Short Communication

Iodine status among pregnant women in rural Sabah, Malaysia

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Background and Objectives: In 2000, legislation on mandatory universal salt iodisation was enacted in Sabah, Malaysia, to reduce the incidence of iodine deficiency disorders among its population. To evaluate the iodine levels among pregnant women from selected rural divisions in Sabah 13 years after the enactment of the universal salt iodisation programme. **Methods and Study Design:** This cross-sectional study was conducted from 1 May to 30 June, 2013, in three rural divisions of Sabah (the Interior, the West Coast, and Kudat). Data regarding domestic iodised salt use and iodine-containing supplement consumption were obtained from respondents through face-to-face interviews; goitre enlargement was examined through palpation and graded according to the World Health Organization classification. Spot urine samples were also obtained to assess urinary iodine levels by using an in-house modified micromethod. **Results:** In total, 534 pregnant women participated. The prevalence of goitre was 1.0% (n=5), noted only in the West Coast and Kudat divisions. Although all pregnant women consumed iodised salt, overall median urinary iodine concentration was only 106 µg/L, indicating insufficient iodine intake, with nearly two-thirds of the women (60%) having a median urinary iodine concentrations of <150 µg/L. **Conclusions:** Pregnant women from the rural divisions in Sabah still exhibit iodine deficiency disorder despite the mandatory universal salt iodisation programme. Iodine supplementation programmes targeting pregnant women are warranted.

Key Words: iodine deficiency disorder, urinary iodine concentration, universal salt iodisation, pregnant woman, Sabah

INTRODUCTION

The mineral iodine is an essential component of the hormones produced by the thyroid gland, and is involved in the regulation of various enzymatic and metabolic processes. The daily iodine requirement for adults is extremely low—approximately 150 µg/day.[1] Long-term iodine deficiency, known as iodine deficiency disorders (IDD), has various negative health outcomes in pregnant women, such as maternal and foetal hypothyroidism and impaired foetal growth and neurological development.[2] In addition, IDD is considered a common cause of preventable mental retardation worlwide.[3] Approximately 2 billion people of all ages worldwide are at risk of IDD because of insufficient iodine intake, with schoolchildren comprising one-third of this proportion.[4] Although IDD can affect any person of any age, pregnant women comprise the most vulnerable high-risk group for IDD. Iodine requirement is high during pregnancy; it may increase by 50% because of increased maternal thyroxine production.[5] Maternal thyroxine is transferred across the placenta before the onset of foetal thyroid hormone production at 10-12 weeks of pregnancy.[6] The most severe adverse effect of iodine deficiency is foetal damage. For instance, a mild-to-moderate iodine deficiency may adversely affect intellectual and neuropsychomotor development in foetuses.[7] The most serious adverse effects of severe and long-term iodine deficiency in pregnant women can increase the risk of foetal and perinatal mortality and permanently reduce motor and cognitive performance in children.[8]

Food alone may be insufficient to fulfil the iodine requirement during pregnancy, particularly in pregnant women in rural inland communities or those with limited access to seafood and sea vegetation. Therefore, a strategy for adding iodised salt in the diet of pregnant women is required to ensure that they receive their daily recommended iodine intake of 250 µg/day.[7] This iodised salt is essential to preventing the adverse health effects of IDD in foetuses. For instance, infants born to mothers sup-

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plemented with iodine before or during pregnancy have superior psychological and neurocognitive performance compared with those born to mothers not supplemented with iodine.[9] Using common universal seasoning salt through a universal salt iodisation (USI) programme is considered the most effective strategy for eliminating IDD in severely iodine-deficient areas because doing so is relatively inexpensive.[3] Although iodised salt consumption remains a risk factor for hyperthyroidism and chronic diseases such as hypertension, atherosclerosis, stroke, and myocardial infarction, the potential health benefits of iodine fortification greatly outweigh these potential risks.[10]

Approximately 70% of the world population consumes iodised salt. This rate has increased in recent decades, leading to a decrease in the number of countries with IDD prevalence from 110 in 1993 to 47 in 2007.[11] In addition, approximately 79 million infants are born with some degree of protection against the adverse consequences of iodine deficiency.[12] Only a few studies have focused on pregnant women at the national level; therefore, insufficient data is available to estimate the regional and global prevalence of iodine deficiency among pregnant women.[13,14]

