Protein energy malnutrition, thyroid hormones and goitre among Malaysian Aborigines and Malays

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The relationship between malnutrition, goitre and thyroid hormones was studied among Aborigines and Malays in Ulu Langat, Malaysia. Fifty Aborigines aged ≥7 years were selected randomly for anthropometric, clinical and hormonal assessment. Fifty Malays of similar age from the nearby Malay village were chosen as controls. The Aborigines had a higher prevalence of malnutrition and goitre compared to the Malays. The prevalence of goitre was 26.5% amongst Aborigines and 19.6% among the Malays. All the nutritional indexes measured were significantly different between the two communities, especially among females. The differences corresponded to significant differences in levels of thyroid-stimulating hormone (TSH) measured using a highly sensitive TSH assay. By univariate analysis the increase in TSH corresponded to the decrease in body mass index (BMI). On the other hand, no association was found between BMI and goitres. No thyroid autoantibodies were detected and all subjects were clinically euthyroid and had normal thyroxine and triidothyronine levels. However, consumption of cassava conferred a four-fold risk of developing goitres. The high prevalence of goitres in malnourished subjects in this region which is not known to be iodine deficient could be due to cassava consumption.

Introduction

Malnutrition is still a major health problem in developing countries especially among the poorest members of the community. In Malaysia, along with rural Malays and Indians in rubber estates, Aborigines are among the least advantaged inhabitants. Malnutrition and communicable diseases are common among them. More than 60% of children under 12 years old were stunted and a higher percentage were undernourished in recent studies[17,18]. However, though chronic malnutrition is a widespread problem amongst Aborigines, the occurrence of related conditions such as goitre, cretinism and malnutrition-related diabetes mellitus is almost unknown in this community.

The high prevalence of endemic goitre associated with iodine deficiency has been reported in the Ibans of Sarawak[20]. Excessive intake of cassava and goitrogen-containing plants was also subsequently implicated in the occurrence of goitres in Sarawak[3,4,23,24]. However no study has been published on the Aborigines in Peninsular Malaysia regarding this problem.

The present study therefore assessed the prevalence of protein energy malnutrition (PEM) and of goitres and measured the thyroid hormone levels amongst a group of Aborigines living in the area near the City of Kuala Lumpur and compared them to Malays living closely together with them.

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Materials and methods

The study was carried out among Aborigines living in Kuala Pangsoon, about 40 km from Kuala Lumpur. Fifty Aborigines aged 7 years and above were selected randomly from 210 people in the village. Fifty Malays of similar age group were selected from a village nearby. Both villages shared the water supply from Ulu Langat river and children went to the same school. There has been a close relationship between the two communities for more than 20 years (Fig. 1).

Socio-economic status and dietary history were carefully assessed by house-to-house survey by trained interviewers. Three-day food recall with food frequency was utilized in the survey. Anthropometric measurements were carried out in a clinic specially set up for the study. Weight was measured using Seca bathroom scales (measured to the nearest 0.5 kg), height by Microtoise (to the nearest 0.1 cm), mid-arm circumference (MAC) by flexible tape and skinfold thickness by Harpenden's caliper to the nearest 0.5 mm.

Clinical evaluation included evaluation for goitre and general health status by an endocrinologist in the team. Goitre was graded according to the Pan American Health Organization[9]. Twenty ml of venous blood samples were taken from individuals after overnight fast. An aliquot

