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Original article

INORGANIC CONTENT OF WATER AND PREVALENCE OF GOITRE IN SRI LANKA

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Abstract

Introduction: Goitre is endemic in Sri Lanka. Iodine deficiency is considered to be the main aetiological factor for goitre in this country. The role of other aetiological factors is well recognized in the literature. The recognized factors apart from iodine include organisms, inorganic content of water and diet. Data on the relationship between goitre and inorganic content of water is not available for Sri Lankan population.

Objectives: To determine the relationship between goitre and inorganic matter of water such as fluoride, magnesium, nitrate and hardness of water.

Design and setting: Descriptive cross-sectional study carried out in 108 *Grama Niladhari* (GN) areas, island wide.

Method: The country was divided into 6 zones based on the rainfall pattern and 18 GN areas were selected from each zone by randomisation based on PPS (Probability P Score). Two water samples were collected randomly from each GN area one from the people with goitres and other from the non-goitre subjects. The water was analysed at the Industrial Technology Institute (ITI).

Results: 108 samples from goitre and non-goitre groups were analyzed respectively. Comparative values for each inorganic content in respect to subjects with and without goitre groups were as follows,

Total hardness ($CaCO_3$) mg /L – 55.44, 59.15; Calcium (Ca) mg /L – 15.76, 13.71;

Magnesium (Mg) mg /L – 3.14, 4.08; Fluoride (F) mg /L – 0.31, 0.37.

There is no discernable statistically significant difference between two groups in relation to inorganic content of water.

Conclusion: There was no clear relationship between the inorganic matter of water and prevalence of goitre in this study.

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Introduction

Goitre is endemic in Sri Lanka and iodine deficiency is considered to be the main aetiological factor. The role of other aetiological factors is well recognized in the literature and some of the recognized factors include organisms, inorganic content of water and diet.

Goitre remains endemic despite iodization of salt. This suggests that other aetiological factors such as inorganic content of water may have an aetiological role in the causation of endemic goitres. Several studies carried out in other parts of the world including Africa and India have clearly shown a relationship between incidence of goitre and inorganic content of water (1-6).

Data on the relationship between goitre and water is lacking in Sri Lanka. A study was undertaken to assess the relationship between inorganic content of water and incidence of goitre.

Objectives

To determine the relationship between goitre and inorganic matter of water such as fluoride, magnesium, nitrate and hardness of water.

Method

An island-wide descriptive cross-sectional study was done on the prevalence of goitres and as part of that study the association of goitre prevalence and inorganic content of water was assessed.

Selection of sample population

Country was divided into 6 zones, namely wet zone – hills, wet zone - coastal, intermediate zone – north, intermediate zone – south, dry zone – east and dry zone – central according to the rainfall pattern. These divisions were based on information obtained from the Centre for Agriculture Research and Geography.

From each zone 18 *Grama Niladhari* (GN) areas were selected by utilising the proportionate population score technique which enabled the selection of 108 GN areas, island-wide.

From each GN area 50 people were selected randomly by using a list of residents available with the relevant Public Health Midwife. Starting from a randomly selected house hold 50 subjects were screened for goitre with a pre-tested questionnaire and examination. At the end of screening process in each GN area there were two groups, one with goitres and others without goitres.

Method of collection of water samples

The following method was adhered to when collecting the water sample.

- The predominant source of water of the people was identified on direct questioning and recorded in the questionnaire.
- A person was selected at random from people with and without goitre and a sample from their water source was obtained ensuring that it represented the predominant water source in each group.

At the end two water samples from each GN area, one from the goitre group and other from the non-goitre group, were collected. This enabled us to collect 108 patient and control samples respectively in the whole island for our study.

Volume and transportation of water samples

Each sample was 500 ml of water. These samples were collected into plastic water cans and were transported in a cool box at a temperature of 0-4°C within 48 hours to Industrial Technological Institute (ITI) in Colombo where the chemical analysis was done.

Results

These tables depict the relevant average values for each inorganic component for goitre and non-goitre groups at all 6 zones.

Table 1. Zone level results

Table 1.1 – Wet zone results

Inorganic content	Wet zone – coastal		Wet zone – hills	
	Goitre	Non-goitre	Goitre	Non-goitre
Total hardness ($CaCO_3$) mg /L	21.77	21.21	28.28	26.26
Calcium (Ca) mg /L	7.05	5.96	7.6	5.6
Magnesium (Mg) mg /L	1.22	1.45	2.4	2.65
Fluoride (F) mg /L	0.05	0.01	0.36	0.36
Nitrate (NO_{3-}) mg/L	1.05	1	0.2	0.8

Table 1.2 – Dry zone results

Zone	Dry zone – east		Dry zone – central	
Inorganic content	Goitre	Non-goitre	Goitre	Non-goitre
Total hardness ($CaCO_3$) mg /L	59.50	51.11	214.14	167.68
Calcium (Ca) mg /L	20.60	13.85	44.44	47.68
Magnesium (Mg) mg /L	3.23	3.48	15.27	14.06
Fluoride (F) mg/L	0.72	0.79	0.7	0.79
Nitrate (NO_{3-}) mg/L	0.10	0.10	0.1	0.10

