

Original Research Article

Iodine deficiency disorders in a South Indian district: still a public health problem?

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ABSTRACT

Background: Iodine deficiency disorders (IDD) constitute the single largest cause of preventable brain damage worldwide leading to learning disabilities and psychomotor impairment. Nearly 266 million school children worldwide have insufficient iodine intake. IDD was found to be a public health problem in 47 countries. Since the information on current prevalence of goiter in Kolar was not available, the present study was undertaken.

Methods: A cross-sectional study was conducted among school children aged 6-12 years in Kolar taluk. A total of 2700 children were selected for goiter examination by multistage random cluster sampling technique. A total of 270 children were tested for the median urinary concentration and 540 salt samples were tested from the households of the study population.

Results: The total goiter rate was 5.66% among primary school children aged 6-12 years with a significant difference between ages. As the age increased the goiter prevalence also increased. The median urinary iodine excretion level was found to be 105 mcg/l and 92.788.7% salt samples had >15 ppm iodine content.

Conclusions: Present study shows mild goiter prevalence in primary school children in Kolar district and an adequate iodine content of salt in urine.

Keywords: Goiter, IDD, Prevalence, Urinary iodine

INTRODUCTION

Micronutrients are the constituents in diet, these are commonly known as vitamins and minerals, even though they are required in small amounts, they are essential for growth, prevention of diseases and overall wellbeing. These nutrients are not produced in the body and are to be obtained from the diet.¹ Deficiencies in micronutrients like iron, iodine, vitamin A, folate and zinc can have negative repercussions. All through the world, more than 2 billion people suffer from more than one micronutrient deficiency.² Iodine is an essential micronutrient which is required at 100-150 micrograms per day for normal human growth and development.

Iodine deficiency disorders (IDD) can be due to deficient iodine in the soil. Earlier, deficiency in iodine was known to result in only goitre and cretinism.³

It is the most common cause of preventable mental retardation in the world. It causes damage during the first trimester of pregnancy and early in childhood. The severe consequences of iodine deficiency disorders (IDD) are cretinism, stillbirth and miscarriage, and high rate of infant mortality. Even a mild deficiency can result in significant loss of learning ability, about 13.5 IQ, including other symptoms like an enlarged thyroid gland, known as goiter.⁴ Children attending schools aged 6 to 12 years are among the vulnerable population for IDD and

hence considered a target for surveillance and are also easily accessible. The affected children were subjected to estimation of iodine in urine and size of thyroid gland. The schools are an appropriate choice to implement educational interventions.⁵

Globally around 1.9 billion people are at risk of developing IDD due to insufficient intake of iodine in the diet. Among school children, around 265 million globally take insufficient iodine in their diet.⁶ Among the surveys undertaken in 324 districts in our country, it was found that 263 districts were endemic for IDD and had >10% prevalence.⁷ Iodisation of table salt was made mandatory in 1983 in order to eliminate IDD.

There has been enormous success toward elimination of IDD by implementation of National Iodine Deficiency Disorders Control Programme (NIDDCP) in 1992. In the year 2005, the government issued a notification with orders to ban the selling of non-iodized salt in India. The rule came to effect under the Food Adulteration Act from the year 2006.⁸

The area under study, Kolar, has been prone to drought with the lands being barren in most parts, with main source of drinking water being ground water. Kolar is also known to be prone for fluorosis. There are no quality research on the prevalence of goiter for the entire district, hence the present study was undertaken with an objective to assess the prevalence of goiter among school children aged 6-12 years and also to estimate the salt and urine iodine in 20% and 10% of the sample population respectively.

METHODS

The present study was a cross-sectional descriptive study, undertaken in schools of Kolar district as a part of the consultancy from the State NIDDCP cell, including the students from all 6 taluks of the district. The children aged between 6-12 years were included from lower and higher primary schools in rural and urban areas of Kolar. The study was conducted from 1st November 2019 to 15th April 2020 (6 months). A total of 2700 students were selected.

Sample size calculated with a prevalence of 19.01% taken as per the study Iodine deficiency in children: A comparative study in two districts of south-interior Karnataka, India; with confidence interval of 99%, absolute error of 2% absolute error and the sample size is 2561. After adding a non-response rate of 5% we get a sample size of 2689 which is rounded off to 2700. The assessment for prevalence of goiter among school children was done using a pre-tested semi structured and pre-validated questionnaire.

The IDD survey at the district was conducted by using the method of population proportionate to size (PPS) sampling in the age group of 6-12 years children. All children in this age group whose parents' consented for the study were included and those with known thyroid disorders and not consenting for the study were excluded.

