill effects of IDD, surveys conducted in various states continuously recognizing new pockets of iodine deficiency (Toteja et al, 2004; Kapil and Singh, 2003). Of the total 480 districts in the country, 282 were surveyed, of which 241 have been found endemic for IDD with goitre rate 10% or more (Government of India, 2003). Estimated 167 million people are at risk for IDD in India, among which 54 million have goiter and over 8 million have neurologic handicaps (Kochupillai, 1986). Recognizing the magnitude of the IDD problem, government of India launched the National Goitre Control Programme (NGCP, 1962), subsequently renamed as National IDD Control Programme (NIDDCP, 1992) with a view to cover a wide spectrum of IDD. Universal Salt Iodisation (USI, 1984) is the primary strategy for IDD elimination by 2010, under which the entire population of the country is to receive edible salt with a minimum of 15 ppm of iodine (Tiwari, Ray, Malhotra, 1998). In all states and Union Territories except Kerala and Gujarat, there is ban on the sale of non-iodised salt for human consumption. This act served as a catalyst for achieving the high coverage in the household consumption of iodized salt in India (Government of India, 2003).

Earlier surveys conducted by the central IDD survey team in Orissa reported that 2 out of 13 districts surveyed were endemic with goiter prevalence 19.3-33.5%. Over the past decade studies have been conducted on the prevalence of IDD in different states (Government of India,2003; Mohapatra, 2000; National Institute of Nutrition, 2003; Sahu et al, 2005; Government of Orissa, 2006). The state government had issued a notification on the complete ban on the sale and import of non-iodized salt since 1994. In post-salt iodization phase, endemic goitre and associated IDD are widely prevalent. On region-basis, iodine deficiency is more pronounced in districts having predominantly tribal population (Sahu et al, 2005; Joshi et al, 1993). Statewide NFHS-II (1998-99) and RCH (2001-02) surveys conducted in Orissa reported as high as 70% of the salt samples had iodine content less than the recommended level of 15 ppm (IIPS and ORC Macro, 2000; IIPS, 2003). There were significant differences in consumption of iodized salt between tribal and non-tribal groups. The tribal populations continued to use salt with inadequate iodine. Moreover, ethnicity reported to be a causal factor for iodine deficiency through environmental background and/or nutritional habits, (Bellis et al, 2000; Monarrez-Espino, Greiner, 2005) but tribal groups have not been studied for iodine nutrition in Orissa. Thus, the present study was undertaken to determine the iodine status of a classical tribal community in Rayagada districts.

Material and methods

Orissa is the tenth largest state in India with an area of 1.56 lakh km^2 situated on the eastern coast with a population of 36.804 million. The state ranks second after Madhya Pradesh in terms of tribal concentration for having 62 tribal and 13 primitive tribal groups, who are the most underprivileged section of society (Government of India, 1984). The tribal population constitutes 22.2% of the total population of Orissa that shares 9.7% of India's total tribal population (Census of India, 2001). Almost 44.21% of the total land area constitutionally declared as Scheduled Area based on preponderance of tribal population and economic backwardness (Govt. of Orissa, 2001).

1. Study design

The study was a cross-sectional field-based survey carried out in 2004-05. The study population consisted of school age children ranging from 6 to 12 years in the community. Children in this age group preferred throughout world to bring uniformity in the results and comparability in the magnitude of the problem and also to assess the impact of interventions to prevent IDD. The study protocol was approved by the Institutional Ethical Committee and the ST & SC Development Department, Government of Orissa gave prior permission for conducting the study. Informed consent was obtained from the village heads and family heads for children.

2. Sample size

A sample size was determined for study area using the formula for cluster surveys in developing countries (Steve et al, 1991). It was calculated on the basis of prevalence of 15% goiter rate at 20% maximum likely error and design effect of 3. This gave the sample size required to be 600.

3. Sampling procedure

The 30-cluster sampling methodology and surveillance methods for assessment of IDD prevalence recommended by WHO/UNICEF/ICCIDD were used for the study (WHO, 2001). All the Dongria Kondh inhabited villages were enlisted with their population. Thirty villages were selected from the total list using population proportionate to size (PPS) technique. List of all villages and their population in each block was obtained from the DKDA office. The cumulative population of all villages in each block was computed. A sampling interval was calculated by dividing the total cumulative population of all the villages by the number of village clusters required. This was repeated until the desired number of clusters was selected. All the school-age children 6-12 years old in the selected village were included. These children were selected from the study population giving due representation to three blocks.

