RESEARCH ARTICLE

Iodine level and Hardness in Drinking Water in Selected Areas of Howrah and Purba Medinipur District, West Bengal state of India

Arijit Debnath[1*], Smritiratan Tripathy[2], Amar K Chandra[3]

Abstract

Endemic goiter has been reported from the southern part of West Bengal. The bioavailability of iodine and hardness of water used for drinking in the region are inversely and directly related to goiter prevalence in several geographical regions. These factors were evaluated to study the etiological factors for the persistence of endemic goiter. The local drinking water concentration can give an induction of the iodine content of the soil. Water hardness is defined by the high concentrations of calcium and magnesium present. In the present study, 5 Community Development (CD) Blocks and 8 CD Blocks attached to the river Ganga are selected from Howrah and coastal areas of Purba Medinipur district, respectively. From each CD Block, at least 8 drinking water samples were collected and analyzed for iodine, calcium, and magnesium content. Iodine content in drinking water samples was found in the range from 7.5 to 95.4 µg/L and the hardness of drinking water was found to range from 210.3 to 625.7 ppm. The presence of magnesium was found to be higher than the calcium salts in most of the samples. These findings suggest that all most all the studied region is environmentally iodine sufficient but water is relatively hard and thus, the possibility of the hardness of water for the persistence of endemic goiter may not be ruled out.

Keywords: Calcium, Drinking water, Iodine, Magnesium, Population survey

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INTRODUCTION

Iodine is an important micronutrient for human development because it is a constituent of the thyroid hormones thyroxine (T_4) and triiodo-thyronine (T_3). These hormones are involved in many different ways in human metabolism and are essential for normal growth, mental, and physical development. Iodine is found in water, soil, and plants. Mostly iodine is present in seawater. It also occurs in the deeper layers of the soil and is found in oil wells and natural gas effluents. Water from such deep wells can provide a major source of iodine. The local drinking water concentration can give an indication of the iodine content of the soil.[1] Water hardness is defined by the concentrations of calcium and magnesium present (hard water having high concentrations). Since calcium and magnesium are suspected additional goiter-inducing factors, this may help to explain why goiter has been observed in some areas without notable iodine deficiency in local waters, rocks and soils. In such areas, iodine deficiency may also be induced by fixation of iodine by calcium in the soils, yielding low concentrations in groundwaters and decreased efficiency of uptake by plants.[2]

In the post-salt iodization phase, endemic goiter has been reported from many areas in India.[3-5] including West Bengal.[6-10] Iodine nutritional status of school children in a rural area of Howrah district in the Gangetic West Bengal showed that despite adequate iodine intake as evidenced by urinary iodine level, the total goiter prevalence was 37.6%.[11] In an epidemiological study, conducted in some selected areas of Howrah district showed that 38% of student suffer in goiter though there is no iodine deficiency as evidenced by urinary iodine level.[10] Slott[12] suggested that goiter in India is directly related to the high calcium content in drinking water. High mineral content, particularly of magnesium and calcium salts have been implicated as goitrogenic factors in several goiter endemic areas.[13-16]

For the purpose of the present study five Community Development (CD) Blocks attached to the river Ganga and eight CD Blocks from the coastal areas of Purba Medinipur district were selected to evaluate the environmental source of iodine or iodine content and hardness of water that the people use for drinking in this region.

METHODS AND MATERIALS

Howrah is one of the most thickly populated districts in Gangetic West Bengal. It has a population of 18,80,530

[1*]Department of Physiology, Suri Vidyasagar College, Suri, Birbhum, West Bengal, India

[2]Department of Physiology, Berhampore Girls, College, Berhampore, Murshidabad, West Bengal, India

[3]Department of Physiology, University College of Science & Technology, University of Calcutta, Kolkata, West Bengal, India

***Corresponding author:** Arijit Debnath, Department of Physiology, Suri Vidyasagar College, Suri, Birbhum, West Bengal, India, Email: arijit.debnath14@gmail.com

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(2001 Census report) living under 14 CD Blocks. Most of its population lives in completely rural areas, whereas some live in industrial but rural areas. People are engaged in either agricultural activities or working in factories. Purba Medinipur is another district having a population of 31,50,357 (2001 Census report) living under 23 CD Blocks. The people of this district are engaged in agricultural activities, working in factories and fisheries. Their diets are mainly non-vegetarian and consist of cereals (rice), pulses, fish and vegetables of Brassica family with others.

From the selected area of each block, at least eight drinking water samples[11] of about 100 mL were collected at random from the available sources like tube wells and kept in wide mouth screw-capped plastic bottles for the determination of iodine and calcium and magnesium content/hardness. The collected water samples were brought to the laboratory and kept at 4°C until analysis. On the day of analysis, the samples were brought at room temperature, all the collected samples from the same area were mixed thoroughly and the iodine content of the samples was measured by its catalytic action on the reduction of ceric ion (Ce^{+4}) to cerous ion (Ce^{+3}) following the method of Karmarkar *et al.*[17] The hardness of water and the presence of calcium and magnesium salt in drinking water samples of those used for iodine estimation were measured following EDTA method.[18]

RESULTS AND DISCUSSION

A total of 104 drinking water samples were analyzed for iodine content. Iodine content of water was highest in Ramnagar-I (95.4 µg/L) of Purba Medinipur district and lowest in Khejuri-II (7.6 µg/L) in the same district (Table 1).

