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Knowledge of iodine nutrition and iodine deficiency disorders among women of reproductive age in Obudu local government area of Cross River State, Nigeria

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Abstract
Introduction: Micronutrient deficiency conditions, in which iodine deficiency is one of the major ones, are silent epidemics affecting over 2 billion people globally. Iodine deficiency disorders (IDDs) are responsible for the world's most dominant preventable brain damage. Iodine deficiency during pregnancy carries severe consequences for both mother and child that includes; still birth, spontaneous abortion and congenital abnormalities. Thus, improving maternal health especially in goitre endemic areas may be contingent on reducing iodine deficiency disorders.
Objective: To determine the respondents knowledge level of iodine nutrition and iodine deficiency disorders in women of reproductive age in Obudu Local Government Area of Cross River State.
Methods: A cross-sectional study design was employed. A total of 330 women of reproductive age constituted the respondents. A semi-structured questionnaire that was interviewer-administered was used to elicit information from the respondents. Observations for visible goitre and urinary iodine concentration levels in a sub-set (10%) of the sample determined. Results were presented in frequencies, percentages, charts and tables. Chi-square (χ^2) was used to test for association between variables at 5% significance level.
Main Results: Results showed that one-third of the respondents, 102 (30.9%) had attained secondary education. Majority of household respondents 155 (47%) had good knowledge scores about iodine nutrition. The association between respondents' knowledge of iodine nutrition and educational level was found to be statistically significant ($p = 0.00001$), implying that the higher the educational level, the higher the knowledge on iodine nutrition. Two-third of the respondents 223 (67.6%) were found to have poor knowledge about IDDs. Visible goitre was observed in 4% of the respondents. Urine analysis showed that the median urinary iodine concentration (UIC) was 139.7µg/L and 42% of the sample sub-set had UIC lower than 150µg/L considered deficient.
Conclusion: When the poor knowledge about iodine nutrition and consequences of its lack, the TGR of 4% observed in this study are aligned with the results of the UIC of this study, then a concerning trend of moderately high IDD prevalence emerges. Renewed good public health education on IDDs is advocated.

Keywords: iodine nutrition, knowledge, iodine deficiency disorders, Obudu, Cross River state, Nigeria

1. Introduction

Micronutrient deficiency conditions are silent epidemics of vitamin and mineral deficiencies [1]. About 2 billion people in developing and developed countries suffer from vitamin and mineral deficiencies, primarily iodine, iron, vitamin A and zinc, with colossal health consequences [2]. These deficiencies affect populations in low-/middle-income countries more but also play a major role in health problems in high-income countries. They not only cause specific diseases, but act as risk factors in infectious and chronic diseases, thereby increasing morbidity, mortality, and decreasing quality of life [3].

Iodine deficiency disorders (IDDs) are responsible for the world's most dominant preventable brain damage [4, 5, 6]. IDD's which can start before birth; jeopardize children's mental health, their very survival and increases infant mortality. Iodine deficiency during pregnancy carries severe consequences for both mother and child that includes; still birth, spontaneous abortion, foetal growth restriction and congenital abnormalities, particularly for populations at risk in Africa and Asia [2, 7, 8]. These deficiency manifestations stem from the major role of iodine in synthesizing thyroid hormone (thyroxin), regulating the growth and development of organisms and in controlling important metabolic activities [8, 9, 10].

Goitre (thyroid enlargement) is tip of the iceberg in terms of the damage iodine deficiency can cause. Of even greater public health significance is the mental impairment that IDDs induce that impact negatively on the individual's intellectual capacity. This can cause a reduction in human energy and work capacity and can drastically bring down the economic productivity of endemic regions [4, 6, 11, 12].

Large proportion of the world's population is at risk of IDDs, that is those who live in areas where iodine deficiency is prevalent (total goitre rates (TGR) above 5%) or are affected in some ways [5, 9, 13, 14, 15, 16]. Several parts of Nigeria had earlier been identified as goitre endemic and hence labelled "goitre endemic belts" including Obudu in Cross River State, Uzo-uwani in Enugu State, Kastina-Ala in Benue State and Mangu in Plateau State in Nigeria [17]. Egbuta *et al*. [18]. cited a participatory information multi-centre study of 1993 that put the national goitre rate at 20% with about 20 million Nigerians estimated to have been affected by IDDs. The same study cited a 1988 article that put TGR of 67% with Cross River State and Obudu with an estimated TGR of 34% and 33% respectively. Additionally,

iodine deficiency prevalence using thyroid hormone concentrations as indicators of iodine status of 65.6% in South-East (where Obudu was geographically located as at then), 41% in South-West and 43% in the North-Western region of Nigeria [18].

