

# Burden of iodine deficiency disorders and its association with various sociodemographic variables in a district of North East India

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## ABSTRACT

**Introduction:** Iodine is one such micronutrient, the deficiency of which can impair the mental growth and development of young children and is the leading cause of preventable mental impairment. The present study has been conducted to study the prevalence of iodine deficiency disorders (IDDs) and its association with various sociodemographic variables among children (6-12 years) residing in the East Khasi Hills district of Meghalaya. **Methods:** The sample size was 2700 with a multistage 30 cluster sampling method. A questionnaire was used to collect data on the various sociodemographic variables. The weight and height of each child were recorded as per the standard procedure. In order to assess goitre, children were examined as per standard procedures prescribed by the National Iodine Deficiency Disorder Control Programme (NIDDCP). **Results:** A total of 2700 children were interviewed in total. Out of these, 1365 (50.5%) were males. The total goitre rate was found to be 195 (7.22%), indicating that IDDs are a mild public health problem in the study area. The median (interquartile range) urinary iodine excretion levels were 150 (108.05-189.37) µg/L. With respect to weight-for-age, it was observed that 93 (3.9%) children were severely underweight and 389 (16.8%) had severe stunting. A significant association was observed between goitre with the age group of children ( $p < .00001$ ), maternal education ( $p < .00001$ ), prevalence of stunting ( $p < .00001$ ), and underweight ( $p < .05$ ).

**Keywords:** Children, deficiency, goiter, iodine

## Introduction

In terms of micro-nutrient deficiencies, iodine deficiency (ID) has been one of the major public health problems in India. Deficiency of iodine leads to a spectrum of disorders affecting every stage of life beginning from pregnancy to childhood and adulthood. It can lead to hypothyroidism and impaired mental

and physical development in infants, children, and adolescents, which has far-reaching consequences into the later stages of life.<sup>[1]</sup> Also, it is important to mention that among micro-nutrient deficiencies, IDD deserves the highest priority because it is the world's single-most significant cause of preventable brain damage and mental retardation in children leading to learning disabilities and psychomotor impairment.<sup>[2]</sup> Children living in iodine-deficient areas on an average have a lower intelligence quotient (IQ) as compared to children living in iodine-sufficient areas.<sup>[3]</sup> Considering the magnitude of this problem, it is important that children be screened and treated early in life for any IDD so as to prevent any intellectual impairment in this

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vital age. The primary care physicians, especially those involved in school health programs, need to be vigilant so as to detect signs and symptoms of IDD in school-going children at an early stage. In sample surveys conducted in 325 districts all over India so far, 263 districts are found to be iodine deficiency disorder (IDD)-endemic.<sup>[4]</sup> Even though use of iodized salt is high in Meghalaya (93%),<sup>[5]</sup> very limited data are available regarding the burden of IDD in this region. The factors that contribute to the occurrence of IDD are complex, including environmental, social, economic, educational, and service-related, as indicated by previous studies.<sup>[6]</sup> With this background, the present study has been conducted to assess the prevalence of IDDs and its association with various socio-demographic factors in children of school-going age.

## Methodology

The present study was a cross-sectional study conducted in the East Khasi Hills district of Meghalaya for a period of 2 years and 6 months. The study population consisted of children belonging to the age group of 6–12 years. The sampling strategy was a multi-stage 30 cluster sampling method.

In the first stage, we collected the list of all the villages in the respective blocks of the district. The number of villages to be selected from each block was determined by proportionate sampling, that is, on the block size. Thereafter, Probability Proportionate to Size sampling was applied to select a total of 30 villages [Table 1]. We then selected one school present in each village randomly for data collection after getting the list from the Inspector of schools. The total sample size was 2700 (90 children each from 30 clusters). A sample of 90 children (45 boys and 45 girls) of the age group of 6–12 years from each school was enrolled for the study. We tried to select an equal number of children from each age group preferably, that is, approximately 14 children from each age group. For selecting the children from each class, systematic random sampling has been used. A pre-tested questionnaire was used to collect data on the socio-demographic variables.

