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IODINE STATUS AND THYROID VOLUME AMONG SCHOOL CHILDREN: APPROACH IN METHODOLOGY OF SARAWAK IODINE DEFICIENCY DISORDER SURVEY 2018

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ABSTRACT

Introduction: Iodine deficiency disorders (IDD) among Sarawakian school children has been highlighted as substantial public health problem. It has mandated universal salt iodization (USI) implemention in Sarawak started since 2008. This paper describes the approach in methodology of Sarawak IDD Survey 2018 which aimed to determine the current status of IDD among school children in Sarawak after 10 years of USI implementation.

Method: The IDD survey was conducted between July and September 2018 involving all 12 divisions in Sarawak. 30 schools were selected via multistage proportionate-to-population size sampling technique and 1200 school children were randomly selected via systematic sampling.

Results: All selected schools participated in the survey, which resulted in a 100% school's response rate. A total of 988 school children participated in the survey, with overall response rates of 82.3%.

Conclusion: The present study findings will highlight the impact of mandatory USI towards the iodine level among school children in Sarawak.

Keywords: Iodine deficiency disorders, total goiter rate, universal salt iodinization, Sarawak.

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1.0 INTRODUCTION

Iodine is an element that is essential for metabolism and normal thyroid function in human body. The synthesis of thyroid hormone is essential for the brain and physical development [1]. Unfortunately, human body does not make iodine, so it is an essential part in dietary intake. The quantity of iodine required by an individual is about 150-200 micrograms per day [2]. Most of the iodine exists in the ocean and seafood, including saltwater fish, shellfish, kelp, seaweed and seaweed products which can provide a considerable amount of iodine [3]. Low levels of iodine in diet for people who do not get enough iodine from their food may lead to health problems collectively referred to as iodine deficiency disorders [4].

Iodine deficiency disorders (IDD) is a major public health problem for population throughout the world which affect human from early fetal life throughout to adulthood [5]. IDD in the fetus is associated with greater incidence of stillbirths, abortions, congenital abnormalities, neurological cretinism and psychomotor defects. In neonate, apart from mortality, the continuing of severe IDD may affect the brain and physical development. IDD in the child and adolescent is associated with juvenile hypothyroidism, impaired mental function and retarded physical development. Studies on the school children living in Iodine deficient (ID) areas indicate impaired school performance and IQs [6]. While IDD in the adult has effect on the capacity and initiative and decision making [7].

Salt iodization is the optimal way to ensure sufficient intake of iodine by all individuals. It should continue to be the primary focus through sustainable programmes for preventing and controlling IDD [8] International experience has convincingly demonstrated that universal salt iodization (USI) is the most reliable, safe and cost-effective way to eliminate IDD [7, 9]. However, the successful implementation of an iodization programme may take several years or longer, because it involves changes in the salt trade. USI guarantees an adequate and regular intake of iodine since dietary salt intake has been shown to be remarkable constant and within narrow ranges across population [7]. A largest part of iodine intake is usually from household salt [10] and average daily intake of salt are range within 5-15 g/day for children and adult and the recommended level of salt iodization should be adjusted to provide approximately 150µg of iodine/day actually consumed by taking into account usual climatic factors [11].

2.0 PROBLEM STATEMENTS

In Sarawak, most of its interior areas are still at risk to IDD due its predominantly mountainous terrain and heavy rain which limits iodine-rich food accessibility (Lim et al, 2015). Nonetheless, modernization and socio-economic development had opened new townships and new businesses which have made outside food including seafood more widely available to the communities living in once remote and inaccessible areas [12]. Back in 1996, a state survey conducted by the Sarawak State Health Department (SSHD) reported a total goitre rate (TGR) of 0.4% among 2524 school children aged 8-10 years with the median urinary iodine concentration (UIC) was 126 µg/L (optimal level) [13]. This was the result of water iodizing system offered during the period as a new cost-effective strategy for the

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control of endemic IDD in Sarawak. But unfortunately, the water iodizing system's equipment was prone to breakdown [14]. Thus, this strategy was not applied further.