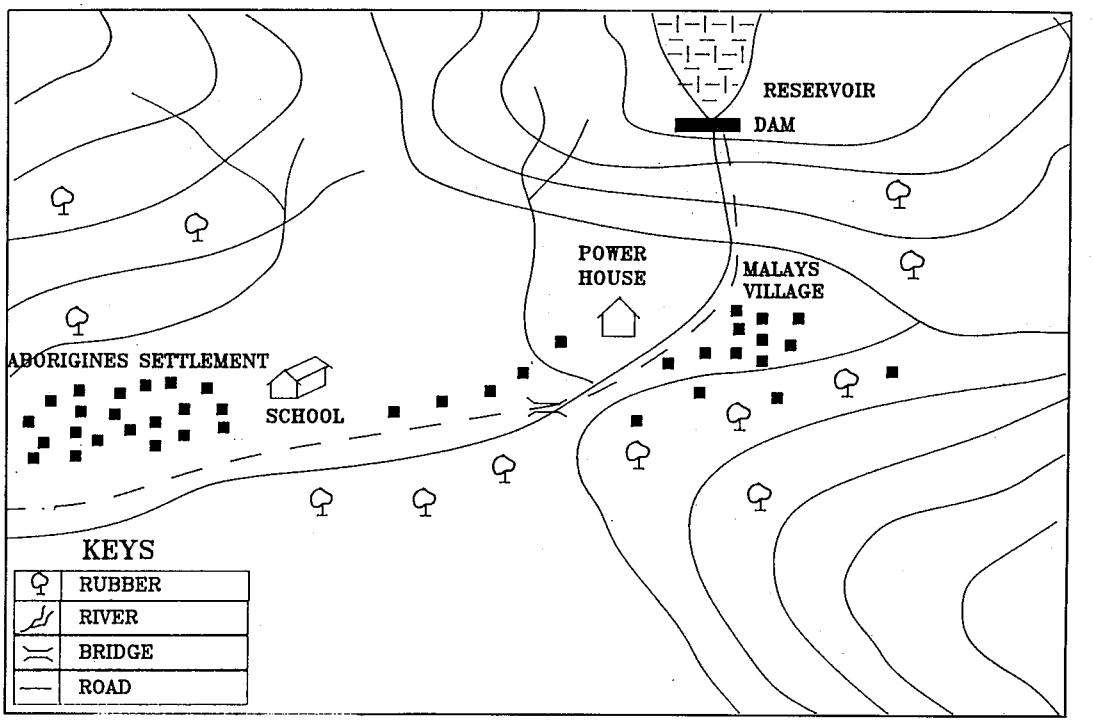

Fig. 1 Map of Kuala Pangsoon showing the Aboriginal settlement area and the Malay village.

of blood was used for measuring haemoglobin, blood cell count and film for malarial parasites. The sera were frozen and transported to the RIA laboratory, Universiti Kebangsaan Malaysia in Kuala Lumpur for measurements of triiodothyronine (T3), thryroxine (T4), thryroid-stimulating hormone (TSH) and other hormones. Hormone assays were performed using North East Thames Regional Immunoassay (NETRIA) reagents obtained from St Bartholomew's Hospital, London. Characteristics of the T4, T3 radioimmunoassays and TSH IRMA assay in our laboratory have been described previously[32].

Statistical analysis

Results were expressed as means ± standard deviation. Data were analysed by Student's *t*-test, difference between proportion and Fisher's exact test. A difference of $P<0.05$ was accepted as significant.

Results

Sociodemographic data

The Aborigines were living in settlement areas established more than 30 years ago started by a few families forming a traditional village which then grew to more than 30 families in recent years. The government gazetted the area as a settlement for Aborigines 20 years ago and supported the infrastructure (Fig. 1). Water was supplied from the river using a gravity-feed system. The main economic activities were farming and gathering jungle produce. Rattan, banana leaves and medicinal herbs were the main merchandise for generating income through sales to a middle man operating daily in the village. Rice and tapioca were the main staple food. Fish were caught from the nearby dam. Vegetables were obtained from backyard gardens or the jungle. Other foods were bought from a retail shop owned by an Aboriginal co-operative in the village. The Malays lived in a traditonal village about 1 km from the settlement area. The village with a population of 350 had been established for almost 30 years. The main economic activities were farming and rubber tapping. The Malays obtained their food mainly from local shops and the nearby small town.

The mean age of the Aborigines was 22.2 ± 14.6 years whereas the Malays were aged 37.1 ± 18 years. The Malays included more old people because many of their young adults migrate to the city for better education and jobs. There was no significant difference in the income of the two communities. The mean income of aborigines was MR $233 compared to MR $315 for the Malays.

Patterns of food intakes

The mean daily dietary energy intake among Aborigines was 1400 ± 473 kcal (5.86 ± 1.98 MJ), proteins 56.6 ± 36.3 g and fats 37.4 ± 23 g. Among the Malays, the mean daily energy intake was 1590 ± 475 kcal (6.65 ± 1.99 MJ), proteins 71.2 ± 8.2 g and fats 49.6 ± 24 g. With the exception of fats, the intake of energy and proteins was not statistically different. The daily intake of iron was significantly different from that of the Malays, with a mean of 11.3 ± 5.9 g iron compared to 7.4 ± 3.1 g among Aborigines ($P<0.05$).

