Dietary intake and the prevalence of goitre among pregnant women on the Southwestern coast of Sri Lanka

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Abstract

This study was conducted to assess the relationship between intakes of dietary goitrogens and the prevalence of goitre among a select group of pregnant women along the coast of Galle District in Southwestern Sri Lanka. Fifty-nine cases and 31 controls, recruited from antenatal clinics and from the field, participated in the study. A single 24 hour dietary recall for each subject was analyzed for intake of energy. A food frequency questionnaire was used to measure usual intakes of seafood and goitrogen containing foods. The relationship between goitre status and high (≥ 1 serving/d) versus low (< 1 serving/d) consumption frequencies of goitrogen containing foods and seafood was assessed by logistic regression. There was no significant relationship between goitre status and frequency of goitrogen intake (*P = 0.08, O.R = 0.33, C.I. = 0.09-1.17*). There were no significant differences between cases and controls in intake of energy and frequency of seafood intake, or the I^- content of drinking water. The results of this study suggest that goitre in this population is not associated with excessive goitrogen consumption.

Key Words: Dietary goitrogens, Goitre, Nutrient intakes, Pregnant women.

Introduction

Goitre is a significant public health problem in Sri Lanka (1). Since the initial goitre surveys conducted some decades ago (2, 3), the prevalence of goitre has increased and has been extended to include larger portions of the island (1). Of particular interest is the relatively high incidence of goitre among the population of the Southwestern coastal areas (1). Thirteen percent of children attending schools along the coast from the Northwest to the South of the island have been classified with a goitre grade of 1A or greater (1). Therefore, the assumption that coastal populations are exempt from iodine deficiency disorders because of the proximity of the ocean appears incorrect.

The fact that the prevalence of goitre is higher among females than among males (1, 2, 4) is disconcerting. Pregnant women living in marginally iodine-depleted areas are particularly vulnerable for developing goitre due to increased glandular stress (5, 6), which may cause prenatal complications (7) and predispose to abnormalities in the foetus (8). Several studies have attempted to determine the cause of goitre in Sri Lanka, but a consensus has not been reached. Factors such as iodine (I^-) content of water, geology, goitrogens in food and water, and the local practice of washing salt before using it in cooking have been discussed in the literature (1, 2, 9, 10). However, the relationship between these factors and the prevalence of goitre is still not clear.

The link between goitrogens in foods consumed in coastal areas on the Southwest coast and the prevalence of goitre has not been fully studied. Further, there are no studies on the frequency of goitrogen consumption and the dietary intake of pregnant women in this area. The available studies on goitre among women are either sparse or outdated (2, 7, 11). Since the prevalence of goitre is increasing in Sri Lanka, and since females, especially during pregnancy,

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are at higher risk than males, it is important to study this population in particular.

Major objectives of the study:

1. To ascertain whether the intake of dietary goitrogens among pregnant women is linked to the prevalence of goitre in this population.

2. To evaluate the frequency of seafood consumption, and I^- content of drinking water of pregnant women with goitre (cases) and without goitre (controls).

Methods

Subjects

Subjects came from coastal towns and villages stretching as far as 28 km north and 16 km south, of the city of Galle. Subjects were recruited at prenatal clinics at the Mahamodera Hospital and from coastal villages. Pregnant, Sinhalese women, living in close proximity to the ocean, no further than 2 km inland, were invited to participate.

Potential subjects were identified by the investigator (A. K. H.) with the aid of two Sinhalese, female interpreters. The purpose and procedures of the study were explained to all potential participants. It was made clear that subjects could discontinue participation in the project at any time that they wished to do so. All subjects read the Letter of purpose and signed an informed consent form prior to participating. The interviewers were trained to administer 24-h recalls and food frequency questionnaires. Ninety pregnant women participated in the study. Of the 59 cases, 16 (27.1%) had been diagnosed with a thyroid condition by a physician, and 14 of these (87.5%) reported having taken medication (thyroxine) for some period of time.

Ascertainment of goitre status

Subjects' necks were visually and physically examined by one of the investigators to assess the presence or absence of a goitre using the ICCIDD's goitre classification method (12). Due to uncertainty in classifying 1A and 1B goitres, only subjects with a goitre visible with the head held in normal position i.e., grade 2 or 3, were classified as cases. Cases were not stratified further by goitre grade during analyses because of the small numbers in each subgroup. A total of 59 cases and 31 controls participated in the project.

