ORIGINAL ARTICLE

Performance evaluation of Iodine Deficiency Disorder control Program in Mandya District

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Abstract

Background: Considering the burden of Iodine Deficiency Disorders in our country, Government of India has an exclusive national health program to prevent it from becoming a major public health concern. To attain its objectives, National Iodine Deficiency Disorder Control Program (NIDDCP) undertakes routine evaluation of the Program all over the country. **Aim & Objective**: To determine the prevalence of Goitre, to estimate Iodine content in salt samples and Iodine excretion in urine samples of schoolchildren aged between 6 to 12 years in Mandya district. **Settings and Design**: A cross sectional institutions based survey was conducted among schoolchildren from the villages in selected clusters of Mandya district. **Materials and Methods**: Probability Proportional to Size sampling method was used to select 30 clusters. 90 children aged between 6 to 12 years from each cluster were screened. Salt Iodine content was ascertained by Iodometric titration method and urinary Iodine excretion was estimated by Sandell-Kolthoff method. **Statistical analysis used**: Frequency, proportions and mean were calculated and inferential statistics were used. **Results**: Prevalence of Goitre was 4.4%, with higher prevalence among girls. 49.8% salt specimens lack adequate iodine (<15ppm) at household level. Median UIE was 164 Micrograms /litre. **Conclusions**: As per the impact indicators, IDD is not a public health concern in Mandya district as of now.

Keywords

Performance Evaluation, Iodine Deficiency Disorder, Prevalence, Goitre, Iodine, Salt Sample, Urine Sample

Introduction

Iodine is an essential micronutrient. It is required at 100-150 micrograms daily for normal human growth and development.(1) Among the 324 districts surveyed in our country, 263 are endemic (prevalence is more than 10%) for IDDs(1). Iodine deficiency disorders (IDDs) are the spectrum of consequences of iodine deficiency in a population resulting from its deficit in water and soil.

The goitre reflects past iodine status whereas urinary iodine is a good marker of recent dietary iodine intake. Urinary iodine excretion (UIE) and goitre are the most common indicators to assess iodine status in a population.(2)

This is met usually through food and water consumed by the population. Its level in food and water depends on the level of Iodine, present in the soil and ground water of the particular geographical area.(3)

IDDs constitute the single largest cause of preventable brain damage worldwide leading to learning disabilities and psychomotor impairment. IDD have been shown to be associated with at least six of the eight Millennium Development Goals.(4) Iodine deficiency during pregnancy can prevent normal development of fetal brain and body. Its deficiency during childhood can result in conditions like cretinism.(4)

The household coverage of iodized salt at the national level was 91.7% with 77.5% of households consuming adequately iodized salt. According to the recent global estimate, 1.88 billion people are at risk of iodine deficiency and 241 million children (~30%) have an inadequate iodine intake.(5) At national level, the prevalence of IDD is >10% but there was a significant reduction in visible goiter.(6)

Despite the efforts of Government, the prevalence of IDDs is on the rise in the country. Present study is the part of this periodic nationwide survey to evaluate the implementation and effect of NIDDCP in Mandya district.

Aims & Objectives

1. To determine the prevalence of Goitre in schoolchildren aged between 6 to 12 years in Mandya District.
2. To estimate Iodine content in salt samples collected from the children aged 6-12 years from their homes
3. To estimate Iodine excretion in urine samples of children aged 6-12 years

Material & Methods

A Cross sectional institution based study was conducted among the school Children aged between 6 to 12 years in the villages of selected clusters of Mandya District. This study was conducted as per the guidelines framed for the nationwide survey by NIDDCP, New Delhi.

Ethical clearance was obtained from the institutional ethics committee, MIMS, Mandya. Permission was taken from the deputy director of public instruction (DDPI), block education officers (BEO) and school head masters of the school in the villages of selected clusters of Mandya District. This study was conducted over period of five months from November 2018 to March 2019

The sample size was predetermined by the national study protocol. The sample size of this study was 2700 children aged between 6 to 12 years satisfying the inclusion criteria. The school children selected from the 30 clusters, from each cluster 90 students were selected. In each cluster 45 boys and 45 girls were selected with due weightage given to the age groups between 6 to 12 years. Thus 1350 boys and 1350 girls were included in the study. The school children were selected by the sampling process. The school children who do not give assent, who are were absent on the day of the survey and children suffering from any serious illness on the day of the survey were excluded from the study

Multistage sampling technique was used for sampling. Probability Proportional to Size method was used to select the 30 clusters within the Mandya district. It was done as described using population of Mandya district according to census 2011. Total rural population Mandya district is 1497407 as per 2011 Census. Villages were enlisted along with its population and cumulative population.

