Dietary supplies of iodine & thiocyanate in the aetiology of endemic goitre in Imphal East district of Manipur, north east India

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Received January 2, 2007

Background & objectives: The present investigation was undertaken to study the iodine nutritional status of school children of Imphal east district in Manipur where endemic goitre persists during post-salt iodization phase along with the investigation of the factors responsible for the occurrence of goitre endemicity.

Methods: A total of 1,286 children (6-12 yr) were clinically examined for goitre from study areas of Imphal east district. A total of 160 urine samples were collected and analyzed to measure urinary iodine and thiocyanate levels. Iodine content was measured in 140 salt samples and 16 drinking water samples.

Results: Overall goitre prevalence was about 30 per cent (grade 1-24.7%; grade 2-5.3%) and median urinary iodine level was 17.25 μg/dl. The mean urinary thiocyanate level was 1.073 ± 0.39 mg/dl. Iodine/thiocyanate ratio (μg/mg) was in the ranges from 15.65 to 22.34. The mean iodine content in drinking water samples was 2.92 ± 1.75 μg/l and 97.8 per cent of edible salts had iodine level above 15 ppm at the consumption point.

Interpretation & conclusion: Our findings showed that in spite of no biochemical iodine deficiency, iodine deficiency disorders (IDD) is a serious public health problem in Imphal east district of Manipur. The consumption pattern of certain plant foods containing thiocyanate (or its precursors) was relatively high that interfere with thyroid hormone synthesis resulting in the excretion of more iodine. Thus, the existing dietary supplies of thiocyanate in relation to iodine may be a possible aetiological factor for the persistence of endemic goitre in the study region during post salt iodization period.

Key words Aetiology of goitre - dietary goitrogen - Manipur - urinary iodine - urinary thiocyanate
district was not for the deficiency of iodine intake but for factors other than iodine deficiency responsible for the occurrence of severe goiter endemicity. Thus the present investigation was undertaken to study the iodine nutritional status of school children in Imphal east district of Manipur and also look for the factors responsible for the occurrence of goitre endemicity.

Material & Methods

Selection of study area: Imphal east is a centrally located and thickly populated valley district of Manipur having the total area of about 670 sq km and population of about 3,93,780 (2001 Census Report) and is surrounded by four districts viz., Imphal west, Thoubal, Ukhrul and Senapati. This valley district is a high level flood plain with an elevation of about 760 meters above the mean sea level. A number of occasional hills and mounds rise above the flat surface which include Heingang, Nongmaiijing Ching, Waithou Ching, Chingarel Ching, etc. It has 7 towns and 3 rural Community Development (CD) blocks. In the present study, 4 localities-2 from rural blocks and 2 from urban areas were selected by random purposive sampling method covering geographically the entire district. In each selected area one primary school and the nearest adjoining secondary school were selected at random where the students of the age group 6-12 yr of both sexes were available as recommended by WHO/UNICEF/ICCIDD. Dietary survey showed that the people of these areas consume cyanogenic plant food containing goitrogenic/antithyroid substances as vegetables as well as they also consume bamboo shoot and its products regularly as common food items.

Clinical goitre survey: The entire study was conducted between November 2005 and August 2006. The expected total population of children in the age group 6-12 yr was 47,254 i.e., 12 per cent of total population. The age of the students was recorded from the school register and was rounded off to the nearest whole number. The Indian Council of Medical Research recommends that approximately 1 per cent of the population can provide valid estimates in a large homogenous population. Thus a sample of 473 students was considered adequate as per ICMR guidelines. However, all the students present in the classes at the time of survey, were considered for investigation. A total of 1,286 students were clinically examined for goitre. The clinical examination for goitre was conducted by trained research staff. Goitre grading was done according to the criteria recommended by joint WHO/UNICEF/ICCIDD (grade 0: no goitre; grade 1: thyroid palpable but not visible; and grade 2: thyroid visible with the neck in normal position).

Iodine and thiocyanate in urine: A total of 160 spot casual urine samples were collected from the clinically examined children (40 from each area) irrespective of their thyroid status at a definite interval maintaining proportionate representation from the entire population of the studied school(s) following ICCIDD/UNICEF/WHO criteria in wide mouth screw capped plastic bottles. To get the 40 samples in each study area, at first all the children were enrolled and then the enrolled children who were present on the day/days of survey were clinically examined for goitre. The enrolled number (suppose X) was divided by 40 to get the quotient value (i.e., X/40 = Y). Among the enrolled students starting from any number every Yth student was selected and was asked to collect urine in the containers on the same day irrespective of their thyroid status. A drop of toluene was added to each urine sample to inhibit bacterial growth and to minimize bad odor. Iodine in urine was determined by the arsenite method following dry ashing in presence of potassium carbonate maintaining internal quality control having a known concentration range of iodine content with each batch of test samples. Thiocyanate content in the urine was measured from the same collected urine samples used for iodine analysis by the method of Aldridge as modified by Michajlovskij and Langer. Iodine in salt and water: The sources of dietary iodine are water, food and the iodized salt available in the studied areas. To monitor the iodine content of salt samples available in the area, 35 marked air tight plastic containers were distributed at random to the students of the studied schools in each locality and they were asked to bring edible salt samples from their households the next day. The salt samples were kept at room temperature in the laboratory and iodine content was measured within a week following the iodometric titration method. Sixteen drinking water samples were collected at random (4 samples from each area) in the screw capped plastic bottles, brought to the laboratory, kept at 4°C and iodine level was measured following the method of Karmarkar et al.

