Prevalence of goitre and iodine deficiency among school children (6–12 years) in rural areas of North Karnataka, India: A cross-sectional survey, 2016–19

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Abstract

Introduction: Iodine deficiency disorders (IDD) have remained an unresolved public health problem in India. In this survey, we have estimated the prevalence of IDD among 6–12 years of school children in rural areas of north Karnataka, India and estimated the prevalence of low iodine content (<15 ppm) in salt at the household level and urine iodine excretion in this population. **Material and Methods:** In this cross-sectional survey, we recruited 16,827 children between 6 and 12 years of age through multistage sampling from six districts. Goitre was examined clinically for all children. Household-level salt iodine estimation and urinary iodine estimation were carried out among a subset of the participants. **Results:** Overall prevalence of goitre was 17.1% (95% CI: 16.5, 17.7). Out of this, 76.7% ($n = 2116$) had Grade-1 goitre, and 23.7% ($n = 656$) had Grade-2 goitre. The prevalence of goitre was higher among females (17.9%, vs. male 16.4%, $P < 0.05$). The prevalence of low iodine content (<15 ppm) in salt was 48.5% (95%CI: 46.7, 50.3). The overall median iodine excretion in urine was 85 μg/L (IQR: 60–150 μg/L). In total, 37.2% ($n = 601$) had mild iodine deficiency, 5.2% ($n = 84$) had moderate deficiency, and 10.1% ($n = 163$) had severe deficiency. All parameters showed high inter- and intradistrict variations. **Conclusion:** North Karnataka has a high goitre prevalence. Low use of iodized salt can be a major reason for the high prevalence of the condition. Ensuring the availability of iodized salt in this region and periodic surveillance to measure the impact of the programme should be the priority in this region.

Keywords: Goiter, India, iodine deficiency (IDD), iodized salt, urinary iodine

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Introduction

Iodine deficiency is a major public health threat, particularly in preschool children and pregnant women in India.[1,2] Iodine is a vital component required by our body for the synthesis of thyroid hormone. Inadequate intake of iodine leads to insufficient production of thyroid hormones, resulting in a series of functional and developmental abnormalities collectively referred to as iodine deficiency disorders (IDD).[3] Iodine deficiency is not only limited to goitre. It often leads to a spectrum of adverse outcomes such as cretinism, hypothyroidism, brain damage, abortion, stillbirth, mental retardation, psychomotor defects, and hearing and speech impairment.[3,4]

Globally, around 2 billion people suffer from iodine deficiency, one-fourth of whom show clinical manifestations.[5,6] More than one-half of the children with low iodine intakes are in south-east Asia (76 million) and Africa (58 million).[7] In Asia, the average prevalence is 15.4%.[8] In India, a large survey across the country found that 333 districts to be endemic for goitre with a prevalence of goitre more than 5% (Ministry of Health and Family Welfare, Government of India; 2011). Reportedly, over 50 million people in India are suffering from goitre, over two million are suffering from cretinism, and nearly 0.1 million stillbirths and neonatal deaths are due to the consequence of iodine-deficient conditions.[9]

The Government of India launched the National Goitre Control Programme in 1962, which was later renamed as the National Iodine Deficiency Disorders Control Programme (NIDDCP) in 1992. The overall aim of the programme is to reduce the prevalence of IDD to less than 10% in endemic districts by activities such as IDD surveys, supply of iodized salt, resurveys every 5 years, monitoring iodized salt consumption, laboratory monitoring of iodized salt, urinary iodine concentration, and education.[10] The Food Safety and Standards Authority of India, through Regulation 2.3.12 of Food Safety and Standards (Prohibition and Restriction on Sales) 2011, restricts the sale of noniodized salt for direct human consumption. To understand the effectiveness of these strategies, frequent community-based surveillance is required. In the Indian setting, a routine surveillance system does not exist to identify goitre prevalence, and therefore, surveillance at the local level is a must. In our current setting, the evidence on goitre prevalence is old and needs to update.[7,8] With this background, Medical Colleges in six districts of North Karnataka collaborated with Model Rural Health Research Unit at Sirwar, Raichur to estimate the prevalence of IDD among 6–12 years of school children. Prevalence of low iodine content (<15 ppm) in salt at household level and urine iodine excretion was also estimated in this population.

