IODINE DEFICIENCY IN SAUDI ARABIA

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Data on the status of iodine deficiency in the Arabian peninsula is scarce. We have conducted a cross-sectional national epidemiological survey in Saudi Arabia to study the iodine status of Saudi schoolchildren, between eight and ten years, who were randomly selected, after taking into consideration the gender, provincial population and area distribution. Casual urine samples were collected and sent to the central laboratory for analysis. Clinical assessment for the presence of goiter was conducted in four areas with different geographical natures. The survey included 4638 subjects, and their median and mean (SD) of urinary iodine concentration was 18 and 17 μg/dL, respectively. We found provincial differences with respect to urinary iodine concentration and the percentage of subjects with urinary iodine concentration <10 μg/dL. The Southern province had the lowest median (11 μg/dL) and the highest percentage (45%) of subjects with urinary iodine concentration <10 μg/dL. On the other hand, subjects of the Western province had the highest median (24 μg/dL) and the lowest percentage (8%) of subjects with urinary iodine concentration <10 μg/dL. The clinical assessment revealed that the highest prevalence and more advanced grade of goiter (22%, 95% CI 19-25, grade 1; 8%, 95% CI 6-10, grade 2) was found in the Asir region, a high-altitude area in the Southern province. The lowest prevalence of goiter (4%, 95% CI 0.8-7.2, grade 1) was found in Gizan, an urban coastal community. There was a significant relationship between the prevalence of goiter and the urinary iodine concentration. The survey for iodine deficiency disorder (IDD) in Saudi Arabia has shown a mild degree of iodine deficiency in the Southern province. Odds ratio (OR) was used to study the statistical relationship between the prevalence of goiter and the urinary iodine concentration. There is a need to launch a control program to ensure the exclusive availability of iodized salt in Saudi Arabia, especially in the Southern province. *Ann Saudi Med 1997;17(3):293-297.*

The term iodine deficiency disorders (IDD) covers a wide variety of clinical conditions affecting the health and well-being of man. About one-third of the world's population, 1.57 billion people, live in iodine-deficient environments and are thus at risk of IDD.[1] More than 190 million people suffer from IDD; among them, about 20 million are believed to be significantly mentally handicapped and over three million have cretinism.

Data on iodine excretion in the urine of adults, adolescents and newborns, and on the iodine content of breast milk, indicate a high prevalence of iodine deficiency in many European countries.[2] However, over the last five decades many European, American and Asian countries have already successfully eliminated IDD or achieved considerable progress toward their control.[3] These successful efforts were largely due to salt iodination for eliminating IDD. This has been endorsed in numerous international forums, including the International Conference on Nutrition (Rome, 1992).

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There are a number of countries in the Eastern Mediterranean region in which IDD, mainly endemic goiter, pose a major public health problem in certain localized areas.[4] Goiter prevention and control programs are frequently postponed in many developing countries, being regarded as a low priority problem.

The three most important indicators used in IDD surveillance, as well as in initial problem assessment, are goiter prevalence, which can be measured either through palpation or through ultrasonography,[5] urinary iodine excretion in a population, and thyroid function tests, especially thyroid-stimulating hormone (TSH) in neonates.

The World Health Organization advised researchers to combine at least two indicators, one morphological and one laboratory test.

The International Council for Control of Iodine Deficiency Disorders (ICCIDD) adopted the following simplified goiter classification in 1992[7]: grade 0, no palpable or visible goiter; grade 1, palpable but not visible when neck is in normal position; grade 2, palpable and visible when neck is in normal position.

Ninety percent of the ingested iodine is excreted in urine; therefore, urinary iodine determination is an accurate means of assessing iodine status.[8] Twenty-four-hour urine collection is the best measure, but is not practical for epidemiological surveys and has been replaced by casual urine samples, with the value expressed either as concentration (µg iodine/dL) or in relation to creatinine (µg iodine/g creatinine). Bourdox[9] recommended relying on the concentration of iodine in casual samples of urine, in epidemiological surveys, since a large population sample will neutralize the factor of the difference in individual urinary dilution.

ICCIDD has recommended using the median of urinary iodine concentration for assessment of iodine status,[10] using the following classification: severe iodine deficiency with a median of <2 µg/dL, moderate iodine deficiency with a median of 2-5 µg/dL, mild iodine deficiency with a median of 5-10 µg/dL. Forty to fifty samples from an area would be adequate to reflect the urinary iodine excretion of the population of that area.

Schoolchildren are the most appropriate group for survey, as they tend to be homogeneous for any given district or region and reflect the current status of iodine deficiency and can be used for monitoring the response for any intervention program.

We have conducted national cross-sectional epidemiological surveys among Saudi schoolchildren, aged eight to 10 years old, for studying the iodine status in Saudi Arabia, through urinary iodine estimate and clinical assessment of thyroid gland.