Ascertainment of gestational age

The gestational age was estimated according to the date of the last regular menstrual period reported by the subjects.

Dietary evaluation

Twenty-four hour recall data

Twenty-four hour dietary recalls were obtained once from each participant. Nutritional values of 24-h recalls were estimated using appropriate food composition tables (13, 14, 15). The food composition table for Sri Lankan foods is not complete. Therefore, the I^- content of foods could not be evaluated directly.

Food frequency data

A food frequency questionnaire was administered to all participants where they were asked to indicate the frequency by which they consume cassava, cruciferous vegetables and yams. Because a high intake of I^- can counteract the effects of goitrogens (16), the frequency of seafood intake (known to have a high I^- content) was also obtained. The frequencies were converted to the number of times per month that the subject reported eating the food. Portion sizes of the foods were not quantified in this study.

Iodide content of drinking water

Water samples were collected from the source most frequently used by the subjects (wells, public and private taps) and I^- content determined by the method of Frant and Ross (17).

Statistical analyses

Percentages and frequencies were used to examine demographic data and other characteristics of the subjects. Student's t-test and chi-square were used to evaluate differences between cases and controls. Consumption frequencies of goitrogens and seafood were studied both as continuous and categorical variables. When goitrogen containing foods and seafood were treated as categorical variables, a consumption frequency of daily or more was considered a high intake and a less than daily consumption was considered low. Logistic regression analyses were conducted to study the relationship between goitre status (dependent variable) and the various goitrogen containing foods and seafood (independent variables) after adjusting for maternal and gestational age and energy intake. Statistical analyses were conducted on the University of Alabama's IBM mainframe computer using Statistical Analysis System (SAS) (18).

The study was approved by The University of Alabama Institutional Review Board, the National Project Coordinator for Health Science Research of the National Institute for Health Science, Sri Lanka, the Regional Director of Health Services, Galle District, and the relevant hospital consultants at the Mahamodera Hospital, Galle.

Results

General characteristics

General characteristics of the subjects are summarized in Table 1. The mean age of the sample was 26 ± 5.25 y (mean ± SD). The controls were significantly older than cases (P = 0.02). The mean gestational age was 29 ± 5.35 wk for cases and 25 ± 6.62 wk for controls (P = 0.01). Approximately 43% of the sample was primigravida, and the mean parity was 1 ± 1.21.

The per capita income differed greatly between participants but not significantly between cases and controls (Table 1). Thirty-nine percent of cases and approximately 35% of controls received food stamps; whereas, less than 7% of cases and controls received Janasaviya assistance. There was no significant difference between the groups in number of participants who received food stamps and Janasaviya assistance.

The mean energy intake for cases and controls were approximately 1554 kcal and 1559 kcal, respectively (P = 0.97). Almost the entire sample used uniodized granulated salt. No one used iodized salt although a few subjects reported having used it previously, taking it more as a course of medication and stopping when the packet emptied. Ninety-seven percent of cases and 84% of controls stated that they always rinsed the salt before using it; whereas, only one case and two controls stated that they never rinsed the salt. Thus, no significant difference existed between cases and controls in rinsing of salt (P = 0.10).

Goitre status and consumption of goitrogen containing foods and seafood

The average monthly frequency of consumption of cassava, cruciferous vegetables, yams, and seafood are presented in Table 2. Goitrogen and seafood intake frequencies varied greatly, both in cases and controls. The frequency of consumption of total goitrogens was significantly higher in controls than in cases (P = 0.02). However, there was no significant difference between cases and controls in the mean frequency of consumption of each individual goitrogen containing food or seafood. Cassava was eaten on an average of three times per month (range 0-16 times per month) by cases and five times per month (range 0-20) by controls. On average, cases consumed cruciferous vegetables eight times per month (range 0-40) and controls 11 times per month (range 1-32). The mean consumption frequency of yams was 5 times per month (range 0-20) for cases and 7 times per month (range 1-28) for controls. The mean frequency of seafood consumption, (39 and 42 times per month, respectively), was not significantly different between cases and controls.

Goitrogen containing foods were also evaluated as categorical variables. After adjusting for maternal and gestational age, energy intake, and frequency of seafood intake, there was no significant difference in risk of goitre development between subjects with high and low frequency of goitrogen intake ($B = -1.11$, $P = 0.08$, $O.R. = 0.33$, $C.I. = 0.09 - 1.17$) (Table 3). Similarly, no significant relationship was found between goitre status and high and low frequency of intake of seafood or any of the individual goitrogen containing foods after adjusting for the above-mentioned covariates.

