

**Assessment of Iodine Deficiency  
Status Among  
Jordanian Children after  
Introduction of Iodized Salt**

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**Principal Investigator: Dr. Sa'ad H.Kharabsheh  
Co- Investigators:**

- ⌚ **Dr. Adel Belbesi**
- ⌚ **Mrs. Wisam Qarqash.**

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## **Abstract:**

Iodine deficiency is the world's major preventable cause of brain damage and mental retardation. The clinical and subclinical manifestations of iodine deficiency collectively known as Iodine Deficiency disorders (IDD) can affect all stages of human growth and development. All these effects can be prevented and controlled by implementation of Universal Salt Iodization program (USI).

This study aims to assess the effects of iodization program on Jordanian population .A national sample of (2601) school children aged 8-10 years was selected, 56% of the sample were Males and 44% of them were females.

The indicators used for this study consisted of; Measurement of the iodine concentration in urine, prevalence of clinical goiter and the proportion of households consuming iodized Salt.

The Results revealed that the median iodine concentration in urine was 15.40 ug/100 ml.

Prevalence rate of goiter was 33.5%.

The proportion of households consuming effectively iodized salt was 85.4%.

A comprehensive monitoring plan will be implemented at all levels and for all types of salts intended for human consumption( whether locally produced or imported ).

# **1. Introduction:**

## **1.1 Public Health Overview**

Iodine deficiency disorders (IDD) are currently a significant health problem in 118 countries. An estimated 1.6 billion People worldwide live in iodine deficient environments and are thus at risk of IDD. Twenty Million of these are believed to be significantly mentally handicapped due to lack of iodine in food and water.

A large proportion of the severely deficient were women in their reproductive years whose babies are at high risk of irreversible mental retardation and retarded psychomotor developments unless they receive adequate amount of iodine.

In addition to mental retardation, goiter is an important consequence of iodine deficiency. In this instance, thyroid enlargement can be viewed as an attempt to compensate for inadequate hormone production by thyroid. Thus, goitre is a marker for iodine deficiency.

## **1.2 Global concern of IDD**

The world summit for children held in New York in September 1990 called for the virtual elimination of iodine deficiency disorders by the year 2000. The goal of elimination was also included in the plan of action adopted by the international conference on Nutrition (Rome 1992).

The main strategy to achieve the goal has been the universal fortification of all food-grade salt consumed by all people by the end of 1995.

As of 1994 it was estimated that there were more than 90 developing countries with iodine deficiency as a public health problem. Most of them established an iodized salt program.

The total number of people and percentage of regional population living in areas at risk of IDD according to UNICFF regions has dropped from 28.9% in 1994 to 13.7% in 1997 due to successful programs of salt iodization.

The population at risk of IDD in the middle east & North Africa accounts for 9.1% (134 million ) and in south Asia 26.1% (410 million ).

### **1.3 Status in Jordan:-**

The prevalence of goiter of all degrees in Jordan among children aged 8-10 years was 37.7% ( based on a national survey conducted in 1993).

Jordan adopted WHO/UNICEF/ICCIDD criteria for monitoring progress towards sustainable elimination of IDD since 1995.

The main components of the national monitoring program were as follows:

1. Establishing IDD committee for program monitoring and evaluation .
2. Political commitment to the elimination of IDD and USI.
3. Legislation was changed to support universal salt iodization.
4. Commitment to assessment and reassessment of progress in the elimination of IDD.
5. Conducting mass media program to increase awareness of iodized salt consumption.
6. Monitoring on regular basis, salt iodine levels in factories, shops and households using reliable test kits.
7. Ensuring regular quality control of salt iodine in factories, labs,ect...

## **1.4 Rationale:**

Iodine deficiency result mainly form geological rather than social and economic conditions. It cannot be eliminated by changing diet habits or by eating specific kinds of food grown in the same area. Rather the correction has to be achieved by supplying iodine from an external source. The iodization of salt is a long term and sustainable solution that will ensure that iodine reaches the entire population and is ingested on a regular basis.

There is a need to continuously monitor iodine replacement programs to ensure efficacy. After launching the nationwide iodization program in 1994 no evaluation studies have been carried out in the country. The Ministry of Health in collaboration with UNICEF & WHO conducted this survey to evaluate the control program and monitor progress towards achieving our long – range goals. Furhtermore, the survey aimed at studying the clinical & biochemical indicators.

## **2. Study objectives:**

Assessing the effects of iodization programs on Jordanian population by:-

- Determining the present prevalence of goiter among school children aged 8-10 years in Jordan .
- Measuring urinary iodine concentration .
- Measuring the condition of progress of implementation of the IDD control program by assuming the consumption of adequately iodized salt .