In Malaysia, the first peninsula survey was conducted in 1995 among 6,716 primary schoolchildren aged 8-10 years; it revealed that the prevalence of goitre was 2.2% and the median urinary iodine concentration (UIC) was 82.4 µg/L.[15] A subsequent state-wide IDD survey conducted in Sabah among 2,122 primary schoolchildren aged 8-10 years in 1996 showed a high prevalence of goitre of 17.7% and median UIC of 65 µg/L.[15] Based on the results of both studies, a mandatory USI programme was introduced in the state of Sabah in 2000;[16] it specified that the levels of iodine added in the salt must be 20-40 mg/kg.[17] Several years after the programme was implemented in Sabah, another state-wide IDD survey, involving 1,097 primary schoolchildren aged 8-10 years, was conducted in 2008. It revealed that the prevalence of goitre had been significantly reduced to only 2.2% and that iodine status had improved remarkably, with a median UIC of 150 µg/L.[16]

Although numerous population-based studies have been conducted in young children, those focusing on pregnant women are scant. Studies conducted in other countries have clearly demonstrated that the iodine nutrition status in pregnant women remains inadequate, even though the general population has achieved iodine sufficiency.[7] Therefore, this study evaluated the iodine status of pregnant women living in several selected rural divisions in Sabah 13 years after the implementation of the mandatory USI programme.

METHODS

Study design

Sabah is divided into five divisions: the Interior, the West Coast, Kudat, Sandakan, and Tawau. This cross-sectional survey was conducted in the three divisions of the Interior, the West Coast, and Kudat, which were selected on the basis of several series of technical discussions with the Sabah State Health Department (SSHD). In these divisions, the following eight rural districts identified as most likely to have high IDD prevalence were selected as study locations: Nabawan, Keningau, Tambunan, and Tenom from the Interior; Kota Belud and Putatan from the West Coast; and Kota Marudu and Pitas from Kudat. All pregnant women attending the government Maternal and Child Health Clinics (MCHCs) during the 2-month study period of 1 May–30 June, 2013, were recruited.

Measurement protocols

Trained health workers conducted face-to-face interviews with the pregnant women by using a structured questionnaire provided by the SSHD and obtained personal information and maternal characteristics such as date of birth, ethnicity, nationality, gestational week, gravida, weight, and height. In addition, the respondents were asked about their domestic iodised salt use and iodine-containing supplement consumption. Goitre was assessed by trained nurses and graded on the basis of the classification of the World Health Organization (WHO): grade 0, no palpable or visible goitre; grade 1, palpable but not visible when the neck is extended; and grade 2, visible when the neck is in the normal position. The sum of the number of women with grade 1 and 2 goitre denoted the total goitre rate (TGR). The TGR was then used to classify IDD severity. A TGR of <5% was regarded as indicating iodine sufficiency, whereas rates of 5.0%-19.9%, 20.0%-29.9%, and ≥30.0% indicated mild, moderate, and severe deficiency, respectively.[3] Spot urine samples were collected in screw-capped bottles, labelled, and immediately transported to the IDD laboratory of Sabah in Kota Kinabalu. The samples were stored at −20°C until further analysis for iodine levels by using an in-house modified micromethod.[18] In brief, this method can measure UICs of 0-200 µg/L. When the concentration was detected to be more than that of reference standard (200 µg/L), the sample was diluted and reanalysed. Considerably close correlations were observed between our in-house micromethod and the reference WHO method.[18] Pregnant women with UICs of <150, 150-249, 250-499, and ≥500 g/L were considered to have insufficient, adequate, more than adequate, or excessive iodine levels, respectively.[3] This study was approved by the director of the SSHD. Detailed information pertaining to this study was provided to all participants, and verbal consent was obtained from each participant before the study commenced; none of them refused to participate.

