Iodine content in drinking water not an important determinant of endemic goitre

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The prevalence of goitre was determined in several communities in rural parts of Pahang. Urine specimens were collected randomly among the participants. Drinking water from various sources such as river and spring, and water from gravity feed systems was also collected to determine the iodine content by using the ashing method. The results were compared to that of Kuala Lumpur City. It was found that the prevalence of goitre in rural areas was between 20 and 70% depending on village, ethnic group, age and gender. The interior parts of the jungle where Aborigines lived was moderately endemic with goitre prevalence of goitre more than 20% and urinary iodine content 2.0–5.0 μg I/dl). A nearby Malay traditional village which was studied had mild endemia (prevalence 10–30% and urinary iodine content 5.0–10.0 μg I/dl) while a Felda Malay resettlement scheme and Kuala Lumpur City did not have endemic goitre. Endemic goitre in rural areas was associated with low iodine content in drinking water. Even though Kuala Lumpur had low iodine content in its drinking water there was no endemic goitre, indicating that other factors were more important.

Introduction

Endemic goitre is a major problem throughout the world especially in the mountainous areas such as the Alps, the Pyrenees, the Himalayas and the Andes. These areas have one similarity, that is a lack of iodine. Endemic goitre is a health problem to about 400 000 people in Asia[1]. In South East Asia, endemic goitre can be found in large areas of Indonesia[2], Thailand and the Philippines[3].

In Malaysia, very little attention has been given to the problem of endemic goitre because the disease has not been a major health problem for long, especially in West Malaysia. Polunin (1971) however found the prevalence of goitre in Sarawak to be high but variable[4]. Among children aged 11–14 years old the prevalence was 1.4–21.4% and for subjects aged 15 years old and above, it was 3.1–55.3% depending on the ethnic group. He also found that in the same ethnic group, the prevalence of goitre among subjects living in rural areas was twice as high as compared to those in the more developed areas[4]. In general, the prevalence of goitre was low in the areas near the sea (3%), but increased gradually up to 100% in areas which were very far from the sea. Besides the lack of iodine in the rural areas, a goitrogen from cassava had been postulated to be associated with the occurrence of goitre in Sarawak[5]. The aim of this study was to determine the association of goitres with iodine content of the ambient drinking water among the Aborigines and Malays in West (Peninsular) Malaysia.

Method and sampling

Population and sampling

A total of 1419 subjects were investigated from six areas. Two were Aboriginal settlements in the jungle (Lanai Post and Batau Post), two were rural areas in state of Pahang (Hulu Sungai village and Felda Koyan resettlement scheme) and two were in Kuala Lumpur City (Bukit Lanjan and Kerina village). A cluster sampling method was used.

Examination for goitres

Neck examination was done by the endocrinologist in our team. The status of goitre was determined according to the classification recommended by the World Health Organisation (Table 1).

Table 1. Goitre grading according to World Health Organisation (1974).

Grade	Explanation
0	Thyroid not palpable or if palpable the size is normal.
1	Thyroid palpable and more than normal but unable to see with neck in normal or extended position.
2	Easily palpable thyroid and able to see with extended neck. The existence of nodule is included in the category.
3	Easily seen thyroid at normal head position.
4	A monstrous goitre.

Urine sample and drinking water

Urine samples were collected randomly from subjects, placed in bottles without any preservative, and sent to the laboratory for the determination of iodine level. Drinking water was collected from various sources and locations such as from nearby rivers and springs, and water piped from gravity feed systems and water reservoirs.

Measurement of iodine level in the urine and drinking water

The level of iodine in the urine and drinking water was determined using the manual alkaline ashing method[6,7]. This involved two steps: first, ashing in a furnace and extraction of iodine from the ash to eliminate any organic materials, followed by iodine estimation using the Sandell–Kolthoff reaction method. In this reaction iodine acts as the catalyst in the oxidation-reduction reaction between Caesium (Ce) and Arsenic (As), measured using a spectrophotometer.

The iodine concentration in randomly selected urine samples and prevalence of goitre were used as indices for estimating the endemicity of the area as shown in Table 2 below[8]:

Table 2.

Endemia	Prevalence of goitre	Median urine iodine (μg I/dl)
Mild	10–30%	5.0–10.0
Moderate	30–50%	2.0–5.0
Severe	50–100%	<2.0

Results

The prevalence of goitre according to location

Post Lanai, an Aboriginal settlement deep in the jungles of Pahang, had the highest prevalence of goitre compared to other locations (Table 3). Among adults, the prevalence of goitre was highest in Post Lanai followed by Post Betau (an Aboriginal resettlement scheme in the jungle) and Hulu Sungai Malay traditional village situated nearby. Among children, the prevalence of goitre was high in the rural areas (Post Lanai and Post Betau) compared to the urban areas of Kuala Lumpur and the Malay traditional village at Hulu Sungai. Prevalence of goitre was low among the Aborigines and Malays in the urban areas, and among the Felda settlers living not far from the above traditional villages.