Necessary permission for ethical clearance obtained from the Institutional Ethical Committee for the study.

Results & Discussion

A total of 1,286 children from the four study areas were clinically examined. The overall goitre prevalence
in school children in the Imphal east district was 30.02 per cent. Though most of the goitre was found palpable (24.73%), but visible goitre (5.29%) among the children of 6-12 yr was also noted (Table I). Thus as per clinical criteria of WHO/UNICEF/ICCIDD\textsuperscript{17}, IDD was a public health problem in this region during post-salt iodization period.

Urinary iodine is the most important biochemical indicator that indicates current state of iodine nutrition and also used as a valuable indicator for the assessment of IDD because 90 per cent body’s iodine is excreted through urine\textsuperscript{13}. In the four studied areas median urinary iodine level was in the ranges 14.5 to 20.25 μg/dl (Table II). In addition, urinary iodine values less than 5 μg/dl in more than 20 per cent sample was not found in any of the areas suggesting that as per WHO/UNICEF/ICCIDD\textsuperscript{19} there was no biochemical iodine deficiency or no inadequacy in iodine intake of the overall population.

WHO/UNICEF/ICCIDD recommends, 90 per cent of the household should get iodized salt at the level of 15 ppm\textsuperscript{19}. National Family Health Survey (NFHS-2) 1998-1999 reported that 87.9 per cent households used adequately iodized salt in Manipur\textsuperscript{20}. Our recent study showed that in Imphal west district the iodine content in edible salt at household level was about 97 per cent \textsuperscript{5}. The present study showed that more than 95 per cent of the households were consuming salts with adequate iodine levels (Table II). An indication of iodine content of the soil can be assessed by the local drinking water iodine concentration\textsuperscript{21,22}. Though there was no biochemical iodine deficiency or deficiency in iodine intake of the population as evidenced by urinary iodine excretion pattern and consumption pattern of iodine through edible salt, endemic goitre persisted throughout the studied region. Thus an attempt was made to find out the involvement of goitrogenic factors other than iodine deficiency for the persistence of this disorder.

The dietary practice of the people of the region was investigated. It was found that the people consume a large number of cyanogenic plants \textit{viz}, cabbage, cauliflower,

### Table I. Goitre prevalence in different studied areas of Imphal east district

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Rural/urban</th>
<th>Total no. of children examined</th>
<th>No. of children with goitre (%)</th>
<th>Severity as public health problem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Grade 1</td>
<td>Grade 2</td>
</tr>
<tr>
<td>Sawombung</td>
<td>Rural</td>
<td>298</td>
<td>77 (25.84)</td>
<td>22 (7.38)</td>
</tr>
<tr>
<td>Keirao</td>
<td>Rural</td>
<td>318</td>
<td>73 (22.96)</td>
<td>33 (10.38)</td>
</tr>
<tr>
<td>Andro</td>
<td>Urban</td>
<td>292</td>
<td>86 (29.45)</td>
<td>6 (2.05)</td>
</tr>
<tr>
<td>Lamlai</td>
<td>Urban</td>
<td>378</td>
<td>82 (21.69)</td>
<td>7 (1.85)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1286</td>
<td>318 (24.73)</td>
<td>68 (5.29)</td>
</tr>
</tbody>
</table>

### Table II. Urinary iodine and thiocyanate (SCN) excretion pattern of studied population and iodine content in edible salt and drinking water of Imphal east district

