Iodine Deficiency Disorders Survey among 6–12 Years School Going Children in North Karnataka Region. Is it Still a Public Health Problem?

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ABSTRACT

Background: Iodine deficiency is one of the most prevalent micronutrient deficiencies globally. Iodine deficiency disorders (IDD) constitute the single largest cause of preventable mental retardation worldwide. National IDD Control Programme (NIDDCP) launched in 1962 in India. Despite, five decades of launching program, still there is uncertainty over its effectiveness in reducing burden of IDD. Hence, the study was undertaken to estimate the prevalence of goiter and the level of iodine concentration in household salt and urine samples of selected school children of 6–12 years age.

Methodology: A community-based cross-sectional study was conducted in the month of December 2019 among 2713 school going children in three taluks of Yadgir district. Multi-stage cluster sampling with population proportional to size was used as recommended by NIDDCP. A pre-tested, semistructured questionnaire was used for data collection. Goiter was assessed clinically and graded as per program guidelines. Urine samples were collected from subsample to estimate median urinary iodine excretion levels. Salt samples from households of selected school children were also collected for iodine estimation. Data were analyzed using SPSS 16.0 version for windows.

Results: The overall prevalence of goiter among the 6–12 years children was found to be 5.1%. Females had higher prevalence compared to males in all the age groups. Of the 257 urine samples, 211 (82.3%) had iodine levels ≥100 µg/L. Of the 530 salt samples, 311 (58.1%) had iodine concentration ≥15 ppm at household level.

Conclusions: Iodine deficiency is mild public health problem in Yadgir district and is still an endemic district. Hence, there is a need for further strengthening of ongoing strategies such as, periodic surveys to assess the change in magnitude of the IDD, strengthening of monitoring system, community education campaigns to sustain gains achieved and mistakes are not repeated.

Key words: Goiter, Iodine deficiency disorders, Urinary iodine, School children

INTRODUCTION

Iodine is an essential micronutrient required for normal thyroid function, growth, and development.[1] Suboptimal intake of iodine causes inadequate thyroid hormone production, which leads to a spectrum of adverse outcomes, collectively termed iodine deficiency disorders (IDDs).[2] The most damaging consequences of IDD are in the first 1000 days of life, from conception until the age of 2 years.[3] Severe iodine deficiency during this period increases the risk of stillbirth, congenital abnormalities, and perinatal and infant mortality and impairs physical growth, motor function, and cognitive development.[2] Among all these disorders the most common manifestation of iodine deficiency, both in children and adults, is goiter which makes goiter as the most common presentation and indicator of iodine deficiency. Fetal and early childhood brain damage is often irreversible, causing mental retardation, and reduced school performance.[1] In adults, iodine deficiency also reduces work productivity.[2] Therefore, widespread iodine deficiency in the population poses a significant threat to national economic growth and development and slows down progress toward health for all, education for all, and millennium development goals, particularly in developing countries.[4] Iodine deficiency is a major global public health challenge.

Globally, the total goiter prevalence is estimated to be 15.8%. Africa has the highest prevalence of 28.3% whereas America has lowest prevalence of 4.7%. The prevalence in South East Asia is 15.4%.[5] Goiter due to iodine deficiency contributes to 2.72% of all sequel of disease worldwide. This statistic makes goiter the 32nd most prevalent disease sequel in human
beings. In India, it is estimated that 54 million people are suffering from goiter, 2.2 million suffering from cretinism, and 90,000 still births and neonatal deaths.[6]

In India, an estimated 350 million people are at the risk of developing IDD due to inadequate consumption of iodized salt (IS).[7] The sample surveys conducted in 29 states and seven union territories across the country showed that out of 390 districts surveyed, 333 districts reported total goiter rate (TGR) >10% and are endemic (prevalence of IDD >5%) and it shows that no state in India is free from iodine deficiency.[8] As per the Coverage Evaluation survey 2009, the accessibility of quality IS has a very wide gap between coverage among rural (85.6%) and urban communities (46.4%).[9,10]