There has been a determined global effort at curbing the effects of IDDs through improving iodine nutrition. Rich dietary sources of iodine include sea-food, water, green vegetables may appear common. For most populations at risk of IDDs, not only do such foods often not constitute part of their daily food menu but most live in areas where the soil is constantly leached and often contains insufficient iodine concentration for food grown in them to meet the recommended dietary allowance of iodine for the population [9, 16, 19]. In recognition of the aforementioned, the main drive for the IDD elimination agenda has been iodine fortification of food-grade salt (the universal salt iodization (USI) program. Since its global introduction, the USI programs have recorded good success, in that it improved iodine nutrition and brought down the global IDD prevalence. However, this global process may be slowing [16, 20].

The universal salt iodization (USI) program took off effectively in Nigeria in 1992 at a time when only 40% of salt consumed in Nigeria was iodized, the Standard Organization of Nigeria (SON) at that time mandated that all food-grade salts be iodized with 50 ppm potassium iodide at the packaging stage [21]. This action was followed up with a series of surveys to check the compliance level of USI. The update from the National Demographic and Health Survey (NDHS, 2003) showed that almost all Nigerian households (97.3%) consumed adequately iodized salt. The report further showed that 98% of households in the south-south zone of Nigeria, where Cross River State is located consumed adequately iodized salt. However, Abua *et al*. [17] reported a 78% iodized salt coverage in a goitre endemic region of Cross River State, indicating a 20% significant drop from the 2003 figures. Jibril *et al*. [8]. cited ICCIDD (2010) report that put Nigeria's coverage at < 75%. These reported figures may have even gone further down as there is evidence of a global decrease in the number of countries with household iodized salt coverage of ≥90% with Africa reported as one of the regions with more countries having <50% iodized salt coverage [20]. This thus raises concerns for a probable increase in IDDs with their concomitant dangerous effects.

With the decreasing trend in iodized salt coverage – the safe and cost- effective strategy for increasing dietary intake of iodine and ultimately the elimination of IDDs [3, 13, 15, 19, 20]; it thus implies that the quest for ways to stop this trend and the consequential dangerous increase in IDDs prevalence must be vigorously pursued. Evidence suggests that the knowledge of the cause of a health condition including the whole continuum of the epidemiology of the disease and awareness of ways to prevent it stands as the bedrock to its control and elimination [10, 22]. Therefore, these negative trends may be reversed if there is understanding of what constitutes good iodine nutrition and knowledge of the manifestations and effects of IDD and how to prevent them particularly by the most vulnerable populations; women of reproductive age for which IDD effects transcend generations - presents a viable solution. This study thus aimed at assessing the knowledge of iodine nutrition, IDD and iodine status indicator of women of reproductive age in Obudu Local government area of Cross River State, Nigeria

2. Materials and Methods

2.1 Ethics statement, study setting and population

Ethical approval for the conduct of this study was obtained from the Research Ethics Committee of Cross River State Ministry of Health. Permission for community entry was obtained from the various community leaders (*Utsu*). Verbal informed consent was equally sought and obtained from heads of households, market leaders and respondents who took part in the study. Written informed consent was also obtained from the sample sub-set for the urine test for iodine concentration. The objectives, significance and benefits of the study were explained to the respondents and participation in this study was strictly on a voluntary basis as the research participants were assured of anonymity and confidentiality of information provided.

The study population comprised women of reproductive age (15 – 49 years) residing in Obudu Local Government Area (LGA) of Cross River State in the South-South region of Nigeria with an estimated projected population as at 2017 from the 2006 figures of 222,274 (National Population Council; 2006). Obudu lies at the lines of the Northeast of Cross River State, Nigeria. Obudu is within the tropical rain forest belt of Nigeria and between 6^0 40´N and 9^0 10´E. The land scale of Obudu is dominated by hills and mountains (most common physical features) most rising to about 1584m above sea level. The topography has a characteristic gradual ascend from the south-west to the east with isolated ridges from Okorshie through Bedia to Katung Village. Climatically, Obudu is influenced by two seasons; the rainy and dry seasons. The rainy season starts from April to mid-November. The dry season on the other hand, is short-lived as it starts from mid-November to late March. This nature of climate has a significant impact on the vegetation of Obudu. Thus, the longer duration of the rainy season exposes the soil to leaching. Soil that is often leached predisposes the soil to low iodine content. Obudu had in the past, been mapped out as an 'Iodine Deficient Belt' in Nigeria [17, 18].