Iodide concentrations in drinking water

Table 1 shows that the I^- content of the water differed greatly between the various sites of collection, ranging from as low as 3.2 µg/L to a high of 101.6 µg/L. The mean I^- concentrations of the drinking water of cases and controls were not significantly different with respective mean values of 12.9 µg/L and 13.1 µg/L.

Discussion

Since this study was not population-based but used a relatively small sample size, the findings may not be generalized. There was great variation in income within each group, but the mean income of the two groups was not significantly different. This suggests that, although the majority of the sample was recruited from public health clinics, cases and controls were relatively similar. Further, since assessment of goitre status was performed by one single investigator, there was no inter-observer variation in the assessment of goitre status in the sample. Dietary data was collected by two interviewers. These interviewers were trained together to limit inter-observer bias. Also, the study was conducted over a short period of time (2 months). Adjustments were made for known confounders in the analysis.

In this study the dietary iodine content was not measured directly. The frequency of seafood consumption and the energy intake, which are indirect measures of iodine intake, did not differ between cases and controls. Further, there was no significant difference in I^- content of the water between cases and controls. Thus, these indirect measures of iodine intake did not appear to be linked with goitre status. The confounding effect, if any, due to dissimilar intake of seafoods between cases and controls, was corrected for in the logistic regression analysis (Table 3).

Different foods containing varying types and amounts of goitrogens and the methods of preparing these foods influence the amount of goitrogens that are ingested (19). In this study, all the different cassava products were grouped together, and no distinctions were made between the different dishes and the methods of preparation. It is not possible, therefore, to draw precise conclusions regarding the goitrogenicity of these foods. There is, however, no reason to believe that the methods of preparing the dishes should have differed greatly between cases and controls.

Some bias associated with the accurate reporting of the food frequency questionnaire was detected. It was not always possible to distinguish whether subjects reported the frequency of "recent" or "usual" intake over a given period of time. In some instances, the intake of certain foods was recorded as "never" because the subjects stated that they avoid those foods during pregnancy, or because they were taking medications. In addition, patients diagnosed with goitre are told by physicians to avoid cassava, cabbage, and certain other goitrogen containing foods, which might have caused under-reporting of goitrogen consumption. Further, there was wide variation in the frequency of seafood consumption for both cases and controls, which reflects the socio-economic disparity within each group and perhaps also "current" rather than "usual" consumption as reported by some participants. Better sampling methods and measurement techniques to assess goitrogen and iodine intake, therefore, would facilitate a clearer understanding of the problem.

In this investigation of relationship between goitre and consumption of dietary goitrogens, cases were significantly younger than controls ($P = 0.02$). This finding differs from that of a study conducted in the hill country of Sri Lanka, where increasing age was positively related to goitre status (7). However, Katugampola (7) contended that the association between goitre status and age seemed to be related to the "cumulative effects of increased demands following each pregnancy." The average parity in this study was relatively low (1.1 ± 1.3 births) and not significantly different between cases and controls. Nevertheless, maternal age was adjusted in all regression analyses.

The mean gestational age was significantly higher for cases than controls ($P = 0.01$) (Table 1). This is in concordance with studies that have found a gradual increase in thyroid volume during pregnancy among women living in areas of marginal iodine depletion (5, 6). Thus, gestational age was adjusted in all regression analyses.

Unfortunately, the intake of iodine could not be assessed directly because the available food composition tables do not contain this information. Ninety-nine percent of the subjects used granulated salt, which until recently had not been iodized. The rinsing of salt prior to its use, a custom discussed by Mahadeva *et al.* (9), was practised by 97% of the women in our study. Any iodine, therefore, is likely to have been removed, indicating that salt was not a good source of iodine for this population.