Sampling interval was calculated by dividing the total population by the total number of clusters selected for the study and sampling interval was found to be 49913. The first cluster (r) was obtained from 0 to 49913, by random number table. Then onwards sampling interval (49913) was added to 'r'th population and corresponding cluster (village) was selected.

The survey team visited to the primary schools for selection of the children aged between 6 to 12 years. Since the enrolment ratio was more than 90% in the study area, all children were selected from schools only (as prescribed in NIDDCP guidelines). In schools with insufficient strength (below 90 number of children from 6 to 12 years), remaining number of children were collected from school of adjacent villages.

For schools having sufficient strength, sampling was done by giving due weightage to all the age groups and gender. Thus equal numbers of students were selected from age 6 to 12 years. Wherever possible, 8 boys and 7 girls were selected from one age group and vice versa in the next age group. Shortage of children in any gender was covered from next age group.

Considering recent trend of sending children to private schools in nearby towns, shortage was observed specially in class 1, 2 and 3 (aged 6, 7, 8 years) . This shortage was filled with children from higher classes. In case of insufficient children from1 to 6th standard (aged 6 to 11 years), children of 7th standard (aged 12 years) who were born on or after 1st February 2006 (less than 13 completed) were included in the study to ensure they are within the upper limit of age criteria.

The study team comprising one Professor, one Assistant Professor and four Post graduate students of Department of Community Medicine was constituted. For technical expertise one Assistant Professor and one Postgraduate student of Biochemistry were included in the team for estimation of Iodine content in salt and urine.

In consultation with experts from Biochemistry department, standard operating protocol (SOP) was developed for estimation of Iodine content in salt and urinary Iodine excretion estimation. Necessary reagents were procured and standardization of the reagents and study method was done for validity and repeatability of the SOP.

After confirmation of satisfactory standardization of the reagents and the procedure, pilot testing was done by test run of both the biochemical estimation procedures. Salt samples were collected from Medical College hostels,

home of staff members and salt used for non edible purposes (non-iodized salt).

Urine samples were collected from children accompanying patients to the general hospital. One sample of normal water was also tested to check the credibility of the test procedures. After satisfactory outcomes were achieved, survey of the schools was started.

Field survey: With Prior intimation to the school headmaster, study team used to visit the school. After explaining the objectives and methodology of the study, written consent was taken from school headmaster. Then the list of students present on that day was obtained and required numbers of children were examined as discussed in sampling method.

Examination of thyroid gland was performed in a well lit room by procedure prescribed by the NIDDM manual. Findings were thus noted down in three grades. Grade 0 is no palpable or visible goitre, grade 2 is mass in the neck consistent with thyroid gland which is palpable when neck is in a normal position but not visible and Grade2 is swelling in the neck that is visible when neck is in a normal position and is consistent with thyroid gland when palpated.

Every fifth kid in each cluster was asked to get one fistful of salt used for cooking purpose. In case if they are using both crystal salt and powder salt for cooking, as it was the case in the study area, salt used in more quantity was preferred. Ziplock plastic covers with stickers having identification details pasted on it were given to children and asked to seal them after filling salt in it.

Urine samples were collected from children of all the age groups (6 to 12 years).Urine was collected from every 10th kid. Sterile urine containers were used for collection and instruction was given to the children about how to collect midstream urine. Samples were transported in thermacol box lined by icepacks. Urine was stored in refrigerator and salt at room temperature. Analyses of the samples were completed on next day.

Two post graduate students of Community Medicine and one Postgraduate student of biochemistry under the guidance and supervision of Assistant Professor of Biochemistry carried out the biochemical procedures. Iodine estimation of salt sample was done by Iodometric titration method. Urinary Iodine excretion estimation was done by Sandell kolthaff reaction.