Statistical analyses were performed using SPSS software (version 18; IBM SPSS, Chicago, IL, USA). All variables were tested for normality by using the Kolmogorov–Smirnov and homogeneity of variance tests before performing any statistical comparison. Descriptive statistics are reported as frequency and percentage for categorical variables such as sociodemographic characteristics and goitre prevalence, unless otherwise indicated. Since UICs were abnormally distributed, they are presented as medians with interquartile ranges. Non-parametric tests (the Kruskal–Wallis and Mann–Whitney tests) were used to analyse the differences between the medians of the UICs. Comparisons between categorical variables were performed using the Pearson's Chi-square test. A p value of <0.05 was considered significant.

RESULTS

Table 1 shows the sociodemographic characteristics of 524 pregnant women from the three selected divisions in Sabah. Most of them (52.1%) were from the Interior division, whereas 32.4% and 15.5% were from the West Coast and Kudat divisions, respectively. The mean participant age was 27.9±6.5 years, with most (72.5%) aged <35 years. Nearly half of the participants were Kadazans or Dusuns (46.8%), and 29.6% were from the Murut tribe. Nearly all of the participants were Malaysian citizens (96.3%). Most women were in the first trimester of their pregnancy (94.8%), followed by those in the second trimester (5.2%); approximately 80% of these women were from gravida 1-4. Regarding iodised salt and iodine supplement intake, all participants domestically used iodised salt, but none had consumed iodine-containing supplements.

In the physical examination, five participants (1.0%) had an enlarged thyroid, indicating IDD; four had grade 1 goitre and one had grade 2 goitre. Regarding geographical location, three grade 1 goitre cases (1.8%) were in the West Coast and the remaining two (one each of grade 1 and 2) were in Kudat. No women from the Interior had goitre.

Table 2 shows the UICs of all women in all three divisions. The median UIC among the participants was 105 µg/L, with the Interior division having the lowest median UIC (95.8 µg/L), followed by the West Coast and Kudat divisions. Significant differences were observed in the median UICs of all three divisions (p=0.017); for example, Kudat had division had a significantly higher median UIC than the Interior division (p<0.01).

Table 3 presents UIC distribution among the pregnant women according to the divisions. More than half (60.5%) of the women had a UIC of <150 µg/L (insufficient iodine), whereas 22.8% had a UIC of 150-249 µg/L (adequate iodine) and 16.6% had a UIC of ≥250 µg/L (more than adequate or excessive iodine). Approximately two-thirds of the women from the Interior (65.6%) were at risk of IDD, whereas 55.8% and 46.9% of those from the West Coast and Kudat were at risk, respectively (Table 3). The median UICs differed significantly between all three divisions (p=0.001); for example, the women from Kudat had significantly higher UICs than those from the Interior (p=0.001).

DISCUSSION

The main effect of hypothyroidism caused by iodine deficiency is impaired neurodevelopment; therefore, the children of iodine-deficient mothers are at a relatively higher risk of cognitive disability.[7] Thus, ensuring optimal and adequate iodine intake in pregnant women is particularly important for preventing adverse effects on their offspring, such as brain damage caused by long-term iodine deficiency.[19] Even slightly low maternal thyroid hormone levels during pregnancy can cause cognitive delays in offspring.[10]

Goitre prevalence and median UIC are the measures used to assess IDD status in the general population. Goitre size assessment through palpation and ultrasonography are also used to assess long-term iodine status. Furthermore, spot UICs reflect iodine intake over the previous few days.[11] In this study, most pregnant women in Sabah exhibited normal thyroid size and extremely low (1.0%) goitre prevalence.[3] This was considered a positive finding because the selected study areas had high IDD risk, as identified in previous surveys conducted by the Institute for Medical Research[16] and the SSHD.[20] The present goitre prevalence was comparable with that of the national IDD survey (TGR, 1.1%);[21] nevertheless, it was

