Short Communication

Performance Evaluation of Iodine Deficiency Disorder Control Program in Chikmagalur District: A Cross-Sectional Community-Based Survey

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Abstract

Background: Routine evaluation of Iodine Deficiency Disorders (IDDs) is done through a national program called National Iodine Deficiency Disorder Control Program (NIDDCP). The aim of this study is to determine the goiter prevalence, to estimate salt Iodine and urinary Iodine levels. **Materials and Methods:** An institution-based cross-sectional study was conducted among 2700 school children across seven taluks of Chikmagalur. A total of 2700 children aged 6 to 12 years were selected from 30 clusters by multistage sampling method. The iodometric titration method and Sandell–Kolthoff method were used for the estimation of salt and urinary Iodine, respectively. Descriptive and Inferential statistics were used. Results: The prevalence of goiter was 13.0%. About 153 (28.3%) salt samples had inadequate iodine content (<15 ppm). Median Urinary Iodine Excretion was 126 µg/L. **Conclusion:** Chikmagalur district is still at risk of a significant public health problem which needs timely interventions and appropriate measures to prevent further consequences due to IDDs.

Keywords: Goiter, iodine deficiency disorder, performance evaluation, prevalence, salt sample, urine sample

Introduction

Micronutrient deficiencies, also called "hidden hunger," lead to a major notable burden of malnutrition (both under- and overnutrition) worldwide, most importantly in developing countries like India.[1]

Iodine is one of the most important micronutrients derived only from the diet.[2] The average requirement of Iodine is 100 to 150 µg/day, which when consumed below the recommended amount leads to wide spectrum of disorders such as mental and physical retardation, deaf-mutism, cretinism, still births, abortion, and so on.[3,4]

Iodine deficiency disorders (IDDs) refer to all consequences of Iodine deficiency in a population that can be prevented by ensuring the adequate intake of Iodine.[5]

Total Goiter Prevalence (TGP) and Urinary Iodine Excretion (UIE) are used as indicators to classify IDDs as significant public health problems. TGP reflects the past Iodine status and UIE reflects the current Iodine status.[3,6]

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In 1984, Chikmagalur district reported many goiter cases which showed a high goiter prevalence of 41.0% which led to the implementation of National Goiter Control Programme (NGCP) in Chikmagalur district.[7]

NGCP was later renamed as National Iodine Deficiency Disorders Control Program (NIDDCP) in 1992 and its main objective is to promote nationwide adequate iodization of salt (>15 ppm) at household levels.[3]

According to National Family Health Survey-5 (2019-2020) report, in India, 94.0% of households had adequately iodized

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salt, in Karnataka 92.8%, and in Chikmagalur 96.8%.[8-10] Annual report 2019-20 showed at national level that 89.0% UIE levels were <100 µg/L.[11]

Considering the above trend and the sensitivity of human health to iodine deficiency, it is necessary to check the iodine consumption level at the household level. Iodine in salt is volatile, it is also necessary to periodically note its level and consider awareness programs on the handling of Iodized salt in the community if necessary. Thus, as a part of the periodic nationwide survey which was conducted all over Karnataka, we conducted an IDDs survey to evaluate the implementation and effectiveness of NIDDCP in the Chikmagalur district.

Objectives

1. To determine the prevalence of goiter in school children aged between 6 and 12 years in Chikmagalur District.
2. To estimate Iodine content in salt samples collected from the houses of study subjects.
3. To estimate Iodine excretion in urine samples of study subjects.

Materials and Methods

As per the NIDDCP guidelines, a cross-sectional institution-based study was conducted from November 2019 to March 2020, among school children aged 6 to 12 years in the Chikmagalur District. Permission was taken from the respective Deputy Director of Public Instruction (DDPI) and Block Education Officers (BEO).

After obtaining institutional ethical clearance, the predetermined sample size of a total of 2700 children was surveyed as per the national protocol.

At first, 30 clusters were selected through a multistage sampling technique based on the probability proportional to size method. From each cluster, one school was randomly selected. From each school, 90 students (45 boys and 45 girls) were randomly selected after giving due weightage to all the age groups and gender. In schools with insufficient strength (<90 students), the remaining number of children were selected from a school of adjacent villages. Gender representation was strictly ensured and age representation was followed to the maximum extent possible considering the feasibility of the survey.