Considering the IDD in India as a public health problem, Government of India had launched National Goiter Control Programme in 1962 which was renamed as National IDD Control Programme (NIDDCP) in 1992, which adapted strategy to consume IS daily and mandated the universal salt iodization under Food Adulteration Act in 2006. Although the burden of IDD declined after the universal salt iodization policy, the problem still continues.[11,12] However, it is necessary to monitor the progress of the program using recommended quantifiable indicators at the state/district level. Indicators such as goiter prevalence, urine iodine excretion (UIE) and salt iodine levels surveys are conducted to know the region’s iodine status. UIE level reflects the current iodine status, while the prevalence of goiter indicates the long-term iodine status in a population. As iodine deficiency has an immediate effect on child’s school performance, so they are usually taken into account for goiter surveys.[13,14]

Literature review found that, surveys have been conducted in different districts of Karnataka in the past few years. All the districts were found to be endemic for IDD. IDD Status of Yadgir District belonging to North Karnataka was not known to state program managers. Hence, this study was entrusted to our college with financial assistance by Directorate of Nutrition division, Bengaluru, Government of Karnataka to find out the prevalence of goiter and to estimate salt and median urinary iodine level among the sampled school children aged between 6 and 12 years in Yadgir district.

METHODOLOGY

Study Area

The total population of the Yadgir district is around 11 lakh having 3 talukas. There are 1581 primary with upper primary schools in Yadgir district with 95.3% students enrolled from 1st standard to 7th standard, majority being in the age group of 6–12 years as per annual status of educational report (Rural) 2019.

Study Design

This was a community-based cross-sectional study.

Study Duration

This study was conducted during December 2019–January 2020.

Study Population

A study sample of school children in the age group of 6–12 years were selected from 30 schools using multi-stage cluster sampling with population proportionate to size (PPS) sampling method. As the school enrolment in Yadgir was more than 90%, the sample was taken only from the schools.

Sample Size

As per the guidelines of IDD survey, a minimum of 2700 children should be examined for Goiter, a minimum of 540 samples of salt should be tested for iodine and a minimum of 270 urine samples should be tested for iodine excretion.

Sampling Procedure

Multistage cluster sampling with population proportional to size was applied as recommended by NIDDCP.[13] The sampling frame comprised cumulative population of each village of three talukas of Yadgir district. In the first stage, 30 villages were selected using PPS method. In the second stage, primary with upper primary schools was selected randomly from the selected village. In the third stage, sample of 90 children which consisted of 45 boys and 45 girls aged 6–12 years was selected from each school in such a way that there is equal representation from each class. Wherever the sample size could not be covered in the selected school, an adjoining school was included to complete the required number in each cluster.

Study Procedure

The study was initiated after approval from the Institutional Ethical Committee. Prior permission was obtained from the Director of Health and Family Welfare Karnataka. The District Development and Panchayat Officer was contacted and briefed about the study and school list was obtained. Informed consent from the Block Education Officer and school heads was obtained before the start of the study. Informed consent was also obtained from the parents. A pre-designed and pre-tested pro forma was used to record demographic and physical examination findings of the students.

Goiter Examination

All selected children were examined clinically by a trained research team, which included faculty members and medical interns from the Department of Community Medicine. Standard palpation
techniques were used to examine the neck for the presence of any goiter. Goiter was classified into Grades 0, 1, and 2 as per the revised guidelines on the NIDDCP and WHO/UNICEF/ICCIDD guide. Sum of Grade 1 and Grade 2 was taken as TGR.\cite{11,15}

**Urine Samples Testing**

Nine spot urine samples were collected randomly from selected children in each school in a labeled wide mouthed screw capped plastic container of 50 ml capacity. The samples were transported to the Indian Council of Medical Research (ICMR) Research Laboratory for processing and for quantitative estimation of iodine in urine, using the method based on Sandell-Kolthoff reaction as per the recommended guidelines.\cite{11,15}

**Salt Samples Testing**

Eighteen selected children were given an airtight self-sealing plastic pouch to bring a spoonful salt consumed by their families from their homes. These samples were transported to the ICMR Research Laboratory for processing and for quantitative estimation.\cite{11,15} A list of all children with Goiter (Grade 1 and 2) identified was provided to the principal of the respective schools so that necessary action such as intimating the parents and referral for further management can be undertaken.