### **3. Methodology:**

Considerable progress has been made in the implementation of the universal salt iodization programs in countries affected by iodine deficiency disorders. WHO, UNICEF and ICCIDD (International Council for the Control of Iodine Deficiency) have jointly recommended that outcome and process indicators to track the progress of IDD elimination programs. Goiter grading by clinical examination and measuring urinary iodine are considered the most feasible outcome indicators to use in the developed countries while iodine content of salt is considered the best process indicator.

#### **3.1 Sampling**

##### **3.1.1 Sampling universe**

Although it is preferable to draw the sample from the general population, but one must bear in mind that balance has to be struck between the ideal and the practical when dealing with sampling and selection of study subjects.

The target population for this study was children in the age group 8-10 years. Taking into consideration nearly 100% enrollment rate for both sexes in this age group, school children in 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> grades constituted the sampling universe for our study.

##### **3.1.2 Sampling Frame**

Schools containing at least one target grade was considered as sampling frame. All kinds of schools were listed ( public, private, UNRWA). Primary

Sampling Units ( PSUs) were selected from the list of all clusters ( schools ) in the country. PSUs were selected with probability proportional to their size (PPS) with the same number of students to be selected in each cluster. A comprehensive list of all students in the target grades was prepared for each selected cluster. Classes were chosen at random from the above list to fulfil the total number of children needed for the cluster. Each selected child was subjected to both clinical examination and urine testing for iodine level.

### **3.1.3 Sample Size**

Sample size was calculated using the following formula:

$$n = Z^2(1-P)D/\delta^2P$$

n = sample size

P= anticipated prevalence

$\delta$  = relative precision to anticipated prevalence

Z= confidence limit

D= design effect

The results of the baseline survey that was carried out in 1993 pointed to an average of 38% prevalence of clinical goiter. Taking into consideration the effect of the mandate of iodized salt over the last 6 years, an overall 25% prevalence was anticipated. Ninety five percent confidence level and 10% relative precision were considered. To obtain a comparable precision to simple random sampling, a design effect of 2 was included in the calculation. This brought the minimum sample size for the purpose of the

clinical examination and urine testing for iodine level to about 2305. A 10% was added to account for the possible non – response rate. This brought the number of selected individuals to 2700 subjects. The proposed 10% increase to account for non-response was to reach the desired minimum sample size and not to improve the non-response rate. The increase of sample size did not affect the bias resulting from non-response.

### **3.2 Testing Table Salt for Iodine**

To show that an IDD program is sustainable WHO has suggested the availability and consumption of adequately iodized salt is greater or equal to 90% as an indicator .

A sample of salt from households and local retailers in each cluster area was collected and analyzed for iodization using a rapid test kits method.

### **3.3 Clinical Examination**

For each selected student, a clinical information sheet was filled. Each student was examined by the clinician and the score for goiter was recorded using WHO criteria as follows:

Grade zero: No palpable or visible goiter.

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, it moves upward in the neck as the subject swallows.

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 .

Clinical examination was performed solely by experienced endocrinologists working at the Ministry of Health .

### **3.4 Urine Collection and Testing**

To assess the iodine intake, urine iodine concentration was used. However, the excretion of iodine varied considerably from day to day according to the variation of the iodine intake. Some data indicated, that the average balance might persist for several weeks. Valid assessment of iodine supply by urinary excretion required a large amount of urine collection from randomly selected subjects.

Complete 24-hour collection of urine was often difficult to achieve in field investigations. An alternative procedure was measuring the ratio between the concentration of iodine and creatinine in casual samples of urine. However it had been shown that this method was not valid when protein malnutrition was present. Direct measurements of urinary iodine concentrations constitute a more valuable index.

Twenty milliliters of fresh urine were collected from each selected subject in a container, and labeled with unique identifier number corresponding to the student's name. All samples were stored at 4 C<sup>o</sup> till assayed at the public health laboratory in Amman by the same technicians who analyzed the 1993 samples. Urine iodine concentration was analyzed according to a standard procedure. The results were expressed as microgram of iodine per 100 milliliter. The above procedure depended on the intensity of Colour formation due to the reaction of extracted urinary iodine with chloric acid with ceric ammonium sulphate reduction in the presence of ferrion indicator.

It was decided that a good number of urine samples should be tested at the university of Jordan for quality control purposes.

### **3.5 Operation of the Study**

Four field teams were formulated to carry out the fieldwork. Each team consisted of one endocrinologist, general practitioner and driver.

The daily activities were managed and supervised by the research committee and field supervisors. Their task was to monitor the progress of the fieldwork and to receive the filled forms and urine samples by the end of the day, check for any mistakes, send the urine samples to the laboratory and prepare for the next day. The supervisory team kept in contact with the field teams by telephone throughout the period of the study to answer any question, which might arise by the field team during the work. Furthermore, they served as a liaison between the field teams and the central research committee.

