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Tracking the Progress towards Elimination of Iodine Deficiency Disorders in Al Haj Yousif Area Khartoum State

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Abstract: ***The major objective of this study has been to assess the iodine deficiency situation in Al Haj Yousif area - Al Khartoum State, Sudan, the study is designed to have precise epidemiological information of IDD. The indicators include goiter prevalence and urinary iodine excretion. A cross sectional community-based field study was conducted in five zones in Al Haj Yousif area using a multistage random sampling technique. The sample population was selected by house-to- house visit. One hundred households (of average members per house of 7^{+2}) were selected, covering 300 children (age 6-12 years) as subjects for goiter examination, a sub sample of 50 children (16.7%) were chosen at random for urinary iodine level assessment. The result of goiter examination revealed that the prevalence rate of goiter was (23.3%) and it was significantly higher in females (26.71%) than males (20.13%). The median urinary iodineexcretion (UIE) was 5.0 µg/dl . In non-goitrous children the median UI was 6.4 µg/dl, 3.8 µg/dl and 2.35 µg/dl for grade 1 and grade 2 goiter respectively. The major findings support that iodine deficiency is a public health problem among children aged 6-12 years in Al Haj Yousif area. The results of this study imply that, it is of major importance to improve the iodine situation in the whole area, and necessitate an intervention program in Al Haj Yousif area. This includes distribution of iodine capsules as a short term strategy and iodized salt as a long term strategy. The study suggests that significant work is needed towards achieving the goal of raising the IDD awareness as wellas IDD elimination***

Keywords: UIE, Iodized salt, Goiter grade

1. Introduction

Iodine deficiency has affected humans for thousands of years. The knowledge on the cause of iodine deficiency and its prevention increased dramatically during the 20th. Century and recognition of the impact of iodine deficiency on brain development has drawn international attention to this condition.

The most important consequences of iodine deficiency are permanent brain damage in the fetus and infant and retarded psychomotor development in the child (Delange, 1994). When the diet contains insufficient iodine, the thyroid gland cannot make enough thyroid hormones to satisfy the body's need, the thyroid gland becomes enlarged due to its desperate efforts to produce the hormones; this enlargement is known as goiter, which is the outward sign of iodine deficiency (ID). Without a proper diet of iodine, the human body is susceptible to the mentioned problems and more, identified as iodine deficiency disorders, or IDDs (Hetzel,1983), although the effects of goiter is mild relative to other IDDs, but it is important in tracking the overall prevalence of ID due to its noticeability. Some of the most severe IDDs are the result of ID during the pregnancy and childhood, due to the sensitivity of brain development to deviations from optimal thyroid hormone levels during that period. Severe instances of ID during pregnancy are associated with stillbirth, spontaneous abortion, severe mental retardation and congenital abnormalities including endemic cretinism (Zimmermann 2009b and Maberly et al. 1994.).Worldwide, it is estimated that 18% of children 6-12 years of age in developing countries have goiter, with the prevalence in the least developed countries estimated to be 29%(WHO, 2001). Iodine deficiency, through its effect on the developing brain, has condemned millions of people to a life of few prospects and continued underdevelopment (WHO, 2001).

People living in areas affected by severe IDD may have an intelligence quotient (IQ) of up to about 13.5 point below that of those from comparable communities in areas where there is no iodine deficiency (Hetzel, 1996). This mental deficiency has an immediate effect on child learning capacity, women's health, the quality of life of communities and their economic productivity. On the other hand, IDD are among the easiest and cheapest of all disorders to prevent (Hetzel, 1996). A person needs only a teaspoon of this micronutrient – consumed in small amounts over a lifetime (WHO, 1994b). Because salt is consumed almost everywhere on daily basis, universal salt iodization is considered the most efficient means of virtually eliminating IDD and is one of the most cost-effective ways to contribute to economic and social development, when iodization of salt is not possible, iodine supplements can be given to susceptible group, introduction of iodized salt to regions of chronic iodine-deficiency disorders might transiently increase the proportion of thyroid disorders, but overall the small risks of iodine excess are far outweighed by the substantial risks of iodine deficiency, International efforts to control iodine-deficiency disorders are slowing, and reaching the third of the worldwide population that remains deficient poses major challenges (Zimmermann M et al. 2008).