Few Sri Lankan studies have measured the I^- content of drinking water in areas in close

Table 1. General characteristics of population by goitre status

Characteristic	n	Controls Mean ± SD (Range)	n	Cases Mean ± SD (Range)	All Mean ± SD (Range)	P
Age (y)	31	27 ± 5.06 (18 - 38)	59	25 ± 5.15 (18 - 40)	26 ± 5.25 (18 - 40)	0.02
Gestational age [a] (wk)	31	25 ± 6.62 (11.71 - 38.57)	58	29 ± 5.35 (8.43-46.14)	28 ± 8.01 (8.43-46.14)	0.01
Parity	31	1.1 ± 1.31 (0-4)	59	1.0 ± 1.11 (0-3)	1.1 ± 1.25 (0-4)	0.79
Height (cm)	28	150 ± 5.80 (140-163)	52	152 ± 5.20 (140-161)	151 ± 5.44 (140-163)	0.20
Energy intake (kcal/d)	31	1559 ± 568.40 (897-3085)	58	1554 ± 463.68 (733-2752)	1556 ± 499.40 (733-3085)	0.97
I^- content of drinking water (μ/L)	20	13.1 ± 15.5 (4.3-76.2)	42	12.9 ± 15.1 (3.2-101.6)	13.0 ± 15.1 (3.2-101.6)	0.95
Income/capita/mo (SL Rs.)[b]	28	585 ± 482 (100-2000)	54	625 ± 405 (25-2000)	611 ± 429 (25-2000)	0.71

a Based on self-reported date of last regular menstrual period

b Sri Lankan rupees, USD 1 = SL Rs. 43

Table 2. Average monthly consumption of selected goitrogen containing foods and seafood by goitre status

Food Item	Controls n = 31 Mean [a] ± SD (Range)	Cases n = 59 Mean [a] ± SD (Range)	All n = 90 Mean a ± SD (Range)	P
Total goitrogens	23 ± 12.43 (9-53)	17 ± 9.53 (4-57)	19 ± 10.96 (4-57)	0.02
Cassava[b]	5 ± 5.23 (0-20)	3 ± 3.21 (0-16)	4 ± 4.05 (0-20)	0.18
Cruciferous vegetables[c]	11 ± 8.38 (1-32)	8 ± 6.73 (0-40)	9 ± 7.42 (0-40)	0.11
Yams[d]	7 ± 6.96 (1-28)	5 ± 3.98 (0-20)	6 ± 5.25 (0-28)	0.15
Seafood[e]	42 ± 13.44 (13-64)	39 ± 12.21 (12-72)	40 ± 12.64 (12-72)	0.36

a Average number of times per month the food or food group is consumed.
b Cassava includes boiled, fried, and curried cassava, and cassava flour.
c Cruciferous vegetables include cabbage, beetroot, Kohlrabi, and turnips.
d Yams include all other yams except cassava.
e Seafood includes fresh and dry fish, fresh and dry sprats (tiny fish), shrimp, baby shrimp, crabs and canned fish.

Table 3. Relationship between goitre status and high (≥ 1 serving/d) and low (< 1 serving/d) frequency of intake of goitrogen containing foods and seafood after adjusting for other covariates

Dependent variable	Independent variable	Regression Coefficient	P	O.R.[a]	95% C.I.[b]
Goitre status	Total goitrogens[c]	- 1.11	0.08	0.33	0.09-1.17
[Cases (n = 57) vs. controls (n = 31)]	Seafood[d]	0.02	0.22	1.02	0.98-1.86

a Odds ratio
b Confidence interval
c Logistic regression model after adjusting for gestational age, maternal age, energy intake, and frequency of seafood intake.
d Logistic regression model after adjusting for gestational age, maternal age, and energy intake.

proximity to the ocean. The results of this study, therefore, cannot be completely compared with the results of previous studies. However, the median I^- concentration for cases and controls were 9.05 μg/L and 9.00 μg/L respectively, values which are similar to those reported by Weerasekera *et al.* (10). Further, the mean I^- concentrations of drinking water for both cases and controls were above 10 μg/L, a level below which goitre is reported to be endemic (2).

The main goal of this study was to determine whether there is a relationship between the frequency in intake of goitrogen containing foods and goitre status. To our knowledge, no other studies have evaluated the relationship between frequency of seafood consumption and goitre status in pregnant women in this area. Crooks *et al.* (20), however, compared the incidence of goitre among pregnant women in Iceland and Scotland (Aberdeen) and found a higher incidence of goitre in Scotland than in Iceland, where seafood consumption is high.

The current investigation indicated that goitrogen containing foods were not consumed frequently enough to pose any harm to the thyroid gland unlike in other populations, where the system is challenged by goitrogens on a continuous basis (21). Therefore, it appears that the problem of goitre within this sample may not be related to the consumption of goitrogen containing foods. Further study of the population on the Southwestern coast, with estimates of dietary intakes over a longer period of time, and where family histories are taken into account for assessing the problem of familial goitre, is in order.