2.2 Study design, sample size and sampling

The study was a cross-sectional study in which both qualitative and quantitative data collection methods were employed. The sample size was determined using the formula of Cochran's formula (1997) for dichotomous descriptive study; employing 74% household coverage of iodized salt as reported by Abua *et al*. [17] at 95% confidence interval and 5% precision. The calculated sample size was eventually increased to 330 to accommodate a 10% perceived non-response rate.

Multi-stage random sampling technique was used to select the study participants. Five wards out of the 10 wards in Obudu LGA were selected employing the balloting method. Three hundred and thirty households (330) were selected from the five selected wards. The number of households chosen for each ward was based on the proportion of the ward's population to the calculated desired sample size of 330 using information from the 2016 Maternal and Child Health Week in Obudu LGA. In each household, only one woman of reproductive age who consented to participate in the study was recruited.

2.3 Data collection instruments and process

2.3.1 Questionnaire

One of the instruments used to collect data for this study was a semi-structured questionnaire that was interviewer-

administered. Section A of the questionnaire elicited information on the socio-demographics of the respondent; Section B on knowledge of iodine nutrition, while sections C sought information on respondent's diet history related to iodine-rich foods and choice of type the of salt consumed. Section D covered knowledge on iodine deficiency disorders and section E documented the presence or otherwise of visible goitre (observation method – qualitative).

The questionnaire was pre-tested with 10% of the total sample size (33) in a nearby Obanliku LGA of Cross River State; that shares almost same characteristics such as the presence of mountains which could be a predisposing factor for the prevalence of iodine deficiency disorder in the study area. The results of this pre-test of respondents' questionnaire were tested for reliability using Cronbach Alpha Test. The test yielded a value of 0.792 for the questionnaire. This value gave an indication of a good level of internal consistency of the items (variables) in the questionnaires.

2.3.2 Determination of urinary iodine concentration

Ten millilitres (10ml) of sample urine was pipetted into a stopper bottle and 25ml of iodine monochloride solution was added and the whole mixture was left to stand in a dark cabinet for 30 minutes after thorough shaking. Similarly, a blank was setup but the urine sample was replaced with 10ml of chloroform only in addition to 25ml of iodine monochloride solution and also left to stand in a dark cabinet for 30 minutes after thorough shaking. At the end of the incubation, 50ml of distilled water was added to the respective stopper bottles together with 10ml of potassium iodide solution and this action liberated iodine which was titrated with the standard thiosulphate solution. The appearance of a pale straw colour required the addition of starch solution and continued titration until the disappearance of the blue colour. Vigorous shaking was employed at all times of titration to ensure that all the iodine was removed from the chloroform layer and the values recorded. The formula below was then used to calculate iodine content;

$$\frac{(a - b) \times 1.27ug/L}{c}$$

where;
a = blank titrec
b = sample titre (urine)
c =weight of sample

Urinary iodine concentration (UIC) is recommended by the World Health Organization (WHO) as the primary indicator for measuring iodine status and for determining iodine deficiency (IDD). Median UIC <150µg/L for pregnant women is considered insufficient; while values ≥150µg/L are considered adequate. For non-pregnant population, UIC of 100 - 199µg/L is considered adequate and UIC values <100µg/L as iodine deficiency [8, 13, 15].

2.4 Data analysis

Data generated was entered and analysed using the Microsoft Excel 2007 and Statistical Package for Social Sciences (SPSS) software (version 20.0). Data presentation included frequency distributions of variables, graphical representations, charts and tables. Tests of significance were determined using Chi-square ($\square^2$) and Fisher exact test at a significance level of 5%. Respondents' knowledge level of iodine nutrition and iodine deficiency disorders were calculated by assigning scores to each response in the related sections of the questionnaire. Scores were later summed up to get the total score for each individual. For iodine nutrition, score range of 0 – 1 represented poor knowledge, score range 2 – 4 represented fair knowledge while score range of 5 – 7 represented good knowledge respectively. The minimum recorded score was 0 while the maximum recorded score was 7 out of a possible total of 7. The score for all the respondents was then collated.

Score range of 0 – 4 represented poor knowledge of iodine deficiency disorders, score range 5 – 9 represented fair knowledge of iodine deficiency disorders while score range of 10 – 14 represented good knowledge of iodine deficiency disorders. The minimum recorded score was 0 while the maximum recorded score was 14 out of a possible total of 14.

