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Iodine intake from food,water and salt and its implication on goiter-the endemicity-A study of Bihar

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ABSTRACT

An epidemiological study for goiter and other nutritional deficiencies was conducted in Vaishali and Gaya district of Bihar using an interview scheduleof 601 schoolchildren to establish the goiter endemic and non-endemic area.A comprehensive study of 60 school children, thirty from Vaishali and Gaya each was carried out.Cooked food and water sample of each child in the summer and winter season was collected using duplicate dietary sampling technique.Total iodine intake in goiter endemic area and the non-endemic area was 65.18±21.2 µg/d and 110.93 ±37.54µg/d respectively.The mean iodine content from food and water was 58.87±30.11 µg/d and 6.31±2.61 µ g/d respectively in the endemic area while in non-endemic area the figure was 101.19± 47.30 µ g/d and 9.74± 6.88 µ g/d respectively.Majoritywere using iodized salt but most of the salt samples had less than 15 ppm iodine.Therefore despite implementation of universal salt iodization programme the IDD is still a major public health problem which should be addressed to mitigate the problem of hidden hunger to achieve sustainable development goals.

Keywords: *Iodine,Goiter,Endemic area, Duplicate dietary sample,Water iodine content,non endemic area,Iodized salt ,IDD,Universal Salt Iodization,SDG,hidden hunger*

Introduction

Iodine, a mineral present in the soil, water, and air is indeed crucial for proper thyroid functionn, which regulates metabolism and plays a vital role in growth and development, particularly during infancy. The availability of iodine in the diet can vary significantly depending on factors like soil composition, as well as the consumption of iodine-rich foods like iodized salt.

In regions where the soil is deficient in iodine, people are more prone to iodine deficiency disorders, such as goiter, hypothyroidism, and intellectual disabilities. This deficiency can be addressed through various means, including dietary supplementation, iodization of salt, and public health interventions aimed at raising awareness.

It's interseting how geological factors can have such a profound impact on human health, highlighting the intricate relationship between the environment and nutrition Thyroid hormones, specifically thyroxine (T4) and triiodothyronine (T3), are crucial for the proper development and function of the central nervous system (CNS), as well as for overall growth and metabolism throughout the body.

Since the body cannot produce iodine on its own, it must be obtained through dietary sources, primarily from iodine-rich foods or iodized salt.

The primary mechanism by which iodine is deposited into the soil is through the volatilization of iodine compounds from the oceans. This process is facilitated by ultraviolet radiation, which helps to release iodine from seawater into the atmosphere.

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Coastal regions tend to have higher levels of iodine in their soil due to their proximity to the ocean and the greater exposure to these iodine-rich aerosols. Iodine can also be continuously leached from the soil, especially in areas with heavy rainfall or poor soil retention.[1]. When the body doesn't have enough iodine to produce an adequate amount of thyroid hormones, it can lead to a range of health problems, collectively known as iodine deficiency disorders (IDD)[2].The most visible consequence of iodine deficiency is goiter, an enlargement of the thyroid gland as it tries to compensate for the lack of iodine. However, beyond goiter, iodine deficiency can have serious implications for human health, particularly in regions where it is endemic.The effects of iodine deficiency in humans causes a spectrum of disorders called iodine deficiency disorders(IDD) and include goitre at all ages,and adverse effects on brain development during rapid brain development phase i.e in the neonatal period. The critical period in endemic areas extend from the second trimester to the second year of life.Deficient intake of iodine during this period can lead to devastating consequences resulting from permanent damage to the brain. Owing to maternal IDD, it is estimated that about one-fifth of pregnant women in India will give birth to children who will not reach their optimum physical and mental potential [4].About 90 percent of daily human need is met by foods and 10 percent from water. However, these values do not reflect the actual amount available to the body.Besides, iodine is so narrowly distributed in food chain that no reliable food-based strategy will guarantee protection from IDD other than living in the coastal area.Iodine deficiency disorders (IDD) are entirely preventable through the administration of adequate iodine from external sources. One of the most effective and cost-efficient methods for preventing IDD is through the iodization of salt.Rural communities can significantly reduce the incidence of iodine deficiency disorders and ensure better overall health and well-being for their populations.

Therefore present study was undertaken to study the intake of dietary iodine(from all sources)and its effect on goitre in school children.