Cassava (tapioca) was consumed by about 60% of Aboriginal household communities at least once a week, compared to 21% among Malay households (Table 1). Seafood such as cockles, prawns and cuttlefish, was rarely taken by Aborigines. The details of food intake patterns have been described elsewhere[27].

Nutritional status

The Malays had a better nutritional status compared to that of Aborigines as shown by a significant difference in body mass index (BMI), mid-arm circumference (MAC) and skinfold thickness between the two populations. The

Table 1. Amount of cassava (tapioca) consumed by Aboriginal ($n = 22$) and Malay ($n = 19$) households.

Consumption of cassava	Aborigines		Malays	
	n	%	*n*	%
At least once a week	13	59.1	4	26.3
Less often or not eaten	9	40.9	15	73.7

$Z = 2.152$, $P<0.05$

Table 2. Mean anthropometric indices for children and adults among Aborigines and Malays.

Anthropometric index	Aborigines		Malays	
	Males	Females	Males	Females
BMI		*		
Children	16.2±1.5	16.0±2.5	16.6±1.8	22.5±9.9
		*		
Adult	20.6–3.1	20.4±3.4	22.7±3.6	23.4±3.2
MAC		*		
Children	19.4±2.8	19.6±2.4	19.8±4.0	23.2±4.4
	*	*		
Adult	26.1±3.1	23.9±2.9	29.1±3.4	21.0±3.1
SISFT	*	*		
Children	5.8±1.1	7.7±2.8	8.9±3.3	13.8±4.9
	*	*		
Adult	8.5±4.3	9.1±5.3	15.4±9.7	19.6±3.3

*$P < 0.05$ compared to Malays.

mean anthropometric data for adults and children (7–17 years old) are shown in Table 2. Malay females had a better nutritional status in all indices and all ages compared to their counterparts, whilst no differences in BMI was seen comparing Malay males to Aborigines.

The mean haemoglobin level of 11.7 g/dl (11.7 ± 2.7) among Aborigines and 13.7 g/dl (13.7 ± 1.8) among Malays were significantly different ($P < 0.05$). For males, the mean haemoglobin level was 12.7 ± 1.1 g/dl for Aborigines and 12.9 ± 5.5 gm/dl for Malays. Among females the levels were 9.9 ± 4.5 and 11.7 ± 3.7 g/dl respectively.

Prevalence of goitre

The prevalence of goitre among Aborigines was 26.5% of which 61.5% was stage 1. The prevalence amongst Malays was 19.6% ($P < 0.05$). The majority of goitres occurred among females of all ages. There were three children with goitres among Aborigines in this study (15% of total number of children 7-17 years old) but none in Malays. All the goitre cases patients clinically euthyroid and no cretins were found. Most goitres were diffuse.

TSH, thyroid hormone levels and thyroid autoantibodies

The mean level of TSH among Aborigines was 2.9 ± 1.5 mIU/l which was significantly higher ($P<0.05$) than amongst the Malays (2.0 ± 1.6). When TSH greater than 5.0 mIU/l was taken as hypothyroidism, three Aboriginal adults (4.3%) had high levels but only one had a goitre. There was no significant difference in the mean T3 and T4 serum levels between Aborigines and Malays. None of the 100 samples whether from those with goitre or without goitre had positive thyroid autoantibodies. The distribution of serum levels of TSH, T3 and T4 among Aborigines and Malays can be seen from Figure 2.

Relationship between BMI, goitre and thyroid hormone levels

Malnourished subjects (BMI < 18) had significantly higher mean TSH level (3.16 ± 1.71 mIU/l) compared to well-nourished subjects (2.14 ± 1.51) ($P = 0.006$).

