PUBLIC HEALTH RESEARCH

Iodine Deficiency Disorders among Pregnant Women in Sarawak, Malaysia

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ABSTRACT

Received 10 April 2018
Accepted 23 July 2018

Introduction Iodine deficiency disorders (IDD) during pregnancy may impair the neurological development of the fetus. The aim of this study is to determine the iodine status among pregnant women (PW) in Sarawak after introduction of mandatory universal salt iodisation (USI) for seven years.

Methods A total of 508 first trimester PW attending government Maternal and Child Health Care clinics in all 11 divisions in Sarawak between 1st April and 15th June 2015 were recruited. Urine samples were obtained and analysed for urinary iodine concentration (UIC) using the modified Sandell-Kolthoff reaction method. For pregnant women, an adequate iodine intake was defined as a median UIC between 150-249 µg/L according to the WHO/UNICEF/ICCIDD's criterion. For further analyses, the 11 divisions were then combined into 3 regions, namely Northern (Miri, Bintulu, Limbang), Central (Kapit, Mukah, Sibu, Sarikei, Betong) and Southern (Kota Samarahan, Kuching, Sri Aman).

Results The median UIC of the PW in Sarawak was 105.6 µg/L, indicating iodine deficiency. A total of 330 (65.0%) PW had UIC<150 µg/L. In terms of urinary iodine levels by region, the median UIC in Northern, Central and Southern regions were 136.3 µg/L, 85.5 µg/L and 97.4 µg/L respectively. The differences in median UIC between regions were significant. In addition, the Northern region (p = 0.001), Malay/Melanau ethnicity (p = 0.015) and parous parity (p = 0.014) were significantly associated with higher median UIC. No significant association was found for locality, age nor gravida.

Conclusions This study indicates inadequate iodine status among PW in Sarawak despite seven years of mandatory USI. In fact, the majority of PW appear not to be protected against IDD and its consequences. In future, a comprehensive study should be carried out to determine the levels of iodine in salt at the retail outlets, villages and households in Sarawak.

Keywords Iodine deficiency disorders - Pregnant women - Mandatory USI - Sarawak.

INTRODUCTION

Iodine is an essential trace element nutrient component for the synthesis of thyroid hormones which are important for mental and physical development.[1] Iodine is normally obtained from the diet and is absorbed by the gastrointestinal tract in the inorganic form of iodide.[2] Inadequate iodine intake can impair thyroid hormone production, resulting in hypothyroidism and a spectrum of disorders collectively known as iodine deficiency disorders (IDD).[3] This deficiency can be easily prevented and controlled by ensuring adequate iodine intake.[4] Approximately two billion people worldwide and 38 million newborn babies in developing countries are still affected by this preventable IDD despite the ongoing and concerted efforts by various organisations in controlling IDD.[5]

During pregnancy, the iodine requirement is sharply increased by more than 50% due to physiological increases in maternal thyroid hormone production.[6,7] Thus, a daily iodine intake of 250 µg/day for pregnant and lactating women is recommended compared to 100 µg/day for adults and 150 µg/day for non-pregnant women of reproductive age.[8] A lack of iodine in a pregnant woman's diet leads to an iodine deficiency (ID) which would subsequently affect the fetus.[9,10] Severe ID during pregnancy may result in a condition associated with a greater incidence of stillbirths, abortions and congenital abnormalities. Mild and moderate deficiency during pregnancy may hinder fetal development and impair motor and physical growth.[11] Although a study has shown that iodine supplementation after birth may improve brain growth and development slightly, it was not able to improve neurologic status or prevent endemic cretinism in fetus.[12]

The solution of IDD elimination is relatively simple, a teaspoon of iodine is all a person requires in a lifetime and since the body cannot store the iodine for long periods, tiny amounts are needed regularly.[8] Many methods of iodisation have been used to increase iodine intake, including the addition of iodine to various foods, such as bread, water and milk.[3] However, the most widely used approach is salt iodisation. Thus, mandatory universal salt iodisation (USI) has been identified as the simplest way to achieve optimal iodine nutrition in populations at risk of ID.[8] This strategy has achieved great success around the world from the use of iodised salt in food manufacturing, table salt and in cooking.[13]