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Median %urine samples &lt; 10 μg/dl</th>
<th>% urine samples &lt; 5 μg/dl</th>
<th>Urinary SCN level mg/dl (Mean ± SD)</th>
<th>Mean of individual I/SCN ratio ± SD (μg/mg)</th>
<th>No. of individual I/SCN &lt;3</th>
<th>&lt;7</th>
<th>% salt samples containing iodine &gt; 15 ppm</th>
<th>Iodine content in drinking water (μg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawombung</td>
<td>15</td>
<td>30</td>
<td>12.5</td>
<td>0.994 ± 0.356</td>
<td>18.75 ± 9.05</td>
<td>-</td>
<td>4</td>
<td>97.1</td>
</tr>
<tr>
<td>Keirao</td>
<td>17</td>
<td>17.5</td>
<td>2.5</td>
<td>0.855 ± 0.262</td>
<td>22.34 ± 8.32</td>
<td>-</td>
<td>2</td>
<td>94.3</td>
</tr>
<tr>
<td>Andro</td>
<td>14.5</td>
<td>13.5</td>
<td>8</td>
<td>1.023 ± 0.293</td>
<td>17.42 ± 7.15</td>
<td>-</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Lamlai</td>
<td>20.25</td>
<td>7.9</td>
<td>0</td>
<td>1.427 ± 0.483</td>
<td>15.65 ± 5.31</td>
<td>-</td>
<td>1</td>
<td>97.1</td>
</tr>
<tr>
<td></td>
<td>17.25</td>
<td>17.4</td>
<td>5.8</td>
<td>1.073 ± 0.390</td>
<td>18.23 ± 7.76</td>
<td>-</td>
<td>8 (5%)</td>
<td>97.8</td>
</tr>
</tbody>
</table>

No. of urine samples from each area – 40; total urine samples: 160. No. of salt samples from each area – 35; total salt samples: 140. No. of drinking water samples from each area – 4; total water samples: 16.
radish, mustard, turnip, beans, etc. along with a large amount of bamboo shoot and its products as common food throughout the year. Indian cyanogenic plant foods are known to have potent anti-thyroid activity. Regular consumption of this type of food affects thyroid physiology and may cause endemic goitre in long run. The amount of thiocyanate in the urine is also a good indicator for the presence of goitrogen in foods. A study conducted in Tripura reported that prevalence of moderate degree of goitre among school children during post-salt iodization phase was due to non uniform adequate iodine supply associated with thiocyanate load. Marwaha et al also observed that thiocyanate appears to play an important role in goitre formation especially among poor children in India during post iodization phase. The mean urinary thiocyanate levels from non-endemic population was reported to be 0.504 ± 0.197 mg/dl. In our present study, the overall mean urinary thiocyanate value was almost double i.e., 1.073 ± 0.390 mg/dl and in all the studied areas the mean urinary thiocyanate values were much higher than the value found in non endemic area.

Available literature suggests that development of goitre does not necessarily depend upon the consumption of large quantities of food containing thiocyanate (SCN) precursors but is critically related to the balance between dietary supplies of iodine and thiocyanate. The dietary supplies of I and SCN are determined from the urinary I/SCN ratios (µg/mg). The ratio is >7 under normal conditions and endemic goitre develops when it reaches a critical threshold of about 3. The means of individual I/SCN ratios obtained in the present study was well above the critical level. However, it was found that there were individuals having I/SCN ratios below 7 but above 3 in each study area. On an average 5 per cent of the studied population had I/SCN ratio < 7 and thus they were susceptible for the development of goitre. Not only thiocyanate but also its precursors such as goitrin and isothiocyanates have potent antithyroid/anti-thyroid peroxidase activity and thus iodine supplementation at the present level fails to prevent this condition.

The concentration of cyanogenic glucosides, glucosinolates and thiocyanate in both uncooked and cooked condition is quite high in bamboo shoots. It has been reported that chronic bamboo shoot consumption gradually develops a state of morphological as well as functional hypothyroidism. Extra iodine supplementation though reduces the anti-thyroid effect of bamboo shoot to an extent but could not reverse it. Thus, consumption of bamboo shoot in different forms in almost a regular proportion in addition to the other cyanogenic food may have a contributory role for the persistence of severe degree of goitre endemicity in the studied region. Thiocyanate and thiocyanate like compounds interfere with iodine metabolism by reducing iodide uptake, stimulating iodide efflux and replacing iodide by thiocyanate in thyroid gland. Thiocyanate or thiocyanate like compounds also inhibit the iodine concentrating mechanism by inhibiting unidirectional clearance of iodide from the thyroid gland or in other words iodine retaining capacity of thyroid/ body appears to be dependent on consumption pattern of cyanogenic plant foods. Therefore most of the iodine is removed from the thyroid gland and ultimately from the body due to thiocyanate overload leaving less iodine for the synthesis of thyroid hormone.

In conclusion, our study reveals that the urinary iodine does not always truly reflect the iodine nutritional status in an environment where consumption of foods containing thiocyanate precursors is relatively high. Thus the existing dietary supplies of thiocyanate in relation to iodine intake may be a possible aetiological factor for the persistence of endemic goitre in the studied region.

Acknowledgment

The authors acknowledge the co-operation received from the staff and students of the schools studied.

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