Cluster sampling method was used to select the villages. Villages for the survey were selected by PPS method using available data for all districts from Registrar General Office. These were listed in a table and cumulative population was calculated. A sample of 30 villages were selected from the district. A sample of 90 children (45 boys and 45 girls) of age group of 6-12 years from every school of selected village was selected as per the operational manual for District IDD Survey.

The general information and clinical examination for goiter were collected from 2700 children in 6-12 years age group as per the aforementioned sampling method. Among the 2700 children enlisted, salt samples were collected from the household of every 5th child who was examined for goiter amounting to a total of 540 children and every alternate child out of those selected for household salt sample collection were selected for urinary iodine estimation amounting to 270 children.

The collected data was entered into Microsoft excel spread sheet. The data was summarized and presented as frequencies, proportion, mean and standard deviation, depending on the quantitative or qualitative variables. Analysis was performed using SPSS 22 version. Chi square was the test of significance for qualitative data. Independent t-test/Z-test was the test of significance for quantitative data between two groups, p value less than 0.05 was considered as statistically significant.

RESULTS

In the study 28.3% were in the age group 6 to 7 years 28.4% were in the age group 8 to 9 years and 43.3% were in the age group 10 to 12 years. In the study proportion of Males and females were almost equal. (50.1% males and 49.88% females respectively).

Majority of subjects (43.3%) were in the age group 10-12 years (male 43.7% and female 42.9%) (Table 1). The study also showed that 94.3% had Grade 0, 4.9% had Grade 1 and 0.8% had Grade 2 Goitre (Table 2). The total goitre rate in the study was 5.66%. It indicates mild public health problem.

In the study, a significant association between age distribution and Grade of Goitre was found, as the age increases, the severity of Goitre grade was noted to be increasing (since p value <0.05) (Table 3).

Table 1: Age and gender distribution of subjects in the study.

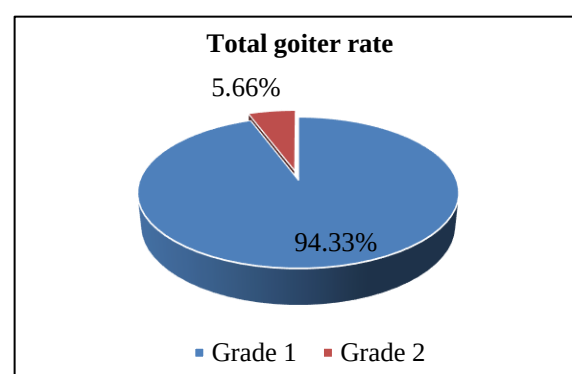
Age	Gender					
	Male		Female		Total	
	Count	%	Count	%	Count	%
6-7 years	387	28.6%	377	27.9%	764	28.3%
8-9 years	375	27.7%	391	29.0%	766	28.4%
10-12 years	591	43.7%	579	42.9%	1170	43.3%
Total	1353	100%	1347	100%	2700	100%

Table 2: Grade of goiter among subjects.

Grade of goiter		Count	%
Grade 0	Not visible and not palpable	2547	94.3%
Grade 1	Palpable and not visible	132	4.9%
Grade 2	Both visible and palpable	21	0.8%
Total		2700	100.0%

In Grade 0 Goitre, among subjects in age group 6 to 7 years, 51.1% were males and 48.9% were females. Among subjects in age group 8 to 9 years, 50.4% were males and 49.6% were females and among subjects in age group 10 to 12 years, 50.7% were males and 49.3% were females. There was no significant association between age and gender in Grade 0 (Table 4).

In Grade 1 Goitre subjects, among subjects in age group 6 to 7 years, 40% were males and 60% were females. Among subjects in age group 8 to 9 years, 32.7% were males and 67.3% were females and among subjects in age group 10 to 12 years, 49.1% were males and 50.9% were females. There was no significant association between age and gender in Grade 1.

**Figure 1: Total goitre rate in the study.****Table 3: Grade of goitre comparison with respect to age distribution.**

Age	Goiter grade					
	Grade 0		Grade 1		Grade 2	
6-7 years	736	96.3%	25	3.3%	3	0.4%
8-9 years	707	92.3%	52	6.8%	7	0.9%
10-12 years	1104	94.4%	55	4.7%	11	0.9%

$\chi^2 = 12.520$, $df = 4$, $p = 0.014$

Table 4: Comparison of grade of goitre with respect to age and gender distribution.

