Iodine deficiency disorders in Sarawak, Malaysia

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The state of Sarawak in Malaysia has a high prevalence of iodine deficiency disorders (IDD). This has been revealed through a review of goitre surveys that were carried out in the State from the early 1970s to the 1990s. The primary cause was low iodine intake. Contributory factors were low iodine content in the soil and water as well as high cassava consumption. Virtual elimination of IDD is one of the nutritional goals of the IDD prevention and control programs. The strategies adopted include the iodination of coarse salt, which is sold in the market by shopkeepers and also provided free from government health clinics; legislation requiring that salt sold in IDD-gazetted areas must be iodised; and the use of iodinators to iodise water supplied by the gravity-feed system to villages and boarding schools in rural areas. The indicators used in the monitoring and evaluation of the program include the availability of iodised salt in the market and households, iodine levels in water supply that had been fitted with iodinators, goitre volume measured by ultrasound, and urinary iodine excretion among school children.

Key words: iodine deficiency disorders, Sarawak, Malaysia, goitre, survey, low iodine intake, program, salt iodination, water iodinators.

Introduction

Iodine deficiency disorders (IDD) and their consequences are one of the numerous socio-economic problems which many developing countries have to face. Some of the consequences of iodine deficiency are irreversible, but all can be completely prevented. Sarawak is a State in Malaysia which has a high prevalence of IDD.

Sarawak lies on the north-western part of the island of Borneo. With an area of 124 450 square kilometres, it is the largest State in Malaysia and is almost as large as Peninsular Malaysia. The State can be divided into three geographical regions: (i) an alluvial and swampy coastal plain; (ii) a hilly region, intersected by mountains; and (iii) a sharply rising mountainous interior.

The climate is equatorial, characterized by high humidity, uniformly high temperatures and heavy rainfall of up to 400 cm annually.

Sarawak has an estimated population of 1.7 million, of which approximately 80% are found in rural areas.[1] However, the population is unevenly distributed: the western coastal region covers 25% of the total land area of the State and holds 75% of the total population; the eastern coastal region occupies 25% of the land area and holds 15% of the population; and the interior region occupies about 50% of the land area and holds only 10% of the population. Iodine deficiency disorders are especially prevalent in the interior region.

Sarawak is multiracial and multicultural. The Malays and Melanaus are mainly coastal dwellers and form approximately 25% of the population. The Chinese form approximately 29% of the population and are mainly concentrated in the urban areas. The remaining population (46%) is made up of numerous indigenous tribes who are found mainly in the hilly and interior regions of the State.

These geographical and demographic characteristics are important in understanding the prevalence and distribution of endemic goitre in Sarawak.

The purpose of this paper was to review IDD in the State of Sarawak. This includes its prevalence and significance as a public health problem; the study methods used to examine IDD; and control programs aimed at eliminating IDD, including monitoring and related legislation.

Iodine deficiency disorders (IDD) as a public health problem

Until the early 1990s IDD was viewed as a problem of endemic goitre which could lead to cretinism in severe cases. While it was known that iodine deficiency caused goitre, irreversible brain damage in the foetus and infant, and retarded psychomotor development in the child, it was only recently that it was widely realized that even mild iodine deficiency early in life can cause deficits in intelligence.[2,3] Recent knowledge on the range of physical and mental handicaps caused by iodine deficiency and the more recent use of the term ‘Iodine Deficiency Disorders’ and not just ‘goitre’ has brought about an awareness of the significance of the problem.

The United Nations World Summit for Children in 1990, where the Government of Malaysia was a participant, provided the impetus for Malaysia to view IDD in a different

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light. The National Plan of Action for Child Survival, Protection and Development included the goal for the virtual elimination of IDD. Since the evolution of this plan, the Ministry of Health has placed a high priority on its programs related to solving nutritional problems in Sarawak, Sabah and parts of Peninsular Malaysia.

Prevalence of IDD in Sarawak

A high incidence of endemic goitre has been noted in central Sarawak in communities along the Rejang River, about 80 kilometres inland, since the early 1950s. Data on the goitre situation in Sarawak have been obtained from limited studies undertaken by different groups of researchers in different parts of the State from the 1970s and 1980s, mostly among females.[4–8] The prevalence of endemic goitre during this period ranged from 20% to over 90%.[9]

Table 1 and Figure 1 summarize the findings of various researchers. In 1970 Polunin concluded that Sarawak had the highest incidence and prevalence of goitre in Malaysia.[10]

In the past, studies were localized in certain remote localities known for their high goitre endemicity and associated low socio-economic, health and nutritional status. These localities may not have been representative of all the remote inland areas in the State. In one such community in the Lubok Antu district, the goitre prevalence in 167 people examined was 99%.[11]

