ORIGINAL ARTICLE

The Prevalence of Goitre in Remote Inland Versus Coastal Areas

A Osman, PhD*
M I Zaleha, BSc*
R Letchumen, MMed**
B A K Khalid, PhD**
* *Department of Community Health, Medical Faculty,*
** *Department of Medicine, Medical Faculty, National University of Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur.*

Summary

The study was conducted to compare the prevalence of goitre among Malays and Aborigines in remote inland rural areas to those in coastal areas. All subjects were examined thoroughly by an experienced endocrinologist for the presence of goitre. The overall goitre prevalence in coastal areas was 6.3%; 6.0% (4/67) of Aborigines and 6.7% (4/60) of Malays were affected. However, in remote inland areas, the prevalence of goitre was almost 5 times higher compared to coastal areas. The prevalence of goitre was 30.7% in Baling; 30.2% (19/63) Aborigines and 30.8% (92/299) Malays were affected. Iodine deficiency is the most likely cause for the high prevalence of goitre in the remote inland areas.

Key Words: Goitre, Remote inland, Coastal areas

Introduction

The term endemic goitre implies enlargement of the thyroid gland where the prevalence exceeds 10% among children aged 6 to 15 years or in the adult population[1]. The major cause is iodine deficiency; however other goitrogenic factors may superimpose its presence and responsible for sporadic goitre[2]. Sporadic goitre is the term used when the prevalence is below 10%; the causes are often unknown.

Endemic goitre and IDD (Iodine Deficiency Disorders) are substantial worldwide problems. A WHO report estimated that in Asia, Africa and Latin America, where the major endemic areas are situated, 800 million people are at risk of IDD, 190 million have them, over 3 million people suffer from cretinism and several million suffer from mental and neurological defects[3]. Thus, about 15% of the world's population is at risk of and 4 to 5% suffer from IDD. Developing countries are mostly affected, and in these regions the population growth is rapid, creating problems of keeping prophylactic measures abreast with this growth.

The predominant factor causing the rising prevalence of goitre is iodine deficiency; there are few exceptions to this rule. In the presence of other goitrogenic factors, iodine deficiency plays a permissive role. Environmental goitrogenic agents are abundant[4,5] and among well known ones are compounds derived from vegetables of the Cruciferae family, particularly the Brassica genus such as cabbage, turnips, brussel sprouts, sweet potatoes and many others. In Zaire, endemic goitre is in part due to the presence of thiocyanate, which blocks the thyroidal uptake of iodine. Thiocyanate is liberated when processing cassava (Manihot esculenta), a staple food in Zaire[6]. Smoking tobacco produces thiocyanate and other goitrogenic

compounds and have been shown to cause thyroid enlargement[7,8]. Excess iodine can be goitrogenic by blocking thyroid hormone synthesis, and in Japan[9] endemic goitre occurs in some coastal areas where iodine rich seaweed is commonly eaten.

Generally, reported goitre prevalence is low in areas close to the sea (approximately 3%) and increased according to degree of rurality[10]. Polunin (1971) in his study in Sarawak found that subjects who lived in the inland areas had twice the prevalence of goitre compared to those who lived in coastal areas. The most notorious areas in Asia, with goitre prevalences up to 70 to 80% and cretinism, are the countries along the Himalayan mountains : Pakistan, India, Nepal and Bhutan. Only the Nordic countries, the British Isles and Belgium are free from endemic goitre[11]. It is our aim in this study to determine the prevalence of goitre in remote inland areas and to compare it to the prevalence in coastal areas.

Materials and Methods

Population and sampling

For remote inland areas, a total of 362 subjects were examined from Baling district, Kedah, comprising of 63 Aborigines from Lubuk Legong village and 299 Malays from Padang Che' Mas village and New Village Mukim Siong. As for coastal areas, 127 subjects were selected, of which 67 were Aborigines from Sungai Kurau village and Sungai Bumbun village, and 60 were Malays from a Malay village in Carey Island, Selangor. Cluster sampling method was used in this study.

