ORIGINAL ARTICLE

Association of iodine status with IQ level and academic achievement of rural primary school children in West Bengal, India

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Abstract

Background: Iodine being an integral component of the thyroid hormones is crucial for physical and mental development. Iodine status & intake is often measured by a surrogate measure, namely urine iodine excretion, as almost all ingested iodine is excreted in the urine. **Aims &Objectives:** To investigate the body Iodine status of rural primary school children and its association with their intelligence level (IQ) & academic achievement. **Materials & Methods:** A cross-sectional analytical study was carried out in three Government schools in the district of 24 Parganas, West Bengal, India among 300 children (150 boys & 150 girls) aged 6 to 8 years studying in class II to IV. Urinary iodine was estimated by the 'Wet Digestion Method (Sandell-Kolthoff reaction). IQ level was evaluated using Ravens Progressive Matrices test. Academic achievement was evaluated on the marks obtained in the term end examinations. **Result:** 12.34%, 15.6% & 24.3% of the children were in the severe, moderate & mild range of iodine deficiency in terms of urinary iodine excretion. It was found that 85.67% & 14.33% of the children were consumed iodated salt ≥15 ppm &< 15 ppm of iodine level. 0.67%, 5% & 27.34 % of them achieved A, B & C of IQ grades, respectively.62.34 % of the students achieved first three academic grades. Body Iodine status of the children has significant positive correlation (P<0.01) with IQ grades and academic achievement. Academic achievement of the children has significant positive correlation (P<0.05) with their intelligence level. **Conclusions:** Poor body Iodine status of the rural primary school children may be one of the causes for their poor intelligence level and academic achievement.

Key Words

Primary school children; Body Iodine Status; Intelligence level; Academic achievement

Introduction

The iodine nutritional status of a population is typically measured by its urinary iodine excretion(UIE) or estimated by indirect measurements such as thyroid volume, goiter prevalence, the thyroid stimulating hormone (TSH) concentrations, or serum thymoglobulin concentrations (1,2,3,4). Iodine deficiency disorders and the surveillance of iodine nutrition status in general have recently been thoroughly reviewed (5).UIE measurements, however, are the most suitable methods for assessing dietary iodine intake. A relatively large fraction of iodine excretion occurs via urine (5,6,7,8). The small portions are excreted in the feces, about 5–10%, and through sweat (6,7,9). Iodine from ingested food initially circulates as iodide. After ingestion iodine is either excreted in the urine, mostly within 24 hours of ingestion, or taken up by the thyroid. If taken up by the thyroid it is incorporated into thyroid hormones but eventually excreted in the urine as thyroid hormones are secreted and degraded.

Iodine deficiency is the single greatest cause of preventable mental retardation. Hypothyroidism during fetal and postnatal life also interferes with normal development and maturation of Central

Nervous System (10,11). But the problem is easily and inexpensively prevented by iodizing salt for human and animal consumption (12). Data from the WHO Global Database on Iodine Deficiency indicate that general iodine intake is below this level in at least 47 countries and among an estimated 31.5% of school-age children worldwide (13).

Globally, India has the largest number of children born vulnerable to iodine-deficiency (14). Iodization of salt is widely regarded as the most effective and sustainable long term public health measure for the prevention and control of IDDs. In order to achieve improved iodine status, NIDDCP need to be constantly monitored due to the fact that IDD simply re-appears if salt iodization is discontinued. This may happen when the responsible public health authorities are demobilized or if the salt industry fails to effectively monitor iodine content. In order to assess the sustainability of control programmes and track their progress towards the IDD elimination goal, criteria have been established by WHO (15).

There is possibility of a strong connection between nutrition and learning. Nutrition, genes, and environment are three major factors impacting cognitive development. Importance of good nutrition in children's mental development and learning is important. Nutrition during the early years of a child's life is linked to performance in later years.

In West Bengal children suffer from various nutritional deficiencies which may contribute to their lower achievement in school performance (16). Iodine deficiency disorder is a public health problem in this state. Five districts of the state were included in the nationwide survey by Directorate General of Health services & all the five districts were declared endemic (17). 60% of the rural families in West Bengal had practice of consuming iodated salt ≥15 ppm, 31.9% of them were using a salt having undesirable level (< 15 ppm) of iodine while 8.1% were using non-iodized salt (18). Unfortunately, apparently no data is available on the role of iodine status in primary school children's academic performance & IQ status.

