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IMPACT OF UNIVERSAL SALT IODIZATION PROGRAMME TOWARDS IODINE STATUS OF PREGNANT WOMEN IN SARAWAK

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ABSTRACT

Background: Iodine deficiency disorder (IDD) is a public health issue in Sarawak. This study aimed to determine the present status of IDD among first trimester pregnant women in Sarawak after a decade of implementation of USI.

Materials and Methods: A cross-sectional study of IDD involved 30 Maternal and Child Health Clinics throughout Sarawak with 750 pregnant women in the selected clinics were randomly selected via systematic sampling. Socio-demographic data, urinary iodine sample, thyroid size examination, and household salt were also collected. Further associations and odds were analysed using Krusskal-Wallis, Chi square and Logistic regression.

Result: The prevalence of goiter rate (TGR) was found to be 1.0% (n=10). The median urinary iodine concentration (UIC) for Sarawak was 123.9µg/L (IQR 56.5-192.1µg/L) which indicates an iodine deficiency. Median UIC for both Sri Aman and Mukah had achieved adequacy of iodine intake which were 150.7 (IQR 128.2-235.8) and 170.2 (IQR 119.1-264.7) respectively. Sarawak divisions and ethnicity were found significant association with UIC.

Conclusion: USI programme should be continue as has improved IDD in Sarawak despite majority of pregnant women in Sarawak still having iodine insufficiency. Programme manager should anticipate to location who has UIC lower than <100 µg/L.

Keywords: Iodine; pregnant women; urine iodine; salt

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1.0 Introduction

Iodine deficiency disorder was identified as a public health issue in Sarawak, Malaysia. The extended impact of iodine deficiency disorder (IDD) can be seen in a pregnant mother, foetus, and children [1]. Pregnant women were the most vulnerable high-risk group among the community because of the higher utilization of iodine [2]. Iodine requirement may increase up to 50% because of increase maternal thyroxin production during pregnancy especially during the early stages of pregnancy until the 12th weeks of gestation [1]. This is due to the foetus thyroid hormone production which starts between the 10th–12th weeks of pregnancy [3]. Deficiency of thyroid hormone during the early stage of pregnancy may lead to congenital abnormalities such as cretinism; a grave and irreversible form of mental retardation [4; 5]. IDD endangers children and can lead to permanently reducing motor and cognitive performance and subsequently reducing quality of life [6].

In combatting IDD, the Sarawak government has started a few initiatives such as prohibiting sale of non-iodized salt at goiter endemic area in 1982 [7] and commencing water iodization programme for rural schools and hostel since 1995 [6]. However, the programmes were subsequently suspended due to ineffectiveness, equipment were prone to breakdown coupled with a high cost of maintenance [8; 9]. Thus, in 2008 the Malaysian government implemented Universal Salt Iodization (USI) in Sarawak [10]. Legislation were imposed requiring all salt for human consumption to be iodized with potassium iodide or iodate, or sodium iodide or iodate and must contain not less than 20 mg/kg and not over 40 mg/kg of iodine [11]. USI programs in IDD countries shows a mass application of iodized salt in the market have improved IDD's in the respective countries [12].

There are various studies being conducted that shows USI programs to be either sustainable or unsustainable [13; 14; 15]. However, monitoring of programme as listed in the guidelines is the key factors in determine successful of programme [5]. Study by Anderson et al. [13] shows USI was sustainable as it is harmless and valuable [16] in controlling and preventing IDD. A big portion of iodine intake originates from household salt [17] and average daily intake of salt ranges within 5-15 g/day for children and adult [18]. The recommended level of salt iodization should be adjusted to provide approximately 150µg of iodine daily consumption taking into account climatic factors [5]. For pregnant women, the recommended daily iodine intake is 250µg/day [5].

Based on the WHO/UNICEF/ICCIDD, median UIC were recommended parameters to monitor iodine in the urine. Urinary iodine concentration (UIC) level of <150, 150-249, 250-499 and ≥500 µg/L in pregnant women were considered to have insufficient, adequate, more than adequate, or excessive iodine level, respectively [6]. Previous study among pregnant women in Sarawak showed the median urinary iodine concentration (UIC) of pregnant women in Sarawak was 105.6µg/L, showing iodine deficiencies [17]. Thus, this study examines the current status of IDD among first trimester pregnant women in Sarawak after 10 years of implementation of USI programme.