Methods

Study design

Cross-sectional study.

Study setting

The study was carried out in rural areas of six districts located in the northern region of the South Indian State of Karnataka bordering the States of Telangana and Maharashtra, viz., Bagalkot, Bidar, Koppal, Bellary (Bellary), Gulbarga (Kalaburgi) and Raichur [Figure 1]. Thirty villages were selected from each district for the study. One government primary school was selected from each of these villages.

Study duration

The study was conducted between November 2016 and September 2019.

Study participants and sampling procedure

The study participants were school children in the age group of 6–12 years living in rural areas of six districts, viz., Bagalkot, Ballary, Bidar, Raichur, Koppal, and Kalaburgi of North Karnataka. One hundred and eighty villages were selected from the six districts (30 in each) by multistage cluster sampling with (PPS), following NIDDCP protocol. In the second stage, primary schools having upper primary classes were selected randomly from each of these villages. In the third stage, a minimum of 90 children was selected from each of these schools between age 6 and 12 years. Therefore, it was planned to recruit 2700 school children from each district covering 30 villages.

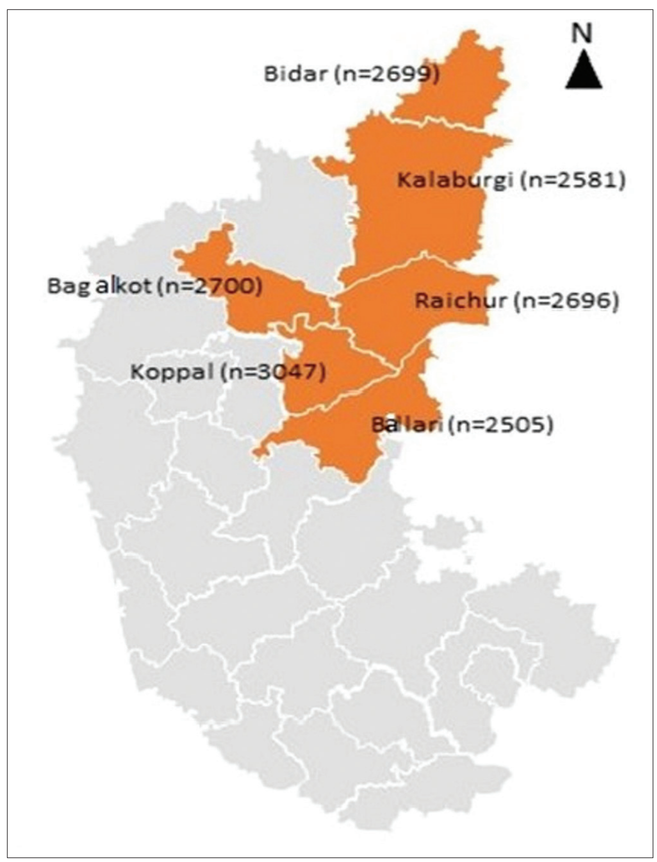

Figure 1: Distribution of study districts, participants (no of participants) North Karnataka, India

Data collection

In each district, the study was conducted by the respective district Government Medical College, following uniform protocol and methods stipulated by the Directorate of Health and Family Welfare Services, Government of Karnataka, Bengaluru. In the selected villages of each district, the identified primary schools were visited and a sample of 90 children were recruited and clinically examined for signs of goitre. This was carried out in 30 villages in each district. All those children below 6 years or above 12 years as per the records in the school were excluded from the study. A predesigned and pretested proforma was used to record the demographic detail and findings of the physical examination of the students.