Triplicates of five serial standards of various concentrations of iodine were prepared every day and best plotted Optometric density (OD) values were used for plotting the curve. Urinary specimen were processed in duplicates. OD values of less than 10% variability was kept as acceptability cut-off for validity of the test procedure. Average of such OD values was calculated and plotted in the curve to obtain the Iodine content in the urinary specimen. OD value variation more than the cut-off were repeated on the subsequent day. 4-5 samples that were randomly selected from every day's batch were repeated the subsequent day for the sake of inter-batch comparison of repeatability of test results.

External validation was not done in the study as the current study followed standard protocol advised by IDD cell. To ensure internal validity, standardization of the iodine was performed in triplicates. Optical density values of the standards were obtained by UV VIs spectrophotometer 119. The average OD value of the standards were plotted on the graph against the concentration gradient and the linearity of the coinciding standard values were ensured daily before commencing with the subject's sample. Two OD readings of each sample were taken and their average was considered to obtain UIE level.

Study tool: Semistructured Pretested Proforma was used to collect the details of the cluster, school, and information of the child. It included age, sex, class, grade of goitre, and particulars related to salt and/or urine sample collected if relevant.

The data was entered into Microsoft excel sheet and it frequency and proportions of goitre grade, adequacy of salt iodine content were calculated. Urinary iodine excretion levels were categorized and cross tabulated against the age categories. Fisher's exact test, student t test and ANOVA were used to find out statistical difference of distribution of urinary & salt iodine levels in study population. ROC analysis was performed to find our predictability (AUC) of these measurements on goitre status.

Results

Mandya district has seven talluks (blocks) and all talluks had representation in the selected clusters. Totally 2700 children aged between 6 to 12 years were examined during the study. This includes 1350 boys and 1350 girls. The mean age of the children was 9.23 + 1.92 years. Among the study participants, 1350 (50.0%) were males and 1350 (50.0%) were females. Majority of the study participants 1291 (47.8%) were from the age group 10-12 years followed by 819 (30.3%) in the age group of 8-9 years. [Table 1]

Prevalence of Goitre was 4.5% in the study. This is below the cut off value of 5% signalling that in Mandya district, IDD is not a public health problem according to NIDDCP criteria for classifying IDD burden.(1) Burden was higher among girls as they had 6.8% prevalence compared to 2.1% in boys. The same trend was observed in all the age groups. [Table 2]

Majority of the goitre cases 103 (85.1%) were of grade 1. This shows the problem is in the initial stages and corrective measure can reverse the problem. Children with grade 2 were referred to the hospital for further evaluation. Seven out of 18 children with grade 2 goitre were already on treatment with thyroxin supplementation. [Table 2]

Total 540 salt samples were analysed for salt iodine content in which, 270 (50%) of the salt samples had inadequate iodine in them. Though marketing of unpacked salt has been stopped in the area in recent years, sale of unbranded salt was observed.

Urinary iodine excretion (UIE) level was studied in 10% of the sample size. Thus 270 samples were analyzed. Low urinary iodine excretion was observed in 26 (9.6%) children. A study conducted by Kapil U in The median UIE levels were 100 mcg/L in 86% districts surveyed in India. (Table 3)

However, mean UIE was 162+ 50.7 and median UIE was 164 microgram/litre. Indicating IDD is not a public health concern in the area.

Distribution of cooking salt iodine concentration and urinary iodine excretion level was analysed across goitre grades, gender and age groups (Table 4). No significant difference was observed.

Discussion

Scenario of clinical goitre has improved from previous years. Evaluation study of NIDDCP in same area done in 2013 had observed goitre prevalence of 6.6%, with significantly more prevalence among girls.(7,8) even at national level, the prevalence of IDD is >10% but there was a significant reduction in visible goiter.(6)Another study by Biradar M et al conducted in neighbour district during 2013 had revealed goitre prevalence of 8.6%. They had also observed higher prevalence among girls (9.6%).(9) These findings are consistent with present study findings or reducing burden.(10)

Bhattacharyya, et al. shown that the prevalence of goiter was 7.22%. The grade 1 goiter was found in 6% of children and grade 2 goiter in 0.7% of the children. The children age group 9- 12 years shown higher prevalence 12.2% than the in the young children 5.5%. (7)