3. Results

3.1 Socio-demographic profile of household respondents

A total of 330 participants completed the questionnaires giving a response rate of 100%. Table 1 shows the socio-demographic characteristics of the study participants. There was a preponderance of respondents 160 (48.5%) between the ages 30 - 39 years, while those between 15 -19 years (1.5%) were the least amongst the respondents. Majority of respondents in this study were traders 117 (35.5%), while 55 (16.7%) were farmers, 51 (15.5%) were unemployed, 37 (11.2 %) were housewives, 35 (11.2%) were civil/public servants and 35 (11.2%) were self-employed. Most respondents were married 227 (68.8%). Most respondents 129 (39.1%) had attained a tertiary level of education. The largest proportion (64.5%) of the respondents reported having a monthly income below the national minimum wage of 18,000 Naira. Majority of the respondents 218 (66.1%) were from 5 – 9 member households indicating relatively large family size.

Table 1: Socio demographic characteristics of respondents

Variables		Frequency (n = 330)	Percent (%)
Age (Years)	15-19	5	1.5
	20-29	109	33
	30-39	160	48.5
	40-49	56	16.7
Marital Status	Single	72	21.8
	Married	227	68.8
	Separated	9	2.7
	Widowed	22	6.7
Educational level	No formal education	29	8.8
	Primary	70	21.2
	Secondary	102	30.9
	Tertiary	129	39.1

Occupation	Trader	117	35.5
	Farmer	55	16.7
	Housewife	37	11.2
	Civil/Public servant	35	10.6
	Unemployed	51	15.5
	Self-employed	35	10.6
Monthly income (Naira)	Below N18,000	212	65.4
	N18,000 – N29,999	56	17.3
	N30,000 – N60,000	39	12
	Above N60,000	17	5.2
How income is gotten	Daily	56	17
	Weekly	124	37.6
	Monthly	150	45.5
Size of Household	Less than 5	71	21.5
	5 – 9	218	66.1
	10 – 15	39	11.8
	Above 15	2	0.6

3.2 Respondents' knowledge of iodine nutrition and its associated deficiency disorders

Majority of household respondents 155 (47%) had good knowledge scores about iodine nutrition while 114 (34.5%) had fair knowledge scores and the remaining 61 (18.5%) had poor knowledge scores as indicated in Figure 1. The information elicited from respondents that were used to deduce the knowledge score included; knowledge of rich sources of dietary iodine particularly iodized salt, benefits of using iodized salts and main source of information regarding iodine nutrition. The diagrammatic representation of the knowledge scores of respondents about iodine associated deficiency disorders is presented in Figure 2. Majority of household respondents 223 (67.6%) had poor knowledge scores about iodine deficiency disorders while 95 (28.8%) had fair knowledge scores about iodine deficiency disorders and the remaining 12 (3.6%) had good knowledge scores about iodine deficiency disorders.

The following were part of the details that were used to derive the knowledge scores for iodine deficiency disorders (IDDs). Sixty-seven (20.4%) of household respondents were quite aware that a lack of iodine in the diet can lead to adverse outcomes while 261 (79.6%) did not possess such knowledge. Of the outcomes which could result from iodine deficiency in the body, 55 (51.9%) identified goitre, 4 (3.7%) identified cretinism, 8 (7.4%) identified mental retardation, 8 (7.4%) identified dwarfism, while some other respondents even associated still birth 6 (5.6%) and spontaneous abortion/miscarriage 10 (9.1%) to iodine deficiency.

