PUBLIC HEALTH RESEARCH

Inadequate Iodine Intake among School Children in Terengganu-Findings from the National Iodine Deficiency Disorder Survey 2008

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ABSTRACT

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Introduction Iodine deficiency is still prevalent worldwide and it is the main cause of goiter, thyroid dysfunction and mental retardation. The aim of the study was to determine the iodine status and goiter prevalence among the school children in Terengganu.

Methods The representative sample consists of 1163 primary school children aged 8-10 years old randomly selected from urban and rural schools in Terengganu using stratified systematic random sampling technique. Urinary iodine levels in spot urine were determined by in house modified micro-method while goiter assessment was carried out by palpation of thyroid gland. The status of iodine deficiency was determined by the median urinary iodine concentrations (UIC) and total goiter prevalence (TGP) in accordance with the WHO criteria.

Results The result showed the median [inter-quartile range (IQR)] urinary iodine concentrations was 78.7µg/L (50.1µg/L -120.0µg/L) indicating the iodine intake was slightly lower than recommended range of 100 µg/L. The rural school children had a significantly lower Iodine levels (median UIC=72.4µg/L, IQR=46.7µg/L -113.0µg/L) than the urban school children (median UIC=87.7µg/L, IQR=54.5 µg/L - 127.5µg/L). The total goiter prevalence (TGP) was 5.7%. The prevalence of goiter was significantly higher in rural (TGP=6.9%) compared to urban areas (TGP=3.6%).

Conclusions The study revealed that school children in Terengganu showed mild iodine deficiency and the condition is more pronounced in children from rural areas. The findings emphasize the importance of intervention implementation, universal salt iodization to ensure sufficient intake of iodine among the Terengganu school children.

Keywords Iodine deficiency - School children - Median urinary iodine concentrations - Thyroid goiter prevalence - Terengganu

INTRODUCTION

Iodine is an essential component of hormones produced by the thyroid gland. Thyroid hormones and therefore iodine are essential elements required for normal growth and development. The result from inadequate thyroid hormone production due to insufficient iodine will have many adverse effects on growth and development in animals and man. These effects are collectively termed iodine deficiency disorders (IDD) [1]. Overall, Iodine deficiency (ID) produces subtle but widespread adverse effects in a population, including decreased educability, apathy and reduced work productivity. ID is considered the most common cause of preventable mental retardation worldwide [2,3].

It is estimated nearly 2 billion individuals from 130 countries have insufficient iodine intake, including 1/3 of the school-age children[4]. IDD is common, especially in Asia, Africa and in large parts of Eastern Europe. Only a small number of countries currently have sustainable iodine sufficiency and about a third of the world's population are still living in areas with some iodine deficiency[5]. The main factor responsible for ID is low dietary supply of iodine, it occurs in communities living in areas where the soil has a low iodine content due to erosion of soil and crops grown in this soil. Therefore, it does not provide adequate amount of iodine when consumed [6].

In 1995, a peninsular-wide survey was carried out among primary school children aged 8-10 years. The survey revealed an overall goiter prevalence of 2.2% among 7,315 children examined by ultrasound and the median urinary concentration was 82.4µg/L among 6,716 children. The data also showed that five out of seven (72%) schools surveyed in Terengganu had median UIC less than 100µg/L[7]. Thereafter, various multi-pronged strategies have been implemented to tackle IDD problem in the country such as universal salt iodisation in Sabah and water iodination was introduced in several states particularly in Sarawak, Kedah, Perak, Kelantan and Terengganu[8]. After many years, a similar national survey was conducted in 2008 in order to collect updated information on the status of IDD and prevalence of goiter among primary school children in the country. Hence, the purpose of this paper is to conduct a secondary data analysis of a National IDD Survey 2008 data set from Terengganu state with the objective to determine the median UIC, to estimate the prevalence of goiter and to compare the difference of UIC level between goiter subjects and non goiter subjects among primary school children in Terengganu.

METHODS

We analysed data from the National IDD Survey 2008. This survey was a cross sectional study conducted from March to June 2008 among the school children aged 8-10 years old in Terengganu. A two stage proportionate to population size sampling (PPS) method was used to obtain representative state sample of Terengganu children. Stage one of sampling involved the division of school into two groups; urban and rural areas. Then, a total of 30 schools (15 urban and 15 rural) were selected randomly using PPS technique. In the second stage, 40 school children aged 8-10 years from each school were then randomly selected from the school roll. In total, 1,200 school children were selected from 30 schools. The study was reviewed and approved by the Medical Research Ethic Committee, Ministry of Health, Malaysia. The approval was also obtained from the Department of Education and school authorities. Parents' or guardians' consent was obtained for all study subjects.