Half of the specimens had inadequate iodine in them. Though marketing of unpacked salt has been stopped in the area in recent years, sale of unbranded salt was observed. Another factor could be cost of the salt, because most of the students reported their mothers use two types of salt in their houses for cooking. Crystal salt was used in large amount and in case if they feel cooked food has less salt, then they use powdered salt as table salt to add while eating. As study team had asked them to bring salt used more commonly, most kids had brought crystal salt. Though it was reported to be packed and marketed, brand could not be ascertained. Kamath et al had also reported similar findings i.e 50 % salt samples having <15ppm iodine at household level in rural Belagavi in 2009. An improved scenario was observed in Mandya during 2013 as inadequate iodine levels were observe in 38% of the surveyed slat samples.(8)

A cross sectional study conducted by CS Pandav et al in twelve distinct in India showed that, the household coverage of iodized salt was 91.7% with 77.5% of households consuming adequately iodized salt. (11)

Chudasama R et al conducted a study shows that the goitre prevalence of 11.2% was found among primary school children (grade 1- 8.6% and grade 2-2.6%). Median urinary iodine excretion level was 110 µg/L. Iodine level more than 15 ppm was found in 92.3% salts samples tested at the household level. (12)

Das DK et al. showed that the total goitre (TGR) was 13.7% Grade 1 was 11.4% and Grade 2 (visible goitre) was 2.3%. The median urinary iodine excretion level was 13 microg/dL. (13)

Extent of goitre manifestation which could be predicted by iodine consumption and its manifestation in the form of urinary iodine excretion were tested using ROC as shown in (Figure 1) & (Figure 2). Accuracy of salt iodine concentration in explaining goitre was up to 55% whereas accuracy of urinary iodine excretion level was up to 60% among the goitre cases. (14)

Biswas AB et al. conducted a cross-sectional study showed that the overall goiter prevalence rate was 8.7% and median UIE level was 15.6 mcg/dL. (15) Majority of the goitre cases were of grade 1(85.1%). Reduction of adequate iodine content at the household level despite increase in sale of packaged salt should be ascertained by further studies. It is also important to note that the other sources of Iodine like water and vegetables or food items could be compensating the daily requirement as supported by our ROC analysis, which showed only 55% accuracy for salt iodine content in cases of goitre. i.e 45% of the goitre cases could not be explained using low iodine content of the salt. (Figure 1)

Low urinary iodine excretion was observed in 26 (9.6%) children. However, mean UIE was 162+ 50.7 and median UIE was 164 microgram/litre. Indicating IDD is not a public health concern in the area. In the same area median UIE was 235 microgram/litre in 2015 as reported by Pushpa Sarkar et al(8). Reduced median UIE is again in agreement with the reducing iodine intake by the children as observed in iodine content in salt specimens. However, a major part of the goitre cases did not manifest low urinary iodine excretion, as seen in ROC analysis which showed 60.8% accuracy, indicating low accuracy of this tool and need for further sensitive tools. (Figure 2)

All above findings suggest that in Mandya district, IDD is not a public health problem as of now. But, reducing iodine intake at household level as suggested by findings of salt analysis and reducing median UIE compared to previous years ring an alarm to take corrective measures at the earliest.

Conclusion

Prevalence of Goitre is 4.5% in children aged between 6-12 years with higher prevalence among girls. 49.8% salt specimens lack adequate iodine (<15ppm) at household level. Median UIE was 164 Micrograms /litre. Considering

these impact indicators, we conclude that, IDD is not a public health concern in Mandya District as of now. But, comparison to earlier reports and studies, Iodine intake in the area is decreasing and IDD can assume public health problem status soon, if not intervened.

Recommendation

Further studies must be undertaken to find out the reasons for higher prevalence of goitre among girls and reduction of iodine content of packaged iodized salt at household level. Evaluation message under IDD program should also include salt iodine content at retailer shop.

Limitation of the study

Crystal and powdered salt both were used by majority of the households. Separate analysis of both the samples was desirable. But it could not be done because of operational and logistics issues.

Relevance of the study

Evaluation of ongoing national programs help in further strengthening of the public health system.

Authors Contribution

All the authors contributed equally in this study.