In Sarawak, a mandatory USI law was passed in 2008 which requires all salt for human consumption to contain iodine at a concentration of 20-40 mg per kg of salt.[14] A recent nation-wide IDD survey in 2011 among school children aged 8 – 10 years old in Sarawak showed that the median urinary iodine concentration of the children was 154.2 µg/L indicating an adequate iodine status.[15] However, some studies have found that the iodine status in children aged 8-10 years may not reflect other vulnerable populations such as pregnant women who are more vulnerable to IDD.[16,17,18,19] Since no information is available on iodine nutrition during pregnancy in Sarawak after initiation of mandatory USI, the aim of this study is to evaluate the current iodine nutrition status among pregnant women after a 7-year USI.

METHODS

This study used secondary data derived from IDD survey conducted by the Sarawak State Health Department. This cross-sectional study among pregnant women (PW) was conducted in all government Maternal Child Health Care (MCHC) clinics in all eleven divisions of Sarawak. These 11 divisions were then combined into three groups by region, namely Northern (Miri, Bintulu, Limbang), Central (Kapit, Mukah, Sibu, Sarikei, Betong) and Southern (Kota Samarahan, Kuching, Sri Aman). All first trimester PW visiting the government MCHC clinics from 1st April to 15 June 2015 were invited to participate in the survey.

The required data for PW such as citizenship, locality, age, ethnicity, gravida and parity were obtained. The spot urine samples were collected in screw cap test tubes. All samples were properly packed and labeled, kept in polystyrene boxes containing ice before being transported to the regional IDD laboratory in neighbouring state of Sabah. The samples were kept in a minus 20^0C freezer prior to analysis. The urinary iodine concentration (UIC) was measured by the modified Sandell-Kolthoff reaction method.[20] According to the WHO classification based on the concentration method, Iodine deficiency in pregnant women was defined as a median UIC below 150 µg/L, while a median UIC of 150–249 µg/L, 250–499 µg/L and ≥ 500 µg/L indicated adequate, exceeding requirements and potentially harmful to healthy thyroid function, respectively.[8]

Data were analysed using the IBM Statistical Package of Social Sciences (SPSS) for Windows version 23.0 (IBM Corp., Armonk, NY, USA). Since the urinary iodine distribution was skewed, values were presented as median and inter-quartile range. Differences in median UIC between regions, age, ethnicity and gravida were tested using Kruskal-Wallis test while mann-Whitney test was use for locality and parity. The differences in distribution of UIC between regions, locality, age, ethnicity, gravida and parity were evaluated using the Chi-square test. Significance level was set at $p < 0.05$.

RESULTS

Table 1 shows the socio-demographic characteristics of pregnant women (PW) in

Sarawak. The participants comprised of 508 PW aged between 16 and 43 years (mean±SD, 28.2±5.4). Of these, 180 resided in the Northern region (35.4%), while 29.7% and 34.9% resided in the Central and Southern regions of Sarawak. Almost all PW (99%) were Malaysians. The majority of the PW (81.7%) were from urban locality. By ethnicity, 43.9% were Bumiputra Sarawak, followed by Malay/Melanau (30.9%) and Chinese (13.4%). Regarding gravida (number of pregnancy), 34.0% of PW were in their first gravida, 133 (26.2%) were in their second gravida and 202 (39.8%) were in their third or more gravida. In terms of parity (number of live birth), most of the PW were nulliparous (73.6%).