4. Methods

The prevalence of IDD in a community are assessed by three indicators; (i) prevalence of goiter which indicates past iodine status of population, (ii) urinary iodine excretion which indicates current iodine intake, (iii) iodine content of salt consumed by the population, which indicates the current intake of iodine and (iv) community knowledge about iodine deficiency and awareness of iodized salt.

i. Goitre prevalence

The enlargement of thyroid gland was assessed clinically by standard palpation method. Goitre grade was scored according to WHO/UNICEF/ ICCIDD criteria (grade 0 - no palpable or visible goiter; grade 1 - an enlarged thyroid that is palpable but not visible when the neck is in a normal position; grade 2 - a palpably enlarged thyroid visible when the neck is in a normal position). The sum of grade 1 and grade 2 provided the total goitre rate (TGR) prevalence (WHO, 1994; ICCIDD, 1999).

ii. Urinary iodine excretion

Urine specimens were collected in iodine free plastic bottles with screw caps, and labeled with identification codes. These samples were transported to laboratory and stored at 4^0C until analysis. UIEL was determined by the modified wet-digestion method of Sandell-Kolthoff reaction in which iodine is determined from its catalytic reduction of cerium ammonium sulfate in the presence of arsenic acid (WHO 2001; Pino, Fang, Braverman, 1998) Further iodine content was determined in 21 (3 from each area) drinking water samples collected from local streams and bore-wells (Dunn et al, 1993). The results were expressed as mg of iodine per litre of urine or water.

iii. Salt iodine determination

Salt samples were also collected from households that were routinely being consumed in their respective homes in auto-seal polythene pouches. The salt samples were kept at room temperature in the laboratory and iodine content was measured within a week by standard iodometric titration method (UNICEF, 1995). A pre-tested questionnaire was used on head of households for collecting information about the knowledge of IDD and awareness of iodized salt.

5. Statistical analysis

Data were analyzed using an SPSS statistical software package for personal computer. Data are presented as percentages in the table. Urinary iodine concentrations were not normally distributed and therefore the median was calculated as the measure of central tendency.

Results

Fig. 1 illustrates the prevalence of goitre among school age children examined according to sex. A total of 623 school age children were studied, comprised of 306 female children (49.1%) and 317 male children (50.9%). Of the total child population, prevalence of TGR was 23.6% while visible goitre (grade 2) was 6.9%. The prevalence of TGR was more among female children (26.1%) as compared to male children (21.1%), but the difference was not statistically significant ($p>0.05$). The goiter was significantly different in respect of age.

The urinary iodine excretion levels (UIEL) of 530 urine samples of school-age children are shown in Fig. 2. UIEL ranged from as low as 22 mg to as high as 213 mg/l. The analysis of distribution of UIEL revealed values lower than 100 mg/l in 48.3% of samples; 41.9% of these had UIEL lower than 50 mg/l. The median urinary iodine level (MUIEL) for all children was found to be 38.5 mg/l, are well below the level accepted for the definition of iodine deficiency, i.e. a concentration of 100 mg/l. The proportion of children had normal ranges (>100 mg/l) were 48.3%. Children with mild, moderate and severe grades of UIEL were 9.8%, 24.2% and 17.7% respectively. Based on these values the area would be categorized as having moderate iodine deficiency. Significant gender difference was noted in MUIEL between females (36.8 mg/l) and males (40.1 mg /l).

Water samples from drinking sources were analyzed for iodine content. A total of 21 water samples collected from 10 stream and 11 tube wells. The mean iodine value was 2.89+1.69 mg/l (95% CI = 2.07-3.71). The mean iodine contents of steam drinking water samples had significantly lower (1.48+1.47, 95% CI = 1.22-3.09 mg/l) than that of tube well water (3.60+1.31, 95% CI = 2.94-5.37 mg/l).

A total of 505 household edible salt samples were analyzed for iodine content. The frequency distribution of iodine content of salt samples tested by titration is presented in Figure 3. It was observed that only 9.9% of the households were consuming adequately iodized salt (>15 ppm). The iodine value of salt samples ranged between 0.8 ppm and 48.0 ppm. The percent of household salt samples with levels of iodine 30 ppm and above was only 2.2%. In general, the majority of salt samples analyzed did not have stipulated iodine content of 15 ppm and above.

Knowledge, attitudes and practices (KAP) study was conducted on 600 households, for which head of the household were interviewed. Community knowledge about IDD, particularly goiter, and awareness of iodized salt and its health benefits was observed to be less than 5% in total sample.