Aims & Objectives

1. To assess the current status of IDD among rural students by estimating urinary Iodine and iodine content of salt consumed by this population.
2. Association of academic performance & IQ level with iodine status of the school children is also determined

Material and Methods

The methodology adopted was a complementary approach using both qualitative and quantitative methods.

Academic achievement of the students were evaluated using following grading from the scores obtained by the participants as per regulations of West Bengal council of primary education:

Grade A - 81 to 100%
Grade B - 66 to 80%
Grade C - 51 to 65 %
Grade D - 36 to 50%
Grade E – 21 to 35%
Grade F - 0 to 20%

Study area and subjects: This study was carried out among four rural primary school children at the Shimulpur, Salka, Kumarhut Village, in the districts of 24 Parganas North & South, West Bengal. A total of 300 students aged 6–8 years (150 boys & 150 girls) participated in this study.

Ethical consideration: The study was approved by the Institutional Ethical Committee of All India Institute of Hygiene & Public Health, Kolkata, Ministry of Health & Family Welfare, and Govt. of India.

The school teachers and parents were briefed about the activities to be undertaken during the study & written informed consent was obtained from the parents of all subjects.

Data analysis: Statistical analysis of the data was performed using the Statistical Package for Social Sciences for Windows SPSS (version 21.0).

Results

According to the UIE level, out of 150 boys 51.25% were normal but 10.25%, 17.28%, 21.22% of the children were in the severe, moderate & mild range of iodine deficiency, respectively; out of 150 girls 44.09% were normal but 14.43%, 13.92%, 27.56% of the children were in the severe, moderate & mild range of iodine deficiency respectively; Out of total 300 school children 47.67% were normal but 12.34%, 15.6% & 24.3% of the children were in the severe, moderate & mild range of iodine deficiency respectively (Figure 1).

Out of 150 boys 83.42%, 12.15% and 3.4% children consumed common salt having iodine level ≥15 ppm, < 15 ppm & 0 ppm respectively; Out of 150 girls 87.92 % ,7.19% and 5.92% children consumed common salt having iodine level ≥15 ppm, < 15 ppm & 0 ppm, respectively; Out of 300 children 85.67%, 9.67% & 4.66% children consumed common salt having iodine level ≥15 ppm, < 15 ppm & 0 ppm respectively(Figure 2).

According to the Raven Progressive Matrices test out of 150 boys 1.33%, 6%, 26.67%, 18% and 48% scored grade I, II, III, IV and V, respectively; out of 150 girls none scored grade I, grade II, III, IV and V scored by 4%, 28%, 17.34% and 50.66% girls, respectively; Out of total 300 school children .67%, 5%, 27.34%, 17.66% and 49.33% scored grade I, II, III, IV and V, respectively (Figure 3).

The study revealed that according to academic gradation out of 150 boys 9.34% obtained grade A, 21.34% grade B, 28.66% grade C, 23.34% grade D, 12.67% grade E & 4.66% grade F; out of 150 girls 16.67% obtained grade A, 22% grade B, 26.67% grade C, 19.34% D, 12% grade E & 3.33% grade F; out of total 300 children 13% obtained grade A, 21.67% grade B, 27.67% grade C, 21.33% grade D, 12.33% grade E & 4% grade F (Figure 4).

Discussion

The urinary iodine level reflects an individual's iodine consumption as 90% of the body'siodine is excreted through urine, and thus the excretion of iodine is used as a biochemicalmarker of iodine intake (25). This study had comprehensively examined the iodine status of a representative sample of school children using valid biochemical & chemical indices. The study revealed that 51.25% boys & 44.09% girls were normal in terms of urinary iodine level (Figure 1). This study shows that there were good population indices (24.3%) of mild iodine deficiency. Little is known about the consequences of mild iodine deficiency in childhood as most research has focused on the effects of moderate and severe iodine deficiency. Girls (28.35%) were found to be more iodine deficient in comparison to boys (27.53%) in terms of severe & moderate level of urinary iodine (Figure 1).