Table 1 Socio-demographic characteristics of pregnant women in Sarawak

Characteristics	Frequency (%)			
	Northern (n=180)	Central (n=151)	Southern (n=177)	Total (n=508)
Locality				
Urban	158 (87.8)	120 (79.5)	137 (77.4)	415 (81.7)
Rural	22 (12.2)	31 (20.5)	40 (22.6)	93 (18.3)
Age (years)				
≤ 25	63 (35.0)	56 (37.1)	52 (29.4)	171 (33.7)
26-30	63 (35.0)	46 (30.5)	60 (33.9)	169 (33.3)
≥31	54 (30.0)	49 (32.5)	65 (36.7)	168 (33.1)
Ethnicity				
Bumiputra Sarawak	69 (38.3)	83 (55.0)	71 (40.1)	223 (43.9)
Malay/Melanau	56 (31.1)	25 (16.6)	76 (42.9)	157 (30.9)
Chinese	22 (12.2)	24 (15.9)	22 (12.4)	68 (13.4)
Others	33 (18.3)	19 (12.6)	8 (4.5)	60 (11.8)
Gravida (number of pregnancy)				
1	71 (39.4)	45 (29.8)	57 (32.2)	173 (34.0)
2	47 (26.1)	40 (26.5)	46 (26.0)	133 (26.2)
≥3	62 (34.4)	66 (43.7)	74 (41.8)	202 (39.8)
Parity (number of live birth)				
Nulliparity	97 (53.9)	127 (84.1)	150 (84.7)	374 (73.6)
Parous	83 (46.1)	24 (15.9)	27 (15.3)	134 (26.4)

Table 2 shows the median urinary iodine concentration (UIC) in pregnant women (PW) in Sarawak by selected background factors. The median UIC among PW in Sarawak as a whole was 105.6 µg/L (IQR 54.3-176.5 µg/L), whereas the medians for the Northern, Central and Southern regions were 136.3 µg/L (IQR, 70.0 - 203.3), 85.5 µg/L (IQR, 41.8 - 155.7) and 97.4 µg/L (IQR, 50.0 - 171.0) respectively. The Northern region (p = 0.001), Malay/Melanau ethnicity (p = 0.015) and parous parity (p = 0.014) were significantly associated with higher median UIC. No significant association was found for locality, age nor gravida.

Table 2 Median Urinary iodine concentration (UIC) among pregnant women (PW) in Sarawak, by selected background characteristics.

Characteristic	n	%	UIC (µg/L)		*p*
			Median	*IQR*	
Overall	508	100.0	105.6	54.3 - 176.5	
Region					
Northern	180	35.4	136.3	70.0 - 203.3	0.001*
Central	151	29.7	85.5	41.8 - 155.7	
Southern	177	34.8	97.4	50.0 - 171.0	
Locality					
Urban	415	81.7	102.9	51.8 - 179.0	0.718
Rural	93	18.3	115.2	58.3 - 174.5	
Age (years)					
≤ 25	171	33.7	117.8	71.9 - 176.4	0.115
26-30	169	33.3	86.2	45.8 - 173.1	
≥31	168	33.1	114.8	50.0 - 179.4	

Ethnicity					
Bumiputra Sarawak	223	43.9	101.7	52.5 - 175.6	
Malay/Melanau	157	30.9	127.1	65.1 - 127.1	0.015*
Chinese	68	13.4	77.2	40.4 - 132.5	
Others	60	11.8	132.6	47.4 - 197.3	
Gravida (num of pregnancy)					
1	173	34.1	101.7	44.4 - 174.5	0.617
2	133	26.2	104.2	59.5 - 188.2	
≥3	202	39.8	116.7	55.4 - 178.8	
Parity (num of live birth)					
Nulliparity	374	73.6	100.9	52.8 - 169.6	0.014*
Parous	134	26.4	139.4	57.7 - 213.8	

*Significant level $p<0.05$

Table 3 shows the distribution of UIC among pregnant women (PW) in Sarawak by designated classifications of insufficient; adequate or excess. The distribution of UIC in PW showed that the majority of PW (65.0%) had insufficient iodine intake (UIC < 150 µg/L). In terms of regions, the percentage of PW with deficient iodine was higher in Central (72.8%), followed by Southern (67.2%) and Northern (56.1%) regions. Most of the nulliparous PW had insufficient iodine intake (68.2%) compared to parous-parity PW (56.0%). The Central region (p = 0.027) and nulli-parity (p = 0.020) were significantly associated with lower UIC. However, locality, age, ethnicity nor gravida had no significant association with UIC levels.

Table 3 Distribution of urinary iodine concentration (UIC) among pregnant women (PW) in Sarawak, by designated classifications of insufficient; adequate or excessive.