Table 1. Goitre survey and findings in Sarawak

Researcher	Location	Respondents				Prevalence of IDD	
		Ethnic group	Age	Sex	Total *n*	% goitre	% cretinism
Polunin (1970)	Kuching, Samarahan	Chinese,	10–14	F	273	49.8	No figures
	Division	Malay, Bidayuh	≥ 15	F	157	52.2	given
	Sri Aman Division	Iban, Malay,	10–14	F	147	38.8	
		Chinese	≥ 15	F	161	80.7	
	Sibu, Sarikei, Kapit	Iban, Malay,	10–14	F	252	34.5	
	Division	Chinese, Kejaman	≥ 15	F	589	55.2	
	Limbang Division	Malay,	10–14	F	20	45.0	
		Chinese, Iban	≥ 15	F	151	45.0	
			10–14	F	1750	30.0	
			≥ 15	F	1058	38.0	
Ogihara *et al.* (1971)	Kapit Division	Iban	All ages	Both sexes	608	8.0 (M) 33.0 (F)	No figures given
Maberly (1975)	Sri Aman Division						
	Lubok Antu (interior)	Iban	≥ 15	Both sexes	167	99.5	No figures
	Ruba (coastal)	Iban	≥ 15	studied in	38	74.1	given
	Bajong (coastal)	Iban	≥ 15	all areas	122	3.0	
Anderson (1975–1978)	Sri Aman Division						
	Lemanak River (interior)	Iban	5–8	M&F	388	76.5	No figures
			WCBA	F	116	90.5	given
	Miri Division						
	Middle Baram River	Kayan, Kenyah	< 7	M&F	556	30.4	
	basin (intermediate)		WCBA	F	142	50.0	
	Mulu area (interior)	Nomadic Persons	All ages	M&F	334	59.3	
	Kapit Division						
	Sut/Mujong River	Iban	< 7	M&F	414	7.0	
	(interior)		WCBA	F	106	30.2	
Alexander (1979)	Sri Aman Division						
	Upper Lemanak River	Iban	8–12	M&F	152	21.7	Nil
	(interior)		≥ 15	F	75	93.3	Nil
	Sibu Division						
	Kanowit District (interior)	Iban	≥ 15	F	137	38.7	Nil
	Kanowit town	Chinese, Iban	7–12	M&F	542	0.7	Nil
Chen and Lim (1982)	Miri Division						
	Tinjar River (interior)	Kayan, Kenyah,	10–14	F	110	78.0	No
		Iban	≥ 15	F	157	77.7	figures
			10–14	M	114	78.6	given
Yap (1985)	Sarikei Division						
	Entabai area (interior)	Iban	< 10	M&F	304 M	0–35	No
			10–14	M&F	341 F	35–50	figures
			≥ 15	F		69.5	given
			≥ 15	F		24.4	
Chen and Yap (1988)	Miri Division						
	Upper Baram (interior)	Penans	≥ 15	F	343	60.6	
		≥ 15	M	364	39.3		

WCBA, Women of child-bearing age; M, male;. F, female; IDD, iodone deficiency disorder.

Even though the findings of most of the studies showed that endemic goitre was highly prevalent in the interior regions of Sarawak, there were pockets where the prevalence was unexpectedly low. For example, in 1979 Alexander reported that endemic goitre was not a problem among the Chinese and Iban in the inland town of Kanowit.[12] On the other hand, Maberly and Eastman found an unusually high prevalence of goitre (74%) among the Iban population in a coastal community.[11] The investigators attributed that to the large consumption of cassava (a known goitrogen) by the community.

Endemic cretinism has also been reported in Sarawak. In a severe goitrous community (of 99% goitre incidence), six (3.6%) out of 167 people surveyed were classified as neurological cretins.[7] However, Alexander found no cretin in the areas which she surveyed.[12]

The perception of IDD may previously have been influenced by the fact that the investigative methods used were mainly confined to physical examinations for goitre and generally done among women. This might have contributed to the reluctance of some local communities to partake in IDD control programs in the past, as exemplified by their refusal to consume iodized salt, because the problem was perceived to be merely goitre.

As support and expertise from both the Malaysian policymakers and international bodies such as WHO and UNICEF became available in early 1990s, the methods to identify and monitor IDD problems became more sophisticated. Thus, findings from this time give a more representative picture of the problem in Sarawak.