Neck examination

All subjects were examined thoroughly by an experienced endocrinologist for the presence of goitre. Goitre status was determined using the classification suggested by World Health Organization (Table I).

Urine specimen and drinking water

Urine samples were collected randomly from participants and placed in bottles without any preservative. The samples were kept in a cool room and sent to the laboratory for the determination of iodine level. Drinking water from various sources and locations such as river, spring water and water from gravity feed system and pipe water were also collected in a similar way.

Table I
Goitre grades according to World Health Organization (1974)

Grades	Explanation
0	Persons without a goitre (person whose lateral lobes of the thyroid gland have volume smaller than the terminal phalange of the thumb of the person being examined).
1	Persons with palpable goitre (person whose thyroid gland is palpable but not visible with the neck in normal position).
2	Persons with visible goitre (person with goitres which are easily visible with the head in normal position).
3	Persons with very large goitre (goitres can be recognized at 10 metres distance). May be associated with pressure symptoms.

Measurement of iodine in the urine and drinking water

The level of iodine in the urine and drinking water was measured using alkaline ashing method[12,13]. This method involves three steps, (i) drying in the oven for 15-18 hours at 110°C, (ii) ashing in pre-heated muffle furnace at 500°C which is then raised to 600°C, and lastly (iii) acid extraction to eliminate any organic materials. Then the iodine level was estimated using Sandell-Koltholf reaction method. This technique was found to give a good acquisition (95-103%)[13]. Accuracy between assays (CV) in 30 control urine samples with the mean concentration of 11.3 ug/L is 10.6%. Iodine concentration in urine of random samples and goitre prevalence are the accepted indices to show endemia of an area (Table II)[14].

Table II
Urinary iodine concentration and goitre prevalence indices to show endemia of an area (Hetzel, 1989)

Endemia	Goitre prevalence	Median of iodine in urine (ug I/dl)
mild	10 - 30%	5.1 - 10.0
moderate	31 - 50%	2.0 - 5.0
severe	>50%	<2.0

Results

Prevalence of goitre according to areas and ethnicity

The prevalence of goitre was significantly higher in remote inland areas compared to coastal areas (almost 5 times higher) (Table III). The Aborigines in remote inland areas had higher goitre prevalence compared to those in the coastal areas (30.2% in remote inland versus 6.0% in coastal areas, $p<0.05$). The same pattern was shown among the Malays (30.8% in remote inland versus 6.7% in coastal areas, $p<0.05$). The difference in prevalence of goitre between the two ethnic groups was small and insignificant.

Prevalence of visible goitre according to areas and ethnicity

The prevalence of visible goitre was higher in remote inland areas as compared to coastal areas (Table IV). Nearly half of the goitre subjects here (45.1%) had visible goitre. The Malays showed a higher prevalence (45.6%) compared to the Aborigines (42.1%) in these areas. No visible goitre was detected in coastal areas.

Iodine levels in random sample urine and drinking water according to location

In general, iodine levels in remote inland areas were lower compared to the iodine levels in coastal areas (Table V). In both areas, there was no significant difference in iodine levels between locations ($p>0.05$).

Table III
Prevalence of goitre according to area and ethnic group

Areas	Overall subjects			Aborigines			Malays		
	n	goitre	(%)	n	goitre	(%)	n	goitre	(%)
Remote inland	362	111	30.7	63	19	30.2	299	92	30.8
Coastal	127	8	6.3	67	4	6.0	60	4	6.7
Chi-square test	$X^2 = 29.643$ $p = 0.000$			$X^2 = 12.507$ $p = 0.000$			$X^2 = 14.213$ $p = 0.000$		

Table IV
Prevalence of visible goitre according to area and ethnic group

Areas	Overall subjects			Aborigines			Malays		
	goitre	visible goitre	(%)	goitre	visible goitre	(%)	goitre	visible goitre	(%)
Remote inland	111	50	45.1	19	8	42.1	2	42	45.6
Coastal	8	0	0	4	0	0	4	0	0

Table V
Iodine levels in random samples of urine and drinking water according to location