Characteristic	n	%	Frequency (%) < 150 (insufficient)	150-249 (adequate)	≥ 250 (excess)	*P*
Overall	508	100.0	330 (65.0)	124 (24.4)	54 (10.6)	
Region						
Northern	180	35.4	101 (56.1)	56 (31.1)	23 (12.8)	0.027*
Central	151	29.7	110 (72.8)	29 (19.2)	12 (7.9)	
Southern	177	34.8	119 (67.2)	39 (22.0)	19 (10.7)	
Locality						
Urban	415	81.7	272 (65.5)	96 (23.1)	47 (11.3)	0.264
Rural	93	18.3	58 (62.4)	28 (30.1)	7 (7.5)	
Age (years)						
≤ 25	171	33.7	104 (60.8)	50 (29.2)	17 (9.9)	0.341
26-30	169	33.3	118 (69.8)	33 (19.5)	18 (10.7)	
≥31	168	33.1	108 (64.3)	41 (24.4)	19 (11.3)	
Ethnicity						
Bumiputra Sarawak	223	43.9	143 (64.1)	55 (24.7)	25 (11.2)	
Malay/Melanau	157	30.9	96 (61.1)	42 (26.8)	19 (12.1)	0.241
Chinese	68	13.4	54 (79.4)	11 (16.2)	3 (4.4)	
Others	60	11.8	37 (61.7)	16 (26.7)	7 (11.7)	
Gravida (num of pregnancy)						
1	173	34.1	114 (65.9)	44 (25.4)	15 (8.7)	0.876
2	133	26.2	85 (63.9)	33 (24.8)	15 (11.3)	
≥3	202	39.8	131 (64.9)	47 (23.3)	24 (11.9)	
Parity (num of live birth)						
Nulliparity	374	73.6	255 (68.2)	86 (23.0)	33 (8.8)	0.020*
Parous	134	26.4	75 (56.0)	38 (28.4)	21 (15.7)	

*Significant level $P<0.05$

DISCUSSION

In pregnant women (PW) as the best approach for prevention and control of iodine deficiency disorders (IDD).[8] The use of urinary iodine excretion as the main indicator of IDD will precisely determine the degree of deficiency as the amount of iodine consumed is almost equal to the amount of iodine excreted per day.[21] Based on the urinary iodine concentration (UIC) criteria for assessing severity of IDD in PW, Sarawak would

be classified as iodine deficient with an overall median UIC of 105.6 µg/L. This value is far below the WHO cut-off point for iodine sufficiency in pregnancy of 150 µg/L.[8] In addition, the median iodine status of PW was also inadequate in all three study regions (Northern, 136.3 µg/L; Central, 85.5 µg/L; Southern, 97.4 µg/L). Furthermore, the distribution of the UIC in this study population shows that majority (65%) were still having less than optimal levels of UIC.[8] Sarawak has been gazetted as a USI state since 2008 and a state-wide IDD survey conducted in school-age children in 2011 clearly confirmed that the population in Sarawak had adequate iodine intake.[15] However, the present study clearly shows inadequate consumption during pregnancy. This scenario should be a serious concern because iodine is the key element required for the synthesis of thyroid hormones crucial for the development of the fetus[22], especially during the first trimester of pregnancy for supporting physical and brain growth of the fetus.[23, 24]

These results are consistent with a study done in the neighbouring Malaysian state of Sabah, which reported that median UIC value of PW of only 105.5 µg/L, with nearly two-thirds of the women (60%) having a UIC of <150 µg/L.[25] Our present study is also consistent with a number of studies done in other countries which indicated that the mandatory USI can provide adequate iodine for the general population, but it is still insufficient for PW.[26,27,28] A study done among 580 PW across trimesters in Kyrgystan showed that median UIC levels of only 111 µg/L and UIC <150 µg/L were observed in 61% of this PW.[26] Furthermore, the median UIC in 1200 urine samples from PW in China was borderline insufficient (146 µg/L) with 51.6% of them having UIC <150 µg/L.[27] Similar to the situation in Sarawak, a study in Niger in 2013 found a median UIC for all PW of only 119 µg/L with more than 60% of PW below 150 µg/L despite mandatory iodisation of table salt since 1996.[28]