### **3.6 Data Entry and Analysis**

All variables in the survey were coded and entered using EPI Info software. Means, median, proportion and cross tabulation were analyzed.

### **3.7 Special Concerns Analysis**

All necessary efforts were taken to prevent the release of toxic fumes during urine testing for iodine level. The current protocol did not involve activities that deal with infectious biological agents or blood collection and processing. The lab activities were part of a routine work and the same procedures to the ones that were used in the project were used on routine basis. Disposal of medical

waste associated with performance of tests was also part of well-established disposal systems in the country. Urine collection from the survey subjects was performed only after getting a written consent from their guardians.

## **RESULTS**

- **Table (1)**, distribution of the study sample according to governorates, The sample is proportional to the population density of the governorates.
- **Table (2)**, Males constituted about 56% of the sample, this percentage is higher than expected, and may be attributed to a higher response rate of male students as well as to higher enrolment of males in mixed rural schools, another reason for higher representation of Males may be related to non stratification for sex during sample selection
- **Table (3)**, shows the distribution of the sample according to grade and age, the proportions were almost similar (34.1% , 34.1% , 31.7%)
- **Table (4)**, shows the response rates for clinical exams and urine collection.  
The over all rates of both indicators were very high.  
According to governorates, the clinical response ranged between 87% - 99% and the range for urine collection was 85.3% - 98.9%.
- In **table (5)**, The over all prevalence rate of goitre found to be 33.5% compared to 37.8% in 1993 study. This finding answers the major concern of the investigators which was to measure the national prevalence of goitre, and since the sample size is too small on the governorate level to allow for the calculation of the actual prevalence rates in each governorate, the governorates rates calculated are to be used as rough indicators only.
- The prevalence of goitre as related to sex was studied, **table (6)**, shows that it was significantly higher among males than among females (36.6%, 27.9% respectively ) in

contrary to 1993 study where females were higher than males ( 39.2, 36.3% respectively ).

- The prevalence of goitre as related to age was studied in **table (7)**, revealed that the rate of goiter increases as age increase 28.7% , 35.7% ,36.5% for 8 , 9 and 10 years ages respectively.

While in the 1993 study, the highest prevalence was among the 9 years old (40.6%) in comparison to 31.8% for the 8 years old and 38.8% for the 10 years old.

- **Table (8)**, reveals a 33.5% over all prevalence rate for goitre which is an improvement over the 1993 findings (37.8%).

Findings, also revealed that grade I constituted about 75% of the total goitre.

- **Tables (9) ,(10) and (11)**, describe the median iodine concentration in urine. The overall median Iodine concentration for this study was 15.4 which is considered to be an optimal intake according to WHO/ICCIDD classification, compared to (4) which was obtained in the 1993 study and was considered as moderate deficiency. This improvement can be attributed largely to the salt iodization program implemented since 1994.

All the governorates, but Jarash showed an optimal or more intake of iodine. Two governorates (Maa'n + Aqaba) showed a risk intake of high amount of iodine.

Although the result of iodine concentration in urine showed an optimal intake, the clinical indicator as a measure for the prevalence of goitre still classifies the students as complaining of severe deficiency. This discrepancy can be explained by the fact that change in the prevalence of goitre takes more than 5-10 years to appear after effective iodized salt consumption ,while the biochemical indicator is more sensitive in reflecting the actual change <sup>8</sup>.

- **Table (12)** shows a comparison between 1993 & 2000 surveys regarding prevalence of goiter and median iodine concentration in urine.  
 The over all prevalence of iodine, has dropped from 37.8% in 1993 to 33.5% in 2000.  
 The prevalence of goitre shows a decrease within all governorates except in Mafrak and Karak. The median iodine concentration in urine is greatly improved since 1993 for all governorates.
- **In table (13)** the findings of the 12 governorates are pooled into three regions( middle , north, south) of the country for the sake of giving more validity for comparisons , since the sample size becomes more reliable and to enable us to make comparisons with 1993 study.  
 For both clinical & Biochemical indicators, there was a clear improvement for all regions in the 2000 study when compared with 1993 study.
- **Table (14)** shows that 24.5% of the study population received insufficient iodine intake ( less than 10ug/100ml), about 47% received adequate intake, while the rest of the students proved to receive either more than adequate or excessive intake (28.8%).  
 WHO/UNICEF/ICCIDD have agreed in principle that the most important criterion for monitoring process towards sustainable elimination of IDD is:  
 The median value must be equal to or above 10 ug /100 ml, and the proportion of children who have urinary iodine below 5ug/100ml should be less than 20% .  
 Our findings showed that the national median was significantly above 10ug/100ml (15.4) and the proportion of children who have Median urinary iodine below 5ug/100ml was 11% and the proportion for those who have values below 10/ug/100ml was 24.5% .