The prevalence of goitre according to age, ethnic group and gender

In general, the prevalence of goitre was higher among the Aborigines compared to the Malays at all ages and of both sexes (Table 4). About 20% of preschool Aboriginal children had goitre compared to 5% among Malay school children. The prevalence among men according to age was between 10 and 23%, while for women it was 11–50%.

Iodine levels in urine and drinking water

There were significant differences in the iodine levels according to location (Table 5). The mean urinary iodine level was low in Aborigines (1.86±1.19μg I/dl in Betau and 2.9±7.61 μg I/dl in Lanai) compared to Malays in the traditional village and urban areas (Hulu Sungai 5.41±1.74μg I/dl, and urban areas 7.73±3.38μg I/dl). These did not correspond to the iodine levels in the drinking water of the areas studied. In Betau the urine iodine level was low and so was the iodine content of the drinking water, but Hulu Sungai and Kuala Lumpur with low iodine content of drinking water, had significantly higher urine iodine levels. Furthermore, Felda Koyan with the highest iodine content in drinking water had low urine iodine comparable to that in Post Lanai (see Table 5).

Table 3. Prevalence of goitre according to age and location.

Location	Age group	Number of subject	Prevalence	Standard deviation	Confidence interval
Lanai Post	2–6	39	20.3	4.1×10^{-3}	19.5–21.1
(Aborigine village)	7–17	61	55.7	4.0×10^{-3}	54.9–56.5
	>17	112	67.3	2.0×10^{-3}	66.9–67.7
Betau Post	2–6	55	21.2	3.0×10^{-3}	66.9–67.7
(Aborigine resettlement)	7–17	68	55.2	8.6×10^{-3}	53.5–56.9
	>17	137	48.2	1.8×10^{-3}	47.8–48.6
Bukit	2–6	57	0	0	0
Lanjan	7–17	68	4.4	3.6×10^{-4}	4.33–4.47
(Aborigine village) Kuala Lumpur	>17	78	24.4	2.3×10^{-3}	23.9–24.9
Hulu	2–6	34	2.9	8.3×10^{-4}	2.74–3.06
Sungai	7–17	59	17.2	2.4×10^{-3}	16.7–17.7
(Malay village)	>17	154	25.0	1.2×10^{-3}	24.8–25.2
Felda	2–6	55	0	0	0
Koyan	7–17	119	1.7	1.4×10^{-4}	1.67–1.73
(Malay resettlement)	>17	133	8.1	5.6×10^{-4}	7.99–8.21
Kerinci	2–6	39	0	0	0
village	7–17	59	1.7	2.8×10^{-4}	1.64–1.76
(Malay)	>	92	6.6	6.7×10^{-4}	6.47–6.73

Table 4. Prevalence of goitre according to age, ethnicity and gender.

Age (year)	Gender	All subjects			Aborigines			Malays		
		sample	goitre	prev (%)	sample	goitre	prev (%)	sample	goitre	prev (%)
2–7	male	94	10	11.0	48	8	16.7	46	2	4.4
	female	88	11	12.5	45	9	20.0	43	2	4.7
7–12	male	157	23	14.6	71	21	29.6	86	1	1.2
	female	146	17	11.6	62	14	10.5	84	3	1.8
13–17	male	60	9	15.0	27	8	29.6	86	1	1.2
	female	71	33	46.5	37	25	67.6	34	8	23.5
18–29	male	89	20	22.5	60	18	30.0	29	2	6.9
	female	127	63	49.6	74	50	67.6	53	13	24.5
30–49	male	147	28	19.1	65	25	38.5	82	3	3.7
	female	174	61	35.1	54	33	61.1	120	28	23.3
50	male	96	20	20.8	43	16	37.2	53	4	7.6
	female	74	27	36.5	30	18	60.0	44	9	20.5

Table 5. Iodine levels in random urine subject and drinking water according to location.

Location		Iodine levels (μg I/dl)				
		Urine			Drinking water	
		n	mean	sd	n	mean
a)	Lanai Post	30	2.90	1.61[ce*]	no specimen	
b)	Betau Post	30	1.86	1.19[ce]	4	0.23
c)	Hulu Sungai village	30	5.41	1.73[de]	2	0.28
d)	Felda Koyan	30	2.95	1.97[e]	2	0.42
e)	Kuala Lumpur	30	7.73	3.38	3	0.15
	ANOVA Test		F	11.2		
			p*	<0.0001		

*Significant ($p<0.05$), b = compared to Post Betau, c = compared to Kg. Hulu Sungai, d = compared to Felda Sg. Koyan, e = compared to Kuala Lumpur.