The weight and height of each child were recorded as per the standard procedure, and Z-scores were interpreted as per the World Health Organization (WHO) child growth standards. The body mass index (BMI) was calculated. Moderate underweight and severe underweight were defined as the weight-for-age less than  $-2$  and  $-3$  SD, respectively, and moderate stunting and severe stunting were defined as the height-for-age less than  $-2$  and  $-3$  SD, respectively.

For assessing goitre, children were examined as per the standards prescribed by the National Iodine Deficiency Disorder Control Programme (NIDDCP). The standard palpation method was used for examining all children for goitre, and WHO criteria of grades 0, 1, and 2 were used to record the goitre score. All clinically reported goitre cases were verified by the principal investigator. The district was considered as

**Table 1: The final list of villages selected from each block**

| Block/urban | No. of clusters selected | List of villages  |
|-------------|--------------------------|---|
| Mawphlang   | 3 (71,491)               | Sohkhar<br>Jaud Lynghoi<br>Nongrum  |
| Myllem      | 12 (287,791)             | Madan Mawkhar<br>Nongrah<br>Laitkor Nongdaneng<br>Laitkor Lumheh<br>Mawlai<br>Pynthormukhrah (CT)<br>Nongmysong<br>Mawpat<br>Umpling<br>Nongthymmai<br>Madanriting<br>Nongksech |
| Mawrykneng  | 3 (67,291)               | Mawlynrei<br>Mawrykneng<br>Smit   |
| Mawkynrew   | 2 (44,602)               | Mawhali<br>Mawlein  |
| Laitkroh    | 2 (33,570)               | Laitsohma<br>Laitmawsiang   |
| Mawsynram   | 3 (54,109)               | Mawlum Tyrsod<br>Mawsynram Dongshilliang<br>Asimpara B  |
| Shella      | 2 (54,039)               | Kunongrim<br>Khahmohi   |
| Pynursla    | 3 (58,870)               | Nonjri<br>Mawpran Nonglyndiang<br>Nongjri Tluh  |

\*Population of each block is given in brackets

an endemic district if the total goitre rate was above 5% in children aged 6–12 years.<sup>[7]</sup>

In the present study, we collected urine samples from all children for analysis. The urine samples were collected in labelled plastic bottles (50 mL capacity with a screw cap and thymol crystals as a preservative), and spectrophotometric estimation of iodine in urine was performed in the laboratory. In case of delay in estimation, urine samples were stored in a deep freezer ( $-20$  degree Centigrade). For a median UIE level, a cut-off value of  $>99$   $\mu\text{g/L}$  was taken for the population. A level of  $<20$   $\mu\text{g/L}$  was defined as severe IDD.<sup>[7]</sup> Every fifth child selected in the class for goitre survey was covered for the collection of salt samples. Approximately 20 grams of the salt was collected in auto-seal plastic pouches and tested qualitatively on the spot with an MBI kit, and the iodine concentration was recorded as 0,  $<15$ , and  $>15$  ppm.

Descriptive analysis was used to describe the variables. Chi Square test was used to analyse association between variables. *P* value  $<.05$  was considered significant.

## Ethics

Consent has been taken from the Director of Mass Education and Inspector of Schools, East Khasi Hills district. Consent was

also taken via consent forms from the school authorities of each school surveyed.

Informed consent was taken from the parents of all the children who participated in the study. The consent forms were both in English and in local language, which were read out clearly by the research assistant, and any queries related to the research were duly addressed. Ethical clearance to conduct the study was taken from the Institutional Ethics Committee of the Institute.

## Results and Analysis

A total of 30 clusters were visited. A total of 2700 children were interviewed in total. Out of these, 1365 (50.5%) were males and 1335 (49.4%) were females. The distribution of children was almost equal across each age group.

The educational statuses of the parents are highlighted in Table 2.

With respect to the mother's occupation, 1141 (42.2%) were housewives, 1340 (49.6%) were self-employed, and only 219 (8.11%) were working women. With regard to the occupation of the father, 1796 (66.5%) were self-employed, 627 (23.22%) were employed in formal government or private sectors, and 277 (10.25%) were not engaged in any occupation.