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Tables

TABLE 1 DISTRIBUTION OF SCHOOL CHILDREN ACCORDING TO AGE AND SEX

Age group in years	Sex		Total (%)
	Male (%)	Female (%)	
6-7	280 (47.4)	310 (52.6)	590 (21.9)
8-9	429 (52.4)	390 (47.6)	819 (30.3)
10-12	641 (49.6)	650 (50.4)	1291 (47.8)
Total	1350	1350	2700 (100.0)

TABLE 2 DISTRIBUTION OF SCHOOLCHILDREN ACCORDING TO THEIR AGE, GENDER AND GOITRE GRADING

Age Category	Gender	Grades of Goitre			Total cases of Goitre (%) (1st +2nd)
		Grade 0	Grade 1	Grade 2	
6-7	Male	276	3	1	4 (1.4)
	Female	288	22	0	22 (7.1)
	Total	564	25	1	26 (4.4)
	Male	420	8	1	9 (2.1)

8-9	Female	359	28	3	31(7.9)
	Total	779	36	4	40 (4.9)
10-12	Male	625	10	6	16 (2.5)
	Female	611	32	7	39 ((6.0)
	Total	1236	42	13	55 (4.2)
Total	Male	1321	21	8	29 (2.1)
	Female	1258	82	10	92 (6.8)
	Total	2579	103	18	121(4.5)

TABLE 3 DISTRIBUTION OF URINARY IODINE EXCRETION VALUES OF STUDY POPULATION

Urinary Iodine in MicroGm/Litre and Iodine status	Number of children (%)
<20 (Severe Iodine deficiency)	3(1.1)
20-49 (Moderate iodine deficiency)	1 (0.4)
50-99 (Mild iodine deficiency)	22 (8.1)
100-199 (Adequate Iodine nutrition)	193 (71.5)
200-299 (Above requirements)	44 (16.3)
>300 (Risk of adverse consequences)	7 (2.6)
Total	270 (100.0)

TABLE 4 SALT IODINE CONCENTRATION AND URINARY IODINE LEVEL ACROSS STUDY VARIABLES

	Salt iodine concentration				urinary iodine concentration			
Goitre grade	**N**	**Mean and Std. Deviation**	**ANOVA F value**	**P value**	**N**	**Mean and Std. Deviation**	**ANOVA F value**	**P value**
Grade 0	512	15.7 ± 6.5			262	162.2 ± 52.9		
Grade 1	22	17.0 ± 7.5	0.72	0.487	7	177.1 ± 15.1	0.277	0.758
Grade 2	6	17.9 ± 3.5			1	158.00		
Total	540	15.8 ± 6.5			270	162.6 ± 52.3		
Gender			t test	p value			t test	P value
Boys	272	16.2 ± 6.4		0.187	130	166.4 ± 54.3		**0.247**
Girls	268	15.4 ± 6.6			140	159.1 ± 50.2		
Age in yrs								
6	35	16.0 ± 6.4	ANOVA	p value	12	159.6 ± 40.1	ANOVA	p value
7	52	14.5 ± 6.3			17	168.4 ± 50.7		
8	63	17.1 ± 7.6			36	166.7 ± 54.1		
9	96	16.1 ± 5.9	0.845	0.535	45	161.9 ± 59.4	0.513	0.824
10	101	15.5 ± 6.6			71	159.7 ± 59.8		
11	99	15.8 ± 7.0			45	168.9 ± 35.8		
12	94	15.5 ± 6.1			44	155.4 ± 49.5		
Total	540	15.8 ± 6.6			270	162.6 ± 52.3		

Figures

FIGURE 1 ROC CURVE DEPICTING GOITRE PREDICTABILITY OF SALT IODINE CONCENTRATION (AUC=0.555)

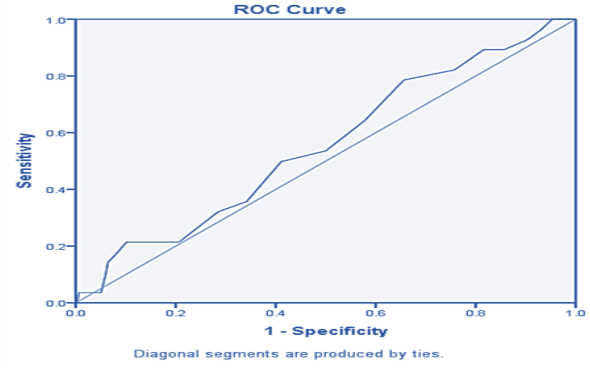

FIGURE 2 ROC CURVE DEPICTING GOITRE PREDICTABILITY OF SALT IODINE CONCENTRATION (AUC= 0.608)