After obtaining written consent from the school headmaster, a list was prepared with the students available on that day, and the required number of children were examined.

Children were examined for the presence of goiter as per the NIDDM guidelines. As per the World Health Organization classification,[3] there are three grades of goiter. Grade 0 is no palpable or visible goiter, grade 1 is thyroid gland palpable but not with visible goiter, and Grade 2 is thyroid gland palpable with visible goiter.

In total 540 salt samples were collected from every fifth child in each cluster. Children were advised to get cooking salt samples from their homes, in a ziplock plastic cover (to avoid evaporation). Samples were stored in a dry place and analyzed within a week of collection to prevent erroneous observations due to the effect of environmental factors.

About 270 Urine samples were collected from every 10th child in sterile urine containers. Children were instructed beforehand on how to collect midstream urine. Urine samples were transported in a thermacol box lined by icepacks and stored in the refrigerator (4-8°C) until analysis.

Iodine estimation of salt samples was done by the Iodometric titration method and UIE estimation by Sandell–Kolthaff reaction method. Both procedures were carried out in the biochemistry department of our institution under expert guidance and supervision. Samples were processed by UVVIs spectrophotometer 119.

Sociodemographic details of the children, details of the cluster, school, grades of goiter, and relevant information related to salt and urine samples were collected using a pretested semistructured questionnaire.

Descriptive statistics such as frequency and proportions were calculated. Inferential statistics such as Fisher's exact test, student t-test, and Analysis of variance were used to find statistically significant differences. Receiver Operating Characteristic (ROC) curve analysis was performed to find out the predictability, that is, Area Under Curve (AUC) of the goiter status with salt and urinary iodine levels.

Results

Among 2700 children, 1350 (50.0%) were males and 1350 (50.0%) were females. Majority of children, that is 1185 (43.9%), belonged to the age group of 10 to 12 years.

The overall prevalence of goiter was 13.0%. The distribution of goiter cases were variable among males and females with respect to age. Among females, the majority of 16.5% of goiter cases were present among the 10 to 12 years age group and among males majority of 12.9% of goiter cases were found among 8- to 9-year-old children. Grade 0 goiter was present among 87.0% of total children, followed by grade 1 (12.4%) and grade 2 goiter (0.6%) [Table 1].

Analysis of 540 cooking salt samples showed that about 153 (28.3%) salt samples had Iodine content <15 ppm.

Among 270 urine samples, the majority of 196 (72.6%) had urinary Iodine levels of 100 to 199 µg/L with adequate Iodine nutrition. The trend in the proportion of children decreased toward extreme values of urinary Iodine levels. Our study observed that 54 (20.0%) out of 270 urine samples had Iodine levels less than 100 µg/L [Table 2].

The mean UIE value was 128 ± 47.3 µg/L and the median UIE was 126 µg/L.

Salt Iodine concentration and urinary Iodine levels were compared across the variables such as grades of goiter,

gender, and age groups. In our study, mean value of salt Iodine concentration among children with grade 0 goiter was significantly high when compared with grades 1 and 2 goiter cases (*P* value = 0.016). Other variables showed no significant difference with respect to salt and urinary Iodine levels [Table 3].

ROC analysis showed low accuracy for prediction of UIE (AUC = 0.5) and salt Iodine levels (AUC = 0.6) with TGP [Figures 1 and 2].