On enquiring about the past history of disease, only 8.4% informed that they had significant past history of diseases. On enquiring about the performance of the student in the class for which the information was provided by the school teacher, 528 (19.5%) students were good, 1744 (64.5%) students were average performers, and 428 (15.8%) of them were poor performers. A total of 926 (32%) of the students had failed in previous classes. Most of the children 2658 (98.4%) were active and playful in the class, and only 42 (1.55%) were less active. Most of the children were able to understand and follow the teacher's instructions in class (2601) (96.3%), whereas only 99 (3.66%) were not able to do so. It was observed that 82 (2.8%) of the children had hearing defects and only 33 (1.1%) were found to have any speech defects. On examination, it was observed that the skin of 370 (13.70%) of the children was very coarse and dry, whereas the rest 2330 (86.2%) had a normal skin.

**Table 2: The educational status of parents of the study group**

|                | Mother's Education |        | Father's Education |        |
|----------------|--------------------|--------|--------------------|--------|
|                | No                 | %      | No                 | %      |
| Illiterate     | 374                | 13.85% | 554                | 20.51% |
| Primary        | 768                | 28.44% | 802                | 29.70% |
| High School    | 826                | 30.59% | 743                | 27.51% |
| Class XII pass | 125                | 4.62%  | 233                | 8.62%  |
| Graduate       | 119                | 4.40%  | 122                | 4.51%  |
| Post graduate  | 4                  | 0.14%  | 4                  | 0.14%  |
| Unknown        | 484                | 17.92% | 242                | 8.96%  |
| Total          | 2700               | 100.00 | 2700               | 100.00 |

The anthropometric measurements that were taken were height and weight. The Z-scores were calculated and classified as per WHO classification. With respect to weight-for-age, it was observed that 93 (3.9%) and 531 (19.6%) children were severe and moderately underweight, respectively. A total of 289 (10.70%) and 501 (18.55%) children had severe and moderate stunting, respectively [Table 2]. With respect to BMI for age, it was found that only five (0.18%) were obese, 104 (3.85%) were overweight, 695 (25.7%) had thinness [Table 3].

On examination of goitre and classification, it was observed that 2505 (92.77%) had no goitre (grade 0), 175 (6.48%) had grade 1 goiter, and 20 (0.74%) had grade 2 goiter. The total goiter rate was found to be 195 (7.22%). Thus, IDD was found to be more than the cut-off (5% as per the International Council for Control of Iodine Deficiency Disorders), that is, 7.22%. From these clinical findings, we can interpret that IDD is a mild public health problem in the study area. The prevalence was higher in the age group of 9–12 years (12.2%) than in younger children (5.5%) ( $P < 0.001$ ). With respect to urinary iodine excretion (UIE), 2146 (79.4%) had adequate levels between 100 and 199  $\mu\text{g/L}$ . It was found that 410 (15.1%) had levels between 50 and 99  $\mu\text{g/L}$ , 71 (2.62%) had UIE levels between 20 and 49  $\mu\text{g/L}$ , and only 69 (2.55%) had levels below 20  $\mu\text{g/L}$ . The median [interquartile range (IQR)] UIE levels were 150 (108.05–189.37)  $\mu\text{g/L}$ . This was found to be normal as per ICCIDD classification. A total of 518/540 (95.9%) salt samples tested had adequate an iodine content of  $>15$  ppm.

Table 4 highlights the goitre prevalence with respect to different variables. A significant association was observed with the age group of the child ( $p < .0001$ ), maternal education ( $p < .00001$ ), prevalence of stunting ( $p < .00001$ ), and underweight ( $p < .05$ ). No association was observed between goitre prevalence and the gender of the child.

## Discussion

The present study reported a 7.22% prevalence of goitre in school-going children, which was more than the 5% cut-off, signifying that IDD was a public health problem in this region. A study conducted in Madhya Pradesh revealed a total goitre rate of 2.81%.<sup>[8]</sup> Another study conducted in the Jammu region of India reported an overall goitre prevalence of 11.98%,<sup>[9]</sup> which is higher in comparison to our study. The median (IQR) UIE levels in this study were found to be 150 (108.05–189.37)  $\mu\text{g/L}$ . This was well above the cut-off level of  $>99$   $\mu\text{g/L}$ . A total of 69 (2.55%) children had levels below 20 micro g/L. A study conducted by Kapil U in a district of Rajasthan found the median UIE to be 200 mcg/L, which is mostly comparable to our study. The percentage of children with UIE  $<20$  micro g/L was 1.1%. This is lower than 2.55% found in our study.<sup>[10]</sup> The study conducted by Bhat IA *et al.*<sup>[9]</sup> in the Jammu region showed that the median UIE was 96.5  $\mu\text{g/L}$ , whereas in a study conducted in the Damoh district of Madhya Pradesh, the median UIE level was 175  $\mu\text{g/L}$ , and 25.9% children had insufficient UIE in their