Recognizing the importance of preventing IDD, the World Health Assembly adopted in 1992 the goal of eliminating iodine deficiency as a public health problem by the year 2005(WHO, 1994b), since 1992, there has been tremendous progress in increasing the amount of salt which is adequately iodized. As a result, many countries are on threshold of achieving IDD elimination (It is estimated that 66 per cent of

edible salt in the world is iodized, (WHO, 2001), in those countries, the emphasis will shift to ensuring that the achievements are sustained for all time, assessment methods of IDDs include urinary iodine concentration, goiter, newborn thyroid-stimulating hormone, and blood thyroglobulin.

Nevertheless, IDDs remains a major problem in developing countries where geographic, economic, and political issues block progress towards its eradication (Hetzel, 1996), it continues despite over half a century of research and iodine prophylaxis programs, to exist untreated in some regions of the world. Unfortunately Iodine Deficiency Disorders exist in their most severe forms in those places which are most difficult to reach with preventive programs. There are areas which depend on local salt production, there are many areas without a proper health system which might be employed in iodine supplementation, and transport is often difficult. The deforestation and the erosion of the soil hasten the process of iodine loss from the subsoil; also polluted water with presence of E. Coli tends to produce goitro-genic substances (Hetzel, 1996). Over the last few years Sudan had been faced by recurrent flooding, which will increase the erosion of the soil. In 2005Sudan Federal Ministry of Health (FMOH) estimated that 22% of Sudan's population is iodine deficient (Federal Ministry of Health Khartoum Forum, 2005).

2. Materials and Methods

2.1 The Study Design Area, and Sample

A cross-sectional community based study has been conducted in Al Haj Yousif- Al Khartoum State, a sample of 300 children aged 6-12 years (154 males and 146 females) was selected from one hundred households, the target population was the school children selected randomly via house-to-house visits, once the first household was selected the second household was the one whose front door was closer to the first household. The third household to visit would be the closest front door of next household. This was repeated until the appropriate number of households was selected (20 households from each zone, if no response is obtained from one household, the one next to it was selected). The main purpose of the study was to provide information on IDD status and to assess the elimination of iodine deficiency disorder in Al Haj Yousif area.

2.2 The Study Tools

2.2.1 Goiter survey

Every child aged 6-12 years in the sample was examined for goiter (300 children), personal features were recorded. The classification method of goiter grades used in this study was based on the modified plan proposed by WHO, UNICEF and ICCIDD in 1993 (WHO/UNICEF/ICCIDD Report, September 1993) which combined grades 1A and 1B together, and grades 2 and 3 into a second grade. Demonstration of the method of goiter examination was conducted prior to the study (WHO, 2001).

2.2.2 Urine Test

The current method used in this study Urinary iodine Excretion test (UIE) was an adaptation of the Pino et al., 1996 method, combining the ammonium persulfate digestion technique with a manual spectrophotometric reading as outlined by Dunn et al (Dunn et al., 1997), this method is recommended because it offers a number of advantages, especially for laboratories in developing countries where resource limitations often exist. On-the-spot casual urine samples in this study were collected in screw-capped plastic vessels from study subjects. 50 urine samples from children-aged 6 to 12 years were then collected, methods of proper sampling collection were followed, labeling, and storage, then transferred in a cold box.

The names of all the children of the household were written on separate slips of paper and the slips placed on the floor, at random, one of the slips is selected and the child whose name is written on that slip of paper is enrolled in the study, equal chances were given to males and females. The severity of iodine deficiency is determined using median urinary iodine concentration values. A suggestion has been made to define the severity of IDD using also the proportion of iodine concentrations below certain cut-off values, and not just from the median value (Karmarker & Pandav, 1999), see figure 3.1. This would allow for the identification of situations where a subgroup of the population remains iodine deficient even though the median iodine concentration is sufficient. "Elimination" of iodine deficiency is defined as achieving a median urinary iodine concentration above 100 µg/l (or 10 µg/dl) with no more than 20% of the specimens registering below 50 µg/l.