In 1993 a state-wide survey of neonatal iodine deficiency was done by measuring thyroid stimulating hormone (TSH) levels from the umbilical cord blood of 3014 newborns.[13] The survey showed that the overall prevalence of neonatal iodine deficiency in Sarawak was 7.5%. Of the 26 districts in the State, seven (26.9%) had neonatal iodine deficiency prevalence of less than 5%, 14 (53.8%) had a prevalence between 5.0 and 9.9%, four (15.3%) had a prevalence between 10 and 14.9%, and one (3.9%) had a prevalence between 15.0 and 19.9%.

In 1996 a state-wide prevalence survey using ultrasound examinations of the thyroid gland as well as urinary iodine excretion was carried out among school children aged 10–12 years as part of a national IDD survey. However, the data are still under analysis.

Aetiology of endemic goitre in Sarawak

Low iodine content of soil and water

Endemic goitre in Sarawak is primarily caused by insufficient iodine in the diet. The natural source of dietary iodine seems to be limited to seafood. This is because the iodine content in the water from rivers and soils is very low to neg-

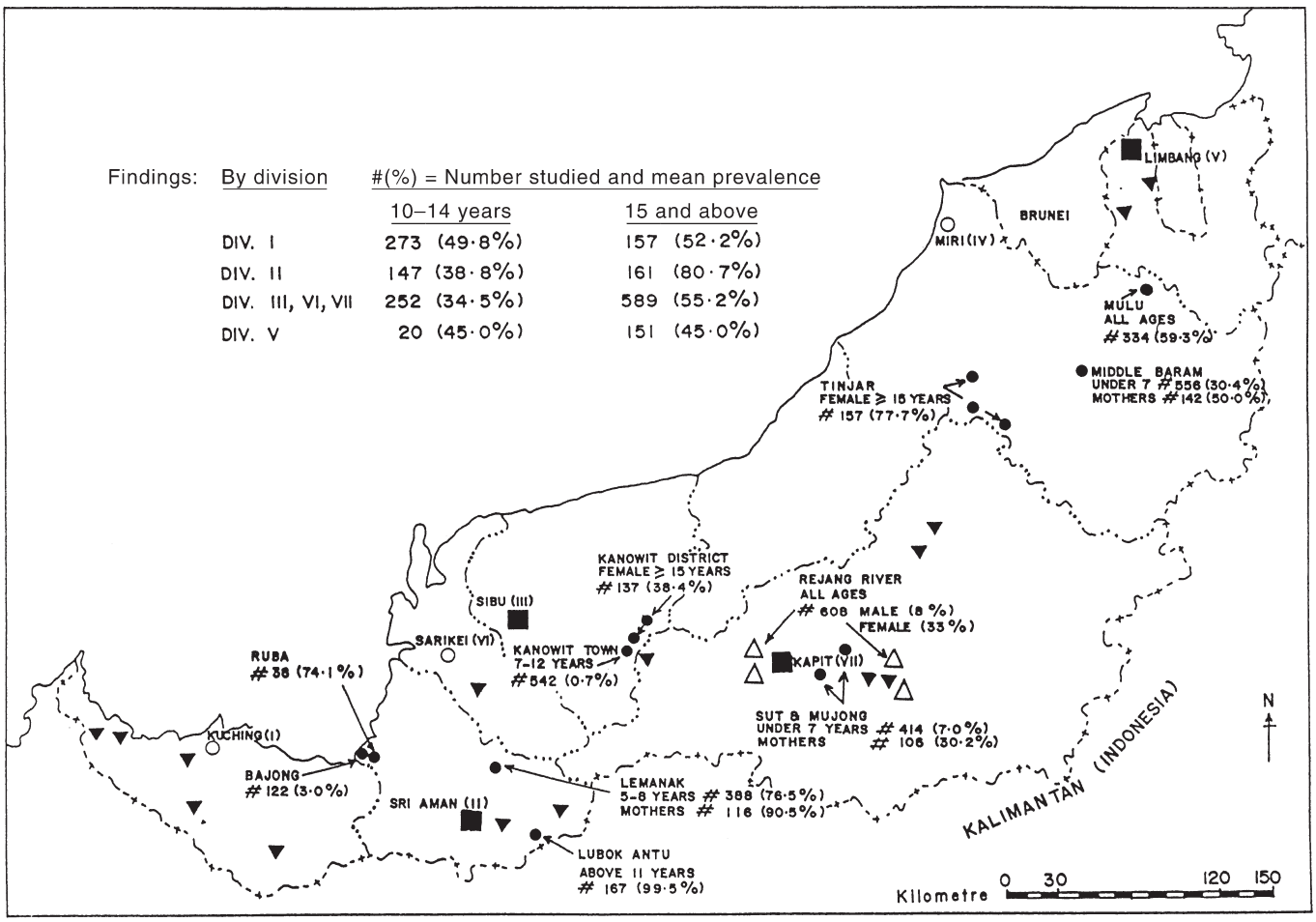

Figure 1. Goitre surveys and prevalence in Sarawak (1970–1982). (○), main towns of divisions; (■), main towns in divisions II, III, V and VII studied by Polunin (1970); (▼), areas studied by Polunin (1970); (Δ), areas studied by Ogihara (1971); (●), areas studied by Maberly (1975), Anderson (1975–1978), Alexander (1979) and Chen and Lim (1982).