**Data Analysis**

Data were entered into Microsoft Excel sheet and were analyzed using professional statistical package SPSS 16 version for windows. Descriptive data represented as mean for numeric variables and proportions for categorical variables.

Guidelines of the NIDDCP for Analysis of Results are as follows:\cite{11,15}

1. Endemic District: The district is declared as endemic district if the TGR is above 5% in the children of the age group 6–12 years surveyed
2. Severity of Public Health is graded as: Mild (TGR 5–19.9%); moderate (TGR 20–29.9%); and severe (TGR >30%)
3. Severity of Public Health is graded as mild (median UIE 50–99); moderate (median UIE 20–49); and severe (median UIE <20)
4. Proportion of urine samples with low median UIE <100 µg/L should be <20%
5. Iodine level of salt samples should be >15 ppm at the consumer/household level
6. Proportion of households consuming adequately iodized salt (>15 ppm) should be >90%

**RESULTS**

**Prevalence of Goiter**

A total of 2713 school children from the selected 30 villages in the age group of 6–12 years were examined for the presence of goiter. Out of 2713 children, proportion of boys (50.1%) and girls (49.9%) participated in the study were equal as per guidelines.\cite{11}

The prevalence of goiter or TGR among the 6–12 years children was found to be 5.1% (i.e., Goiter Grades 1 and 2) which is just above the cutoff of 5% to define an area as an endemic for IDDs. The prevalence of goiter was observed to increase with age, but was found to be statistically significant ($P = 0.042$). Females had higher prevalence compared to males in all the age groups but the difference between sexes was not statistically significant, as shown in Table 1.

**Analysis of Iodine Levels in Urine Samples by Sandell-Kolthoff Method**

Out of 257 urine samples collected, median urinary iodine level was 180 µg/L which is above the recommended level of 100 µg/L, as shown in Table 2.

**Quantitative Analysis of Iodine Levels in Salt Samples**

As per the revised NIDDCP guidelines during the survey, 540 (20% of the total sample size) salt samples were collected from the houses of children. Approximately 20 g of salt were collected in auto seal plastic pouches and the

<table>
<thead>
<tr>
<th>Age group</th>
<th>Gender</th>
<th>Total examined</th>
<th>WHO goiter grade</th>
<th>TGR (Grade 1+2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6–7</td>
<td>Male</td>
<td>398</td>
<td>383 15 0 15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>407</td>
<td>388 19 0 19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>805</td>
<td>771 34 0 34</td>
<td></td>
</tr>
<tr>
<td>8–9</td>
<td>Male</td>
<td>443</td>
<td>413 28 2 30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>422</td>
<td>393 27 2 29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>865</td>
<td>806 55 4 59</td>
<td></td>
</tr>
<tr>
<td>10–12</td>
<td>Male</td>
<td>517</td>
<td>501 15 1 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>526</td>
<td>393 29 1 30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1043</td>
<td>894 44 2 46</td>
<td></td>
</tr>
<tr>
<td>Grand total</td>
<td>2713</td>
<td>2574 133 6 139</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figures in parenthesis indicate percentages. Chi-square value = 9.920, DF=4, $P = 0.042$. TGR: Total goiter rate
iodine concentration of the salt samples was estimated by quantitative analysis at ICMR approved laboratory, Sirwar, Raichur district, Karnataka.

Of the 540 salt samples, 311 (58.13%) had iodine concentration of more than or equal to 15 ppm at household level. 224 (41.87%) of the salt samples had iodine concentration <15 ppm, of which 76 samples (14.20%) had no iodine content in them, as shown in Table 3.

