Assessment of urinary Iodine concentration among non-pregnant women at childbearing age attending a sample of primary health care centers in three Iraqi governorates

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List of Abbreviations

UI………………Urinary Iodine

IDD ……………Iodine Deficiency Disorders

NRI ……………Nutrition Research Institute

ICCIDD ………..International Council for the Control of Iodine Deficiency Disorders

WHO …………..World Health Organization

Abstract

This cross-sectional study is an attempt to estimate the extent of iodine deficiency in a convenient sample of non-pregnant women of childbearing age (15-49 years) attending a number of primary health centers in three governorates (Baghdad,Basrah and Ninevah) through estimating the urinary iodine level , the study was conducted for the period from 28/11/2010 to 12/12/2010.

The sample comprised of 438 non-pregnant women of child bearing age (15-49 years), the data were collected through direct interview, and urine samples were taken for laboratory analysis.

The study showed that the overall sample median urinary iodine concentration for this study is 58.7 µg/l ,64.7% of women in Ninevah included in the study were with moderate iodine deficiency, followed by Basrah 24.7% and Baghdad 24.6%, Rural areas found to be affected by iodine deficiency more than urban areas for which the highest percentages (91.2%) of those women with less than 100 µg/L can be found in the rural areas with a median UI of less than 50 µg/L indicating a moderate iodine deficiency.

Introduction

Iodine deficiency disorders (IDD) refer to all of the consequences of iodine deficiency in a population that can be prevented by ensuring that the population has an adequate intake of iodine. Iodine deficiency, through its effects on the developing brain, has condemned millions of people to a life of few prospects and continued underdevelopment. On a worldwide basis, iodine deficiency is the single most important preventable cause of brain damage. [(3)]

People living in areas affected by severe iodine deficiency may have an intelligence quotient (IQ) of up to 13.5 points below that of those from comparable communities in areas where there is no iodine deficiency [(1)] .This mental deficiency has an immediate effect on child learning capacity, women's health, the quality of life in communities, and economic productivity.[(13)]

When the body becomes iodine-deficient the consequences can affect a person both physically and mentally. After many months of iodine deficiency a person may develop a goiter (an unsightly swelling of the thyroid gland in front of the neck), hypothyroidism and reduced mental function. It also increases the risk of still birth and infant deaths. [(5)]

Iodine-deficient women may give birth to babies with severe mental and neurological impairment. If this deficiency occurs during infancy or childhood, it causes irreversible mental retardation, growth failure, speech and hearing defects, among others. Even mild deficiency may cause a low intellectual capacity. [(4)]

On the other hand, IDD are among the easiest and least expensive of all nutrient disorders to prevent. The addition of a small, constant amount of iodine to the salt that people consume daily is all that is needed. [(11)].The elimination of IDD is a critical development issue, and should be given the highest priority by governments and international agencies. [(5) ;(7).]

Recognizing the importance of preventing IDD, the World Health Assembly adopted in 1991 the goal of eliminating iodine deficiency as a public health problem. In 1990, world leaders had endorsed this goal when they met at the World Summit for Children at the United Nations. [(9), (10)]

It was reaffirmed by the International Conference on Nutrition in 1992. In 1993, WHO and UNICEF recommended universal salt iodization (USI) as the main strategy to achieve elimination of IDD [(2)]. In 2005, the importance of IDD elimination was again recognized when the World Health Assembly adopted a resolution committing to reporting on the global IDD situation every three years. [(14)]

Since 1990, there has been tremendous progress in increasing the proportion of dietary salt which is adequately iodized. As a result, many countries have achieved, or are now on the threshold of achieving IDD elimination. In those countries, the emphasis will shift to ensuring that these achievements are permanently sustained. [(6), (12)]

Aims of the study

1) To estimate the extent of Iodine deficiency among non-pregnant women at childbearing age (15-49 years) attending a sample of primary health care centers in 3 Iraqi governorates (Baghdad, Basrah and Nineveh)
2) The distribution of Iodine deficiency by some demographical, biological and environmental variables has also been considered.

Materials and Methods

Target areas, populations and team members

Three Iraqi governorates (Baghdad, Basrah and Ninevah) enrolled in this cross sectional survey, During this survey, 3 central supervisors were dispatched from Nutrition Research Institute (NRI) along with 3 lab technicians to the 3 selected governorates and 3 teams with their regional supervisors in each province start their field work in the 8 health centers for the period of 28/11-12/12/2010, each team consisted of two members (one health worker and one lab technician). Each team planned to include 50 child from each health center (collectively 3 health centers to be included and a total of 150 child per each governorate) so an overall convenient sample size of 438 non-pregnant women at child-bearing age are included in the survey.