Median urinary iodine excretion value of 104 µg/l (Figure 1) was higher than the cut off value of 100 µg/l as per WHO (15).The proportions of values less than 100 µg/l and less than 50 µg/l were also well above the program targets of <50% and <20%, respectively. These findings along with median UIE values indicate that there was no iodine deficiency in the population. In West Bengal the study conducted in Malda(26) observed median UIE level of 150 µg/l and in Birbhum(27)124 µg/l. These findings corroborate with the outcome of the present study. However, the study conducted in Howrah (28) district revealed median UIE level as high as 350 µg/l. The strength of this study was that the salt samples were obtained from the same households where the children resided. This has provided the opportunity to analyze the relationships between consumption of iodized salt, approximated by the salt iodine content in the households, and the iodine status of the population, which in this study is reflected by the urinary iodine concentrations in children living in these households. It was found that 85.67% of the children had the practice of consuming iodated salt ≥15 ppm while 14.33% of them were using a salt having undesirable level (< 15 ppm) of iodine of which 4.66% were non-iodized (Figure 2). Urinary iodine level has significant positive correlation (r =.795, P<0.01) with salt iodine level which clearly established the fact that low iodine consumption from iodated salt is responsible for undesirable iodine status in children.

During infancy, an adequate amount of iodine is required for normal mental development (29,30); a meta-analysis estimated that iodine deficiency in a population lowered mean IQ scores by 13.5 points(31,32).The study revealed undesirable outcome regarding IQ results although current practices in consumption of salt iodine was optimum in families. Only 5.67% students achieved first two IQ grades (Figure 3). While only 1.33% boys scored first grade, none among the girls achieved this highest grade.

Only 34.67% of the study population was found to achieve either A or B Grade in their academic activities, whereas 37.56 % of them failed to achieve better than D Grade (Figure 4). This reflects a poor level of academic achievement of the children. Lower IQ level may be one of the reasons. These findings strongly indicate the positive influence of iodine on IQ development and academic performance.

IQ grades of the children has significant positive correlation (r =.213, P<0.01) with urinary iodine level. Academic achievement of the children has significant positive correlation with their intelligence level (r =.115, P<0.05) & urinary iodine level (r =.436, P<0.01).

Conclusion

The study among the primary school children revealed that:

- Low urinary iodine level prevails among them despite consuming desirably iodized common salt by a large cross-section of them.
- Low intake of iodine from iodated salt is responsible for undesirable iodine status.
- Urinary iodine level is significantly associated with IQ and academic achievement of the study population.

Recommendation

Appropriate action should be taken to ensure adequate iodine intake by the primary school children studied by periodic monitoring of the iodine level of the salt they consume.

Limitation of the study

Estimation of iodine in the salt sample by iodimetric titration would have been provided a more reliable result than the semi-quantitative method used.

Relevance of the study

1. There was no report on the prevalence of iodine deficiency among the studied population.
2. No study has been done prior to our study to associate iodine deficiency with IQ and school performance among the primary school children in West Bengal.

Authors Contribution

KB: Concept design, Data collection, Acquisition & analysis of data, Literature search, Manuscript drafting, IM: Concept design, interpretation of data & critical revising of manuscript, DC : Concept design & planning for data collection, Concept for manuscript drafting & final approval.

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Tables

TABLE 1CRITERIA FOR ASSESSING IODINE DEFICIENCY BASED ON URINARY IODINE LEVEL USED IN THE STUDY

Median UI (μg/l)	Iodine intake	Iodine nutrition
< 20	Insufficient	Severe iodine deficiency
20–49	Insufficient	Moderate iodine deficiency
50–99	Insufficient	Mild iodine deficiency
100–199	Adequate	Optimal iodine nutrition
200–299	More than adequate	Risk of iodine-induced hyperthyroidism within 5–10 years following introduction of iodized salt in susceptible groups
>300	Excessive	Risk of adverse health consequences (iodine induced hyperthyroidism, auto-immune thyroid diseases)

Source: WHO et al.