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2.0 Materials and Methods

2.1 Ethical Approval

This was a collaborative study between the Institute for Public Health, Malaysia and Sarawak State Health Department, Malaysia funded by the National Institute of Health, Ministry of Health Malaysia. This study was registered under National Medical Research Registry (NMRR ID-17-2932-39.316) and approved by the Medical Research and Ethics Committee (KKM.NIHSEC.P18-313). In addition, the methodology of this study has been published in the International Journal of Public Health Science (IJPHS) [19].

2.2 Study Design

The Sarawak's IDD study was a cross-sectional survey conducted between July and September 2018. It covers 30 government maternal child health clinics (MCHCs) throughout Sarawak using probability proportional to population size (PPS) sampling technique. The total sample size required was 750 (25 respondents per selected MCHC) based on the 95% confidence interval (CI), relative precision of 5%, design effect of 2, anticipated IDD prevalence of 65% based on a previous study, and 20% of non-response rate [17]. The inclusion criteria comprises 1st trimester pregnant women (12 weeks of gestation), aged 18 years and above, and attending appointments at the 30 selected MCHCs.

2.3 Study Instrument

Data were got through; face-to-face interview conducted using WHO/UNICEF/ICCIDD IDD survey questionnaires which include socio-demographic, thyroid size examination; urine for iodine, and household salt [6].

2.4 Thyroid Size

Thyroid was examined by trained staff nurses. It was graded according to 0, 1, and 2 according to WHO/UNICEF/ICCIDD IDD [6]. Grade 0 denotes no goiter; grade 1 denotes an enlarged thyroid that is palpable but not visible when the neck is in the normal position; Grade 2 indicates a swelling in the neck that is visible when the neck is in a normal position.

2.5 Iodine in blood

Iodine in blood venous blood samples (10.0 ml) were collected into plain vacutainer tubes by trained staff nurses. Free T4 and free T3 status were determined using commercial Architect Free Thyroxin (free T4) 7K6529 and Architect Free Triiodothyronine (free T3) 7K6330, respectively. Normal reference ranges established by the commercial kit manufacturer were used for assessing thyroid dysfunction: TSH (0.35 - 4.94 mIU/L, free T4 (9.0 - 19.1 pmol/L), free T3 (2.63 - 5.71 pmol/L), TPOAb (<5.61 IU/mL) and TGAb (<4.11 IU/mL).

2.6 Iodine in urine

Urine samples were collected using urine container and kept in the polystyrene container at -18^0 C before despatching to an IDD Laboratory in Kota Kinabalu, Sabah. Urinary iodine

determination was done using an in-house modified micro plate method based on manual digestion with ammonium persulfate followed by the calorimetric determination of the modified Sandel-Kolthoff reaction by using 96-multi-well plates and an absorbance micro-plate reader at 405 nm [20].

2.7 Iodine Salt

Pregnant women were requested to bring along approximately 80g of salt from their respective homes in self-sealing polythene bags. Subsequently it was properly packed and labelled prior to despatching to the Nutrition Unit, Institute for Medical Research (IMR) Kuala Lumpur for analysis. Iodiometric titration method is the most accurate analytical methods available and this 'gold standards' method is recommended for factory quality assurance and research study. WHO/UNICEF/ICCIDD suggests 10% salt samples of calculated respondents are adequate to determine household coverage [6].

2.8 Data Analysis

Data were checked and refined before being analysed using the Statistical Package for the Social Sciences (SPSS) version 21. Complex sampling data analysis was used at 95% confidence interval to illustrate the social demographic of the respondents (Relative standard error (RSE) was set below than 50). The data distribution was not normal. Association between median UIC and Sarawak's division, age groups, ethnicity, number of gravida and household iodized salt were tested using Kruskal-Wallis test. Multiple logistic regression was used to determine the odds.

3.0 Result

3.1 Demographic Characteristics

A total of 677 pregnant mothers had participated in this study with a response rate of 90.2%. Majority of them were Malays (35.2%) followed by Iban (29.5%), Chinese (13%), others (9.0%), Bidayuh (7.2%), and Melanau (6.1%). 28.5% of respondents were primigravida.

3.2 Prevalence of Goiter among Pregnant Women in Sarawak (n=677)

Goitre grade (n)			Total goitre rate (1+2)
0	**1**	**2**	
670 (99.0%)	4 (0.6%)	3 (0.4%)	7 (1.0%)

Prevalence of goiter rate (TGR) was found to be 1.0% (n=10) as shown in Table 3.2. There were four cases for grade 1 and three cases for grade 2. In addition, six out of seven goitres were found to have normal TSH, T4 and T3 level.