Training

The training of field staff started at 27th -November 2010 by each central supervisor for the team members in the 3 governorates included in the study (2 members per team; a total of 6 trainees per province) (a total of 16 members to be trained with 3 regional supervisors).

- ***Laboratory training***

The training of laboratory technicians included procedures for performing the urine sampling techniques and maintenance.

- ***Interview techniques training***

Trained on how to conduct interviews and complete the questionnaires.

- ***Regional supervisor training***

Regional supervisors trained to check completed data collection forms, correct survey procedures and survey best practices.

Method for measuring urinary iodine (UI) using ammonium persulfate[15]

❖ ***Advantages of the method***

- Safe digestion process
- Simple manual method
- Avoids expensive or sophisticated instrumentation

- Reagents can be made in the laboratory, so the method is not reliant on diagnostic suppliers
- Good performance characteristics
- Cost effective and sustainable

❖ *Principle*

Urine is digested with ammonium persulfate. Iodide is the catalyst in the reduction of ceric ammonium sulfate (yellow) to cerous form (colourless), and is detected by rate of colour disappearance (Sandell-Kolthoff reaction).

❖ *Equipment*

Heating block (vented fume hood not necessary), colorimeter, thermometer, test tubes (13 x 100 mm), reagent flasks and bottles, pipettes, balance scales.

❖ *Reagents*

1. Ammonium persulfate (analytical grade)
2. As_2O_3
3. NaCl
4. H_2SO_4
5. $Ce(NH_4)_4(SO_4)_4 .2H_2O$
6. Deionized H_2O
7. KIO_3

❖ *Solutions*

1.0 M (Molarity) Ammonium persulfate: Dissolve 114.1 g $H_2N_2O_8S_2$ in H_2O; make up to 500 ml with H_2O. Store away from light. Stable for at least one month.

5 N H_2SO_4: Slowly add 139 ml concentrated (36 N) H_2SO_4 to about 700 ml deionized water (careful - this generates heat!). When cool, adjust with deionized water to a final volume of 1 litre.

Arsenious acid solution: In a 2000 ml Erlenmeyer flask, place 20 g As_2O_3 and 50 g NaCl, then slowly add 400 ml 5 N H_2SO_4. Add water to about 1 litre, heat gently to dissolve, cool to room temperature, dilute with water to 2 litres, filter, store in a dark bottle away from light at room temperature. The solution is stable for months.

Ceric ammonium sulfate solution: Dissolve 48 g ceric ammonium sulfate in 1 litre 3.5 N H_2SO_4. (The 3.5 N $H_2SO_4$is made by slowly adding 97 ml concentrated (36 N) H_2SO_4 to about 800 ml deionized water (careful – this generates heat!), and when cool, adjusting with deionized water to a final volume of 1 litre). Store in a dark bottle away from light at room temperature. The solution is stable for months.

Standard iodine solution, 1 mg iodine/ml (7.9 mmol/l): Dissolve 0.168 mg KIO_3 in deionized water to a final volume of 100 ml (1.68 mg KIO_3 contains 1.0 mg iodine; KIO_3 is preferred over KI because it is more stable, but KI has been used by some laboratories without apparent problems). It may be more convenient to make a more concentrated solution, e.g., 10 or 100 mg iodine/ml, then dilute to 1 mg/ml. Store in a dark bottle. The solution is stable for months. Useful standards are 20, 50, 100, 150, 200, and 300 mg/l.

❖ ***Procedure***

1. Mix urine to suspend sediment.
2. Pipette 250 ml of each urine sample into a 13 x 100 mm test tube. Pipette each iodine standard into a test tube, and then add H_2O as needed to make a final volume of 250 ml. Duplicate iodine standards and a set of internal urine standards should be included in each assay.
3. Add 1 ml 1.0 M ammonium persulfate to each tube.
4. Heat all tubes for 60 minutes at 100oC.
5. Cool tubes to room temperature.
6. Add 2.5 ml arsenious acid solution. Mix by inversion or vortex. Let stand for 15 minutes.
7. Add 300 ml of ceric ammonium sulfate solution to each tube (quickly mixing) at 15-30 second intervals between successive tubes. A stopwatch should be used for this. With practice, a 15 second interval is convenient.