In 2008, a National IDD survey conducted in Malaysia revealed the median UIC of school children in Sarawak was at borderline-adequate level (101.9 µg/L) and children from rural areas were still having inadequate iodine (median UIC, 96.6 µg/L) [15]. Hence, a legislation on universal salt iodization (USI) was enacted in Sarawak in the same year which required 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 ppm and not more than 40 ppm of iodine [16].

The universal salt iodization had been shown to reduce the risk of IDD in Sarawak [17]. However, there are some cases of unnecessarily high iodine intakes that may occasionally be associated with Iodine-Induced Hyperthyroidism [18, 19]. For example, in Denmark, the incidence of hyperthyroidism increased every year after USI was introduced [20].

3.0 METHODOLOGY

3.1 Scope of the study

In identifying the scope of the survey, suggestion and feedback were obtained from IDD programme manager in Sarawak State Health Department. The main research team members reviewed and studied closely the suggested issues and shortlisted the relevant scope. The main scope of this study is to determine relevant information on the current status of IDD and the consumption of iodized salt among children in Sarawak after 10 years of introduction of legislation on USI. In addition, it will also provide important reference data for future policy maker in controlling IDD.

3.2 Study Design and Specific Aims

Sarawak Iodine Deficiency Disorder Survey 2018 was a cross-sectional study conducted from July to September 2018 among school children aged 8 to 10 years old in Sarawak. The study was conducted by Institute for Public Health, one of the research institutes under the Ministry of Health Malaysia in collaboration with Sarawak State Health Department. Study approval was obtained from the Medical Research and Ethic Committee, Ministry of Health Malaysia, prior to the study (NMRR-17-2931-39285). This study specifically will determine:

a. The impact of USI on levels of urinary iodine among school children

b. The impact of USI on levels of goitre among school children

c. The impact of USI on levels of hyper/hypothyroidism status among school children

e. The levels of iodine in salt from school children's home

f. The levels of iodine in salt from school kitchens

g. The consumption of iodine rich food among school children

h. The consumption of goitrogen food among school children

i. The relationship between levels of urinary iodine, goitre, iodized salt, iodine rich food and goitrogen food among SC

3.3 Sample Size

The sample size was calculated using an appropriate formula on the basis of the ability to estimate the prevalence of the health conditions specified in this survey with adequate or acceptable precision [21]. Previously published data from National IDD survey 2008 were used to estimate the prevalence of these conditions [15]. The sample size was then inflated to cater for estimated design effect and nonresponse. Finally, the sample size was adjusted according to the needs of the analysis whether at state level or division level.

3.4 Sampling Frame

Geographically, Sarawak is divided into 12 divisions. A list of the government primary schools in Sarawak and its enrolment was obtained from Sarawak State Education Department. Based on the frame, there were 1264 primary schools in Sarawak in that year. The sampling did not include student from private schools. The multistage proportionate to population size sampling technique was used to randomly select schools.

3.5 Sampling Design

Multistage proportionate to population size (PPS) sampling technique was implemented [22]. The sampling involved 2 stages. The first stage was the selection of schools in the Sarawak state. The schools (primary sampling units) were selected randomly with probability proportional to enrolment for each division. A total of 30 schools were proportionally selected in the state (see Table 1).

The second stage was the selection of students (secondary sampling units). All students in Standard 3, 4 and 5 were included in the sampling frame. A systematic probability sampling with random start was used to select student from each selected school. In each of the 30 selected schools, 40 children aged 8 to 10 were randomly selected by this systematic sampling. Therefore, a total of 1200 school children will be involved in the study.