Material and Method

Study Population

The sample included 4638 Saudi schoolchildren, aged eight to 10 years old. They were randomly selected from different regions of the country. Schoolchildren of this age category are a useful target group for IDD surveillance because of their combined high vulnerability, easy access and usefulness for a variety of surveillance activities.[11] The probability proportionate to size (PPS) cluster, recommended by the WHO, was employed in this study.[11] The number of schoolchildren in the target age group for each province was ascertained. The target sample for each province was calculated using PPS and distributed, based on demographic and geographical population distribution such as urban, rural, altitude, coastal and mountainous areas. Schools were randomly selected from the list of schools for the target age group in each province. Every 10th student among the target group was enrolled in the study.

Chemical Measurement

Casual urine sample of 10 mL was collected in a plain tube from the studied population and stored at 4°C. Upon completion of the target sample for each region, samples were flown for analysis to the central laboratory at the College of Science, King Saud University, Riyadh. All the samples were stored for up to four weeks before iodine concentration was analyzed.

Iodine determination was done by the colorimetric method,[9] where urine was digested with chloric acid solution (28% potassium chlorate in 21% perchloric acid). The mixed ingredients were heated in the tubes for 50 to 60 minutes in a heating block at 110°C to 115°C in a hood with a perchloric acid trap, then cooled to room temperature. This was followed by adding 3.5 mL arsenious acid solution (1% arsenic trioxide in 20% 5N sulfuric acid, plus 2.5% sodium chloride) and 350 µL ceric ammonium sulfate solution (4.8% N, 3.5N sulfuric acid. Then the absorbency was read at 405 nm in a colorimeter (Spectro photometer, Pharmacia LKB Biochrome Ltd., Cambridge, England) after 20 minutes.

The results were calculated through constructing a standard curve on a graph paper by plotting iodine concentration of each standard against its spectrophotometer reading. The iodine concentration for each sample was located through plotting each spectrophotometer absorption on the standard curve and urinary iodine concentration was expressed as µg/dL.

Quality Control

Quality control of the analysis was checked using known iodine concentrations run after each 10 test samples. The intra- and interassay coefficient of variation (CV) were 11.7% and 11.2%, respectively, for concentration at 30 µg/dL and 20 µg/dL respectively.

Quality control and quality assurance for the method used were checked by selecting randomly from all the regions and analyzing 4.3% (200) of the total urine samples in the ICCIDD iodine reference laboratory in the University of Virginia, School of Medicine, Division of Endocrinology. The obtained results from the reference laboratory were precisely within the results obtained locally for iodine concentration below 2 µg/dL (P=0.001, r=0.991). For those iodine concentrations >10 µg/dL, the obtained results from the reference laboratory were close to the results obtained locally (P=0.0001, r=0.78).

Clinical Assessment

After completion of the urinary iodine determination, a random sample of 1357 schoolchildren, aged eight to 10 years, was selected from areas of different geographical nature, i.e., coastal, high altitude and deserts. Field visits to the randomly selected schools were accomplished through the simple random method from the list of primary schools at the General Directorate of Education. Clinical neck examination was done and goiter was ascertained and classified as per the modified WHO criteria for goiter assessment. Neck examination was done by one investigator (AN) for all students, who did not know the individual urinary iodine concentration.

Statistical Analysis

Statistical analysis was done using Statpack Gold (statistical analysis package). Data are presented as median, mean (SD) and percentage in tables. Student's *t*-test was used for comparison between means and number of continuous. Odds ratio (OR) was used to study the statistical relationship between the prevalence of goiter and the urinary iodine concentration. A *P*-value <0.05 was considered as significant.

Results

There were 4638 schoolchildren, 2365 (51%) male and 2273 (49%) female subjects. The national median and mean (SD) urinary iodine concentrations were 18 and 17 (8) µg/dL. The median and mean (SD) urinary iodine concentrations for male and female subjects were 18, 17 (8) and 17, 17 (8) µg/dL respectively (*P*=0.008). The majority of subjects had urinary iodine concentration >10 µg/dL.

The sample size, median, mean (SD) urinary iodine concentration and percentage of subjects with urinary iodine concentration <10 µg/dL are shown in Table 1. At the national level, about one-quarter of the studied population (1043 students, i.e., 23%) had urinary iodine concentration <10 µg/dL.

The Southern province had the highest percentage (45%) of students with low urinary iodine concentration, <10 µg/dL, and 18% of students in the Southern province had a urinary iodine concentration <5 µg/dL. The lowest percentage was observed in the Central and Western provinces (8%) (Table 2).

A total of 3200 (69%) students live in urban communities and 1438 (31%) students live in rural communities. The median and mean (SD) urinary iodine concentration for urban and rural subjects were 17, 16 (7) and 20, 18 (8) µg/dL, respectively (*P*=0.0001).

A total of 1256 students, living in a low altitude area, had significantly higher urinary iodine concentration, with median and mean (SD) of 20, 19 (7) µg/dL, when compared with 1259 students living in a high altitude area, with median and mean (SD) of urinary iodine concentration of 11, 13 (8) µg/dL (*P*=0.0001).