Material and Methods

The study was conducted in Vaishali and Gaya districts of Bihar.These districts were selected after collecting the secondary data available about the total goiter rate(TGR) in the districts during study period.A stratified random sampling technique was used for the selection of subjects for the study. One block from each of the selected districts was choosen as study area.An epidemiological survey for goiter and other deficiency diseases were carried out in one middle school of each block.After getting the result of total goiter rate in the selected area a comprehensive study of thirty school children was conducted. The selected children for the study were in the age group of 10-12 years.The palpation method was done to find out the total goiter rate. For the estimation of iodine intake from the diet, a duplicate dietary sampling method was adopted to find out the iodine content from their diet. Two plate system was adopted to conduct a diet survey. An equal amount of diet consumed in a day was put in a labeled polythene bag,leftover,if any, was recorded and subtracted from the total amount of food collected. For the estimation of iodine from water the duplicate sampling of water was also recorded. The children were asked to drink water from a measured can in a day,the left over water in the can was recorded after 24 hrs. Only a subsample of water(100 ml) was collected in labeled polythene bottles. All the samples were kept in freezer till analysis .The samples were collected twice in a year i.e in summer as well in winter. Salt samples as consumed in the household of selected subjects were also collected in labeled polythene bags in both seasons.

Storage and preparation of samples: The weighed amount of food sample was dried to a constant weight at 60 degrees C in a hot air oven. The dried samples were ground to a fine powder in an electric mixer cum grinder and stored in air tight containers.Then samples were ready for chemical analysis of iodine content.

Determination of Iodine: It was done using the improved routine method [5].The alkaline ashing of the food sample was carried out. Fifty gram of the food/salt samples were put in a corning tube , 0.5 ml of 4 M potassium hydroxide solution was added to it and the sample was dried at 105˚Cfor 20 hrs.The samples were put horizontally in a muffle furnace & heated at 150˚C for 30 minutes then the temperature was raised to 600˚C and maintained for an hour. All the corning tubes were taken out from the muffle furnace and after dissolving the ash in 10 ml of water and shaking for 10 minutes were filtered using Whatman filter paper no. 42.

Estimation of Iodine content of food, water, and salt samples: For one estimation one ml of water/one ml of supernatant food/salt samples was used.In a test tube,1 ml of the test sample was mixed with 1 ml of arsenic solution.Then one ml of Cerium sulfate solution was added at a measured time interval and the tubes were placed in hot water bath at 50 ˚C . After 28 minutes 0.25 ml brucine solution was added at the same time interval to stop the Arsenic-cerium –Iodide reaction.The color at a wavelength of 420 nm was measured on a spectrophotometer.

A calibration graph was plotted using different concentration and reading of the absorbance of the sample solution was taken against thecalibrationgraph,The results were expressed in ng/g of sample.

Epidemiological survey: The data of the epidemiological survey for total goiter rate depicted the goiter prevalence was 4.5 and 23.8 percent respectively in non-endemic and endemic areas respectively which were selected as per secondarydata & the study justified their selection as non-endemic and endemic area respectively.

Table:1 Distribution of children according to their TGR status in study area

N=60

Sex	Boys		Girls		Both Sexes	
Age(years)	N EA	E A	NEA	EA	NEA	EA
>7	-	-	-	-	-	-
7-10	2	2	-	2	2	4
10-13	18	4	26	5	44	9
13-15	2	0	2	0	4	0
Total	22(18.03)	6(2.82)	28(31.82)	7(3.93)	50(23.8)	13(3.32)

(Figures in parenthesis indicate percentage)

Comprehensive Study

This type of study would likely include both general information about the study population and specific details about individual children, including factors such as birth order, family structure (single child, twin birth, single parent household), maternal employment status, and dietary habits.It's clear that the study is aiming for a thorough understanding of the factors contributing to iodine deficiency disorders (IDD) especially goitre among children. Including information on the frequency of goitrogenic foods, the source of water, and the depth of the water table used for drinking purposes provides valuable insights into additional factors that may affect iodine status.

Results and Discussion

The mean±SD of iodine intake by school children in goiter endemic area was 65.18±21.2 µg/d, during summer 70.99±26.78 µg/dand in winter 59.6±33.41 µg/d while these figure were 110.93±37.54 µg/d, 114.68±39.73 µg/d and 107.39 µg/d respectively in non -endemic area. The iodine intake ranged 28.08 µg/d to 180.94 µg/d in the endemic area and 32.24 to 233.32 µg/d in non-endemic area .Iodine from food content was the major contributor to daily iodine intake which included the contribution of iodine from salt also. As depicted in Table 2 below, the mean intake of iodine in both the study areas were significantly different as noted from " t" test of significance.

Table 2: Iodine intake (μg/d) by school children of an endemic and non-Endemic Area

Area	Endemic area(n_1)	Non-Endemic area(n_2)	"t"
Food	58±30.11	101.19±47.30	5.8***
Water	6.31±2.61	9.74±6.88	2.68***
Total	65.18±21.2	110.93±37.54	6.19***

**** Significant at P<0.01*

Similarly, the iodine intake was different in endemic and non-endemic areas during summer as well as in winter. But no seasonal fluctuations were observed in total iodine intake and however, the intake of amount of water and iodine from water was significantly more in summer than in winter. (Table 3).