When malnutrition was sub-divided into mildly malnourished (BMI >15<18) and moderately malnourished (BMI < 15), there was a significant difference in the mean level of TSH between the two groups (analysis of variance, $F = 4.41$, $P = 0.015$). Using Student's Neuman-Keuls test, a significant difference was found in the TSH level between moderately-malnourished and well-

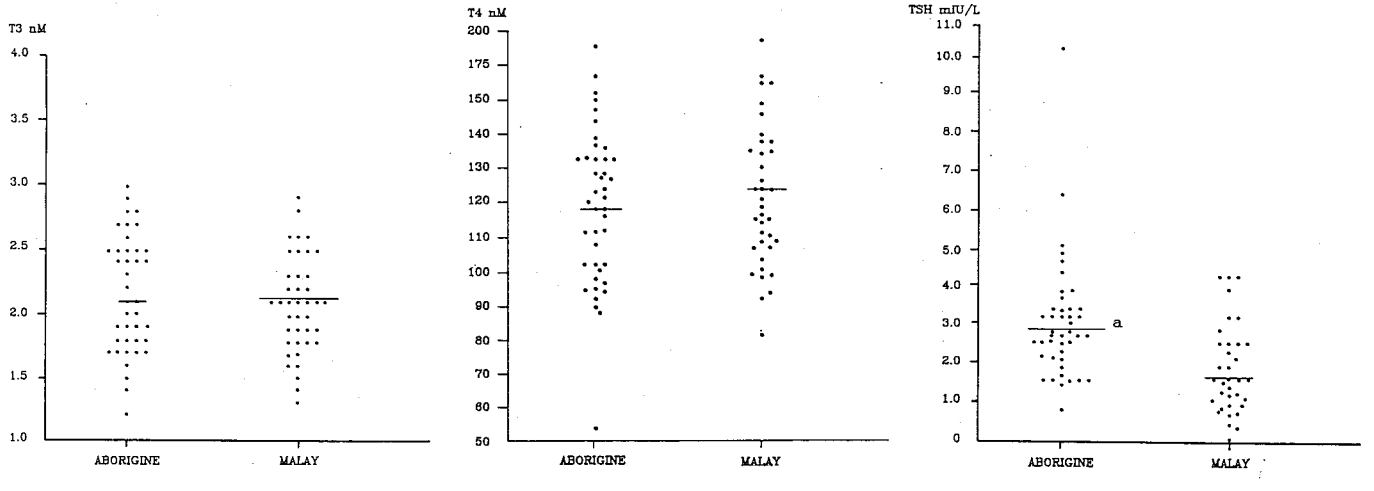

Fig. 2 The distribution of TSH, T3 and T4 among Aborigines and Malays in Kuala Pangsoon. – indicates the mean, a = significant difference ($P < 0.05$) of the mean TSH level between Aborigines and Malays.

nourished subjects (Table 3). There was a significant negative correlation between nutritional status of individuals and TSH levels (r = -0.262, P = 0.013, Fig. 3).

Intake of cassava and goitre

There was a significant association between the intake of cassava and prevalence of goitre (Fisher's exact test = 0.033, odds ratio = 4). Individuals who consumed cassava more than two to four times per week had four times the risk of developing goitre (Table 4).

Table 3. The relationship between BMI and TSH levels among Aborigines and Malays in Kuala Pangsoon.

BMI	*n*	TSH level means	sd	sem	F-test
Moderately malnourished	13	3.46	0.74	0.21	
Mildly malnourished	14	2.88	2.27	0.61	* 4.41
Well nourished	62	2.14	1.51	0.19	

* P = 0.015

Table 4. Relationship between cassava intake and occurrence of goitre among all subjects.

Consumption of cassava	Goitre	No goitre
Regular (n = 18) (at least 2 –4 times a week)	8 (45%)	10
Not regular(n = 73)	14 (19%)	59
Total (n = 91)	22 (24%)	69

Fisher's Exact Test P = 0.033, odds ratio = 3.37

Discussion

Endemic goitre is a global problem especially in mountainous areas of the world, mainly associated with iodine deficiency[29]. In non-iodine deficient areas, various goitrogens including cyanogenic glycoside in cassava[11], aliphatic disulfides in onions and garlic[13]; goitrin and cheilorine in milk and Escheria Coli in drinking water have been shown to cause goitre[13]. Excessive iodine intake has also been associated with high incidence of goitre in some areas of China[19] and Japan[31]. Nutritional status has never been shown to be related to the occurrence of goitre. In a study among children none of the nutritional indicators, including BMI and skinfold thickness, were related to occurrence of goitre[26]. Similar findings were found in experimental animals[12].