Table 1. Socio-demographic characteristics of pregnant women in Sabah

Characteristics	Frequency (%)			
	Interior (n=273)	West Coast (n=170)	Kudat (n=81)	Total (n=524)
Age				
≤20	43 (15.8)	12 (7.1)	5 (6.2)	60 (11.5)
20-24.9	56 (20.5)	35 (20.6)	24 (29.6)	115 (21.9)
25-29.9	82 (30.0)	48 (28.2)	24 (29.6)	154 (29.4)
30-34.9	57 (20.9)	36 (21.2)	18 (22.2)	111 (21.2)
≥35	35 (12.8)	39 (22.9)	10 (12.3)	84 (16.0)
Ethnicity				
Kadazan/Dusun	105 (38.5)	112 (65.9)	28 (34.6)	245 (46.8)
Murut	118 (43.2)	24 (14.1)	13 (16.0)	155 (29.6)
Bugis	2 (0.7)	2 (1.2)	17 (21.0)	21 (4.0)
Rungus	1 (0.4)	0 (0.0)	8 (9.9)	9 (1.7)
Others	47 (17.2)	32 (18.8)	15 (18.5)	94 (17.9)
Citizenship				
Malaysian	259 (94.9)	165 (97.1)	80 (98.8)	504 (96.2)
Non Malaysian	14 (5.1)	5 (2.9)	1 (1.2)	20 (3.8)
Trimester (week)				
1-12	272 (99.6)	145 (85.3)	80 (98.8)	497 (94.8)
13-28	1 (0.4)	25 (14.7)	1 (1.2)	27 (5.2)
≥29	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gravida				
1-4	219 (80.2)	130 (76.5)	64 (79.0)	413 (78.8)
5-8	47 (17.2)	34 (20.0)	17 (21.0)	96 (18.7)
≥9	7 (2.6)	6 (3.5)	0 (0.0)	13 (2.5)

Table 2. Median and mean urinary iodine concentration of pregnant women in Sabah

Division	n	urinary iodine concentration (μg/L)	
		Median (IQR)	Mean±SD
Interior [a]	273	95.8 (50.5-183)	131±111
West Coast [b]	170	108 (42.3-232)	158±150
Kudat [c]	81	151 (75.5-211)	202±222
Total	524	1051 (51.5-195)	151±147

Kruskal-Wallis test: ^{abc}p=0.017.
Mann-Whitney test: ^{ab}p=0.414; ^{bc}p=0.065; ^{ac}p=0.003.

Table 3. Distribution of urinary iodine concentration of pregnant women in Sabah

Division	n	Urinary iodine concentration (μg/L)			
		<150 (Insufficient)	150-249 (Adequate)	250-499 (Above requirement)	≥500 (Excessive)
Interior [d]	273	179 (65.6)	62 (22.7)	27 (9.9)	5 (1.8)
West Coast [e]	170	100 (58.8)	33 (19.4)	31 (18.2)	6 (3.5)
Kudat [f]	81	38 (46.9)	25 (30.9)	10 (12.3)	8 (9.9)
Total	524	317 (60.5)	120 (22.9)	68 (13.0)	19 (3.6)

Chi-Square test: ^{def}p=0.001; ^{de}p=0.044; ^{ef}p=0.022; ^{df}p=0.001.

lower than that reported in 1996 in the Sabah state-wide IDD Survey (TGR, 17.7%).[15] These findings indirectly indicated that iodine deficiency was corrected over time after the implementation of the USI programme in Sabah. This hypothesis was corroborated by findings reported in other studies conducted at other locations, all of which concluded that goitre size decreases after iodisation programme implementation.[22-24] Although the goitre palpation method has low specificity in countries with successful USI programmes, it is still recommended in most epidemiological studies assessing IDD severity.[3]

The low TGR (0.9%) in the present study may be associated with the results of UICs. With the progress of IDD-prevention programmes, TGR becomes less useful as a criteria for IDD, whereas UIC becomes more useful.[3,25] The previous Sabah state-wide IDD survey conducted in 2008 showed that the median UIC of schoolchildren was 158 μg/L, indicating adequate iodine intake among the population in Sabah.[16] However, the present study showed that the median UIC was only 106 μg/L (60% of the women had UIC <150 μg/L), indicating insufficient iodine intake in the pregnant women in Sabah. Only pregnant women residing in Kudat had a borderline adequate median UIC. Notably, the median UIC decreased as the increase district remoteness increased; thus, the decrease was more pronounced among the women residing in the Interior. Because iodine is mainly consumed through household salt, sustained salt iodisation can aid in maintaining adequate iodine levels in all populations, including pregnant women. To treat IDD, ensuring that 90% of household salt is iodised at the recommended level of 15 ppm is necessary.[2] Here, although the pregnant women reported consuming iodised salt at home, most had inadequate iodine levels based on the UIC findings, thus suggesting inadequate iodine intake.[3]