Discussion

Endemic goitres not only cause cosmetic problems but may also be associated with hypothyroidism and cretinisms[9]. One to 5% of the population in endemic goitre areas have cretinism. High prevalence of subclinical cretinism was also found in endemic areas[10]. These will affect the mental development and physical growth of affected individuals[11]. Some goitres may become very large and block the airway passages[8]. Any measures which attempt to reduce the prevalence of goitre must correct the causes or at least reduce them. One simplistic measure would be to increase the iodine content of drinking water of affected populations. This study clearly showed that the iodine content of drinking water, and measurement of urinary iodine, did not correlate with the prevalence of goitre. Other confounding factors such as goitrogens in the diet or genetic susceptibility may be more important. If urinary iodine was used as the only criterion, then not only should the Aborigines in Lanai and Betau get iodine supplements, but also the Malays at Felda Koyan, who had relatively low iodine in their water and low prevalence of goitre. The Malays in Hulu Sungai, with higher prevalence of goitre, would not get iodine supplements, even though the iodine content of their drinking water was low. If the iodine content of the drinking water was used as the sole criterion for adequacy of iodine supply to a population, then the whole of the population of Kuala Lumpur city would be supplemented with iodine. This may in fact cause more harm to them because their iodine supply from other sources was adequate, as shown by the high iodine content in the urine.

Our previous study had found the prevalence of goitre to be higher among Aborigines compared to Malays living in an almost identical environment[12]. The prevalence of goitre increased with age and was highest among female Aborigines, peaking at the 13–17 years age group. During this period, thyroid gland growth is usually maximal and coincides with thyroid stimulating hormone (TSH) increments[13]. The higher prevalence of goitre in the Orang Asli (Aborigines) could possibly be contributed to by malnutrition which was more prevalent in them compared to Malays. Malnutrition resulted in higher TSH levels[14]. The Aborigines also consumed more cassava, and cassava leaves are known to contain goitrogens[12]. In Kuala Lumpur city, the lack of goitres despite low iodine content of the water could possibly be due to sufficient iodine in the food intake, as shown by adequate iodine levels in the urine.

Conclusion

The prevalence of goitre was high in the rural populations especially among the Aborigines. However, the prevalence was not associated with the urinary iodine content nor the content of iodine in drinking water.

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飲水的碘并非地方性甲狀腺腫的重要決定因素
摘要

作者在PAHANG州農村的幾個社區調查了甲狀腺腫的患病率，他們隨機收集受試者的尿液樣本分析碘含量。食水從幾方面來源，他們收集了河水、泉水和水庫中的水，用ASHING法測定水的碘含量。與吉隆坡市相比較，結果發現農村地區甲狀腺腫的發病率在２０－７０％之間，叢林深處的土著也患有中等度的甲狀腺腫（患病率在２０％以上，每１００毫升尿液碘含量爲２．０－５．０微克）。作者同時研究了附近一個馬來傳統的鄉村，發現有輕微的甲狀腺腫（患病率在１０－３０％，每１００毫升尿液碘含量爲５．０－１０．０微克）。但是在一個馬來開發區(FELDA)和吉隆坡市并未發現地方性甲狀腺腫，作者認爲農村地區的地方性甲狀腺腫與食水含碘低有關，但是吉隆坡市的食水含碘量雖低，并未發現有地方性甲狀腺腫，這顯示出有更重要的其它因素。

ABSTRAK

Prevalensi gondok dikaji pada beberapa komunitas di kawasan perkampungan Pahang. Spesimen urin dikumpul secara acak dari peserta. Air minum dari pelbagai punca seperti sungai, air mata air (spring water) dan air pergunungan (gravity feed) dikumpul untuk menentukan kandungan yodium secara metoda pengabuan. Hasilnya dibandingkan dengan hasil yang diperolehi daripada Bandaraya Kuala Lumpar. Didapati prevalensi gondok di kawasan perkampungan antara 20–70% menurut kawasan, jumpulan etnik, umur dan seks. Bahagian pedalaman yang didiami oleh orang Asli mengalami gondok endemik yang sederhana prevalensi gondok melebihi 20% dan kandungan yodium urin 2.0–5.0 μg I/dl). Orang Melayu di perkampungan tradisional yang berhampiran, mengalami endemisitas yang ringan (prevalensi gondok 10–30% dan kandungan yodium urin 5.0–10.0 μg I/dl) sementara penempatan orang Melayu FELDA dan Bandaraya Kuala Lumpur tidak mengalami endemisitas. Gondok endemik di kawasan perkampungan berkait rapat dengan kandungan yodium yang rendah dalam air minum. Walaupun Kuala Lumpur mempunyai air minuman yang rendah kandungan yodiumnya, tidak terdapat endemisitas yang mana menunjukkan adanya faktor lain yang lebith penting.