2.3 Data Entry and Data Analysis

The data was entered into a Microsoft Excel file, and the data entry was double checked for errors. The data analysis was done using the Microsoft Excel and the statistical package of social sciences (SPSS) Version 15 statistical software program. Quality control protocols followed in all aspects of the study ensured that data is reliable.

3. Results

Table 3.1 indicates the distribution of sample according to goiter grade, sex and zone. From the table, only two cases of grade 2 goiter were observed, in Dar Al Salam and Alwihda, both cases were females the prevalence according to zones was 1.28% in Dar Al Salam and in Alwihdah was 1.45%. goiter Grade 1 recorded a higher prevalence (22.66%) among examined children.

Table 3.1: Percentage distribution of sample examined by zone, sex and grade of goiter

Zone	Total No. Of children	Grade 0				Grade 1				Grade 2			
		Male		Female		Male		Female		Male		Female	
		No	%	No	%	No	%	No	%	No	%	No	%
Dar Al Salam	69	23	33.33	19	27.54	13	18.84	13	18.84	-		1	1.45
Alwihda	78	31	39.74	31	39.74	6	7.69	9	11.54			1	1.28
Alemtidad	28	11	39.29	9	32.14	5	17.86	3	10.71	-		-	-
Albarakah	66	28	42.42	27	40.90	4	6.06	7	10.61	-		-	-
Altakamol	59	30	50.85	21	35.59	3	5.08	5	8.47	-		-	-
Total	300	123	41.0	107	35.67	31	10.33	37	12.33			2	0.66

Table 3.2 Illustrates that the overall median urinary iodine was 5.0µg/dl. In nongoitrous children the total median urinary iodine was 6.4µg/dl, ranging from 5.4 µg/dl in Dar Al Salam to 10.8 µg/dl in Albarakah and Altakamol. In grade 1 goiter, the total median urinary iodine level was 3.8 g/dl, ranging from 3.35 µg/dl in Dar Al Salam to 4.65 µg/dl in Alemtidad. In grade 2 goiter, the median UI was 2.35 µg/dl, ranging from 1.9 µg/dl in Dar Alsalam to 2.8 µg/dl in Alwihda.

Table 3.2: Median urinary iodine (µg/dl) in the subsample examined by zone and grade of goiter

Zone	Goiter Grade						Total	
	0		1		2			
	No	Median µg/dl	No	Median µg/dl	No	Median µg/dl	No	Median µg/dl
Dar Al Salam	7	5.4	2	3.35	1	1.9	10	4.2
Alwihda	8	5.6	1	3.8	1	2.8	10	4.7
Alemtidad	8	10.5	2	4.65	-	-	10	7.75
Albarakah	5	10.8	5	3.4	-	-	10	5.0
Altakamol	7	10.8	3	4.5	-	-	10	7.9
Total	35	6.4	13	3.8	2	2.35	50	5.0