The daily dietary intake of iodine varies widely from region to region depending on the iodine content of soil, water and dietary habit. Iodine is consumed through foodstuffs and water in both inorganic and organically bound forms. Iodate ions are converted into iodide (I^-) in the stomach. The rapidity of absorption of organically bound iodine and its absorbed form are uncertain, but eventually, it is made available as inorganic iodide. Iodide (NaI) is rapidly (within 30 minutes) and efficiently absorbed from the gastrointestinal tract and distributed in the extracellular fluid (ECF). Two main processes are constantly removing the most iodide of the ECF; excretion by the kidney and trapping by the thyroid gland. The thyroid cell trapping mechanism, the iodine pump, gives the gland the ability to concentrate iodide.[19]

Zeltser *et al.*,[1] have categorized the iodine deficient zone as the severe deficient zone having iodine less than 4 µg/L of water, moderate iodine-deficient zone with iodine level 4 to 10 µg/L of water and relative iodine deficient zone having iodine level below 20 µg/L of water. According to this criterion, the overall result showed that the region is environmentally iodine sufficient though Khejuri-II (7.6µg/L) had under moderate iodine-deficient zone and Contai-I (14.5µg/L) and Contai-II (18.0 µg/L) had relative iodine deficient zone (Table 1). The people use the drinking water from shallow tube wells of 150–200 feet deep. Despite environmental iodine sufficiency, the region's people are affected by endemic goiter.[10, 11] This observation led us to search for other common environmental factors found in water. Magnesium and Calcium salt present in drinking water have been suspected as a goitrogenic factor in certain iodine-sufficient goitrogenic areas of South America.[13, 14]

Total hardness of drinking water collected from different areas was determined and found in the range from 210.3 ppm to 625.7 ppm. The presence of magnesium salt was higher than calcium salts in all the samples. The hardness of water was found highest in the Panchla block (625.7 ppm). The

Table 1: Bioavailability of iodine and hardness in drinking water in selected areas of Purba Medinipur and Howrah districts.

#	*Study areas (CD Blocks)*	*Iodine (µg/L)*	*Hardness of water (ppm)*		
	Dist. Purba Medinipur		*Calcium*	*Magnesium*	*Total*
1	Sutahata	60	21.4	248.5	269.9
2	Haldia	65	50.6	260.4	311.0
3	Nandigram-I	40.5	47.7	300.6	348.3
4	Khejuri-II	7.6	30.5	195.5	226.0
5	Contai-I	14.5	45.1	290	335.1
6	Contai-II	18.0	46.2	315.5	361.7
7	Ramnagar-I	95.4	48.5	190.2	238.7
8	Ramnagar-II	77.8	70.8	139.5	210.3
	Dist. Howrah				
9	Panchla	40.3	95.2	530.5	625.7
10	Ulberia-I	85.6	31	248.2	279.2
11	Ulberia-II	55.2	65.5	368	434.3
12	Shyampur-I	51.4	66.2	170	236.2
13	Jagatballavpur	53.2	73.5	159.8	233.3

calcium hardness values were found in the range 21.4 ppm to 95.2 ppm and magnesium hardness values in the range 139.5 ppm to 530.5 ppm (Table 1).

In the studied areas, according to the specification of Indian Standard Drinking Water, calcium level was found within a permissible limit that is 200 ppm but the presence of magnesium salt was more in almost all the areas (13 areas of 13 CD Blocks) than the permissible limit that is.[20] Day and Propwell-Jacson[21] reported that magnesium level was more closely correlated with goiter prevalence than calcium levels. Therefore, the presence of magnesium salt in drinking water as observed in this study, may pose a serious threat of thyroid disorders in the studied region. Das *et al.*[15] reported that increased hardness of drinking water (Ca^{2+}, Mg^{2+}) and significant environmental iodine deficiency are important factors in the etiology of endemic goiter in many regions of Nigeria. But the exact mechanism by which calcium and magnesium cause goiter is not known. Excess calcium in the thyroid follicles' colloid causes the compactness of thyroglobulin molecules (containing T_3 and T_4) in follicular cells and their subsequent release in circulation.[22] This may be a possible reason for developing hypothyroidism/goiter in such a situation.

The overall results of this study suggest that the persistence of endemic goiter in the studied region is not for environmental iodine deficiency except in some specific regions of Purba Medinipur district. However, the water is hard for the presence of excess magnesium salt. Thus, the possibility of the hardness of the water in the persistence of endemic goiter may not be ruled out.

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