The possible reasons for the lower level of UIC in PW in our study may be due to less iodised salt being consumed by the PW as a result of increased awareness of health issues. It is noted that the study areas have a good coverage of government MCHC clinics. Thus, many PW manage to obtained medical advice from the clinics as most of them already believe in the modern treatment.[29] Furthermore, the influence of healthcare providers and health education on changing habitual dietary practices during pregnancy may have contributed to reduced salt intake.[30] Salt added to food has resulted in most populations consuming salt at levels far exceeding needs. This practice has been associated with elevated blood pressure, a risk factor for cardiovascular disease.[11] Therefore, most countries recommend reduced salt consumption for blood pressure control, especially for vulnerable groups and this is also in line with WHO recommendations.[9]

With regards to socio-demographic characteristics, iodine levels were found to be significantly higher in Northern region compared to other regions, in Malay/Melanau ethnicity, and among PW of parous. This regional variation in iodine intake are not surprising as the 2011 Sarawak nation-wide survey of school-aged children also showed differences in iodine status between study areas.[15] This is probably a reflection of the level of better socio-economic development that has taken place and a population of higher socio-economic status in Northern region such as Miri and Bintulu whereby the economic largely based on the petroleum and natural gas industries. One could presume that the iodine status is better than the other areas because of higher income.[15] In addition, the less developed areas in this region such as Bario Highlands in Baram District have their own source of salt that contained a very high level of iodine which might contributed to higher UIC among PW in the Northern region.[31] Our findings are also in agreement with a study of iodine status among pregnant women in neighbouring Sabah, Malaysia which reported significant differences in median UIC level between three studied divisions, which noted that the median UIC decreased as the district remoteness increased.[25]

The median UIC in parous-parity PW in our study was significantly higher than nulliparous PW (139.4 µg/L vs 100.9 µg/L). One possible reason is that since most of the parous-parity PW had previously delivered at health facilities, they may have been exposed to health education from health-care workers. Consequently, parous women may have better knowledge regarding IDD than their nulliparous counterparts.[8] Awareness is one of the most important determinant factor in eliminating iodine deficiency.[32] In addition, as the knowledge status of PW improves, misconceptions and wrong beliefs in IDD will decrease which may have a positive impact on their iodine status.[33] Therefore, to ensure that the successful implementation of USI in PW, a public education programme is needed to educate the PW about why and how to prevent iodine deficiency.[34]

The strength of this study is that the urine samples appear to be adequate to assess the iodine status for each region in Sarawak. The minimum number of urine samples needed to estimate the iodine intake level in PW were 122 with a 95% confidence within a precision range of ±10%.[35] In addition, this study was conducted during the first trimester of gestation as the main changes in thyroid function associated with pregnancy begin in the first trimester.[24] Nevertheless, there are some

limitations in this study. First, information on iodine concentrations in edible salt utilised by the PW was not collected and if these salt samples can be taken from them, results may be more informative. Second, thyroid hormones, such as thyroxine and triiodothyronine which can give us a clearer picture of their iodine status were not measured. However, with all the limitations, this study is still able to provide a good indication of overall IDD status among PW in Sarawak.

CONCLUSIONS

This study indicates inadequate iodine status among PW in Sarawak. The findings demonstrated that the pregnant women and their newborns are still at risk of IDD in Sarawak despite a mandatory USI legislation for seven years.36 This would clearly be an issue of public health importance as it affects a majority of PW sampled from all over the state. We suggest that regular monitoring and appropriate nutrition education are essential as strategies to improve the IDD status among PW. In future, a comprehensive study should be carried out to determine the levels of iodine in salt at the retail outlets, villages and households in Sarawak.

ACKNOWLEDGMENTS

We thank the Director General of Health Malaysia for permission to publish this paper. We are grateful to all the health care staff from Sarawak MCH clinics for their cooperation and all pregnant women who participated in the study.

AUTHOR DISCLOSURES

The authors declare that they have no conflicting of interests.

ETHICS APPROVAL

This study used secondary data derived from IDD survey conducted by the Sarawak State Health Department (SSHD). This survey was part of the routine health survey conducted by the SSHD. Thus, the used data considered routine data and the ethical approval is not needed.

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