TABLE 2PARAMETERS MEASURED

PARAMETERS	TOOLS/METHODS
ACADEMIC RESULTS	Term end results of individuals
URINARY IODINE	Wet Digestion Method (Sandell-Kolthoff reaction) (19)
SALT IODINE	Spot kit test method (Produced by MBI Chemicals, Chennai, India) (20) (21) (22) (23)
PSYCHOLOGICAL TEST (IQ) OF THE LEARNERS	Raven's Progressive Matrices Test (non-verbal intelligence test)(24)

ASSESSMENT ACADEMIC ACHIEVEMENT OF THE LEARNERS

Figures

FIGURE 1DISTRIBUTION OF THE SCHOOL CHILDREN ACCORDING TO THE URINARY IODINE EXCRETION (N=300)

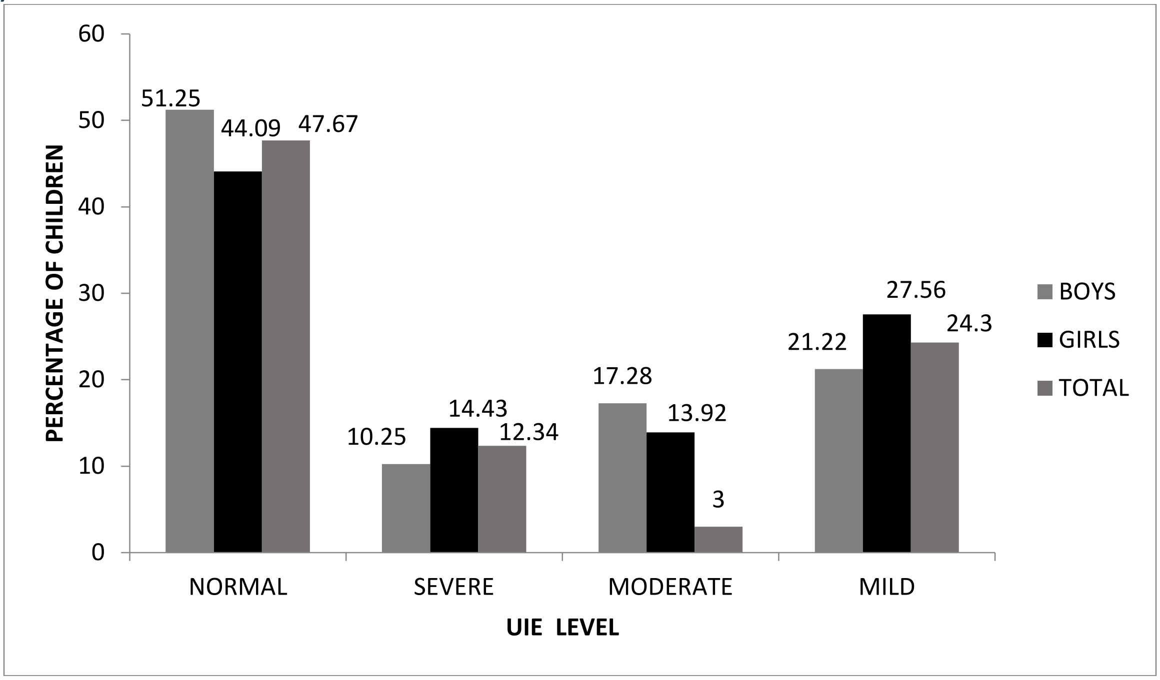

FIGURE 2DISTRIBUTION OF THE SCHOOL CHILDREN ACCORDING TO THE SALT IODINE CONSUMPTION (N=300)