Age	Goiter grades											
	Grade 0				Grade 1				Grade 2			
	Male		Female		Male		Female		Male		Female	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
6-7 years	376	51.1%	360	48.9%	10	40%	15	60%	1	33.3%	2	66.6%
8-9 years	356	50.4%	351	49.6%	17	32.7%	35	67.3%	2	25%	6	75%
10-12 years	560	50.7%	544	49.3%	27	49.1%	28	50.9%	4	36.4%	7	63.6%
P value	0.078				2.984				0.117			

In Grade 2 Goitre subjects, among subjects in age group 6 to 7 years, 33.3% were males and 66.6% were females. Among subjects in age group 8 to 9 years, 25% were males and 75% were females and among subjects in age group 10 to 12 years, 36.4% were males and 63.6% were females. There was no significant association between age and gender in Grade 2. In the study at consumer level, 11.3% had <15 PPM of iodine in salt consumed and

88.7% had >15 PPM of Iodine in salt consumed (Table 5). In the study 4.44% had UIE <20 (Severe Iodine Deficiency), 8.88% had UIE 20 to 49 (Moderate Iodine deficiency), 25.2% had UIE 50 to 99 (Mild Iodine deficiency), 35.5% had UIE 100 to 199 (Optimal), 21.8% had UIE 200 to 299 (Risk of Iodine induced Hyperthyroidism) and 11.0% had >300 UIE (risk of adverse health consequences due to hyperthyroidism)

(Table 6). Median Urine Iodine Estimation was 105 µg/l, mean UIE was 132.07 µg/l (Table 7).

Table 5: Salt iodine estimation classification subjects.

Iodine content of salt	No of households	Percentage (%)
<15ppm (Inadequate)	61	11.3
>15ppm (Adequate)	479	88.7
Total	540	100

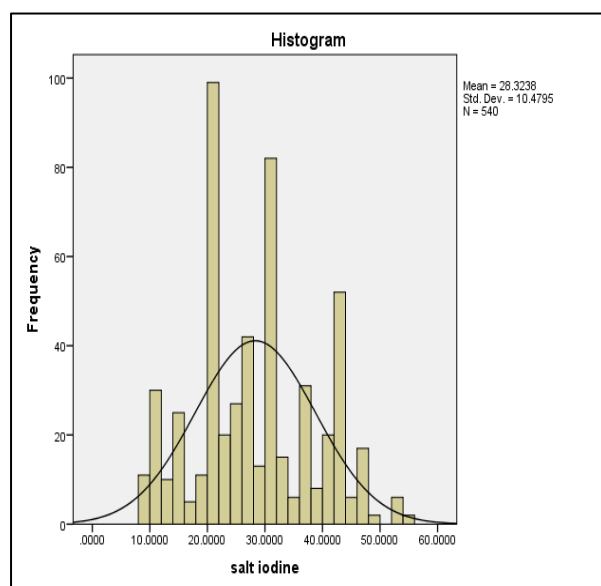


Figure 2: Distribution of Salt Iodine estimation in study subjects.

Table 6: Urine Iodine Estimation classification among subject.

	Urine Iodine Excretion (µg/l)	Iodine intake	Count	%
Urine Iodine Estimation	<20	Insufficient	12	4.44
	20-49	Insufficient	24	8.88
	50-99	Insufficient	68	25.2
	100-199	Adequate	96	35.5
	200-299	More than adequate	59	21.8
	>300	Excessive	11	4.07
	Total		270	100

Table 7: Median Urine Iodine Estimation distribution among subjects.

Urine Iodine Estimation (UIE)					
N	Mean	SD	Median	Min	Max
270	132.07	77.02	105	10	315

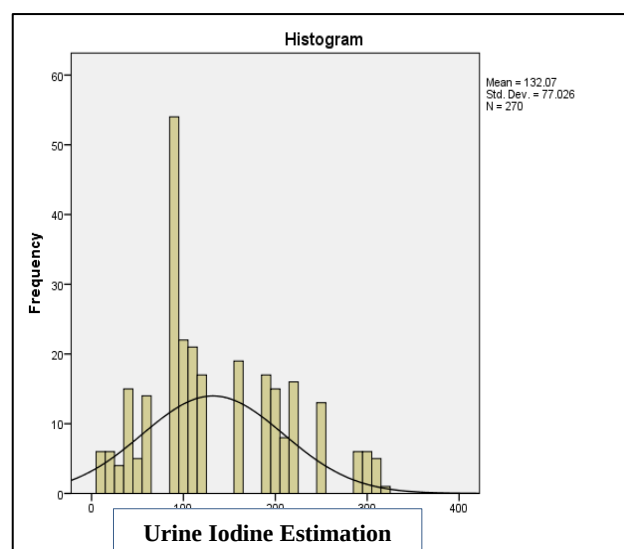


Figure 3: Distribution of UIE in study subjects.

DISCUSSION

Our study was undertaken more than two decades post the enactment of compulsory iodization of table salt in India. The aim was to explore the current status of prevalence of IDD in Kolar district among school children aged 6-12 years.