Table 1: Distribution of primary school sampled by division

Divisions	**Total school selected**
1. Kuching	8
2.Samarahan	1
3.Serian	1
4.Sri Aman	1

5.Betong	1
6.Sarikei	1
7.Mukah	1
8. Sibu	3
9. Kapit	3
10. Bintulu	3
11. Miri	6
12. Limbang	1

3.6 Study Instruments and Data Collection Technique

All required data were obtained through interviews on dietary iodine intake, anthropometric examination, thyroid size examination, hyper/hypothyroidism assessment and analysis of urine from the study respondents. The iodine content in the salt from school children's home and school kitchen will also be determined.

3.6.1 Socio-demographic profile

The socio-demographic data obtained include student's gender, age, ethnicity, received school supplementary food program, and whether they live in the school hostel.

3.6.2 Dietary iodine intake

Face to face an interview with the school children has been carried out by trained health workers using the pre-tested questionnaires to obtain demographic and dietary iodine intake. The demographic questionnaire included questions related to personal information such as age, gender and ethnicity. The consumption patterns of iodine rich foods over the past one month (daily, weekly and monthly) were measured using semi-quantitative food frequency questionnaire (FFQ) adopted from National IDD Survey 2008 [23]. It included 11 iodine rich food items such as fish and fish products, other seafood and seaweed, 7 goitrogen rich food items such as tubers and cabbage. A food album containing pictures of commonly eaten iodine rich food were used to help the school children identify the food items. Household utensils such as cup and spoon were also used to help the children quantify the amount of food taken.

3.6.3 Thyroid volume

Enlargement of the thyroid gland in school children was assessed by the trained nurses and graded according to classification of the WHO/UNICEF/ICCIDD [11]. Grade 0; No palpable or visible goitre, grade 1; a mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in the normal position. Grade 2; a swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated. A prevalence rate of 0-4.9 is considered as none, 5.0%-19.9% as mild, 20.0%-29.9% as moderate; ≥ 30.0% as severe IDD [11].

3.6.4 Urine iodine concentration (UIC)

A spot urine samples were collected using urine cups from all the participants and about 15 ml of the urine samples was then transferred into a storage tube. The samples were kept in the container before transported to the IDD laboratory in Kota Kinabalu. The samples were stored at -18^{o}C until analysis. Urinary iodine determination was done using in-house modified microplate method based on manual digestion with ammonium persulfate followed by the calorimetric determination of the Sandel-Kolthoff reaction by using 96-multiwell plates and an absorbance microplate reader at 405 nm [24]. Based on six categories of urinary excretion classification: <20ug/L, severe deficient; 20-49 ug/L, moderate deficient; 50-99, mild deficient; 100-199, optimal; 200-299, more than adequate and >300ug/L, excessive [11].

3.6.5 Iodine in salt

All the children were asked to bring approximately 80g of salt from their respective homes in self-sealing polythene bags. The presence of iodine in salt was then tested using Rapid Test Kits provided by the Institute for Medical Research (IMR) and iodine level determination using iodimetric titration method at Food Quality Laboratory in Sarawak. In addition, about 80g of salt from school kitchens will be collected in self-sealing polythene bags and the level of iodine was determined using iodimetric titration method [25] at same Laboratory. The salt iodine level of <20ppm was considered as non-satisfactory, 20ppm–40ppm as satisfactory and >40ppm as excess (Government of Malaysia, 2013).

3.6.6 Anthropometric examination

The data like weight and height will be carried out using Seca weigh machine model 880 and Seca bodymeter model 208 respectively. Weight was measured to the nearest 0.1 kg and height was measures to the nearest 0.1 cm. Based on weight and height measurement, BMI-for-Age Z score (BAZ) was classified according to z-score for BMI-for-age as recommended by WHO, the term thinness refers to having BMI-for-age (5 to 19 years) below than -2SD while obesity is classified as having BMI-for-age (5-19 years) above +2SD (WHO, 2007)

3.6.7 Hyper/hypothyroidism assessment

A staff nurse on the team will carried out face to face interviews with the children and conducted physical assessment to gather information on hyper/hypothyroidism status. This assessment consists of 12 items which covered: a). Proximal muscle weakness, hyper-reflexia; b). Warm, sweaty palms; c). hand sweating; d). Fine tremours (finger); e). Lid retraction, lid lag; f). Resting tachycardia; g). Apathy/lethargy; h). Facial puffiness; i). Slow speech; j). Hoarse voice; k). Cold intolerance; l). Fat/obese; m). Constipation.