Goitre examination: Each selected child was examined clinically by a research team comprising trained doctors under the supervision of a teaching faculty from the Department of Community Medicine, of the respective Government Medical College of each district. The training was imparted to doctors involved in the project by the investigators of the respective Medical College. Examination for goitre was carried out by palpatory method and classified as Grade 0, 1, and 2 according to the prescribed guidelines of NIDDCP and WHO/UNICEF (New Delhi, Revised Guidelines of NIDDCP 2006): Grade 0 (thyroid gland neither visible nor palpable), Grade 1 (palpable thyroid gland but not visible externally), and Grade 2 (palpable and externally visible thyroid gland) according to the prescribed guidelines of NIDDCP and WHO/UNICEF (New Delhi, Revised Guidelines of NIDDCP 2006).

Salt and urine sample collection

A list of recruited children was prepared for each school. Salt samples (30 g) were collected from the households of every fifth child from the list. Thus, a total of 540 salt samples (18 salt samples from each school) were collected for the estimation of iodine content. Every alternate child who was selected for salt sampling was recruited for the collection of urine samples. Thus, a total of 270 urine samples (nine urine samples from each school) were collected for the estimation of Urinary Iodine Excretion (UIE) from each district.

Laboratory analyses of the samples

After collection, samples were brought to the respective medical colleges. Samples were stored in a cool and dry place and were later carried to Model Rural Health Research Unit (MRHRU) Sirwar, Raichur District, for laboratory tests and analyses. The iodine content of salt was estimated by the iodometric titration method, and urinary iodine levels were estimated by the wet digestion method (Sandell and Kolthoff, 1936) at MRHRU.

Definition of the outcome variables

Endemic District: The district is declared as an endemic district if the total goitre rate (TGR) is above 5% in the children of the age group 6–12 year surveyed.

Endemicity of goitre: The endemicity is classified as mild (TGR5 – 19.9%), moderate (TGR 20 – 29.9%), and severe (TGR > 30%).

Urine iodine level: A normal level was considered as ≥ 100 μg/L. The severity was classified as mild (median UIE 50–99 μg/L), moderate (median UIE 20–49 μg/L), and severe (median UIE < 20 μg/L).

Household salt iodine level: The iodine level of salt > 15 ppm at the household level is considered as adequate.

Statistical methods

Data were entered in Microsoft Excel sheet and analysed using Statistical Software for Social Sciences (SPSS) software (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). The prevalence of goitre was expressed in percentage with a 95% confidence interval (CI) at the district level. The difference in prevalence among different groups was examined through Chi-square test. Urine iodine excretion was summarized by median value with interquartile range (IQR). The median difference in urine iodine among different groups was examined through nonparametric tests. A P value of < 0.05 was considered statistically significant. Prevalence of low urine iodine (<100 μg/L) and household-level low iodine in salt (<15 ppm) was expressed in percentage with 95% CI till district level. Maps were created using Quantum Geographic Information System (QGIS) open software.

Ethical consideration

The study was carried out as part of the periodic assessment of IDDs by the Government of Karnataka in various districts of the State. Statutory approvals and ethics committee clearances were obtained by the respective Medical Colleges in each district following their institutional norms (SNMC/IECHSR/2018-19/A05/1.5 dated 15.09.2018). In addition to the verbal assent from the children, informed written consent was obtained from the parents/guardians of all the children before the examination. Prior permission was also obtained from the state health and education department and the respective schools.

Results

We recruited 16,827 children from six districts. Data of 16,165 children were included in the final analysis after removal of incomplete data and data with age discrepancy [Figure 2]. The district-wise distribution of the participants is shown in Figure 2. The mean age of the participants was 9 ± 2 years and 51.1% participants were girls.