Prevalence of goiter

It was observed that the prevalence of goiter including both palpable and visible, was 5.66%. As per the criteria given by WHO to assess severity of goiter, prevalence range of 5-19.9% is a mild public health problem as it falls in the range of 5.0-19.9%. This indicates that our district is currently in the phase of transition from being endemic for goiter to reaching a stage of iodine sufficiency.⁷ The prevalence of goiter varies widely all through India, as shown by numerous studies, where the prevalence ranges from 0.125% to 50.1%.^{8,9} In Meerut, the prevalence of goiter was reported to be 50% which falls under severe endemicity as reported by Joshi et al. The cause for persistent severity of in certain areas can be due to deficiency in the environment, another factor contribution to this may be consumption of diet with high content of goitrogenous foods that interferes with absorption and utilisation of iodine.^{9,10} Goiter was found to be a mild public health issue in areas of Champaran and Bharatpur by Umesh Kapil where the prevalence were 7.2% and 11.6% respectively.^{11,12} Other studies with similar findings were seen in Uttarakhand where the total goiter rate was 13.2% and 17% in Faridabad as observed by Lohiya et al.^{13,14}

The reason for this broad variation in prevalence can be because of the demographic characteristics in our country which influence the prevalence of goiter.¹⁵ This could also be due to variation in the methodology adopted in

terms of sample size and age groups included in various studies.

Grades of goiter

We observed that among the Grades of goiter, Grade 1 (4.9%) was found to be more prevalent than Grade 2 (0.8%). The studies in Imphal and Sundarban area of West Bengal showed that, the most common type in goiter was Grade 1 (25% and 31% respectively) and a lower prevalence of Grade 2 which was found to be 5.3% and 2.6% respectively.^{16,17}

Other studies with similar findings were found to be in certain areas of Manipur and Kulgam where the prevalence of Grade 1 goiter was found to be higher than Grade 2 goiter.^{18,19}

Age and prevalence of goiter

The prevalence of goiter was found to increase with age in the present study, with highest prevalence among 8-9 years age group (7.7%). The studies conducted in Haryana found similar results where the goiter prevalence was higher among 9-12 years of age when compared to the other age groups as observed by Chaudhary et al.²⁰ Similar findings of an increased goiter prevalence with age was observed in Jamnagar and Gujarat by Makwana and Amin et al respectively.^{21,22}

Urine iodine excretion (UIE)

The median urine iodine in the present study was found to be 105 µg/L, 25.2% of them had inadequate UIE, whereas 35.5% of the children had adequate and 21.8 had more than adequate urine iodine excretion. A similar finding was found by Umesh K where around 85% of the districts our country had sufficient UIE.²⁴ Another observation made at the Sundarbans was that the Urine iodine levels was sufficient in 77% of children whereas inadequate among 23% of the children aged 6-12 years.²⁵ But a contradictory finding was made in Kolhapur where only 20% sample of urine had adequate iodine excretion and the rest were found to be deficient.¹⁷

Salt iodine

The salt iodine content was found to be adequate (>15ppm) in 88.7% of the samples. The 11.3% of the samples which had inadequate iodine content can be explained due to improper methods of storing the iodized salt at the household level.

Our findings were supported by Das et al who found that most of the of the samples (98%) had adequate iodine content in Chandigarh.²⁵ But an opposite finding was seen West Bengal (Howrah and Purba districts) where around 66% of houses had adequate iodine in the salt used for daily consumption.²⁶ In Jodhpur, Rajasthan, it was observed that majority of children consumed inadequately

iodized salt which indicates that the consumption of iodized salt in desert area is extremely low in spite of the national programs in operation.²³

Limitations

As this is a cross-sectional study, the causal association cannot be established for the persistence of goiter as a public health problem is Kolar district which has been overcome by extending the research as a prospective study in order to find the factors responsible for the same. As there are ethical considerations with respect to intervention to be done for those found deficient for iodine, an educational intervention has been planned for the same.

CONCLUSION

From the study it can be concluded that prevalence of Grade 1 Goitre was 4.9% (male 2% and female 2.89%) while Grade 2 was 0.8%(male 0.25% and female 0.52%) . Total Goitre rate in the study was 5.66%. It Indicates Mild Public Health problem.

In the study 4.44% had Urine Iodine Excretion (UIE) <20 (Severe Iodine Deficiency), 8.88% had UIE 20 to 49 (Moderate Iodine deficiency), 25.2% had UIE 50 to 99 (Mild Iodine deficiency), 35.5% had UIE 100 to 199 (Optimal), 21.8% had UIE 200 to 299 (Risk of Iodine induced Hyperthyroidism) and 11.0% had >300 UIE (Risk of Adverse health consequences due to Hyperthyroidism).

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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