The urine samples were collected from all study subjects. About 15 ml of the urine sample was then transferred to a glass tube with screw caps, sealed tightly, labeled and stored in a cool, dry place and sent to the Institute for Medical Research laboratory for analysis. The iodine concentrations in the urine were determined by the in house modified micro-method [9]. The cut-off points proposed by WHO/UNICEF/ICCIDD for classifying iodine nutrition into degrees of public health significance are <20 µg/L (severely deficient), 20-49 µg/L (moderately deficient), 50-99 µg/L (mildly deficient), 100-199 µg/L (optimal), 200-299 µg/L (more than adequate.) and >300 µg/L [6](excessive).

All subjects who were present on the days of survey were clinically examined for enlargement of thyroid by trained medical staff nurses working at the Ministry of Health (Grade 0: no goiter; Grade 1: thyroid palpable but not visible; Grade 2: thyroid visible with neck in normal position) [6]. According to the criteria for classification of goiter, goiter prevalence rate of 5.0-19.9% was considered mild; 20-29.9% was moderate and 30% and above was considered as a severe public health problem[6].

Statistical Analysis

The collected data was analyzed using the Statistical Package for Social Science, Version 11.5 (SPSS) software programme. Differences between groups in distribution of urinary iodine excretion and prevalence of goiter were evaluated using Pearson's chi-square test while differences in median UIC between groups were evaluated using Mann-Whitney U test. Two-tailed p values less than 0.05 was taken as significant.

RESULTS

A total of 1,163 (96.9%) out of 1,200 subjects participated in the study; 581 (285 males, 296 females; aged: 8-10 years) in urban areas and 582 (300 males, 282 females; aged:8-10 years) in rural

areas. Since the survey was sometimes carried out at different days in some schools, there were a small proportion of school children with missing data on one or the other component due to absenteeism of subjects on the study day.

The median and distribution of urinary iodine concentration (UIC) levels among all the subjects are shown in Table 1 and Table 2. The overall state-wide median UIC was 78.6 µg/L (which falls within the status of mild ID). The pattern was the same in the urban areas (87.7 µg/L) and rural areas (72.4 µg/L). However, the median UIC in the urban areas was significantly higher than in the rural areas (p=0.001). Among the study subjects, the distribution of UIC in rural areas showed 68% of these subjects had UIC <100 µg/L and 29% of them had UIC <50 µg/L. It was found that 62% and 21% of the urban subjects had UIC levels of <100 µg/L and <50 µg/L, respectively. A significant difference was found in the distribution of UIC in both areas (p=0.031).

Table 1 Median urinary iodine concentrations in Terengganu

Area	Number of schools	n	Urinary iodine concentrations (µg/l)		p-value
			Median	Interquartile Range	
Urban	15	573	87.7	54.5-127.9	0.001
Rural	15	577	72.4	46.6-113.1	
Total	30	1,150	78.6	50.1-120.1	

Mann-Whitney U-test

Table 2 Distribution of urinary iodine concentrations in Terengganu

Area	Number of schools	n	Urinary iodine concentrations (µg/l)						p-value
			<20	20-49	50-99	100-199	200-299	≥300	
Urban	15	573	19 (3.3%)	101 (17.6%)	233 (40.7%)	183 (31.9%)	20 (3.5%)	17 (3.0%)	0.031
Rural	15	577	21 (3.6%)	144 (25.0%)	229 (39.7%)	148 (25.6%)	15 (2.6%)	20 (3.5%)	
Total	30	1,150	40 (3.5%)	245 (21.3%)	462 (40.2%)	331 (28.8%)	35 (3.0%)	37 (3.2%)	

Chi-squared test

The distribution of goiter grades among the study subjects is shown in Table 3. The overall goiter prevalence among the study subjects in Terengganu state was found to be 5.2% (5-19.9% indicate mild ID) and the prevalence of visible goiter was only 0.5%. The prevalence of goiter in rural and urban areas was 6.9% and 3.6% respectively and it was significantly higher in rural areas than in urban areas (p=0.013).

Table 3 Distribution of goiter grades in Terengganu

Area	n	Goiter grades			All goiters (1+2)	p-value
		Grade-0	Grade-1	Grade-2		
Urban	581	560 (96.4%)	19 (3.3%)	2 (0.3%)	21 (3.6%)	0.013
Rural	582	542 (93.1%)	36 (6.2%)	4 (0.7%)	40 (6.9%)	
Total	1,163	1102 (94.8%)	55 (4.7%)	6 (0.5%)	61 5.2%)	

Chi-squared test: Grade-0 vs All goiters

Table 4 shows the UIC among goiter and non-goiter subjects. Overall, median UIC was significantly higher among the non-goiter subjects (median UIC=79.7 µg/L) when compared to those with goiter (median UIC=61.2 µg/L). A consistent finding was also found between goiter and non goiter subjects in the rural areas. However among the urban study subjects, there was no significant difference in median UIC between goiter subjects when compared to those without goiter.