3.7 Field Implementation

A total of 12 data collection teams were formed, with one nutritionist as supervisor, one staff nurse, one community nurse and one driver. Those 12 teams, divided throughout 12 divisions in Sarawak. Data collection was carried out from July to September 2018. Information sheets and consent forms were distributed to parents of every student from the selected classes. All

individual information was kept confidential. A dummy identification was given to each respondent instead of his or her name to make sure the study was anonymous.

3.8 Quality Control

Quality control was done during field data collection to ensure collection of data was of high-quality standard. The data collection team members explained the contents of the questionnaires and clarified any questions raised by respondents. The team members also checked the validity of answers filled by the respondents. At the central level, all forms were rechecked for the validity of the answers.

4.0 DATA ANALYSIS

In this study, the collected data was entered manually into excel format datasheet. Each data was coded accordingly so that no mistakes and no irregularities prevailed that might give an uncorrected report. The raw data was printed out to detect any irregularities and errors in entry. The data analysis was done by exporting the raw data (Excel format) into the statistical tools, SPSS software version 23 (IBM SPSS, Chicago). The data analysis had taken into account the sample weight due to the complex sampling design and response rate. Frequency and percentage were use to describe the characteristic of the respondents.

5.0 RESULTS

All selected schools participated in the survey, which resulted in a 100% school's response rate. A total of 988 school children participated in the survey, with overall response rates of 82.3%. Details of the respondents' characteristics of the study are explained in Table 2.

Table 2: Distribution of respondents by selected demographic characteristics

Survey Characteristics	**Percentage (%)**	**n**
Overall	100	988
Gender		
• Male	50.1	495
• Female	49.9	493
Grade		
• Standard 2	31.9	315
• Standard 3	36.7	363
• Standard 4	31.4	310

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6.0 DISCUSSION

The Sarawak Iodine Deficiency Disorder Survey 2018 among school children was aimed to provide current nutritional iodine status and the impact of universal salt iodization (USI) among school children (SC) in Sarawak. Uniquely, this study should represent the school children population in Sarawak as the current methodology also replicating the previous school-based health survey [26] and also previous National IDD survey 2008 [15]. This study also had showed substantial high response rate which also comparable with previous local surveys [26, 15].

Some limitation in capturing private school children population was also been justified by the methodology. In conducting a state level survey among children age 8 to 10 years old, sampling from government schools was considered the best feasible approach to obtain a representative sample [26]. Based on the Malaysia Educational Statistics 2018, the number of government schools represents about 98% of all the schools in Malaysia [27]. Given the difficulty in obtaining a complete list of students in private schools for sampling purposes and considering the fact that the proportion of private schools was only about 2%, the research team decided to exclude private schools in the survey. Because the proportion of private schools was so small, it was believed that this exclusion would not have a significant effect on the findings.

As conclusion, the Sarawak Iodine Deficiency Disorder Survey 2018 was planned with the goal of obtaining data or information to support Ministry of Health Malaysia especially Sarawak State Health Department. These data should complement the current public health intervention especially related to the iodine deficiency disorders issue in Sarawak. Hopefully, the study will show the positive impact of universal salt iodization (USI) among school children (SC) in Sarawak in improving health for children especially in Sarawak.

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DECLARATION

The author declare that all of the authors have reviewed this article and have contribute in producing this article.

AUTHORS CONTRIBUTION

Author 1: Contribute idea, searching the information needed and write up the manuscript.
Author 2: Contribute idea, searching the information needed.
Author 3: Contribute idea and editing the manuscript.
Author 4: Contribute idea and editing the manuscript.
Author 5: Contribute idea and editing the manuscript.
Author 6: Contribute idea and editing the manuscript.

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