8. Allow to sit at room temperature. Exactly 30 minutes after addition of ceric ammonium sulfate to the first tube, read its absorbance at 420 nm. Read successive tubes at the same interval as when adding the ceric ammonium sulfate.

- ***Calculation of results***

Construct a standard curve on graph paper by plotting iodine concentration of each standard on the abscissa against its optical density at 405 mg/l (OD405) on the ordinate.

Definition of outcome

Urinary iodine execration provides a good indication of recent dietary iodine intake. A sample size of at least 30 individuals will compensate for the individual variation in iodine concentration that may occur.

The cut-off points for defining the iodine status of a population according to the median urinary iodine concentration are given in table (1) according to World Health Organization (WHO) and International Council for the Control of Iodine Deficiency Disorders (ICCIDD) cutoff .

Table (1): Definition of iodine status of a population based on median urinary iodine concentration.

Iodine status	Median urinary iodine concentration (µg/L)
Sever iodine deficiency	<20
Moderate iodine deficiency	20-49
Mild iodine deficiency	50-99
Ideal iodine intake	100-200
More than adequate iodine intake : may pose increased risk of iodine-induced hyperthyroidism	201-299
Excessive iodine intake	>300

For the elimination of iodine deficiency it is required that the median urinary iodine concentration should be 100 µg/l or more and not more than 20% of samples should be below 50 µg/l. [8]

Statistical Analyses

Data analysis for the inquired variables was done by using data analysis softwares namely SPSS , Excel and the results represented by using tables and charts describing the distributions of variables under study according to demographic, biologic and environmental factors reaching to determining the answer for our main objectives in the study.

Results and Discussions

This cross section survey includes 438 non-pregnant women at childbearing age (15-49 year) attended eight PHCs in the three included provinces in the study; most of the women (38.4%) were aged between (22-31 years) and most of them (87%) are living in urban environment as shown in figure (1).

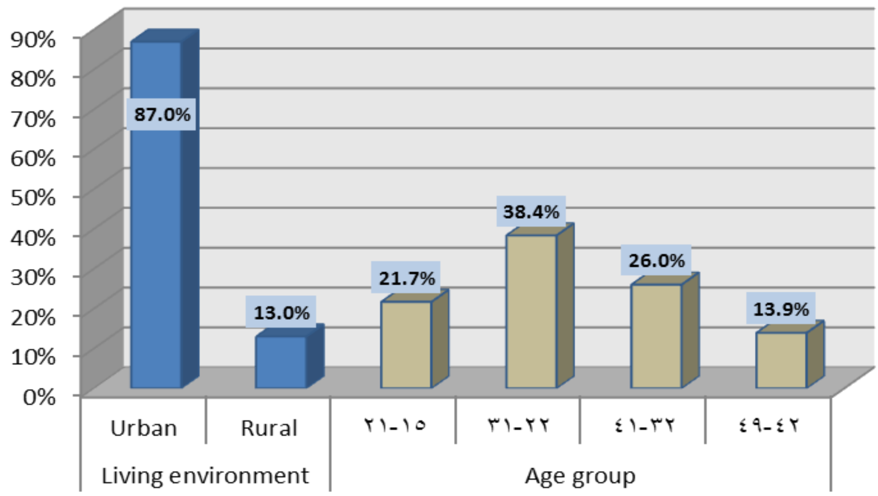

Figure (1): Distribution of study sample by age groups and living environment.

Distributing the sample on marital status and occupation; as shown in figure (2); revealed that most of included women in this survey were housekeepers (85.6%) and mostly were married (83.6%) and these figures are part of the overall sampling indicators from the questionnaire form that will be distributed later on with the main factors under study.