In West Malaysia, goitre is not a main public health problem because of availability of iodine-rich foods. Whether the iodine-rich foods reach all sections of the community or their drinking water contains enough iodine is not known especially among the Aborigines who live in the interior of the jungle. In this study even though the Aborigines lived close to the city, the prevalence of malnutrition and goitre were higher compared to the Malays who lived in a similar environment. However, the prevalence of goitre among the Aborigines (26.5%) was low compared to the Ibans in Sarawak. The prevalence among Ibans was 74% in mild endemic areas and as high as 99.5% in high endemic area[20]. We could not form any conclusion regarding the role of iodine in the pathogenesis of goitre because no measurement of iodine intake or estimation of urinary iodine was done. Assuming the area is not iodine-deficient, then the two most important factors that may be associated with the development of goitre are malnutrition and goitrogenic substances.

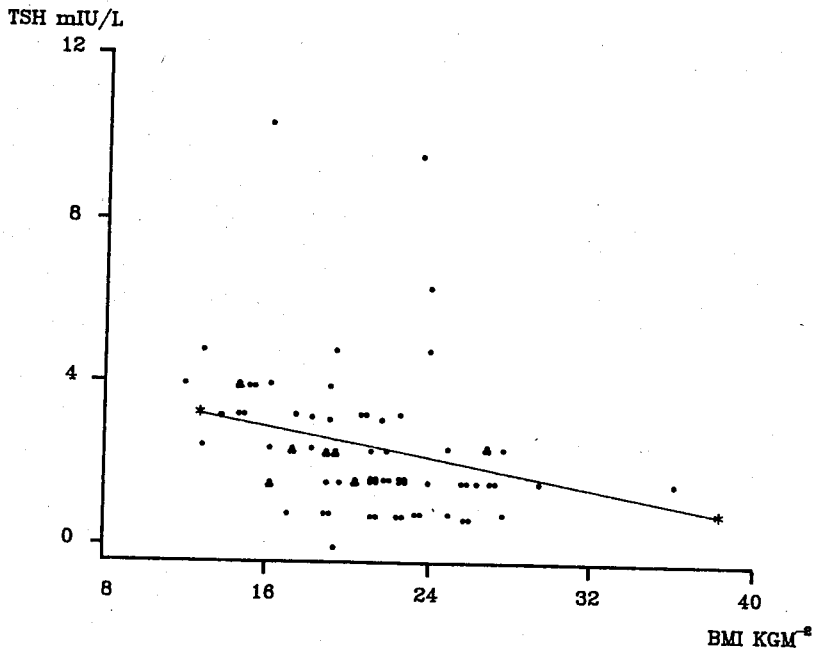

Fig. 3 The scatter diagram showing the correlation between BMI and TSH levels among all subjects in Kuala Pangsoon. Y = 4.36 – 0.09 X with r = –0.262 , t = –2.528 , df = 87 and P = 0.013.

Even though there was a significant difference between the nutritional status of the two communities, especially among females, and in the preponderance of goitre in females, there was no association between BMI and goitre. Various studies have indicated a conflicting relationship, and in one there was no relationship whatsoever between nutritional indices and prevalence of goitre among school-children[26]. This finding was supported by a study in Zaire that malnutrition was not associated with incidence of goitre[8]. A study in Bangladesh however found the prevalence of goitre varied significantly and was inversely related with underweight and wasting after controlling for the effect of socioeconomic status[30]. The lack of correlation between presence of goitre and nutritional status could be due to the crude assessment of goitres. Using highly sensitive TSH assays, however, we could detect a highly significant association between the mean TSH level and nutritional status assessed by BMI. Malnourished individuals had higher levels of TSH compared to a well-nourished subjects. Elevated TSH in protein energy malnutrition (PEM) is probably a response to stimulation by thytropin-releasing hormone (TRH) even though the serum levels of T4 and T3 were normal, and the patients assessed as clinically euthyroid. This compensated euthyroid state could only be detected by the use of highly sensitive TSH assays and implies an intact hypothalamo-pituitary axis. In severe malnutrition, not found in this study, the reduction in thyroid hormones is mainly due to adaptive response at peripheral metabolism of T4 by directing deiodination pathway of T4 to reverse T3[1]. Such changes arise from the body's adaptation in order to conserve energy and body protein[34]. Adequate protein and energy intake tends to reverse those abnormalities[15].