3.2.1 Distribution of Household Iodized Salt in Sarawak

Total samples (*n*)	Iodized salt level		
	Non satisfactory <20ppm (%)	Satisfactory ≥20-40 ppm (%)	Excess >40ppm (%)
100	14 (14)	44 (44)	42 (42)

Based on the household iodized salt in Sarawak, 14% of iodized salt was non-satisfactory (<20 ppm), 44% satisfactory (≥20-40ppm), and 42% in excess (>40 ppm).

3.2.2 Distribution of Urinary Iodine Concentration among Pregnant Women In Sarawak Based on Sociodemographic Profile

Variables	n	Median UIC µg/L, (IQR)	Frequency (*n*)	
			<150 µg/dL (%)	≥150 µg/dL (%)
Sarawak	646	123.9 (56.5-192.1)	397 (61.5)	249 (38.5)
Sarawak's division[a]	646			
Kuching	130	138.6 (59.9-188.3)	74 (56.9)	56 (43.1)
Samarahan	74	145.3 (60.0-198.1)	41 (55.4)	33 (44.6)
Serian	45	102.2 (58.3-160.6)	32 (71.1)	13 (28.9)
Sri Aman	25	150.7 (128.2-235.8)	12 (48.0)	13 (52.0)
Betong	28	112.7 (38.5-200.0)	19 (67.9)	9 (32.1)
Sarikei	47	75.4 (32.3-136.4)	36 (76.6)	11 (23.4)
Mukah	25	170.2 (119.1-264.7)	8 (32.0)	17 (68.0)
Sibu	74	90.2 (37.8-139.0)	58 (78.4)	16 (21.6)
Kapit	37	145.4 (75.2-215.3)	20 (54.1)	17 (45.9)
Bintulu	37	143.3 (79.9-196.5)	22 (59.5)	15 (40.5)
Miri	74	135.7 (71.0-206.6)	39 (52.7)	35 (47.3)
Limbang	50	98.1 (34.4-175.8)	36 (72.0)	14 (28.0)
Age groups	646			
<25 years old	171	127.7 (63.9-187.5)	110 (64.3)	61 (35.7)
25 – 30 years old	220	121.9 (56.2-198.0)	133 (60.5)	87 (39.5)
31 – 35 years old	179	113.5 (48.4-185.4)	114 (63.7)	65 (36.3)
>35 years old	76	144.3 (63.2-200.2)	40 (52.6)	36 (47.4)
Ethnicity [b]	646			
Iban	190	123.3 (63.0-197.2)	118 (62.1)	72 (37.9)
Malay	222	140.0 (71.7-200.0)	124 (55.9)	98 (44.1)
Chinese	85	79.8 (41.2-152.6)	63 (74.1)	22 (25.9)
Bidayuh	48	137.4 (57.6-194.6)	29 (60.4)	19 (39.6)
Melanau	41	116.3 (59.2-169.9)	24 (58.5)	17 (41.5)
Lain-lain	60	93.5 (41.7-178.2)	39 (65.0)	21 (35.0)

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No. of gravida	646			
Gravida 1	184	117.4 (54.9-182.1)	120 (65.2)	64 (34.8)
Gravida 2	198	133.0 (50.5-203.2)	117 (59.1)	81 (40.9)
Gravida 3	124	107.0 (107.0-191.6)	77 (62.1)	47 (37.9)
Gravida ≥4	140	128.6 (76.2-191.5)	83 (59.3)	57 (40.7)
Household iodized salt	99			
Non satisfactory (<20ppm)	14	80.8 (52.9-183.7)	10 (71.4)	4 (28.6)
Satisfactory (20-40ppm)	44	151 (39.3-221.3)	22 (50.0)	22 (50.0)
Excess (>40ppm)	41	129.1 (58.8-218.0)	23 (56.1)	18 (43.9)

[a] P<0.001, significantly different using Kruskal-Wallis Test
[b] P <0.05, significantly different using Kruskal-Wallis Test

The median urinary iodine concentration (UIC) level for Sarawak was 123.9µg/L (IQR 56.5-192.1µg/L) which shows an iodine deficiency. IDD among first trimester pregnant women in Sarawak was 61.5%. Median UIC for both Sri Aman and Mukah had achieved adequacy of iodine intake were at 150.7µg/L (IQR 128.2-235.8) and 170.2µg/L (IQR 119.1-264.7) respectively. Serian, Betong, Sarikei, Sibu, and Limbang had median UIC level below Sarawak's UIC, which were 102.2 µg/L (IQR 58.3-160.6), 112.7 µg/L (IQR 38.5-200.0), 75.4 µg/L (IQR 32.3-136.4), 90.2 µg/L (IQR 37.8-139.0) and 98.1 µg/L (IQR 34.4-175.8) respectively. The age group of more than 35 years old has the highest median UIC level at 144.3µg/L (IQR 63.2-200.2). Over 60% in the other age groups had insufficient UIC level. Chinese ethnicity and women in their third pregnancy had the lowest median UIC within the groups, 79.8 µg/L (IQR 41.2-152.6) and 107.0 µg/L (IQR 107.0-191.6) respectively.