Discussion

The WHO/UNICEF/ICCIDD set out criteria for tracking progress towards sustainable elimination of IDD as a public health problem (WHO, 2001). The biological and programme indicators which must be met for a region to be declared free of IDD are summarized in appendix (Table 1). The study reveals a moderate iodine deficiency by goiter and MUIEL with poor coverage of household salt having adequate iodine. Urinary iodine excretion is widely recognized as a valid means for ascertaining the iodine intake in a population, estimation of the prevalence of goiter in an area gives important indications about the severity of iodine deficiency (Dunn,Van der Har, 1990). Because goiter represents maladaptation of the thyroid to iodine deficiency, the reduction to <5% in school-aged children indicates the disappearance of IDD. Accordingly, a prevalence rate of 5.0-19.9% is considered as mild; 20.0-29.9% as moderate and prevalence rate of above 30% is considered as a severe public health problem.

The problem of goitre was thought to be endemic only to hilly regions. Surveys conducted during 1989-2004 in 10 out of 30 districts including the state have revealed all areas to be endemic for IDD programmes with goiter rates from 7.7 to 39.6% (Table 2). Goitre is prevalent at endemic levels even years after salt iodization program with a wide variation between the districts (Mohapatra et al, 2000; NIN, 2003; Sahu, 2005). This variation could probably be attributed to geographical differences with in the state along with environmental and dietary deficiencies including sampling methodology. A comprehensive state survey of 1200 school children reported a goiter rate of 8.4% (Pandav, 2005). The extent of iodine deficiency in study areas reflected as mild (Bargarh, Keonjhar, Nuapara and Ganjam), moderate (Puri, Cuttack, Gajapati) and severe (Sundargarh, Deogarh and Kandhamal) (Mohapatra et al, 2000; NIN, 2003; Sahu, 2005; Government of Orissa, 2006). It is striking to note that goiter prevalence found to be strikingly high in districts having major scheduled tribal (ST) concentrations like Gajapathi (21%), Kandhamal (30%), Deogarh (34%) and Sundargarh (40%). Re-evaluation of IDD status was done after induction of iodized salt in the districts of Sundargarh, Cuttack, Bargarh and Kandhamal districts (Mohapatra et al, 2000; NIN, 2003; Sahu, 2005; Government of Orissa, 2006). These surveys indicate no impact in reduction of TGR, rather than slight increase in all districts except in Bargarh. From the year 1987 to 2003, the goiter prevalence increased from 30.3% to 39.6% in Sundargarh and from

Fig. 1 : Prevalence of goitre among Dongria Kondh school-age children in Ryagada district of Orissa

Fig. : 2 Distribution of urinary iodine excretion levels (ug/l) of Dongria Kondh school-age children in Rayagada district

Fig. : 3 Iodine content of household edible salt (n=368)

21.6% to 21.8% in Cuttack. The results show that all the districts surveyed including the state have goitre rates well above the level recognized for endemicity of 5% (Table 2).

Measurement of UIEL is more sensitive index of very recent dietary iodine intake. WHO guidelines recommend use of spot urinary specimens to provide biological assessment of a population's iodine status, because 90% of ingested iodine is excreted in the urine (Karmarkar and Pandav, 1999). For IDD surveys, the population distribution of urinary iodine is required rather than individual levels. Because the frequency distribution of urinary iodine is usually skewed towards elevated values, the median is considered instead of the mean as indicating the status of iodine nutrition (WHO, 2001). Iodine deficiency is defined as severe (< 20 mg/l), moderate (20-49 mg/l), mild (50-99 mg/l), sufficient (>100 mg/l) or excess (> 300 mg/l).

Frequency distribution of low (mild, moderate, and severe) and adequate iodine intakes in various districts according to their MUIEL are given in appendix (Table 3). The data on UIEL is available for only four districts in Orissa. In the present study, median UIE level of children was 38.6 mg/l, 48.3% of them had UIE level of less than 50 mg/l indication as a moderate public health problem. In our previous survey in Bargarh district during 1997-1999 found a MUIEL of 22.5 mg/l (Mohapatra et al, 2000). In Cuttack (110 mg/l) and Sundargarh (103 mg/l) and Puri (125 mg/l) districts, MUIEL found to be normal, but UIEL indicated inadequate intake of iodine in a substantial proportion of children (NIN, 2003). The first state survey was done in 2004, which showed 85.4 mg/l of MUIEL and 60% had UIEL <100 mg/l suggesting biological iodine deficiency, which was not at all unexpected, as analysis of salt samples also revealed more than half of the population consumed non-iodized salt (Pandav, 2005). These data support the fact that a silent iodine supplementation results in the state incapable of homogeneously reaching the entire population because of its socioeconomic disparities (IIPS and ORC Macro, 2000; IIPS, 2003).