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References

1. Fernando MA, Balasuriya S, Herath KB, Katugampola S. Endemic goitre in Sri Lanka. In: Dissanayake CB, Gunatilaka L, eds. Some aspects of the chemistry of the environment of Sri Lanka. Colombo: NARESA, 1987: 45-64.

2. Mahadeva K, Senthe Shanmuganathan S. The problem of goitre in Ceylon. British Journal of Nutrition 1967; 21:341-352.

3. Wilson DC. Goitre in Ceylon and Nigeria. British Journal of Nutrition 1954; 8:90-99.

4. Deo MG, Subramanium TAV. Iodine metabolism in children and women with endemic goitre in Ceylon. British Journal of Nutrition 1971; 25:97-105.

5. Glinoer D, De Nayer P, Bourdoux P, *et al.* Regulation of maternal thyroid during pregnancy. Journal of Clinical Endocrinology and Metabolism 1990; 71:276-287.

6. Rasmussen NG, Hornnes PJ, Hegedus L. Ultrasonographically determined thyroid size in pregnancy and post partum: The goitrogenic effect of increased glandular stress American Journal of Obstetrics and Gynaecology 1989; 160:1216-1120.

7. Katugampola SL. The prevalence of goitre in pregnancy – A preliminary study. Ceylon Journal of Medicine 1989; 32:85-89.

8. Pharoah POD, Buttfield IH, Hetzel BS. Neurological damage to the foetus resulting from severe iodine deficiency during pregnancy. Lancet 1971; 1:308-310.

9. Mahadeva K, Seneviratne DA, Jayatilleke DB, Senthe Shanmuganathan S, Premachandra P, Nagarajah M. Further studies on the problem of goitre in Ceylon. British Journal of Nutrition 1968; 22:527-534.

10. Weerasekera DA, Bandara HMN, Piyasena RD. Iodine content of drinking water and goitre endemicity in Sri Lanka. Ceylon Medical Journal 1985; 30:117-123.

11. Gembicki M, Herath KB, Piyasena RD, and Wikramanayake TW. Thyroid radioiodine uptake studies on some euthyroid Ceylonese. Ceylon Medical Journal 1973; 18:134-137.

12. Dunn JT, Van der Haar F. A practical guide to the correction of iodine deficiency. Tech Manual No. 3. The Netherlands: International Council for Control of Iodine Deficiecny Disorders, 1990.

13. Gopalan C, Rama Sastri BV, Balasubramanian SC. Nutritive value of Indian foods. New Delhi: Indian Council of Medical Research, 1985.

14. Pennington JAT, Church HN. Bowes and Church's food values of portions commonly used, 14th edition. New York: Harper & Row, Publishers, 1985.

15. Perera WDA, Jayasekera PM, Thaha SZ. Tables of food composition for use in Sri Lanka. Colombo: JF & I Printers, 1986.

16. Kamalu BP, Agharanaya JC. The effect of a nutritionally-balanced cassava *(Manihot esculenta Crantz)* diet on endocrine function using the dog as a model 2. Thyroid. British Journal of Nutrition 1991; 65:373-379.

17. Frant MS, Ross JW Jr. Use of a total ionic strength adjustment buffer for electrode determination of fluoride in water supplies. Analytical Chemistry 1968; 40:1169-1171.

18. SAS Institute, Inc. SAS user's guide: basics, version, 5th edition. Cary, NC: SAS Institute, Inc., 1985.

19. Bourdoux P, Seghers P, Mafuta M, Vanderpas J, Vanderpas-Rivera M, Delange F, Ermans AM. Cassava products: HCN content and detoxification processes. In: Delange F, Iteke FB, Ermans AM, eds. Nutritional factors involved in the goitrogenic action of cassava. Ottawa: International Development Research Centre, IDRC - 184e: 51-58.

20. Crooks J, Tulloch MI, Turnbull AC, Davidson D, Skulason T, Snaedal G. Comparative incidence of goitre in pregnancy in Iceland and Scotland. Lancet 1967; 2:625-627.

21. Bourdoux P, Delange F, Gerard M, Mafuta M, Hanson A, Ermans AM. Evidence that cassava ingestion increases thiocyanate formation: a possible etiological factor in endemic goitre. Journal of Clinical Endocrinology and Metabolism 1978; 46:613-621.