Location	Iodine levels (ug I/dl) *random samples of urine n	mean	sd	drinking water n	mean
Remote inland (Baling)					
a. Kg. Pdg. Che' Mas	135	1.88	1.59	5	1.20
b. Kg. Baru Mkm. Siong	131	1.75	1.27	2	0.54
c. Kg. Lubuk Legong	59	1.65	1.18	3	1.06
Coastal (Carey Island)					
a. Kg. Sg. Kurau	26	1.55	1.14	2	0.51
b. Kg. Sg. Bumbun	39	2.35	1.59	1	0.24
c. Kg. Melayu	59	2.05	1.49	2	0.56

* *The difference between iodine levels in random samples of urine by location;*
Analysis of variance (ANOVA); F = 1.58 p = 0.1634 (not significant)

Lubuk Legong village which was an Aborigine settlement, had the lowest iodine content in the urine (1.65 ± 1.18 ug I/dl) compared to other locations in remote inland areas (1.88 ± 1.59 ug I/dl in Padang Che' Mas village and 1.75 ± 1.27 ug I/dl in New Village Mukim Siong). However, in coastal areas, the lowest iodine content in urine was found in Sungai Kurau village (Aborigine settlement), with the iodine levels of 1.55 1.14 ug I/dl. This is followed by Kg. Melayu (2.05 ± 1.49 ug I/dl) and Sungai Bumbun village (2.35 ± 1.59 ug I/dl).

The iodine levels in drinking water, were surprisingly higher in the remote inland areas compared to coastal areas. It is likely that the iodine source in coastal areas is not only limited to drinking water, but more to other iodine sources such as foods of marine origin, vegetables, bread, cereals, maize, meat and dairy products such as milk and eggs. These alternative sources are also likely to be more easily available in the coastal areas.

Iodine levels in random sample urine according to village and sex

Basically, urine iodine levels were higher among men compared to women in majority of villages (Table VI). However, significant difference in iodine levels was only found in Kg. Melayu (coastal area) ($p<0.05$). Comparison between villages in remote inland or coastal areas showed no significant difference in iodine levels ($p>0.05$).

Comparison of iodine levels in random sample urine according to area and ethnic group

There was no significant difference in iodine levels in random sample urine according to areas (Remote inland : 1.79 ± 1.40 ug I/dl, Coastal : 2.04 ± 1.47 ug I/dl; $p>0.05$) (Table VII). Comparison between the Malays in remote inland and coastal areas was not statistically significant; the same result was obtained in the Aborigines ($p>0.05$). Iodine levels between ethnic group in both areas also showed no significant difference ($p>0.05$).

Discussion

Disorders resulting from severe iodine deficiency affect more than 400 million people in Asia alone. These disorders include stillbirths, abortions and congenital anomalies, endemic cretinism, characterized most commonly by mental deficiency, deaf, mutism, and spastic diplegia and lesser degrees of neurological defect related to fetal iodine deficiency; and impaired mental function in children and adults with goitre associated

Table VI
Iodine levels in random samples of urine according to village, ethnic and sex

Location	Ethnic	# Iodine levels (ug I/dl) Male n	mean	sd	Female n	mean	sd	+p (t test)
Remote inland (Baling)								
a. Kg. Pdg. Che' Mas	M	61	1.80	1.52	74	1.96	1.66	0.564
b. Kg. Baru Mkm Siong	M	47	1.86	1.16	84	1.70	1.33	0.491
c. Kg. Lubuk Legong	A	32	1.87	1.40	27	1.38	0.80	0.113
Coastal (Carey Island)								
a. Kg. Sg. Kurau	A	12	1.24	1.02	14	1.82	1.20	0.201
b. Kg. Sg. Bumbun	A	18	2.63	1.72	21	2.11	1.47	0.315
c. Kg. Melayu	M	32	2.51	1.53	27	1.51	1.26	0.009*

M = Malay
A = Aborigines
 # The difference between iodine levels in random samples of urine by villages;
Analysis of variance (ANOVA); (Remote inland : F = 0.74 p = 0.477;
Coastal : F = 2.76 p = 0.067; NS)
+ Comparison between sex (t test)