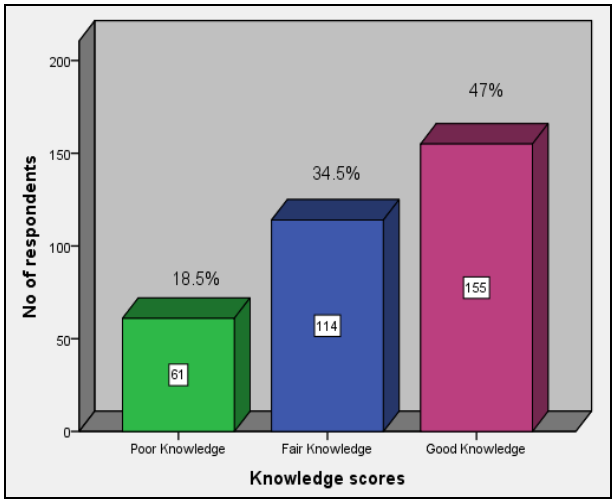

Fig 1: Respondents knowledge score level of iodine nutrition

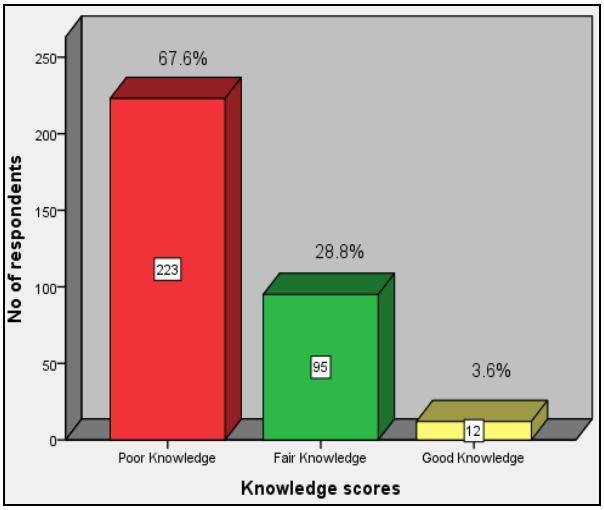

Fig 2: Respondents knowledge score level of iodine deficiency disorders

3.3 Associations between respondents' knowledge scores and key variables

The test of association (Table 2) between respondents' knowledge of iodine nutrition and highest educational level attained yielded degree of freedom (df) = 6, and Chi-square ($\square^2$) Calculated of 72.51 was found to be statistically significant (p = 0.00001), implying that the higher the educational level, the higher the knowledge on iodine nutrition.

We had hypothesized that there is no statistically significant association between respondents' knowledge of iodine deficiency disorders and usage of iodized salts in diets among women of reproductive age in the study area. The test result shows that p-value = 0.00001; degree of freedom (df) = 4, and Chi-square ($\square^2$) Calculated of 214.0 (Table 2). This association was observed to be statistically significant (p: 0.000 < 0.05), implying that respondents with good knowledge score regarding IDDs are most likely to use iodized salt.

Table 2: Relationship between respondents' knowledge scores and educational level/iodized salt use

Test variable		Poor knowledge	Fair Knowledge	Good knowledge	Chi-square (χ^2)	P- value
Educational level	No formal education	12 (19.7)	11 (9.64)	6 (3.9)	72.51	<0.00001
	Primary	29 (47.5)	25 (21.9)	16 (10.3)		
	Secondary	12 (19.7)	45 (39.7)	45 (29.0)		
	Tertiary	8 (13.1)	33 (28.9)	88 (56.8)		
Iodized Salt Use	Use iodized salt	8 (3.6)	71 (74.7)	9 (75.0)	214	<0.00001
	Doesn't use	28 (12.6)	19 (20.0)	1 (8.3)		
	Don't know if salt is iodized	187 (83.9)	5 (5.3)	2 (16.7)		

Figures in parenthesis represent percentages Statistical significance based on P-value < 0.05

3.4 Urinary iodine concentration and observation for visible goitre

To estimate the urinary iodine concentration in the study area, a select sample of respondents totalling 10% of the total sample size was used to draw this estimate. Test results from this study, showed that the mean urinary iodine content was 135.89µg/L while the median urinary iodine content was 139.7µg/L with the range of urinary iodine content spanning from as low as 69.85µg/L to as high as 207.5µg/L to give a difference of 137.65µg/L (Table 3).

Physical observations for the presence of goitre in the neck region of respondents were made. The presence of an enlarged thyroid gland indicating goitre was found in 13 respondents in the course of the study. This translated to a total goitre rate (TGR) of about 4% among the sampled population.

Table 3: Distribution of Nutritional Iodine Status (Urinary Iodine Concentration (UIC)

Iodine status (UIC) category	Frequency (n = 33)*	Per cent (%)
Deficient (<150µg/L)	14	42
Adequate (≥150µg/L)	19	58
	Mean	Median (Range)
Urinary Iodine Concentration (UIC)	135.9µg/L	139.7µg/L (69.9µg/L – 207.5µg/L)

*10% sub-set of total sample

4. Discussion

This study assessed the knowledge of iodine nutrition and iodine deficiency disorders (IDDs) and nutritional iodine status amongst women of reproductive age. Findings of this study indicate that more than half of the respondents (53%) did not have good knowledge of iodine nutrition. This is in consonance with to the report of a similar study of Sebosta *et al*., [22] carried out in Free State, South Africa which revealed even higher proportion (86.9%) of respondents that did not know about iodine or even aware (76.7%) of the main source of iodine in food. The overall marginal fair knowledge of iodine nutrition is also reflected and ties closely to the low proportion (26.7%) of respondents that reported the use of iodized salt. This association between lack of knowledge of IDD and use of iodized salt – the main stay of IDD elimination [3, 5, 19, 20]; was found to be statistically significant (p = <0.00001). Results of this study further indicate that, a significantly lower proportion (2.7%) of respondents that had good knowledge of the benefits of iodized salt in IDD and used it.