Iodine is found in the earth's crust in sparse amounts in the form of iodide, which is soluble, in areas where there is much rainfall or floods leached the iodine out of the soil (Koibuchi and Chin, 2000). The mountainous regions are all iodine deficient, showing that wide problem of IDD. The environmental deficiency leads to iodine deficiency in all forms of plant life and cereal grown in the soil. Hence populations living in systems of subsistence agriculture are iodine deficient, due to inadequate amounts of iodine in soil, water and food. The prediction of iodine intake is difficult, if not impossible, because the amount of iodine in individual foods and in water can vary by a factor of 100 or more (Pedersen et al, 1999). Iodine content of water in India reported in ranges 6-36 mg/l (Sharma et al, 1999). Iodine content of drinking water samples in this study was 1.5 mg/l for streams and 2.9 mg/l for bore wells, indicating environmentally deficiency (Zeltser et al, 1992).

India was one of the first countries to launch NCGP in 1962 to supply iodized salt for human consumption in endemic areas of Kangra valley in Himachal Pradesh (1956-72) (Ramalingaswami, Subramanyam, Deo, 1961; Sooch, 1973). To ensure adequate availability and use of iodized salt, the Government had adopted USI (1984) on complete ban on the sale of non-iodized salt. According to this, salt should contain a minimum of 30 ppm of iodine at the manufacturers and 15 ppm at the consumers level under PFA Act (PFA. 1994; Vir, 1994) The national goal is to increase the accessibility of iodized salt to >95% of the population irrespective of region or ethnicity. As a result of NIDDCP, production of iodized salt increased from 0.2 to 4.7 million tones during 1983-2002 (Government of India, 2003). The production, distribution and consumption of iodized salt increased gradually, with a national survey in 1999 showing 70% of households were consuming iodized salt (IIPS and ORC Macro, 2000). However, the central ban on sale of non-iodized salt was lifted with effect from 26th May 2000, which has now been reinstated from 15th June 2005, the law came into effect on September 2006 (Gazette of India, 2000; Hindustan Times, 15 September, 2000). This ambiguity resulted in hampering both production as well as household coverage of iodized salt in the country (Kapil and Singh, 2005).

The distribution of households salt having adequate iodine content in different districts surveyed in Orissa are given in appendix (Table 4). The regular and routine measurement of iodized salt using the field test kits has consistently showing the availability of adequately iodized salt since 1989. NFHS-II survey showed that 35% of the population consuming iodized salt (IIPS and ORC Macro, 2000). This figure fell to 30% in 2002-03 after the removal of the ban (IIPS, 2003). During 2002, a special survey was conducted in Puri, Cuttack and Sundargarh districts revealed that 35% of the population is using iodized salt (Government of Orissa, 2006). According to a recent survey using standard methodology in the state, reported 45% of salt samples having stipulated iodine content by titration (Pandav, 2005).

While considerable population consumes iodized salt, there are putative differences by residence, socioeconomic status and ethnicity. Backward communities still using non-iodized salt for reasons like the higher price of iodized salt and lack of awareness (Table 4). ST population continued to deprive of iodine nutrition than other communities in the state. The results show that only 10% of the ST population has access to salt with stipulated level of iodine. In this tribal study only 10% of Dongria community is using iodized salt. The RCH survey documented similar findings that 17% of tribal population consumed adequately iodized salt in Rayagada districts (IIPS, 2003). The variation between the findings of the two surveys could be possibly due to difference in the sampling methodology. In NFHS and RCH surveys the spot testing kit was used while in the present study the iodometric titration method was utilized for the same. Moreover, the study population is more backward with primitive ways of subsistence farming than others. The RCH surveys revealed that ST communities consume iodized salt considerably less as compared to other communities (IIPS and ORC Macro 2000). Ethic disparities found more significant in the districts of Malkanigiri, Rayagada, Kandhamal, Sundargarh, Keonjhar, Nuapara and Sambalpur districts, where tribals constitute over one-third of total population. However, the variation is marginal in northern border districts of Mayubhanj and Keonjhar, which share the states of Jharkhand and West Bengal. Household consumption of adequately iodized salt continued to be much less in socioeconomic deprived ST communities (IIPS, 2003). Less than 10% of the total study households were reported to be aware of goiter and of its control by iodized salt. Similar poor KAP findings have been noticed in our previous study in Bargarh district (Mohapatra et al, 2001). In visits to the local schools and health centers, the team encountered lack of educational material on IDD. In the households, 93% using crystal salt as preferred one over powder salt and only 2% of residents were aware of iodized salt, and no one knew of its benefits.