**Table 3: The classification of nutritional status based on weight-for-age, height-for-age, and BMI for age**

| Weight-for-Age                             | No. (%)     | Height-for-Age                          | No. (%)     | BMI for Age            | No. (%)     |
|--|-------------|---|-------------|------------------------|-------------|
| Severe underweight<br><-3.00 WAZ           | 93 (3.44)   | Severe stunting<br>< -3.00 HAZ          | 289 (10.70) | Obese (>+2SD)          | 5 (0.2)     |
| Moderate underweight<br>-3.00 to -2.01 WAZ | 531 (19.6)  | Moderate stunting<br>-3.00 to -2.01 HAZ | 501 (18.55) | Overweight (>+ 1SD)    | 104 (3.6)   |
| Mild underweight<br>-2.00 to -1.01 WAZ     | 674 (24.9)  | Mild stunting<br>-2.00 to -1.01 HAZ     | 968 (35.85) | Normal (-1SD to +1 SD) | 1896 (70.2) |
| Normal<br>± 1.00 WAZ                       | 1402 (51.9) | Normal<br>± 1.00 HAZ                    | 942 (34.88) | Thinness (<-2SD)       | 695 (25.7)  |
| Total                                      | 2700 (100)  | Total                                   | 2700 (100)  | Total                  | 2700 (100)  |

\*WHO Child growth standards, 2006

**Table 4: Goitre prevalence with respect to different variables**

|                       | Goitre Present n (%) | Goitre Absent n (%) | Chi Square (P)                         |
|-----------------------|----------------------|---------------------|--|
| Age                   |                      |                     |  |
| 6-<9 years            | 91 (3.37)            | 1655 (61.29)        | Chi sq=29.803;<br>P<0.00001            |
| 9-12 years            | 104 (3.85)           | 850 (31.48)         |  |
| Gender                |                      |                     |  |
| Male                  | 101 (3.74)           | 1264 (46.81)        | Chi Sq=0.1291;<br>P=.719323, P>0.05    |
| Female                | 94 (3.48)            | 1241 (45.96)        |  |
| Maternal Education    |                      |                     |  |
| Illiterate            | 71 (3.20)            | 303 (13.6)          | Chi square=135.5423,<br>P<.00001       |
| Primary               | 102 (4.60)           | 666 (30.05)         |  |
| High school and above | 19 (0.85)            | 1055 (47.60)        |  |
| Underweight           |                      |                     |  |
| Normal                | 83 (3.07)            | 1319 (48.85)        | Chi square=7.379,<br>P=.006598; P<0.05 |
| Underweight           | 112 (4.14)           | 1186 (43.92)        |  |
| Stunting              |                      |                     |  |
| Normal                | 101 (3.74)           | 841 (31.15)         | Chi Square=26.441.<br>P<0.00001        |
| Stunted               | 94 (3.48)            | 1664 (61.63)        |  |
| Total                 | 195 (7.22)           | 2505 (92.78)        |  |

\*\*NB: The denominator for maternal education is taken as 2216 as educational statuses of 484 mothers were not known

samples.<sup>[8]</sup> High goitre incidence with normal median UIE, as in this study, has been observed from some other regions in India as well.<sup>[11]</sup> This may result as the thyroid size reflects previous iodine nutrition and goitre may take years to shrink even after attaining iodine sufficiency.<sup>[12]</sup> The iodine content of 95.9% salt samples was adequate, which is similar to the studies conducted earlier. At the national level, the household coverage of iodized salt was 91.7%.<sup>[13]</sup>