ligible because of the depletion of iodine (and other minerals) through constant leaching under heavy rainfall. Analyses by Ogihara *et al.*[14] of water from the upper Rejang River and its stream showed a mean iodine content of 0.3 µg per litre of water compared with the mean level of 3.4 µg iodine per litre in tap water in Honshun district in Japan. In a hilly, inland area of Kuching Division, Anderson reported iodine levels ranging from nil to 0.8 µg iodine per litre in drinking water taken from regular sources.[4]

The inadequate iodine found in local food and water is aggravated by the low consumption of seafood in Sarawak.[10] The price of seafood is invariably higher in the inland areas due to high transportation costs. The demand for expensive seafood (i.e. fish) could be easily replaced by the supplies of river fish; unfortunately, however, these may not contain as much iodine as sea fish. Therefore, it is not surprising to observe the occurrence of goitre among many communities in the interior regions who tend to have less access to the iodine-rich seafoods.

Cassava consumption

Circumstantial evidence that cassava (*Manihot utilizsima*, Pohl) might be another contributory cause for endemic goitre development in the consuming communities in Sarawak was found in a coastal area of the State, where near dependence on cassava roots and leaves (as a result of frequent rice shortages) resulted in a goitre prevalence of 74%.[11] The Agricultural Research Centre in Sarawak reported varying quantities of cyanogen in different varieties of cassava.[15]

Preliminary evidence of cyanogenic activity in euthyroid goitrous subjects in studies by Maberly, Eastman, Waite *et al.* showed very high levels of urinary thiocyanate among Sarawak subjects.[16]

IDD prevention and control program

In 1957 the State Health Department of Sarawak established salt iodization plants in two main towns (Kuching and Sibu) to iodize coarse salt, free of charge, in order to provide the required dietary iodine to the population at risk. The iodized salt, containing one part potassium iodate to 10 000, was dyed green to distinguish it from other non-iodized salt. The iodized salt was meant for sale by salt-dealers through the commercial distribution networks in rural areas in Sarawak. The use of the colour was, however, discontinued in 1990 in line with the Malaysian Food Act, 1983.

The iodized salt program has been successful in the Rejang river basin where the salt is widely distributed and consumed. The program was not as successful in other parts of the State where there seemed to be a lack of demand for iodized salt, possibly due to its colour or to peoples' perceptions of goitre.

To complement this commercial effort as well as to extend the use of iodized salt further, the Health Department in 1979 started to provide the iodized salt State-wide through government health clinics. The emphasis was on supplying iodized salt to antenatal mothers. The practice is still continuing and, in the 1990s, more iodized salt is given out to ensure that the entire family uses iodized salt.

In the past, iodized salt was packed in half-kilogram double-layered black plastic bags. A new packaging, featuring white opaque plastic with health information on iodine, was introduced in 1996 in the hope that it would improve acceptance among the communities.

Another step was taken in 1982 when legislation was introduced under the Sarawak Public Health Ordinance, 1962, which requires all salt supplied, distributed or sold for human consumption in gazetted goitrous areas to be iodized. With the introduction of the Malaysian Food Act, 1983, the said section was revoked and a new regulation, Regulation 285 (iodized salt) of Food Regulation, 1985 was in place in 1990. As of 1990, 16 of the 27 districts and four additional subdistricts, mainly in the interior regions of Sarawak, have been identified as goitrous. For various reasons, this legislation still cannot be enforced. However, surveys conducted in 1994 and 1995 showed that iodized salt was available from 64.5% of the shops in gazetted areas and from 61.7% of shops in non-gazetted areas. This has improved from 28.0% as found by a past survey conducted in 1988.[17]

A 1993 survey on knowledge, attitude and practice (KAP) of goitre and iodized salt revealed that a majority (80%) of the people preferred iodized salt. Presently, many brands of iodized salt are now widely available in the market at a price which ranges from RM1.00 to 1.60 per kilogram and comparable to non-iodized salt.