Table 4 Urinary iodine concentration among the goiter and non-goiter subjects in Terengganu

Group	n	Urinary iodine concentrations (µg/l)		p-value
		Median	Interquartile range	
Urban				
Goiter	21	63.2	40.7-122.1	
No goiter	552	87.9	55.5-128.1	0.287
Rural				
Goiter	40	55.6	39.1-91.6	
No goiter	537	72.8	48.1-114.1	0.034
Total				
Goiter	61	61.2	40.7-99.6	
No goiter	1089	79.7	51.2-121.1	0.009

Mann-Whitney U-test

DISCUSSION

Urinary iodine level is used as a valuable indicator for the assessment of IDD in a region because 90% of body's iodine is excreted through urine. It is a more sensitive indicator to recent changes in iodine intake and a median UIC of 100 µg/L indicates that there is no ID in the population[6]. Results among the school children in Terengganu showed that the median UIC of the subjects was 78.6 µg/L (Urban=87.7 µg/L; rural=72.4 µg/L). Therefore, our data demonstrates that Terengganu is an area of mild ID. Although little is known about the consequences of mild ID in childhood as most researches focused on the effects of moderate and severe ID, however, the correction of even mild ID in children can improve their ability to learn [10].

These values are slightly lower than the present study population which showed that national median UIC was 109 µg/L [8]. However, this is similar to the previous study conducted in Terengganu, which reported the study median UIC of 74.0 µg/L [11]. The previous Peninsular wide survey also showed that the majority of school children in Terengganu had median UIC less than 100 µg/L [7]. The median UIC for the urban population was higher than the rural population is consistent with the National results [7,8] and other small scale studies in Malaysia [12,13] as well as other countries [14,15]. This is probably due to the fact that people who live in rural areas get less supply of iodine despite easy access to abundant seafood resources in the community.

Assessment of goiter is the most common indicator used to assess the severity of IDD at baseline and has a role in evaluating the long term impact of IDD control programmes [5]. Based on goiter prevalence criteria, prevalence of more than 5% indicates the areas suffering from ID[6]. In our study, a total goiter prevalence (TGP) of 5.2% signifies the existence of mild ID. It is much higher than the national TGP of 2.1% [8] and TGP in an earlier Peninsular- wide survey of 2.2% [7]. In urban areas, there seems to be discrepancy between the prevalence of goiter by palpation method (TGP=3.6%) and UIC (median=87.7 µg/L). The lack of agreement between the two IDD indicators in urban areas could be due to the goiter palpation method which is known to have low specificity and may not be useful for areas of iodine status approaching normality [4]. These data must be interpreted with much caution, as TGP does not reflect recent changes in iodine intake[16]. Therefore, the prevalence of IDD as determined by the two indicators are not necessary be consistent [17].

Regarding the relationship between iodine status and goiter as shown in Table 3, there were low levels of iodine intake among the subjects with goiter and without goiter. This indicates that dietary iodine among both groups is currently inadequate[6]. Although the level of socio economic development has taken place particularly during the last 20 years, which has made outside food including seafood more widely available to communities living in urban and rural areas of Terengganu[18]. However, our data has provided evidence that all the subjects in Terengganu are still iodine deficient, irrespective of geographical areas and goiter status of the subjects. This finding is consistent with a comprehensive study in a few developed countries [19, 20]. There was a significant difference in iodine status among subjects with goiter compared to those without goiter in rural areas but not in urban subjects. This observation could possibly be explained by the small number of goiter subjects in urban areas which can increase the chance of error [21].

The sampling frame was population-based and random in order to limit bias and increase the ability to generalize the inputs. In addition, the response rate was very high, and the data obtained is representative to Terengganu school children. The main limitation of our study was that the palpation method is known to have low specificity and the slight increase in thyroid size could not be detected by palpation [22]. However, this method is particularly still useful in assessing the goiter prevalence since the cut-off point (TGR of 5%) for assessing the severity of IDD takes into account that some goiter assessment by palpation could be inaccurate [6].

In conclusion, our study indicates that school children from the Terengganu state have mild ID and the condition is more pronounced in children from rural areas. In response to the widespread of mild ID observed in the current and previous survey, the programme of mandatory salt iodization is the most practical method to decrease or even eliminate ID in the areas. In addition, the use of water iodinator system for the control of IDD in these areas can also be implemented [23]. However, the success of the programme depends heavily not only on good maintenance and monitoring but also on children participation and awareness [11]. In future study, our UIC and goiter grade data in this study can serve as a basis to evaluate the effects of mandatory salt fortification or water iodisation programme in Terengganu.

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