Several reasons may explain the low iodised salt intake among the pregnant women in the present study. One of these could be the health concern that high salt intake can cause high blood pressure; in addition, various intervention programmes for reducing excessive salt intake have been implemented in Malaysia in both government and private hospitals.[26] Similar dietary strategies for reducing excessive salt intake and preventing pregnancy-induced hypertension are provided to pregnant women during periodic antenatal care visits at MCHCs operated by the Ministry of Health; these can create awareness among these women, resulting in behavioural changes and reducing salt intake in their daily diet. Another plausible reason could be related to the fact that a large proportion of the population in Sabah, particularly those people residing in rural areas, consume a diet with extremely low iodine levels or do not consume iodised salt.[15] This phenomenon is worsened by the inefficient distribution, packaging, and handling of iodised salt; improper long-term iodised salt storage before use; habitually leaving salt in use in open plastic bags; and prolonged cooking with salt.[27] In rural areas, fish products are not commonly consumed, and goitrogens present in local food items such as cassava leaves and tubers can further reduce the availability of iodine.[28] In addition, without changing their dietary behaviour, pregnant women do not fulfil their increased recommended iodine intake.[14]

The present findings corroborate those of numerous other studies, which have also reported that pregnant women residing in areas where people generally have sufficient iodine intake may still experience IDD. For example, in the United States, although the overall adult population is iodine-sufficient, a subset of pregnant and lactating women still have inadequate dietary iodine intake. The National Health and Nutrition Examination Survey conducted during 2005-2008 revealed that 35.3% of pregnant women had UICs <100 μg/L,[29] even though an effective national programme for dietary iodine supplementation had been implemented for more than 90 years.[10] Similarly, a mandatory salt iodisation programme was launched in Turkey in 1998; however, 7 years later, the median UIC of pregnant women was 77.4 μg/L.[30] Studies conducted in Asturias and other Spanish regions have reported overall median UIC of <150 μg/L, even though the WHO has classified Spain as a country with no iodine deficiency.[31] In Italy, a case–control study compared 100 pregnant women and 100 age-matched non-pregnant women, revealing median UICs of 74 and 182 μg/L, respectively.[32]

To achieve adequate and optimal iodine nutritional status among pregnant women, the Public Health Committee of the American Thyroid Association recommended additional iodine supplementation of 150 μg/day for pregnant women in the United States and Canada.[33] Similarly, a Spanish group working on IDD and thyroid dysfunction recommended an additional prescription of potassium iodide before pregnancy until lactation.[31] The Turkey and Italy study authors suggested that the relevant authorities facilitate iodine supplementation through means such as the distribution of iodised oil capsules to pregnant women.[32]

The strength of the present study is the 100% response rate of the pregnant women and the relatively large amount of complete data obtained. However, the current findings must be interpreted with caution because they do not represent the current overall situation in Sabah or Malaysia. In addition, the domestic use of iodised salt was determined using a self-reported method, which is subject to recall biases.[34] Nevertheless, the present study has provided useful baseline findings because it involved a representative sample of pregnant women in Sabah and elucidated the actual prevalence of IDD among these women.

Conclusion

In countries where mandatory USI had been successfully implemented, iodine intake among pregnant women is generally adequate. However, despite such a programme, IDD remains prevalent among pregnant women in Sabah. Thus, a comprehensive survey should be conducted at all MCHCs in all divisions of Malaysia to more thoroughly and accurately determine iodine levels among pregnant women in Sabah. To fulfil the increasing need for iodine, relevant authorities should develop USI programmes for pregnant women, particularly those at high IDD risk because of their location in a rural Sabah division.

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AUTHOR DISCLOSURES

The authors declare that they have no conflicts of interest.
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