The findings from this study that the association between respondents' knowledge of iodine nutrition and educational level was found to be statistically significant (p = 0.00001), implies that education both formal and informal, particularly nutrition education is critical in the drive at the elimination of IDDs. This is in consonance with the conclusions of Panigrahi [10] in a study among women of urban slums of Cuttack city, Orissa, India and Sebosta *et al*. [22]., of the pivotal need for raising awareness about iodine nutrition particularly amongst segments of the population at risks of IDDs.

Also, the knowledge of iodine deficiency disorders and the consequential grievous effects on human overall wellbeing by the respondents was quite limited. About two-thirds (67.6%) of the respondents in this study had poor knowledge about IDD manifestations. This is similar to the report of a study carried out by Panigrahi [10] which demonstrated that 78% of women had no knowledge of the benefits of iodized salts or the dangers of iodine deficiency. Observations from this study further revealed that just a handful (17.4%) identified goitre and mental retardation (4%) as a consequence of iodine deficiency. This can also relate to the report of Sebosta *et al*. [22], that 89.1% of respondents had no idea of the harmful effects of iodine deficiency.

It has been acknowledged that iodine deficiency can lead to foetal wastage such as abortion, still births and congenital abnormalities [4, 6, 8, 11]. In this study, some study respondents were not aware that iodine deficiency could lead to outcomes such as spontaneous abortion/miscarriages, still births, dwarfism and mental retardation. Furthermore, the dearth of knowledge about iodine and its associated deficiencies may be prolonging endemicity of IDDs in this study area. Conversely, good knowledge about the aetiology of a health condition has been recognised to positively influence the adoption of prevention measures, promote health-seeking behaviours and hence facilitates a reduction in its health and socioeconomic burden [21, 22].

A total goitre rate (TGR) of 4% was observed in this study. Thus it could be deduced that out of every 100 women of reproductive age in Obudu Local Government Area of Cross River State, four (4) were likely to have a goitre. This indicates the presence of moderate iodine deficiency in this area [13, 15, 16]. This underscores the fact that the study area had been identified as goitre endemic area with previously reported TGR of 33% [8, 17, 18]. Moreover, when the sample size (330) used in this study is matched against the projected estimated total population of women of reproductive age (60,377) in Obudu LGA as of 2017, then, the extrapolation of TGR for the study area may be closer to or higher than the 33% TGR reported in 1988. The implication of having even mild maternal IDD is grave. Maternal iodine deficiency during pre-natal stages can endanger the mental health and survival of the child and can even result in still births or spontaneous abortions [6, 8 19]. This thus presents a justification for why awareness and maternal education

regarding micronutrient intake through health education and public enlightenment programmes should be at the core of IDD elimination programmes.

Furthermore, study result shows that 42% of the sample sub-set had urinary iodine concentration lower than 150µg/L considered deficient with the median urinary iodine concentration of 139.7ug/L observed in this study indicative of deficiency [2, 8, 14, 15]. This could serve as a proxy of the extent of iodine deficiency that may be prevalent in the entire population. We adopted the categorization of iodine nutritional status using the urinary iodine concentration (UIC) for pregnant women of <150µg/L considered deficient, rather than <100µg/L for the general (non-pregnant) population [13, 15] because, our study population fall into that category and some may have been pregnant during the time of this study. Additionally, given that the study area is iodine deficiency endemic area, using the range for the general population [17] may underestimate the degree of the public health burden of IDDs.

5. Conclusion

When the poor knowledge about iodine nutrition and consequences of its lack, the TGR of 4% observed in this study are aligned with the results of the urinary iodine concentration (UIC) of this study, then a concerning trend of moderately high IDD prevalence emerges. Thus sensitization on prevention measures of IDD's is therefore recommended to be carried out in communities at risk in order to prevent the deadly consequences of IDD's and reduce the prevalence of inter-generational mental retardation which affects the development of the society.

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