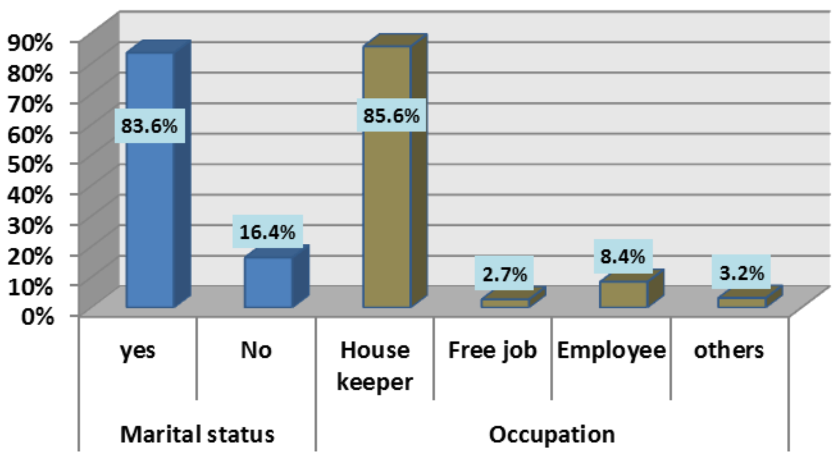

Figure (2): Distribution of study sample by marital status and occupation.

Educational level also was taken into account on sampling and their cross relation with the study factors and figure (3) shows that most of enrolled women (39%) finished their elementary level of education.

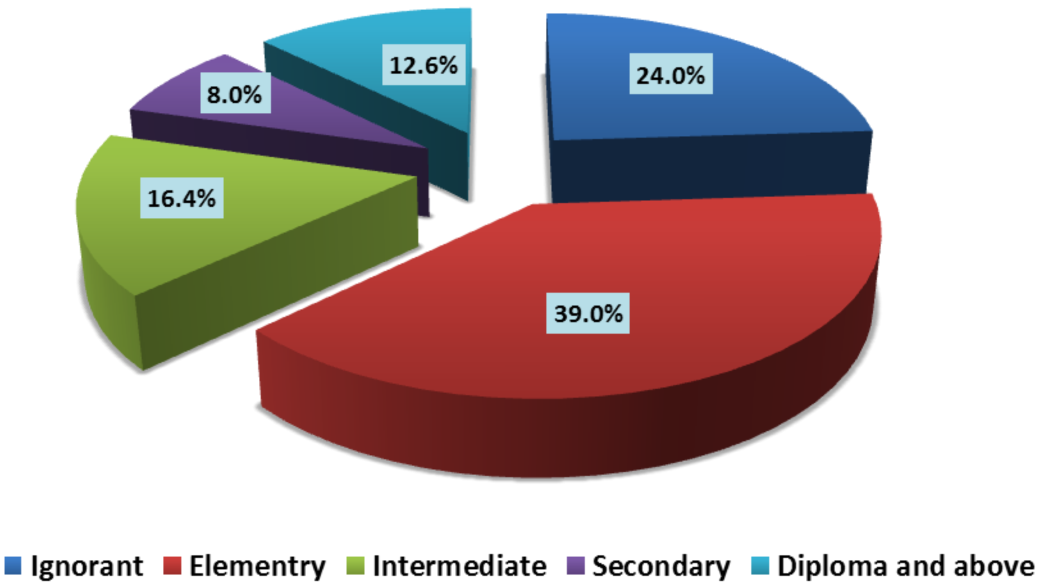

Figure (3): Distribution of study sample by educational level.

The overall sample median urinary iodine (UI) concentration for this study is 58.7 µg/l which indicates that there is a mild iodine deficiency in these three governorates for non-pregnant women of childbearing age according to WHO and ICCIDD cutoff standards, this result is higher than that of female in Darfur / Sudan 10.5 µg/l, while in Oman in 2004,the median urinary iodine was 162 µg/l. More than 71% of those women having a UI of less than 100 µg/L with a more than 38% having their UI below 50 µg/L or the moderate form of iodine deficiency as shown in table (2), both are higher than that were recorded in Oman in 2004 among women in childbearing age (less than 100 µg/L the prevalence was 16.8% and that for less than 50 µg/L was 4.9%).[16]

Table (2) shows the percentage of urinary iodine levels at various cut off values and the median for the sample non-pregnant women of childbearing age according to different characteristics. Distributing the median urinary iodine by governorates indicate that it's ranged between 44.3 µg/l in Ninevah and 86.7 µg/l in Basrah which indicating a moderate and mild iodine deficiency in these governorates respectively with a higher prevalence of those women having <100 µg/L urinary iodine level (ideal iodine intake is 100-200 µg/L) can be found in Ninevah (92.7%) followed by Baghdad (61.6%) and Basrah (60%).