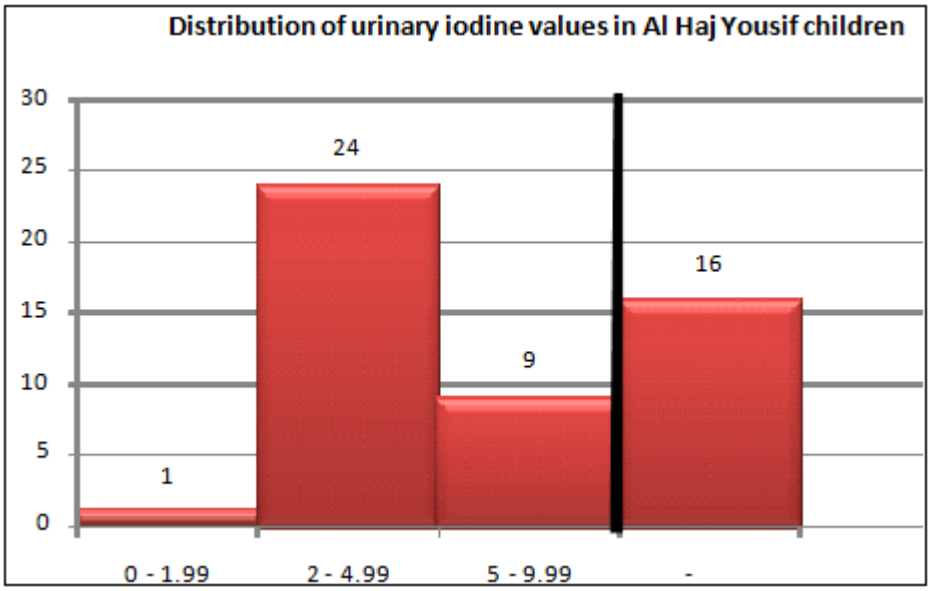

Figure 3.1: illustrate the levels of median urinary iodine in a subsample of 50 children according to goiter grade in the different zones in Al Haj Yousif area.

The dark line in Fig 3.1represents the cut-off value of 10 µg/dl, which has been recommended as the value to determine the adequacy of iodine nutrition in a population**.**

0 – 1.99 µg/dl one case
2 – 4.99 µg/dl 24 cases
5 – 9.99 µg/dl 9 cases
>10 µg/dl 16 cases

The range of urinary iodine excretion values were 1.9 – 12.0 µg/dl. 50 % of the values were < 5 µg/dl and 68% of the values < 10µg/dl.

Table 3.3: Criteria for tracking progress towards eliminating IDD as a public health problem

Indicator	*Goal*	*Al Haj Yousif*
Thyroid size (age 6- 12 years) Proportion with enlarged thyroid	< 5 %	23.3 %
Urinary Iodine Median urinary iodine µg/dl Proportion below 100 µg/dl Proportion below 50 µg/dl	 > 10 µg/dl < 50 % < 20 %	 5.0 µg/dl 68% 50%
Salt iodization: Proportion of Households consuming adequately iodized salt	> 90	1%

The overall results for this study are briefly outlined in the table 3. 4.

Table 3.4: Brief outline for the overall result

Variable	*Value*
Number of children studied	300
Mean age	9.0± 2.0
Goiter Grade 1	22.66
Goiter Grade 2	0.67%
Total Goiter Rate	23.33% (23.3± 4.8) (95%CI– 18.5-28.1)
Urinary Iodine- children age 6-12 years	
Number of urine sample analyzed	50 samples
UIE (Median)	5.0 µg/dl
Proportion of values < 100 µg/dl	68 %
Proportion of values< 50 µg/dl	50 %
Number of salt samples analyzed	20
Proportion of households consuming iodized	1**%**

4. Discussion

This a cross sectional community-based study, conducted in five zones in Al Haj Yousif area using a multistage random sampling technique, goiter examination and urinary iodine test were used as the IDD indicators. The study revealed that the prevalence of goiter in Al Haj Yousifwas 23.3%, IDD affected both sexes; however the prevalence is higher in females (26.71%), than (20.13%) in males.

This is consistent with other previous national studies which were done in 1989 and 1997 in different zones in Sudan, always female had more prevalence of goiter than males. In 1997 survey, the distribution of the cases by sex at state level showed that in both states (Khartoum and Darfur), more cases were among females than males, 408 (30.5%) in South Darfur and 341 (25.5%) in North Darfur but in south Darfur the females lie in the severe status while those in North Darfur are in moderate status. Among males the number of cases in South Darfur 362 (27.1%) & status is moderate and in North Darfur 225 (16.8%) both are in the moderate status. By looking at the total goiter rate "TGR" in Khartoum state by sex, there was a problem among females (7.1%, 283) than (3.7%, 159) among males (Sudan Federal Ministry of Health, 1999).