Table:3 Mean ±SD of iodine intake by school children during the summer and winter season of an endemic and non-endemic area of Bihar

Area	Endemic	Area		Non-endemic	Area	
Season	Summer	Winter	"t"	Summer	Winter	"t"
Food	62.16±26.11	55.58±30.11	0.84	100.86±36.46	101.53±56.08	0.05
Water	8.83±3.9	4.02±1.68	6.16***	13.82±10.55	5.86±4.98	2.3**
Total	70.99±26.78	59.60±33.31	0.949	114.68±39.73	106.39±57.75	0.92

**** Significant at P<0.01*

Significant seasonal differences in iodine intake from water were also reported by Jain[7] and Kaur[8].In the present study, the mean iodine intake of the subjects in endemic area and non-endemic area was lower than the Recommended Dietary Allowances (RDA) .The findings were in line with the findings of Anderson *et al*[9] who found that 29. 8 percent population of SAC(school age children)had insufficient intake of this nutrient.He further reported that sharp regional differences persist; southeast Asia has the largest number of SAC with low iodine intakes (76 million) and there has been little progress in Africa, where 39% (58 million) have inadequate iodine intakes, thus it was concluded that although iodine nutrition has been improving since 2003, global progress may be slow.Similarly, water iodine concentration(WIC) in drinking water in Sweden is low as shown by Manousou *et* al[10] the median WIC in all treatment plants was 4.0 μg/L and varied from 0 to 27 μg/L.
Iodine Content in salt:As evident fromTable 4 the analysis of the iodine content of the collected sample revealed that only 16.67% of the salt samples had desired level of iodine in the endemic area while in non -endemic it was 11.67 % and the majority in both the study areas had the salt content within 5-10 ppm. The analysis also revealed a non-significant seasonal variation in iodine content of salt in both areas.

Table 4:Iodine content of salt in summer and winter season in Endemic and Non-endemic areas of Bihar

N=60

Area	Endemic Area			Non-endemic area		
I content of salt(ppm)	Summer (n_1=30)	Winter (n_2=30)	Total(N_1=60)	Summer (n_1=30)	Winter (n_1=30)	Total(N_2=60)
0	4(13.33)	-	4(6.67)	2(6.67)	2(6.67)	4(6.67)
1-5	2(6.67)	13(43.33)	15(25)	7(23.33)	9(30.00)	16(26.67)
5-10	24(80)	11(36.67)	35(58.33)	7(23.33)	2(6.67)	9(15)
10-15	-	1(3.33)	1(1.67)	12(40.00)	12(40.00)	24(40.0)
>15	-	5(16.67)	5(8.33)	2(6.67)	5(16.67)	7(11.67)
Mean±SD	-	-	6.58±2.97			8.55±4.08

Figure in parentheses indicates the percentage.

Similar observations were recorded *by Manousou et al*(2012) who found that74% of thesamples had a WIC between 0 and 5 μg/L. The median WIC was 4.0 μg/L (range 0–27) in groundwater and 3.5 μg/L (range 0–13) in surface water.Kapil *et al* [7] reported that in Bihar no salt at the beneficiary level had nil Iodinecontent,28.5 % salt samples having less than 15 ppm iodine while rest were adequately iodized. Hira et al[8] had reported that 10 brands of salt out of 62 different brands collected from different regions of Punjab had 30 ppm iodine.

Summary and Conclusion: The study revealed that the prevalence of goitre is showing a decreasing trend in both the study areas. The mean ±SD of the iodine level in salt samples collected from the endemic and non-endemic area was 6.58±2.97μg/d and 8.55±4.08μg/d respectively.Iodized salt was consumed by the majority of school children in both the areas.However, the level of iodine was below 15 ppm in most of the salt samples.The mean± SD of daily dietary intake of iodine in endemic and non-endemic areas was 58.87±30.11 μg/d and 101.19±.47.3 μg/d. Total intake of iodine included iodine intake from water also which was 65.18±30.8 μg/din in endemic areas&110.93±37.54 μg/d in non-endemic areas.The mean daily iodine intake of goitre non-endemic area was significantly higher than that of school children of the endemic area however the iodine content of salt was used in these areas were statistically not different. Thus it can be inferred that dietary iodine intake has positive correlation with total goitre rate & water iodine content contributes to Iodine nutrition

Despite universal salt iodization programme, globally 241 million school children, still have insufficient dietary iodine intakes. Iodine deficiency has been identified as one of the four key global risk factors for developmental disabilities where there is a need for urgent intervention. Major challenges include reaching economically disadvantaged groups living in remote areas and convincing the food industry(including small scale salt producers) to iodize their general consumable salt.

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