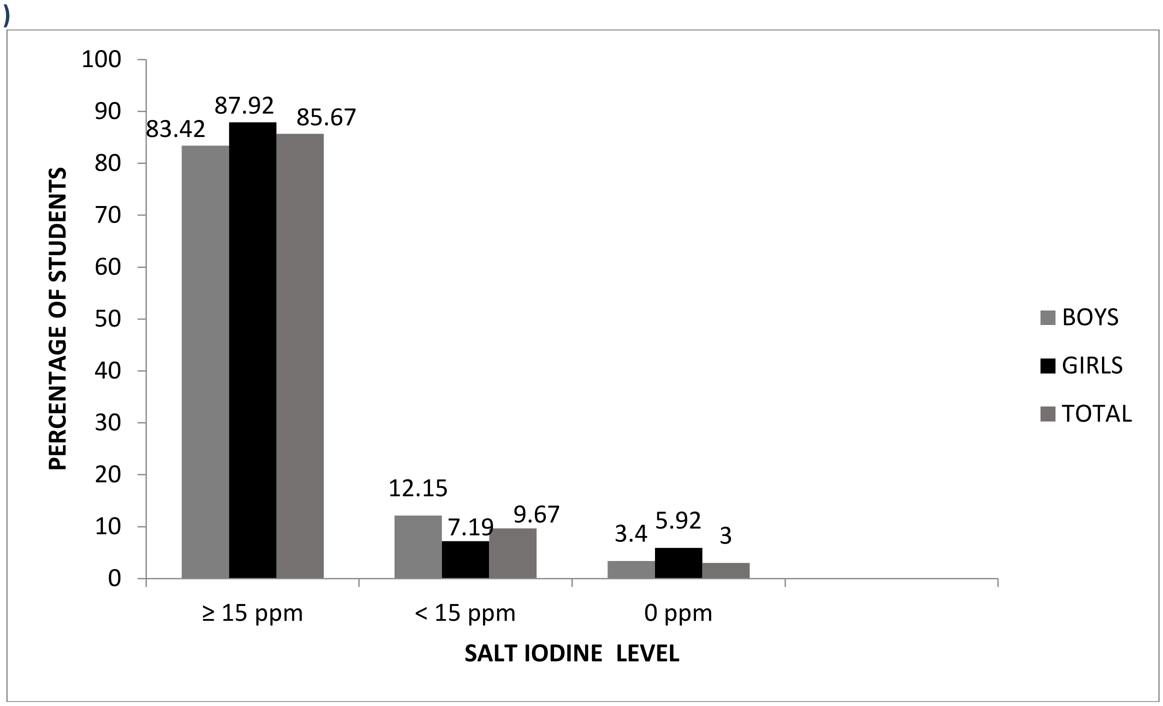

FIGURE 3 DISTRIBUTION OF THE SCHOOL CHILDREN ACCORDING TO THE RAVEN PROGRESSIVE MATRICES TEST (N=300)

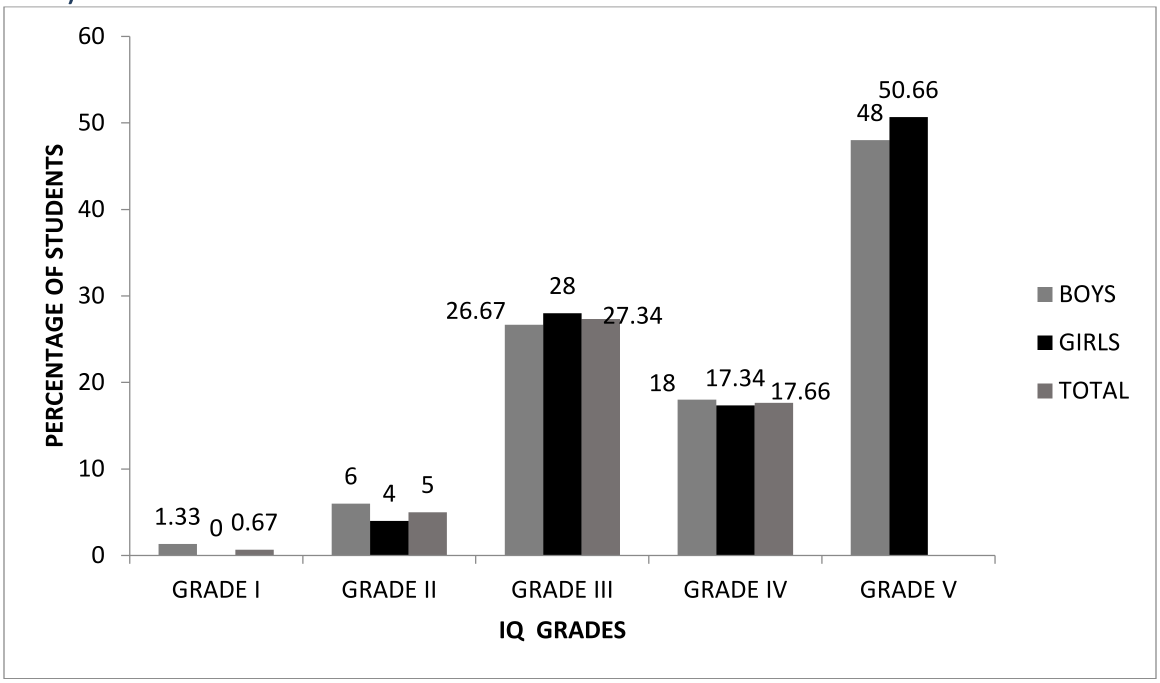

FIGURE 4 DISTRIBUTION OF THE SCHOOL CHILDREN ACCORDING TO THE ACADEMIC GRADATION (N=300)