Apart from salt-iodization, two other strategies for the treatment and control of endemic goitre were tested over a period of 1–2 years in the 1980s in several endemic goitrous village communities. In the first study, the use of iodized-oil injection was found to be unsuitable because of the high incidence of the Jod Basedow phenomenon and rapid depletion of iodine stores within two years.[18] This strategy required close biochemical supervision of the subjects and, therefore, was not practical in the remote affected areas.

Another strategy which used an iodinator fitted to the existing gravity feed water supply to the village was found to be encouraging. Within 9 months the prevalence of goitre was reduced from 61% to 30%, with 79% of goitre showing a visible reduction in size. This particular method was also reported to have a beneficial sterilizing effect on the water supply.[19] However, it was later discovered that the equipment used broke down easily and the method was not adopted.

In 1993 a different type of iodinator was tried for over a year in several villages in highly endemic areas. It successfully reduced goitre by 22.6–35.8%, and significant and sustained increases in median urinary iodine excretions, reaching levels recommended for an iodine-sufficient population, were observed.[20] As a result, the iodinator system was extended to villages and rural schools. By October 1997, 362 systems had been fitted in 300 villages and 40 boarding schools.

Monitoring and evaluation of the program and indicators used

Monitoring is carried out on the quantity of salt iodized by the iodinating plants, iodized salt supplied to the government health clinics for distribution, and the availability of iodized salt in the markets.

For the iodinator systems, monitoring of iodine in the water samples and urinary iodine excretions are done in villages and schools fitted with the iodinators.

The survey on schoolchildren for goitre and urinary iodine excretion is done once every five years as an indicator for the national IDD program.

National legislation to support IDD prevention

The relevant sections of the Food Act (1983) pertaining to iodized salt is shown in Appendix 1. In that Act iodized salt is defined as salt to which potassium iodide or sodium iodide has been added. The Department has recommended that the Section be amended to include sodium or potassium iodate, which is more stable than the iodide. At present, the iodine compound used by the Sarawak Health Department is iodate. A further step would be to extend the gazetted areas to the whole state. This is still under review.

Conclusion

IDD problems, though initially known as endemic goitre, have been recognized in Sarawak for over 40 years. Control programs had been instituted. Current findings indicate that the problem is under control, especially in areas which were previously highly endemic. However, more sustained monitoring of the problem is necessary to ensure the whole population is iodine-sufficient and that IDD will be virtually eliminated by the year 2000 in Sarawak.

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Appendix 1: Definition of table salt and iodised salt

Extract from Food Act 1993

283. (1) Salt, other that crude rock salt, shall be crystalline sodium chloride.
(2) On a water-free basis, salt –
(a) shall contain not less than 95 per cent of sodium chloride;
(b) may contain not more than –
(i) 1.4 per cent of sulphates, calculated as calcium sulphate ($CaSO_4$);
(ii) 0.5 per cent of calcium and magnesium chloride ($CaCl_2$ and $MgCl_2$); and
(iii) 0.1 per cent of substances other than calcium sulphate, insoluble in cold water; and
(c) shall not contain metal contaminant in a proportion greater than that specified in the Fourteenth Schedule.

284. (1) Table salt shall be refined salt. It shall contain not less than 97 per cent of sodium chloride on a water-free basis and shall not lose more than 1 per cent of its weight on drying at 130°C.
(2) Table salt may contain not more than –
(a) 0.5 per cent of sulphates, calculated as calcium sulphate ($CaSO_4$);
(b) a total of 0.25 per cent of calcium and magnesium chloride ($CaCl_2$ and $MgCl_2$); and
(c) 2 per cent of anticaking agent as permitted food conditioner;
(d) 0.1 per cent of substances other than calcium sulphate or permitted anticaking agent, that are insoluble in cold water.

285. (1) Iodised table salt or iodised salt shall be table salt to which has been added potassium iodide or sodium iodide. It shall comply with the standard for table salt prescribed in regulation 284 and shall contain not less than 25 mg/kg and not more than 40 mg/kg of iodide calculated as potassium iodide.
(2) Iodised table salt or iodised salt may contain sodium thiosulphate ($Na_2S_2O_3$) and sodium carbonate (Na_2CO_3), each in a proportion not exceeding 1,000 mg/kg as permitted food conditioner.
(3) The Director or any officer authorised by him in writing may, by notification in the Gazette, direct that in certain areas as designated by the Director or such authorised officer, no person shall manufacture for sale, sell, expose or offer for sale, consign or deliver salt for household use and human consumption unless there has been added to it potassium iodide or sodium iodide in an amount of not less than 25 mg/kg and not more than 40 mg/kg calculated as potassium iodide.