The findings of the present study revealed a significant difference between males and females' goiter grade, the highest prevalence of goiter rate recorded was in Dar Al Salam, while the lowest was in Altakamol (39.13% and 13.56% respectively). There is significant difference between areas in goiter prevalence ($p < 0.05$). This significant difference in such a small geographical area may indicate the implication of other cofactors. This is substantiated by lower rates of iodine urinary excretion in Dar Al Salam zones' children, probably due to poverty, low hygiene, iron deficiency, higher consumption of goitrogens, and the high numbers of displaced people from the western region (Darfur). Considering goiter prevalence by grade; 22.66% of cases had grade 1 goiter, 54.41% of them female. Only two cases, in Dar Al Salam and Alwihda had grade 2 goiter 0.67% (both were females). This result is in intermediate range, compared with the last survey which was done in 1997 by the National Nutrition Department. In 1997 IDD survey which covered seven zones, the goiterprevalence ranging from 5.4 - 42.1 in Khartoum and Upper Nile States(Sudan Federal Ministry of Health, 1999).

Despite the large variation world-wide in daily iodine excretion, assessment of iodine concentration in casual urine samples remains a valuable method for evaluating iodine status (Bourdoux et al. 1996). In a school where 200-300 children may be examined for goiter, a systematic sub-sample can be sampled for urine; that is, every 6th child provides a urine sample, the volume required for most analysis methods is small (1 ml), the iodine content remains stable, and the samples do not require refrigeration (Benimiloud et al., 1994). In this study a subsample of 50 children (16.7%) were chosen for urinary iodine tests. The median urinary iodine concentrations was 5.0 µg/dl. For non-goitrous children 6.4µg/dl, and 3.8 µg/dl and 2.35 µg/dl for grade 1 and 2 goitrous children respectively. Severe, moderate and mild ID is present when the concentration of iodine in urine is less than 2.0 µg/dl, 2-5 µg/dl and 5-10 µg/dl respectively (Lambrg, 1991). Therefore it is apparent that Iodine Deficiency is of moderate to severe in grade 1 and 2 goiter and is of mild to moderate in non-goitrous cases in the present study, which may indicate that iodine excretion is inversely related to the non-goitrous. In 1997 IDD national Sudan survey, which covered seven zones, the median urinary iodine analysis from the sub-samples showed that the problem was severe in Western zone, with level of only 1.99 µg/dl this followed by Upper Nile &Kordofan zones both of them were suffering from moderate iodine deficiency. Khartoum was at the Upper limit of the mild range. When seven zones classified by sex, female of Darfur were found to suffer severe iodine deficiency with a median of 1.05 µg/dl, when as males were suffering moderate iodine deficiency problem (median 3.28µg/dl). In Khartoum the males' median was of 9.81µg/dl was also better than the females' median of 4.54µg/dl.

It is apparent that IDD is a public health problem of moderate severity in Al- Haj Yousif. This rate is higher than that cited by Dr. Eltom in 2003 (the survey was done in 1994) in Khartoum state. This difference could be attributed to the random migration of people from Western region under a stressed humanitarian situation as a result of Darfur conflict, as well as iodine deficiency in the area.

5. Conclusions

The elimination of IDD is a critical development issue, and should be given the highest priority by governments and international agencies, now accelerating implementation is required, identifying areas where IDDs are prevalent with no control measures available, and publicizing of such information are urgently needed and National prevention and control programmes involving a number of government sectors in countries with IDD need to be established.

The prevalence of IDD in AlHaj Yousif among children aged 6-12 years is of moderate severity which indicates that IDD are a public health problem in this area, iodine supplementation program is required to combat IDD in this area, and there is a need for more national precise and new epidemiological information, the study suggests creation of trained resource persons for future IDD elimination activities.

In Sudan iodized salt for animal consumption has to be covered by legislation, this will also ensure that no leakage of non-iodized salt into the market. An effective educational preventive campaign to make all interested parties aware of IDD and its correction should therefore be a very important component of an IDD program.

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