Goitre prevalence

Goitre was found in 2772 children out of 16,165 children with prevalence 17.1%. Out of them, 76.7% and 23.7% had Grade-1 and Grade-2 goitre, respectively. Prevalence of goitre was higher among females than males participants (17.9 vs 16.4%;

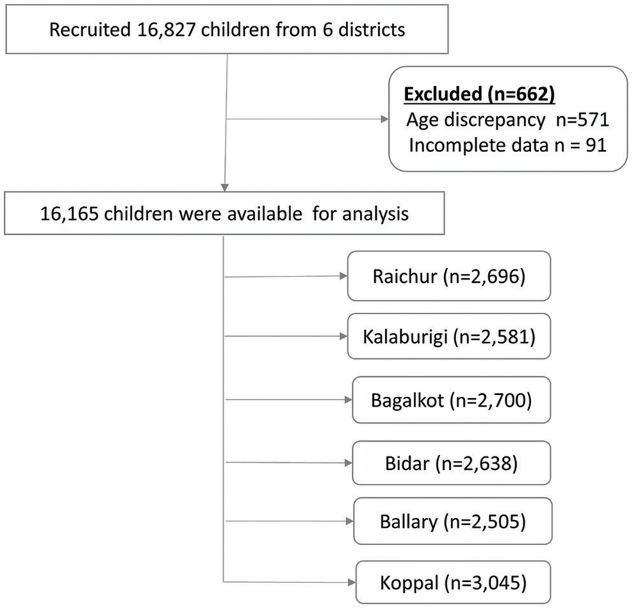

Figure 2: Flow diagram of the study

$P < 0.05$). The highest prevalence of goitre was found in Bidar district (28.4%), followed by Bagalkote (22%), Ballary (20.2%), Koppal (14.5%), Raichur (13.6%), and Kalaburgi (4.6%). Detailed analysis with taluk-level data has been presented in Table 1.

Salt sample analysis

Total 3011 salt samples were analysed at the household level, out of which 1459 (48.5) samples had less iodine (<15 ppm) than recommended. The prevalence of low-iodine content in salt was high in Koppal (78%), Raichur (61.8%), and Ballari (60.0%) districts. [Table 1].

Urine analysis

Urine was tested for iodine for 1617 participants. The overall median iodine excretion in urine was 85 µg/L (IQR: 60-150 µg/L). There was no significant difference in median urine excretion between male (85.0 µg/L) and female (87.5 µg/L) ($P > 0.05$). Out of 1617 urine samples analysed for iodine, 601 (37.2%) had mild iodine deficiency, 84 (5.2%) had a moderate deficiency, and 163 (10.1%) had severe deficiency. The district-level difference for median urine iodine excretion was statistically significant [Table 2; $P < 0.05$]). The prevalence of low-urine iodine varied between 22% in the Raichur district and 68.8% in Bidar. [Table 2] All the talukas in the three districts, namely, Bidar, Ballari, and Koppal, showed a prevalence of low-urine iodine > 50%. [Table 2].

Discussion

In this study, the prevalence of the goitre was estimated among school-going children (6–12 years) in northern part of the Karnataka state and the distribution of goitre prevalence was up to Taluk level. This survey found that almost one out of six children suffer from goitre. The prevalence varies substantially among the districts and even within the districts at the Taluk level. We have also estimated the laboratory indicators for goitre, like household level iodine in salt and iodine level in urine. Overall, the iodine content of salt was below the recommended level for almost half of the households. The urine iodine deficiency showed a similar prevalence and varied widely among the geographic regions.

Our study revealed an overall goitre prevalence of 17.1% among school-going rural children which falls under 'mild' severity IDD. This prevalence is much higher than the national goal of < 5% throughout the country and the national-level estimates.[10,11] The district-wise prevalence ranged between a minimum of 4.3% in Kalaburgi district and a maximum of 28.4% in Bidar district. Only Kalaburgi district achieved < 5% prevalence mark of endemic goitre free district. Two districts, viz., Raichur and Koppal fell into the mild endemicity category, while Bagalkot, Ballary, and Bidar fell into the moderate category. The prevalence was alarmingly high for almost all the talukas from Bagalkot and Bidar district. Studies carried out from other parts of Karnataka state showed a prevalence ranging between 8.6% and 21.1%, mostly higher in the rural areas.[12–15] In contrast, one study reported goitre prevalence of only 0.1% in the Mandya district, the reason being attributed to adequate utilization of iodized salt.[16]