**DISCUSSION**

A total of 2713 school children in the age group of 6–12 years were examined for the presence of goiter. The goiter prevalence rate of 5.1% among the 6–12 years school children indicates that IDD is a mild public health problem in the district of Yadgir, Karnataka, India. Comparable findings were observed in a study done by Sarkar et al., in Mandya district, reported that the prevalence rate was 6.6% in school children and females had a higher prevalence compared to males in all the age groups.[16] (IDD3). Another study done by Makwan et al. shows that the overall prevalence of goiter among the study population was 4.83%.[17]

While studies from other areas of Karnataka such as in Ramanagara district (2017), Udupi district (2015–2017), and in Rural Belgaum (2009) showed higher prevalence of 8.3%, 13%, and 16.6%, respectively.[18,12,19]

The prevalence of goiter was higher in girls (5.8%) than in boys (4.5%) in the present study. This was consistent with the study by Zama et al. in school children of district Chamarajanagar, Karnataka, India, found that the TGR was higher in females (54.63%) as compared to males (45.37%).[20]

A study by Gupta et al. in Lucknow, India, also reported a higher prevalence of goiter among females (19.9%) than in males (6.8%).[21] A study conducted by Biradar et al. in district Ramanagara, Karnataka, India, showed that females had a higher prevalence of 35.3% as compared to males with the prevalence of 31.4%.[18]

In the present study, 311 (58.13%) had salt iodine concentration of more than or equal to 15 ppm at household level and 76 (14.12%) had no iodine in salt samples. The results were comparable to study by Kamath et al. in rural Belgaum, revealed that only 50% of the household had adequate iodine content (>15 ppm).[19] Low iodine content in salt samples may be due to usage of non-iodized salt or loss of iodine in distribution process or lack of knowledge regarding salt storage practices. However, it is not associated with prevalence of goiter in the present study. Contrary to our findings, study by Biradar et al. in Mandya district showed that the higher percentage (95.3%) of the salt sample had iodine concentration ≥15 and 2.6% had no iodine content.[18]

UIE levels are the most useful indicator of IDD which indicates current status of iodine nutrition and it has been recommended that no iodine deficiency is indicated in a population when median urinary excretion level is ≥100 mcg/L. In the present study, median urinary iodine level was 180 µg/L which is above the recommended level of 100 µg/L. Similar findings were reported in studies conducted in other districts of Karnataka and also by studies across the country in other states.[16-21]

In the present study, the prevalence of goiter is 5.1% which is just above the cutoff criteria to designate region as endemic district and median UIE is 180 µg/L, which indicate the adequate iodine nutritional status in Yadgir dist. However, 311 (58.13%) had salt iodine concentration of more than or equal to 15 ppm at household level and 76 samples (14.20%) had no iodine content out of 224 (41.87%) salt samples containing <15ppm. This shows, adequate salt iodine at household levels is very low, may be because of usage of crystal non-iodized salt, salt storage without lid in households, exposure to heat and sunlight in retail shops. Interesting finding is that, even though household salt iodine levels (>15 ppm) are very low, the goiter prevalence and median UIE are within the accepted range and there is no association between salt iodine levels and goiter prevalence and median UIE. The reason may be deficiency of salt iodine at household level getting compensated by Mid may meals provided in schools and food provided by ICDS centers. Similar findings are reported in a study conducted by Reddy et al. in Udupi district.[22]

**CONCLUSION**

The present study showed, mild goiter prevalence and adequate median UIE levels in Yadgir district, but proportion...
of households consuming iodized salt (>15 ppm) consuming is very low, indicating district is transitioning from iodine deficient to iodine sufficient status. Therefore, there is a need for ensuring sustainability of IDD control activities by periodic surveys to assess the magnitude of the IDD with respect to impact of IS intervention, laboratory testing of IS in Public Distribution System, framing of communication campaigns around the benefits of iodine for brain development, school performance and success in life and to adapt proper salt storage and usage practices in community which overall help in strengthening of NIDDCP program and finally to achieve sustainable elimination of IDD in India.

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REFERENCES