It was found that the prevalence of UI <100 µg/L according to sample age groups was around 70% and for UI <50 µg/L was 40% in those aged 15-21 years with still a low median UI. When distributing UI level cutoffs on living environment between rural and urban areas ;(91.2%) of rural areas found to have a UI less than 100 μg/L and (61.4%) were below 50 μg/L and a median UI below 50 μg/L indicating a moderate iodine deficiency problem in these areas which might indicating an inadequate Iodized salt consumption or consumption of inadequately fortified salt or poor iodine food intake .UI level distributed by educational level shows that the highest percentage of those having UI below 100 μg/l were found in elementary level with a median UI indicating a mild iodine deficiency . Still a mild iodine deficiency can be found on distributing UI level by women's occupation with a higher percentage of those having UI level below 100 μg/l in women having a free job (83.3%). No significant differences were found between UI level with different factors ($P>0.05$) and there were no significant differences between UI levels on marital status.

Table (2): Prevalence of urinary iodine levels by different study sample characteristics

Characteristics	N of Urine samples	Prevalence of urinary iodine levels			Median (µg/l)
		<50 µg/l Prevalence%	<100 µg/l Prevalence%	≥100 µg/l Prevalence%	
Governorates					
Baghdad	138	24.6%	61.6%	38.4%	67.1
Basrah	150	24.7%	60.0%	40.0%	86.7
Ninevah	150	64.7%	92.7%	7.3%	44.3
Age group (years)					
15-21	95	40.0%	72.6%	27.4%	56.6
22-31	168	38.1%	72.6%	27.4%	58.1
32-41	114	39.5%	71.9%	28.1%	59.2
42-49	61	34.4%	67.2%	32.8%	68.3
Living Environment					
Urban	381	34.9%	68.8%	31.2%	66.6
Rural	57	61.4%	91.2%	8.8%	44.3
Educational level					
Ignorant	105	49.5%	73.3%	26.7%	50.4
Elementary	171	43.9%	78.4%	21.6%	55.9
Intermediate	72	26.4%	65.3%	34.7%	66.3
Secondary	35	25.7%	60.0%	40.0%	82.8
Diploma and above	55	23.6%	63.6%	36.4%	86.2
Occupation					
House keeper	375	41.6%	72.5%	27.5%	56.5
Free job	12	8.3%	83.3%	16.7%	69.4
Employee	37	27.0%	67.6%	32.4%	80.8
others	14	7.1%	50.0%	50.0%	94.7
Marital status					
yes	366	40.7%	73.5%	26.5%	57.1
No	72	26.4%	62.5%	37.5%	78.0
TOTAL	**438**	**38.4%**	**71.7%**	**28.3%**	**58.7**

Conclusions

From study results and interpretations we can conclude that Iodine deficiency disorders is still a problem in Iraq with more than (70%) of non-pregnant women of childbearing age (15-49 years) having a mild iodine deficiency with a median UI of more than 58 μg/L .

Most of women with mild iodine deficiency can be found in Ninevah (92.7%) with a moderate iodine deficiency indicated by their median UI of 44.3 μg/L, Rural areas found to be affected by iodine deficiency more than urban areas for which the highest percentages (91.2%) of those women with less than 100 μg/L can be found in the rural areas with a median UI of less than 50 μg/L indicating a moderate iodine deficiency.

No significant differences were found between UI level with different factors ($P>0.05$) and there were no significant differences between UI levels on marital status can be seen.

Recommendations

1- Sustained presence of a national multi-sector coalition responsible to the government for the national programme for the elimination of IDD with the following characteristics:
   a. National stature;
   b. All concerned sectors, including the salt industry, represented, with defined roles and responsibilities.
2- Enactment of legislation and supportive regulations on universal salt iodization.
3- Massive national education and should be undertaken to promote community awareness of the importance of the use of iodized salt and the hazardous effects of inappropriate iodine intake. This should be directed mainly at the rural community and achieved through educational and social marketing campaigns.
4- Routine availability of data on salt and population-based data on urinary iodine every five years and periodic surveys should be conducted on a representative sample, proportionate to the size of the population, to monitor the progress of the elimination of IDD and the sustained production and use of iodized salt.
5- Monitoring systems for the salt iodization programme should be strengthened to ensure regular quality control.
6- Availability and use of adequately iodized salt (>20 ppm iodine and <40 ppm) must be guaranteed through sustained availability of fortification substance and factory feeders.

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