We found half of the households (51.5%) in our study used iodized-edible salt with iodine levels more than recommended 15 ppm. Despite having high iodine content in salt, Bidar district has the highest goitre prevalence among the study states. We noticed a similar contrasting finding in Kalaburgi district, where half of the proportion of salt samples showed low iodine content, but prevalence of IDD was strikingly less than in the other districts. This could be attributed to the cooking method and type of food that affects the bioavailability of iodine.[17,18] Studies conducted earlier in the same state have shown that the overall use of iodized salt in our study area was variable (30%–100%).[15-19] On the contrary, NHFS 5 reported that the number of households in rural areas utilizing iodized salt in Karnataka has increased to 89.4% in 2019–2020 from 82.0% in 2015–2016.[20] Nevertheless, the high prevalence of low iodine content in salt in our study is supported by the presence of a high prevalence of low urinary iodine excretion in our study participants. Urinary iodine excretion is a sensitive marker of iodine intake, and it reflects on the recent changes in iodine status.[21]

Indeed, low iodine content in edible salt can be a crucial factor for such a high prevalence of goitre, but other causes of dietary deficiency of iodine, like presence of goitrogen in common foods, cooking methods, environmental factors like presence of hardness in water, low iodine content in soil due to certain agricultural practices (pesticide use), can also lead to goitre.[22–25] However, exploring such additional factors was beyond our scope in this survey.

Limitations: As the diagnosis of goitre was clinical, we expect both false positive and false negative reporting from the assessor

Table 1: District wise prevalence of goitre among 6–12 years children in the rural areas of North Karnataka, India, 2016–19

District (Number of participants examined)	Goitre prevalence (%) (Number of participants with goitre (*n*); 95% CI)	Talukas	Taluk-level prevalence of goitre, *n* (%)	Taluka-level prevalence of low iodine content in household salt, *n* (%)
Raichur (2696)	13.6 (*n*=368; 95% CI: 12.3, 14.9)	Deodurga	43 (9.6)	52 (59.1)
		Manvi	81 (15.0)	61 (56.5)
		Sindhanur	101 (16.1)	78 (62.9)
		Linsugur	92 (14.6)	83 (65.9)
		Raichur	51 (11.3)	57 (63.3)
Kalaburgi (2581)	4.3 (*n*=112; 95% CI: 3.5, 5.1)	Gulbarga	19 (3.2)	36 (31.0)
		Jewargi	0 (0)	18 (52.9)
		Afzalpur	4 (0.8)	29 (26.9)
		Chitapur	32 (11.3)	19 (35.2)
		Chincholi	25 (9.7)	24 (44.4)
		Aland	32 (6.2)	25 (30.1)
		Sedam	0 (0)	21 (38.9)
Bagalkot (2700)	22.0 (*n*=593; 95% CI: 20.4, 23.6)	Bagalkot	78 (21.7)	53 (73.6)
		Badami	185 (34.3)	36 (33.3)
		Hungund	105 (23.3)	46 (51.1)
		Bilagi	64 (17.8)	25 (34.7)
		Mudhol	93 (20.7)	45 (50.0)
		Jamkhandi	68 (12.6)	50 (46.3)
Bidar (2638) (Goitre prevalence =)	28.4 (*n*=750; 95% CI: 26.6, 30.2)	Basavakalyan	152 (28.1)	19 (18.4)
		Bidar	60 (11.1)	21 (19.6)
		Humnabad	175 (36.5)	34 (31.2)
		Aurad	215 (39.8)	14 (13.0)
		Bhalki	148 (27.5)	9 (8.5)
Ballari (2505) (Goitre prevalence =)	20.2 (*n*=507; 95% CI: 18.9, 21.5)	Ballari	83 (12.4)	82 (56.9)
		Siraguppa	38 (15.1)	43 (79.6)
		Hospet	126 (37.5)	42 (58.3)
		Kudiligi	63 (18.4)	40 (55.6)
		Sandur	88 (26.3)	44 (61.1)
		Hadagali	44 (18.0)	35 (64.8)
		HB Halli	65 (19.9)	38 (52.8)
Koppal (3045) (Goitre	14.5 (*n*=442; 95% CI: 13.7, 15.3)	Koppal	11 (8.1)	27 (62.8)
		Gangavathi	25 (15.5)	112 (91.1)
		Kushtagi	9 (7.3)	65 (78.3)
		Yalbura	12 (11.9)	30 (56.6)
		Nelajeri	15 (23.4)	38 (77.6)

Nonendemic (<5%)
Mild (5–19.9%)
Moderate (20–29.9%)
Severe (≥30%)

despite rigorous training. To avoid false reporting on laboratory tests, we performed standardized techniques for sample collection, transport, storage, and testing.