Conclusion

The results of present study and others reported in the state reveal that IDD pose a significant public health problem, more so in tribal pockets. These findings would stress the need for regular monitoring of the salt iodization and education about the nutritional value of iodized salts in the prevention of IDD and in achieving the goal of USI in the state. There is an urgent need for renewed efforts to reinforce focus on rural and remote tribal areas where sale of non-iodated salt is common. Education and communication strategies to community and different stakeholders are essential to communicate the messages on iodine nutrition are equally essential for sustainability.

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Appendices

Table 1: Criteria for monitoring progress towards sustainable IDD elimination as a public health problem

Indicators	Goals	Present study
I. Biological indicators		
Thyroid size • Proportion with enlarged thyroid in school children aged 6-12 years	<5%	23.6
Salt Iodization coverage • Proportion of households consuming adequately iodized salt*	>90%	10.0
Urinary iodine • Median urinary iodine excretion levels (µg/l) • Proportion of population with urinary iodine levels below 100µg/l • Proportion of population with urinary iodine levels below 50µg/l	 >100 <50% <20%	 37.0 52.0 42.0
II. Programmatic indicators	At least 8 of the 10 goals	
• National body responsible to the government for IDD elimination. It should be multidisciplinary, involving the relevant fields of nutrition, medicine, education, the salt industry, the media, and consumers, with a chairman appointed by the Minister of Health;		-
• Evidence of political commitment to USI and elimination of IDD;		-
• Appointment of a responsible executive officer for the IDD elimination programme;		yes
• Legislation or regulation of USI;		yes
• Commitment to regular progress in IDD elimination, with access to laboratories able to provide accurate data on salt and urinary iodine;		-
• A programme of public education and social mobilization on the importance of IDD and the consumption of iodized salt;		-
• Regular data on iodized salt at the factory, retail and household levels;		-
• Regular laboratory data on urinary iodine in school-age children, with appropriate sampling for higher-risk areas;		-
• Co-operation from the salt industry in maintenance of quality control;		-
• A database for recording results or regular monitoring procedures particularly for salt iodine, urinary iodine and, if available, neonatal thyroid stimulating hormone (TSH), with mandatory public reporting.		-

*Adequately iodized salt refers to at least 15 ppm (15 mg/kg) at household level.
These goals are expressed as percentage of population.

Table 2: Prevalence of iodine deficiency by goitre in different districts of Orissa

District/ state	Year	Age group	N	Goitre prevalence (%)				Reference
				Grade0	Grade1	Grade2	TGR	
Sundargarh	1987	All ages	7045	69.7	-	-	33.5	Govt. of Orissa, 2006
	2001	6-12 years	10500	60.4	36.8	2.8	39.6	NIN, 2003
Puri	1989	All ages	6672	89.7	-	-	19.3	Govt. of Orissa, 2006
Cuttack	1998	All ages	11000	78.4	-	-	21.6	Govt. of Orissa, 2006
	2001	6-12 years	10500	78.2	20.5	1.3	21.8	NIN, 2003
Keonjhar	1999	6-12 years	7821	84.2	-	-	14.4	Govt. of Orissa, 2006
Bargarh	1999	6-12 years	3088	89.2	10.2	0.6	10.8	Mohapatra et al 2000
	2002	-	-	92.3	-	-	7.7	Govt. of Orissa, 2006
Nuapara	2000	-	2467	85.5	-	-	14.5	Govt. of Orissa, 2006
Deogarh	2001	6-12 years	635	65.7	-	-	34.3	Govt. of Orissa, 2006
Ganjam	2003	6-12 years	-	84.2	-	-	15.8	Govt. of Orissa, 2006
Kandhamal	2003	-	-	71.1	-	-	27.9	Govt. of Orissa, 2006
	2005	6-12 years	1448	69.8	-	-	30.2	Sahu et al 2005
Gajapati	2004	-	-	78.8	-	-	21.2	Govt. of Orissa, 2006
Orissa	2004	6-12 years	1200	92.0	7.6	0.4	8.0	Pandav, 2005
Present study	2006	6-12 years	623	76.4	18.9	4.7	23.6	NA
National goal (%)		*6-12 years*	*NA*	*NA*	*NA*	*NA*	*<5.0*	WHO 2001

TGR-Total goitre rate (%): normal <5%, mild 5-19.9%, moderate 20-29.9%, and severe >30% (WHO 2001), - indicate data not available; NA-Not applicable.