Table 1: Distribution of school children according to their age, gender, and goiter grading

Age category	Gender	Grades of goiter			Total cases of Goiter (%) (1st and 2nd)
		Grade 0	Grade 1	Grade 2	
6-7	Male	325	42	4	46 (12.4)
	Female	351	42	1	43 (10.9)
	Total	676	84	5	89 (11.6)
8-9	Male	343	49	2	51 (12.9)
	Female	305	50	1	51 (14.3)
	Total	648	99	3	102 (13.6)
10-12	Male	523	59	3	62 (10.6)
	Female	501	94	5	99 (16.5)
	Total	1024	153	8	161 (13.6)
Total	Male	1191	150	9	159 (11.8)
	Female	1157	186	7	193 (14.3)
	Total	2348	336	16	352 (13.0)

Table 2: Distribution of urinary Iodine excretion values of study population

Urinary Iodine in μg/L and Iodine status	Number of children (%)
<20 (Severe Iodine deficiency)	3 (1.1)
20-49 (Moderate Iodine deficiency)	13 (4.8)
50-99 (Mild Iodine deficiency)	38 (14.1)
100-199 (Adequate Iodine nutrition)	196 (72.6)
200-299 (Above requirements)	20 (7.4)
>300 (Risk of adverse consequences)	0 (0.0)
Total	270

Discussion

In the pre-iodization era (1986), the prevalence of goiter in the Chikmagalur district was 41.0%, which showed a greater reduction in the post-iodization era (2001) to less than 10.0%, after the launch of NGCP in the Chikmagalur district.[7] But in the present study, the prevalence of goiter was 13.0% (95% CI 11.7 – 14.3%), which is more than the 5.0% cut-off set by the National program indicating it is a significant public health problem. Although it poses a significant public health problem, as per national guidelines, it comes under the mild category of severity.[3]

A study done recently in 2020 by Ranganath *et al*. in the Chitradurga district showed a comparatively lesser prevalence of 10.3% which again is mildly endemic for IDDs similar to our study.[12] However, a study done in Mandya district by Harish *et al.* during 2019-20 showed a low goiter prevalence of 4.5%.[13] The higher prevalence in our study shows that the Iodine requirements are not properly met by food or soil. This in turn could be contributed to hilly terrain of Chikmagalur compared to the non-hilly terrain of Mandya.

Although 71.3% of our study salt samples were adequately iodized, nearly one quarter having inadequate Iodine content, needs further evaluation.

The Iodine content in salts varied from place to place. Studies done in Chitradurga and Ramnagara districts showed adequately iodized salt in more than 95.0% of their household

Table 3: Salt Iodine concentration and urinary Iodine level across study variables

Study variable	*n*	Salt Iodine content in PPM		*P*	*n*	Urinary Iodine excretion		*P*
		Mean and SD	ANOVA *F*			Mean and SD	ANOVA *F*	
Goiter grade								
Grade 0	465	15.02±4.7	4.169	0.016*	241	128.28±47.9	0.203	0.817
Grade 1	73	13.38±4.0			27	122.22±39.5		
Grade 2	2	13.00±2.8			2	130.00±45.3		
Gender								
Male	270	14.74±4.5		0.801 (*t*-test)	135	124.56±48.5		0.275
Female	270	14.84±4.7			135	130.81±45.5		
Age in years								
6	37	14.89±3.8	1.285	0.262	13	134.77±49.5	0.719	0.635
7	51	13.92±4.2			28	117.00±51.7		
8	59	13.88±5.3			34	126.6±50.7		
9	105	15.25±4.7			50	135.10±47.9		
10	107	15.21±5.2			52	126.88±48.2		
11	114	15.14±4.0			58	131.07±43.2		
12	67	14.22±4.4			35	119.66±42.4		
Total	540	14.79±4.6			270	127.69±47.0		