- **Table (15)**, when we look to the findings of governorates, 10 governorates fulfilled the criteria mentioned above. Jarash governorate results showed a problem in both criteria, where the proportion of children having urinary iodine below 5ug/100ml was 21.7% and the proportion for those having urinary iodine below 10ug/100ml was 61% . In Mafrak governorate, the proportion of children having urinary iodine below 5ug/100ml was 27% , while the proportion of having urinary iodine below 10ug/100ml was satisfactory .
- **Table (16)**, shows 85.4% of the sample consumed iodized salt, which is lower than 90% according to WHO criteria .

Upon agreement with the laboratory of Jordan University Hospital, 87 urine samples were selected randomly from the total of 2426 urine samples ( constitute about 4%) , these samples were tested both at the university laboratory, and at the public health laboratory.

The results of this quality control showed that the individual concordance between the university results and the public health laboratory results was 50%.

This does not mean that both results of the urine sample were equal , but it means that both of them were lying within the same category ( i.e severe , moderate, and mild deficiency in addition to optimal and excessive intake).

The median, mean and standard deviation were calculated for the measurements of urine sample tested both at the university and public Health laboratories.

The mean and median of results were higher in the university laboratory (19.8 , 20 for university compared to 16.8 , 17 for PHL) .

Both medians of university and PHL showed either optimal iodine intake (P.H.L) or excessive intake (university laboratory).

## **Conclusions & Recommendations**

It was evident from the findings of this study that biochemical indicator as measured by Iodine excretion in the urine was more sensitive and reliable in measuring the actual situation of Iodine intake since it is an objective measure and can be considered free of affection by observer bias as it may happen with the clinical classification especially when classifying grade 1 goitre from grade zero.

This study showed that a good proportion of the study population are still consuming salt without iodine fortification (14.5%) , due to the fact, that some small unknown packagers are still not complying to the standards and specifications which makes the addition of iodine to the salt as mandatory .

Another important finding of this study pointed out that about 29% of the study population receive iodine intake of more than adequate or excessive intake.

### **Recommendations:**

1. More significance should be given in the future to the biochemical indicator than clinical indicator in monitoring IDD.
2. The level of Iodine in the salt should be reduced from a dose of 40-60 mg/kg to a dose of 30 mg/kg(  $\pm$  10 mg/kg).. This strategy becomes valid only when the monitoring system becomes mature enough and the program is confident that all factories, retailers and distributors comply with the optimum salt iodization .

3. A comprehensive monitoring plan should be implemented on all levels of the market to ensure compliance of all salt producers with the standards and specification of Iodine fortification.

## **Tables**

## **Annexes**

## **Annex ( 1)**

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## Annex (2)

### Research Team

#### **1st. Research Committee:**

1. Dr. Sa'ad Kharabsheh / M.O.H
2. Dr. Adel Belbesi. /=
3. Eng. Wisam Qarqash /=

#### **2nd. Field Team:**

1. Dr. Ahmed Khair /Endocrinologist /M.O.H
2. Dr. Amal Mudanat /= /=
3. Dr. Mohammed Helal /= /=
4. Dr. Rouda Al Khateeb /= /=
5. Dr. Mohammed Al Kayed /M.O.H
6. Dr. Saleh Elawa. /=
7. Najeah Qasrawi /=
8. Myasar Mouqbel. /=

#### **3rd. Field Supervisor :**

1. Dr. Ali Asa'ad /=
2. Dr. Abdul Mun'am Al- Sallaj /=
3. Dr. Malek Habashna /=
4. Dr. Khalid Abu Rumman /=

#### **4th. Laboratory Technicians:**

1. Dr. Aktham Haddadin.
2. Miss Ruba El – Nabulsi
3. Mrs. Heifa Saleem
4. Muna Habash

#### **5th. Data entry & Analysis:**

1. Miss Sahar El- Deir
2. Mr. Nasir Al- Satary
3. Mr. Mohammed al – Khateeb.

**6th. Consultants:**

1. Dr. Mohammad Al- Khateeb/ Lab.  
Consultant / university of Jordan .
2. Dr. Ibrahim Al- Khateeb/ Nutritionist/  
University of science and Technology

**7th. Part time contributors from Ministry of Education:**

1. Miss. Malak Al- Khateeb.
2. Mr. Issa Nassar .

**8th. Administrative Staff :**

1. Mr. Gazy Beny Nasair
2. Mr. Belal Shehadeh.
3. Mr. Hashem Khraisat
4. Mr. Majid Quteishat
5. Mr. Mohammed jaber
6. Mr. Sameer Al- Dalee