Table 1.3 – Intermediate zone results

Zone	Intermediate zone – north		Intermediate zone – south	
Inorganic content	Goitre	Non-goitre	Goitre	Non-goitre
Total hardness ($CaCO_3$) mg /L	58.59	59.30	98.98	106.1
Calcium (Ca) mg /L	16.97	17.37	25.46	25.86
Magnesium (Mg) mg /L	5.31	6.03	8.49	9.94
Fluoride (F) mg /L	0.475	0.45	0.21	0.23
Nitrate (NO_{3-}) mg/L	0.2	0.20	0.20	0.5

Table 2. Island-wide results

Parameters analyzed	Goitre group	Non-goitre group
Total hardness ($CaCO_3$) mg /L	55.44 (22.00-116.20)	59.15 (20.91-117.05)
Calcium (Ca) mg /L	15.76 (6.83-33.13)	13.71 (5.41-32.03)
Magnesium (Mg) mg /L	3.14 (1.28-8.89)	4.08 (1.52-9.31)
Fluoride (F) mg /L	0.31 (0.1-0.7)	0.37 (0.1-0.7)
Nitrate (NO_{3-}) mg /L	0.2 (0.1-0.9)	0.45 (0.1-1.4)

The median **value** and the relevant **25th and 75th centile values** are depicted within brackets.

Discussion

Iodine deficiency is considered to be the main aetiological factor in the causation of endemic goitres in Sri Lanka. Contribution of other aetiological factors in the incidence of goitres has not been assessed in detail. Despite iodization of salt becoming mandatory following the enactment of legislative measure in 1995, goitre remains endemic, which suggests that other factors like the quality of water may contribute to the prevalence of goitre.

Most inorganic compounds have a similar mechanism attributed in the causation of goitres. Eg: thyrocytes show more affinity to fluoride than iodine. Therefore when fluoride and iodine is available in considerable amounts high uptake of fluoride by the thyroid gland will block the iodine transport channels in the gland reducing thyroid hormone synthesis (6). It is known that nitrates also competitively inhibits iodine uptake by a similar mechanism (7). Very little is known about the mechanisms involved in causation of goitre for other mineral components despite their clear association with the prevalence of goitre in the literature (1).

The analysis of water requires careful collection of specimens and standard protocol of analysis. This was carried out meticulously with the assistance of ITI. Previous studies alluded to have analysed inorganic content and the quality of water. In this

study the parameters assessed were Ca^{++}, Mg^{++}, nitrates, fluorides and hardness of water.

Results obtained from the analysis are tabulated in Tables 1 and 2. Median values for each inorganic component for goitre and non-goitre groups at the zone level are depicted in Table 1 series. The comparative values of the two groups for each inorganic component do not show any significant difference at all in the 6 zones.

The median value and the relevant 25th and 75th centile values for each inorganic component for two groups at the island-wide level are depicted in Table 2. There is no significant difference among the comparative values for goitre and non-goitre groups even in this analysis.

The comparative values for goitre and non-goitre group for each inorganic component didn't show a statistically significant difference either at the zone level or the island-wide level in this study.

In some parts of the world bacterial contamination of water, mainly *E. coli* has been implicated as an aetiological factor for goitres (8). Bacteriological analysis was not feasible due to logistical difficulties. Detailed studies are necessary before a definitive link between water and goitre can be discerned.

Conclusion

There is no relationship between inorganic content of water and prevalence of goitre in Sri Lanka.

References

1. Ubom GA. Case study in Plateau State. *Nigeria -Sci-Total-Environ* 1991 Sep;1071-11. (Water used for drinking and cooking high in mineral content, including calcium, magnesium, nitrate, chloride and total hardness has a relationship with incidence of goitre).

2. Hettche HO. Association between high nitrate concentrations in drinking-water and goitre incidence. *Zeitblatt Allgemeine Pathologie* 1956; **95**: 187-93.

3. Höring H, Schiller F. *Nitrate Schriften Reihe für Gesundheit und Umwelt* 1987; Suppl **1**: 38-46. (Inorganic nitrate in drinking-water is a manifested factor of endemic goitre).

4. Desai VK, *et al*. Epidemiological study of goitre in endemic fluorosis district of Gujarat. *Fluoride* 1993; **26**: 187-90.

5. Wilson DC. Women's Medical Service, India (retd.) Fluorine in the etiology of endemic goitre. *The Lancet* 1981.

6. Kaviti JN. *East African Medical Journal* July 1982: 363-4.
(Concurrent occurrence of fluorosis and endemic goitre may have a causal relationship in parts of central Kenya).

7. Guidelines for drinking-water quality, 2nd ed. Addendum to Vol. 2. Health criteria and other supporting information. World Health Organization, Geneva, 1998.

8. Cherinet A, Kelbessa U. *East African Medical Journal* 2000; **77**: 133-7.
(Study also provides further evidence that coliforms and *E. coli* isolated from drinking water contribute to the high incidence of endemic goitre other than iodine deficiency).