Table VII
Iodine levels in random samples of urine according to area and ethnic group

Areas	Ethnic	Male n	mean	sd	Female n	mean	sd	+p	Total n	mean	sd	*p
Remote inland (Baling)	[a]M	108	1.83	1.37	158	1.82	1.49	0.3634	325	1.79	1.40	0.466 (NS)
	[b]A	32	1.87	1.40	27	1.38	0.80	0.0045(S)				
Coastal (Carey Island)	M	32	2.51	1.53	27	1.51	1.26	0.3131	124	2.04	1.47	
	A	30	2.07	1.62	35	1.99	1.35	0.3146				

M = Malays A= Aborigines; S = Significant NS = Not Significant
** Comparison between remote inland and coastal areas, t test; t = 1.11, p = 0.466 not significant)*
+ Comparison between male and female, t test; p is significant at 0.05.
a Comparison between the Malays in remote inland and coastal areas
t test; t = -0.927 p = 0.355 (not significant)
b Comparison between the Aborigines in remote inland and coastal areas
t test; t = -1.736 p = 0.085 (not significant)
a,b Comparison between ethnic in remote inland or coastal areas
Remote inland; t test; t = 1.010 p = 0.313
Coastal; t test; t = -0.077 p = 0.085

with subnormal concentrations of circulating thyroxine[14]. The best known effect of iodine deficiency is endemic goitre. Goitre has caused a major problem throughout the world especially in remote areas such as the Alps, the Pyrenees, the Himalayas and the Andes. In Bangladesh, Bhutan, Burma, India, Indonesia, Nepal, Sri Lanka and Thailand about 277 million people live in significantly iodine deficient areas, and about 102 million of them is suffering from goitre[15]. Endemic goitre is no longer a major health problem, hence, this disease was given little attention especially in West Malaysia[16]. However, in East Malaysia such as in Sri Aman Division, Lubok Antu and the upper Lemanak in Sarawak the prevalence of goitre was still high[17].

It is known that in a place located in more remote areas, the levels of iodine in urine samples were lower. Even though in this research there was no significant difference in levels of iodine between coastal and remote inland areas, the levels was higher in coastal areas. We also found that the prevalence of goitre was almost 5 times higher in remote inland areas as compared to coastal areas in both ethnic groups. This is probably due to the fact that people who live in remote areas get less suply of iodine. These communities are largely dependent on locally produced food and most of these are deficient in iodine. Our previous study showed that frequent intake of tapioca and less intake of seafood such as cuttlefish, cockle; chicken and egg have a significant association with goitre prevalence[18]. This will explain why the prevalence of goitre was high in remote inland areas as was reported in East Malaysia[19]. Djokomoeljanto (1984) also found that the prevalence of goitre was higher in rural areas especially among the Aborigines compared to those who live in urban areas[20]. According to Eastman and Phillips (1988), places that have high prevalence of endemic goitre may be due to the remoteness and isolation of the locations involved[21]. In this study, no significant difference was observed between the Malays and the Aborigines in the same area, but significant difference was observed between geographic location.

It is known that the prevalence of goitre is higher among women compared to men. From the Penan study by Chen in 1988, about 60.0% of adult women have goitre and 39.9% of adult men exhibited goitres[22]. The level of iodine in women that we observed were lower compared to men in both Aborigines and Malays, however the difference was statistically not significant ($p>0.05$). Low levels of iodine, as well as the increased requirement for iodine in women especially during lactation and childbearing can cause severe iodine deficiency in women.

From this study, we found that the prevalence of goitre in remote inland areas was much higher compared to coastal areas even though the iodine levels in drinking water was lower compared to remote inland areas. This is because those people who lived in coastal areas take foods of marine origin in which, it is richer in iodine than any other foodstuff. They also take less goitrogenic food such as tapioca. Iodine intake of 100 ug for children below 10 years old and 150 ug for older children and adults is sufficient to prevent goitre[5].

Conclusion

The prevalence of goitre was higher in remote inland areas compared to coastal areas whilst urinary iodine levels were lower in remote inland areas compared to coastal areas.

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