Based on Kruskall Wallis analysis, there were statistical significant association between median UIC level and Sarawak division (P<0.001); median UIC level and ethnicity (P <0.05). However, there was no association found between median UIC level with age group, number of gravida, and household iodized salt. Multiple logistic regressions between median UIC and age groups, ethnicity, number of gravida, and household iodized salt showed that there were no statistical significant associations found.

4.0 Discussion

Iodine deficiency still present after 10 years of USI programme in Sarawak, Malaysia. Elimination of IDD may require more time, as some countries need approximately 15 years [21] to achieve an adequate UIC, and some countries require even longer periods [22; 23]. However, recent studies show that median UIC among pregnant women in Sarawak has increased 17.3% from 105.6µg/L to 123.9µg/L [17]. Statistical analysis found that location plays an important role in determining UIC [17; 23; 24; 25]. Therefore, the Sarawak State Health Department should focus on Serian, Betong, Sarikei, Sibu, and Limbang in combatting IDD. Incidence of cretinism, mental slowness or neurodevelopmental disturbances among children could be the indicator for the policy maker to put up additional intervention to speed up the effect of USI especially on targeted locality.

Household coverage with adequately iodised salt was below target level by WHO/UNICEF/ICCIDD as more than 30 countries achieved the goal of USI with iodised salt >90% [6]. Household salt collection was randomly collected but not to a specific location in Sarawak. Therefore, it is difficult to determine the distribution of household salt with the UIC level. Study by Zimmermann et al. in Morocco found poor distribution of USI lead to IDD [26]. Optimisation of universal salt iodisation in Sarawak should be priority action by health inspector as it bound by the law [11].

All age groups had almost similar prevalence of IDD which ranges between 60%-65% except for age group >35 years old. They could supply 1st trimester with iodised tablets as 6 out of 10 pregnant mothers have IDD. Studies have shown that supplements of iodised salt to pregnant mothers have improved the median UIC [26]. However, this practice can only be used after USI has been optimised throughout Sarawak, as this requires an extra budget from the healthcare provider. Pre-marital counsel for child bearing mother on IDD is important as a study done in Filipino found that UIC among child bearing mother was insufficient [25].

Ethnicity plays an important role in IDD among pregnant women especially in a multi-racial country [27; 28]. Kruskal-Wallis found a significant association between median UIC and ethnicity. Chinese and other ethnics were found to have a high prevalence of having low median UIC. However, it could be due to variation in dietary [27]. National study by Korean found that excessive iodine consumption among school-age children lead to an elimination of IDD in the country [29].

5.0 Conclusion and recommendation

As recommendations, monitoring of iodised salt by health inspectorate on imported salt should be mandatory mandated at least quarterly or randomly as household salt are imported by Malaysia and as its not obey to the law and complies to regulations are sustainable [30]. Second, iodine tables could be introduced to pregnant women in Sarawak division who has UIC level below 100µg/L as a specific focus are crucial to generate a greater impact on treating IDD with minimal healthcare cost [26]. Third, family health doctors should include ethnicity as a risk factor of IDD for pregnant mothers in Sarawak and additional health awareness on IDD need to be emphasised as knowledge on IDD among pregnant women were found low in Australia and Norway [31; 32]. In conclusion, these strategies had supported by other studies through high coverage and adequate iodised salt, regular monitoring of salt iodisation and iodine status of population, and specific focus on vulnerable population groups [13; 26; 29].

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Declaration

Author(s) declare that there are no potential conflicts of interest relevant to this article that was reported.

Author's contribution

Author 1: Acquisition, analysis and interpretation of data, drafting the work, final approval of the article, Author 2: Substantial contributions to the concepts and design, acquisition of data, revising it critically for important intellectual content and final approval of the article, Author 3: Acquisition of data, revising it critically for important intellectual content and final approval of the article Author 4: Substantial contributions to the concepts and design, acquisition of data, revising it critically for important intellectual content and final approval of the article and Author 5: Substantial contributions to the concepts and design, revising it critically for important intellectual content and final approval of the article.

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