*P<0.05 is statistically significant

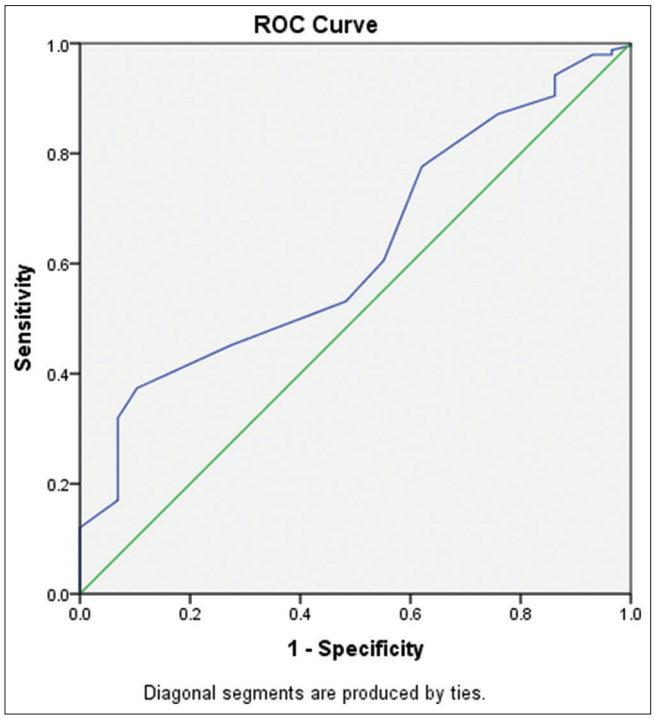

Figure 1: ROC curve depicting goiter predictability of salt Iodine concentration (AUC = 0.621)

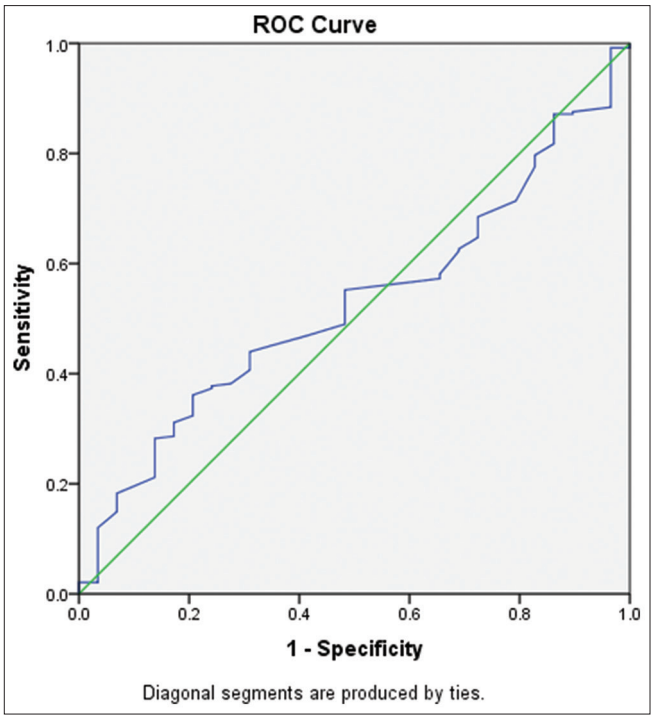

Figure 2: ROC curve depicting goiter predictability of urinary Iodine concentration (AUC = 0.545)

salt samples.[12,14] However, less than half of the salt samples had adequate Iodine levels in a study done in Bagalkot.[15]

The median urinary Iodine level of 126 µg/L in our study showed that the present status of Iodine was satisfactory. In a study done in Bagalkot, more than 50.0% of urine samples had urinary Iodine levels <100 µg/L,[15] whereas in our study, only one-fifth of urine samples had urinary Iodine levels <100 µg/L. This could be because of the supplementation of Iodine through other dietary sources such as Mid-day meals and awareness in the study area.

In our study, though the goiter prevalence was high, the median urinary Iodine level was normal. Similar results were obtained by a study done in Chitradurga where most of them with normal urinary Iodine values had visible goiter.[12] A main limitation of assessing the IDD burden using TGP is that, in endemic areas, it may not return to normal even months or years after correction of Iodine deficiency.[7] ROC analysis performed by our study also showed low accuracy for the prediction of UIE (AUC = 0.5) and salt Iodine levels (AUC = 0.6) with TGP. The trend of TGP is a better indicator than just the point prevalence for assessing Iodine deficiency.

Conclusion

Reduction of goiter prevalence from 41.0% to 13.0% over 40 years and optimal median UIE (126 µg/L) reflects a transition from Iodine deficient to Iodine adequacy status since TGP reflects past status and median UIE reflects the current status of Iodine. However, with a goiter prevalence of more than 5.0%, Chikmagalur district is at risk of a significant public health problem of IDDs. Timely interventions with appropriate measures could prevent its population from suffering from the devastating consequences of Iodine deficiency.

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Conflicts of interest

There are no conflicts of interest.

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