Conclusion

North Karnataka has a high goitre prevalence even after decades of NIDDCP implementation in the state. Low use of iodized salt can be a major reason for the high prevalence of the condition. As a short-term measure, we strongly recommend ensuring the availability of iodized salt in this region. Simultaneously, periodic surveillance must go on to measure the impact of the programme. Besides, researchers/policymakers must pay attention to ruling out the other factors of dietary iodine deficiency among these populations. The primary-care physicians and the paediatricians of the region should keep iodine deficiency in mind and screen the children for hypothyroidism. They should encourage the parents for utilization of iodized salts for the prevention of IDD.

Key messages

- Goitre prevalence is high in Northern Karnataka.
- Usage of low iodine-containing salt is a common practice.
- Implementation of goitre reduction policies needs urgent re-evaluation.
- Periodic goitre surveillance needs to be continued.

Table 2: Urine excretion of iodine among 6–12 years rural children, North Karnataka, India, 2016–19

District (Number of samples tested)	Number of samples deficient in urine iodine (<100 μg/L)	Prevalence of low urine iodine excretion (95% CI)	Talukas	Prevalence (%) of urine iodine deficiency (<100.0) (*n*)
Raichur (277)	61	22.0 (17.0, 27.0) (Mild – 72.1, Moderate – 18.0, Severe – 9.9)	Deodurga	13.3 (6)
			Manvi	20.0 (11)
			Sindhanur	24.6 (15)
			Linsugur	9.4 (6)
			Raichur	37.0 (17)
Kalaburgi (233)	59	25.3% (19.6, 31.0) (Mild – 72.9, Moderate – 27.1)	Gulbarga	24.1 (7)
			Jewargi	20.0 (1)
			Afzalpur	24.7 (24)
			Chitapur	14.3 (1)
			Chincholi	14.3 (1)
			Aland	28.4 (25)
			Sedam	-
Bagalkot (270)	164	60.7% (54.7, 66.7) (Mild – 57.9, Moderate – 7.9, Severe – 34.2)	Bagalkot	72.4 (21)
			Badami	59.1 (26)
			Hungund	46.7 (21)
			Bilagi	55.9 (19)
			Mudhol	36.8 (14)
			Jamkhandi	66.7 (34)
Bidar (276)	190	68.8% (63.2, 74.4) (Mild – 66.3, Moderate – 7.4, Severe – 26.3)	Basavakalyan	31 (70.5)
			Bidar	28 (58.3)
			Humnabad	40 (78.4)
			Aurad	27 (60.0)
			Bhalki	26 (52.0)
Ballari (287)	192	66.9% (64.3, 72.5) (Mild – 74.0, Moderate – 9.9, Severe – 16.1)	Ballari	44 (55.7)
			Siraguppa	20 (66.7)
			Hospet	20 (50.0)
			Kudiligi	28 (73.7)
			Sandur	29 (78.4)
			Hadagali	21 (77.8)
			HB Halli	28 (82.4)
Koppal (274)	182	66.4% (60.7, 72.1) (Mild – 83.0, Moderate – 6.0, Severe – 11.0)	Koppal	53 (60.9)
			Gangavathi	34 (66.7)
			Kushtagi	40 (76.9)
			Yalbura	35 (61.4)
			Nelajeri	18 (75.0)

- Capacity building for physicians at primary-care level for diagnosis and management of goitre must be strengthened.

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Conflicts of interest

There are no conflicts of interest.

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