Table 3: Urinary iodine levels of school/age children in selected districts of Orissa

District/State surveyed	Year	N	Urinary iodine excretion levels µg/l*					Reference
			Median	≥100	50-99	20-49	<20	
Puri	2001	145	125.0	-	-	-	-	Govt. of Orissa, 2006
Bargarh	1999	414	22.5	9.2	1.5	59.4	29.9	Mohapatra et al 2000
Cuttack	2001	210	110.0	58.1	19.5	12.9	9.5	NIN, 2003
Sundergarh	2001	208	103.0	51.0	24.0	13.0	12.0	NIN, 2003
Orissa	2004	1200	85.4	60.3	28.1	21.9	10.3	Pandav, 2005
Present study	2006	411	50.2	14.3	34.9	38.6	12.2	NA
National goal (%)		NA	>100	NA	<50%	<20%	NA	WHO 2001

Frequency distribution of urinary iodine excretion levels in µg/l: < 20 µg/l iodine deficiency (severe), 21–50 µg/l iodine deficiency (moderate), 51–100 µg/l iodine deficiency (mild), ≥101 µg/l (adequate iodine intake) (WHO 2001)
- indicate data is not available; NA-Not applicable.

Table 4: Distribution of household salt with adequate iodine content in different districts of Orissa

District /state Surveyed	ST (%)	Survey period	N	Salt having adequate iodine ($\geq$15 ppm)					Reference
				Total	Residence		Community		
					Rural	Urban	SC/ST	Others	
Cuttack	3.6	2002	4184	29.3	-	-	-	-	NIN, 2003
		2002	*210	22.9	-	-	-	-	NIN, 2003
Angul	11.7	2002	1039	41.2	25.5	85.7	28.8	46.1	IIPS, 2003
Bargarh	19.4	2002	1049	33.4	20.2	67.6	27.3	37.8	IIPS, 2003
Bhadrak	1.9	2002	1079	29.4	21.5	48.2	20.6	34.6	IIPS, 2003
Ganjam	2.9	2002	1072	16.2	7.3	36.8	6.7	19.6	IIPS, 2003
Jajpur	7.8	2002	1047	27.7	21.3	43.0	20.1	32.2	IIPS, 2003
Kandhamal	52.0	2002	1062	27.5	11.4	64.8	16.9	48.0	IIPS, 2003
Keonjhor	44.5	2002	1077	34.0	24.0	59.1	28.7	42.1	IIPS, 2003
Khurda	5.2	2002	1063	33.6	24.6	54.2	27.6	35.0	IIPS, 2003
Malkanaigiri	57.4	2002	1062	10.8	6.8	47.2	6.3	28.2	IIPS, 2003
Mayurbhanj	56.6	2002	1075	37.3	27.4	61.1	30.2	45.8	IIPS, 2003
Nuapara	34.7	2002	1075	37.3	26.9	63.7	25.3	46.1	IIPS, 2003
Rayagada	55.8	2002	1070	29.9	15.3	63.8	17.0	52.1	IIPS, 2003
Sambalpur	34.5	2002	1066	38.7	25.3	70.8	25.9	51.7	IIPS, 2003
Sonapur	9.8	2002	1093	17.2	7.1	40.7	7.4	22.1	IIPS, 2003
Sundargarh	50.2	2002	10500	17.5	-	-	-	-	NIN, 2003
		2002	*215	22.4	-	-	-	-	NIN, 2003
		2002	1059	38.0	16.1	80.0	20.3	65.7	NIN, 2003
Orissa	22.1	1999	4689	35.0	30.9	81.3	12.5	56.7	IIPS & ORC Macro 2000
		2002	15988	30.1	20.5	51.8	22.7	43.1	NIN, 2003
		2004	*1200	45.0	-	-	-	-	Pandav, 2005
Present study	55.8	2006	*368	9.90	NA	NA	9.90	NA	NA
National goal (%)			NA	>95	>95	>95	>95	>95	WHO 2001

*Indicate salt iodine tested by quantitative titration, remaining by qualitative spot testing method. -indicate no data available or not required; SC-Scheduled caste population; ST-Scheduled tribe population; NA-Not applicable.