The role of cassava in the development of goitre is well-documented in the literature. Cassava was found to have a definite antithyroid action in humans and animals resulting in the development of endemic goitre and cretinism[10]. This action is due to endogenous release of thiocyanate (SCN) from linamarin, a cyanogenic glycoside contained in cassava. Nevertheless not all populations that consume cassava as their staple food developed goitre[11]. The prevalence of goitre was related either to reduction in iodine intake in the presence of high SCN intake or to an increasing SCN intake in the presence of a uniform iodine and SCN in the diet[6]. In this study cassava was consumed by more than 60% of the Aboriginal household at least once a week compared to 25% among the Malays. Cross-tabulation between goitre and frequency of cassava consumption showed an association between incidence of goitre and intake of cassava of with ingestion at least two to four times per week increasing the risk four times compared to the risk of less regular intake.

Low iodine levels of river drinking water could not be excluded because no measurement was made. Low iodine in drinking water was the major cause of endemic goitre in Sarawak[23] and China[5]. Other goitrogens such as lime, calcium fluoride and water pollution have been investigated by others[7, 14, 25, 33]. Autoimmune thyroiditis such as Hashimoto's thyroiditis may also cause goitres, especially in children and young adults, with female incidence four times that of males. High titres of antithyroid antibodies have been a common finding[16]. In this study, none of the subjects, Aborigines or Malays, had positive autoantibodies. Thus subacute thyroiditis or Hashimoto's thyroiditis is not a likely a cause of goitre in the area.

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Telah diteliti hubungan antara malnutrisi, gondok dan hormon tiroid pada orang pribumi dan Melayu di Ulu Langat, Malaysia. Lima puluh orang pribumi berusia 7 tahun dibilih secara acak dan dilakukan pengukuran antropometri, pemeriksaan klinis dan pengukuran kadar hormon. Lima puluh orang Melayu di sekitar desa Malay dengan usia yang sama dipilih sebagai kontrol. Orang pribumi memiliki prevalensi malnutrisi dan gondok yang lebih tinggi dibandingkan dengan orang Melayu. Prevalensi gondok adalah 26.5% pada orang pribumi dan 19.6% pada orang Melayu. Semua indeks nutrisi yang diukur berbeda secara bermakna di antara kedua kelompok, terutama diantara kaum wanita. Perbedaan yang bermakna didapatkan pada kadar 'thyroid-stimulating' hormon (TSH) yang diukur dengan memakai uji TSH dengan sensitivitas yang tinggi. Dengan menggunakan analisa univariate, peningkatan TSH berhubungan dengan penurunan 'body mass index' (BMI). Sebaliknya, tidak didapatkan hubungan antara BMI dan gondok. Tiroid otoantibodi tidak ditemukan dan semua subyek secara klinis dalam keadaan eutiroid dan memiliki kadar tiroksin dan triiodotironin yang normal. Bagaimanapun juga, konsumsi ketela dapat mengakibatkan 4 kali lipat terjadinya gondok. Angka prevalensi yang tinggi pada subyek yang kurang gizi di daerah ini dapat diakibatkan oleh konsumsi ketela, dan bukan akibat dari kekurangan yodium.

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作者報導了馬來西亞 Vlu Langar 地區的土著和馬來西亞人的營養不良，甲狀腺腫和甲狀腺激素之間的關係。

隨機選取了50位年齡在七歲以上的土著為試驗對象，進行了生理測量、臨床檢查和激素測定。另選50位年齡相近的住在附近村落的馬來西亞人為對照。

結果發現土著的營養不良和甲狀腺腫的發病較馬來西亞人為高，土著的甲狀腺腫發病率為26.5% 而馬來西亞人為19.6% 。

二者之間的所有營養指數差異很大，女性尤為明顯。這些差異與甲狀腺素的濃液是相關的。

分析顯示，促甲狀腺素濃度升高、体重指數下降。另一方面，他們發現体重指數與甲狀腺腫無關。所有對象甲狀腺功能正常，甲狀腺素和三碘甲狀腺氨酸濃度正常，沒有測出甲狀腺自身抗体。

作者報導，進食木薯地區的人患甲狀腺腫的危險高達四倍。但是否進食木薯可引起缺碘隨而誘發甲狀腺腫仍未明確。