A higher prevalence of goitre has been observed in the 9–12-year age group in this study, which is similar to the study conducted by Chaudhary *C et al.*<sup>[14]</sup> No significant difference was observed in the goitre rates between males and females in the present study [Table 3]. A systematic review on the relationship between goitre status and gender revealed that the proportional prevalence of goitre was greater for females than males [0.54 (95% CI = 0.53-0.56) versus 0.46 (95% CI = 0.44-0.47)].<sup>[15]</sup> Another study conducted by Chaudhary *C et al.*<sup>[14]</sup> in Haryana revealed that the goitre prevalence was more in females (p =0.0003), which is unlike the present study. This may be attributed to the various socio-cultural factors in this region. Our study showed a significant association of goitre prevalence with maternal education. This could be explained by the fact that the educated

mothers would have more knowledge on adequate dietary practices and also understand the importance of consumption of iodized salt in children. The present study showed a significant association between goitre and the prevalence of stunting and underweight in children, as also noted in other studies. A study conducted in Gujrat, India, shows that protein-energy malnutrition (PEM) was highly prevalent in mild to moderately iodine-deficient school children and adults of Gujarat (western India).<sup>[16]</sup> Another study conducted in Nigeria found a significant association between goitre and stunting (p < 0.05).<sup>[17]</sup> A study conducted among children aged 7–15 years in Kyrgyzstan found that children with goitre showed a higher prevalence of stunting and being underweight.<sup>[18]</sup> Evidence from other studies also supports that PEM could be one of the factors for IDD.<sup>[19]</sup> A study conducted among Turkish school children found that the BMI Z-score and weight-for-height were significantly lower in children with palpable goitre than in children without goitre.<sup>[20]</sup> The association of goitre with malnutrition may be because of various factors. Iodine absorption decreases in children with PEM.<sup>[16]</sup> Also, decreased iodine clearance and uptake may also lead to a decreased iodine concentration in the thyroid gland.<sup>[21]</sup> Thus, PEM can affect the thyroid haemostasis in various ways, particularly in regions with IDD.<sup>[22]</sup>

As mentioned above, IDD continues to exist as a public health problem in Meghalaya. This also has a significant effect on the intellectual development of children. Screening of school-going children for malnutrition and IDD can be a very vital tool for early intervention and treatment. This will help prevent any developmental delay or intellectual impairment in children. Primary care physicians need to be vigilant and oriented in order to detect any signs and symptoms of IDD in children. School health programs need to include IDD disorders in their health screening module with orientation of the health staff involved in screening of children. Because of their association with malnutrition, integration of IDD control efforts with existing nutrition programs in the context of health promotion can bring significant changes at the community level.

The limitations in the present study were that confirmation of IDD for those with goitre could not be performed by thyroid function tests because of difficulty in obtaining serum samples from school-going students. It was also difficult to predict the iodine status of an individual by a spot sample of UIE instead of a 24-hour sample, which was difficult to obtain because of technical reasons.

## Conclusion

From the present study, it was found that the total goitre prevalence is 6.72%, which indicates that IDDs are still a public health problem in Meghalaya. The median UIE was 150 micro g/dl, which was normal. IDD was significantly associated with stunting and underweight. This necessitates the need to screen school children for early detection and intervention so as to prevent any intellectual impairment. Primary care physicians involved in school health programs can play a vital role in screening and early detection of IDD in children. They are also required to provide orientation to the health staff involved in the screening programs for children. Integration of health promotion activities under the existing nutrition programs with the IDD control efforts can go a long way in reducing the burden of both malnutrition and IDDs in this region.

## Key Message

- IDDs continue to exist as a public health problem in this region of Meghalaya.
- It is difficult to predict IDD just by examination of the neck. Monitoring of UIE and monitoring of salt content of iodine are other useful tools to predict IDD.
- Screening of school-going children along with the generation of awareness regarding the consequences of IDD among the population is important.
- Integration of IDD control programs with other nutrition programs will strengthen the IDD control efforts in this region.

### Take Home Message:

- IDD and malnutrition can coexist in many children, which may significantly impair the intellectual development in children.
- Primary care physicians need to be vigilant and oriented so

as to detect and treat these deficiencies in children at an early stage.

- Health education programs need to impart knowledge of IDD and its prevention at the community level along with existing nutrition promotion activities.

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## Conflicts of interest

There are no conflicts of interest.

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