There were 1357 subjects from different geographical areas who had their necks examined for the presence of goiter. Table 3 shows prevalence and grade of goiter in different geographical areas, with their corresponding median urinary iodine concentration. The table demonstrates a significant inverse relationship between median urinary iodine concentration and the percent prevalence of goiter in the sampled provinces (OR=0.4, 95% CI= 0.3-0.8, *P*=0.005). The Asir region of the Southern province had the highest and most advanced grade of goiter, the lowest corresponding median of urinary iodine concentration and the highest percentage of subjects with urinary iodine concentration <10 µg/dL.

TABLE 1. *The sample size, median, and mean (SD) urinary iodine concentration and percentage of subjects with urinary iodine concentration <10 mg/dL.*

		Urinary iodine concentration (µg/dL)		
Province	Sample size	Median	Mean (SD)	% Subjects with iodine concentration <10 µg/dL
Central	1148	21	20 (6)	8%
West	716	24	22 (7)	8%
East	736	19	18 (6)	15%
North	475	17	17 (6)	19%
South	1563	11	12 (7)	45%
National	4638	18	17 (8)	23%

TABLE 2. *Percent distribution of the sample students according to their residence (province) and urinary iodine concentration.*

		Urinary iodine concentration (µg/dL)		
Province	Sample size	% <5 µg/dL	% 5-10 µg/dL	% >10 µg/dL
Central	1148	2	6	92
West	716	2	6	92
East	736	4	11	85
North	475	5	12	83
South	1563	18	27	55
National	4638	8	15	77

Discussion

In many countries of the Middle East, endemic goiter has been a familiar condition for decades and yet it has never attracted the particular attention of health managers and decision makers. This situation resulted in alarming prevalence rates in certain regions, which have continued unchecked. Results of surveys indicated that the Eastern Mediterranean region may have the largest number of countries, approximately 11 out of 23, in which iodine deficiency disorders pose a public health problem, although the precise extent of the problem in each of these countries is not yet known.[4] It seems that the subject has neither stimulated the researchers in most of the countries, nor aroused the nutritional curiosity of epidemiologists. In Saudi Arabia, this is the first documented national IDD survey.

The national median urinary iodine concentration is not in keeping with iodine deficiency; however, there is a provincial variation with respect to iodine status, where the Southern province has the lowest median urinary iodine concentration (11 µg/dL) and the highest percentage of subjects (18% and 27%) with urinary iodine concentration <5 µg/dL and 5-10 µg/dL, respectively. On the other hand, the Western province has the highest (24 µg/dL)

TABLE 3. *Prevalence, 95% confidence intervals and grade of goiter and their corresponding median urinary iodine concentration (mg/dL) among schoolchildren in different geographical areas.*

		Goiter prevalence (95%CI)			UIC*	
Province	Nature	No.	1	2	No.**	Median
Central, Riyadh	Desert	306	8 (5-11)	0	104	19
Southern, Gizan	Coastal, not-mountainous	140	4 (0.8-7.2)	0	46	23
Southern, Fifa	Coastal, mountainous	181	25 (18.7-31.3)	0	45	11
Southern, Assir	High altitude	730	22 (19-25)	8 (6-10)	255	10

*Urinary iodine concentration; **number of subjects who had their urinary iodine concentration tested.

median urinary iodine concentration and the lowest percentage of subjects (8%) with urinary iodine concentration <10 µg/dL. The difference can be attributed to the special character of each of these provinces, where the Southern province is characterized by being of high altitude, low to medium income, and without easy access to high iodine content food such as fish and fresh food, compared with the Western province, which is of low altitude, medium to high income and has easy access to food high in iodine content.

Median urinary iodine concentration of male subjects is significantly higher than for female subjects. Median urinary iodine concentration for subjects living in rural communities is significantly higher than for subjects living in urban communities. The underlying factors for such findings should be the focus of future studies.

The median urinary iodine concentration of subjects living in low altitude areas is significantly higher than for subjects living in high altitude areas, and this is related to the differential natural availability of iodine in high and low altitude.[12]

Goiter prevalence in the studied areas ranged from 8% to 30%. These figures are much less than what is reported by other countries in the Eastern Mediterranean region. In Iran, the nearby Gulf country, the prevalence among schoolchildren reached 80% in the Shahryar area southwest of Tehran. On the other side of the Red Sea, the prevalence of goiter among Sudanese schoolchildren reached 40% to 65%, especially in the Darfu area. In Libyan Arab Jamahiriya and Tunisia, it ranged from 20% to 55% and 15% to 51%, respectively.[13]

The clinical assessment showed good correlation between the prevalence of goiter and the median of urinary iodine concentration in different geographical areas, where the highest prevalence and advanced grade of goiter is found in Asir region of the Southern province, which has the lowest median urinary iodine concentration. Fifa, a coastal mountainous region of the Southern province, has a similar overall prevalence, however, a milder grade of goiter, when compared with the Asir region. This difference can be attributed to the nature of the food and accessibility to food of high iodine content. In general, the prevalence of goiter was 28%, the majority in grade 1. Finally, the relative increase in goiter prevalence in spite of median urinary iodine concentration of ≥10 µg/dL, probably reflects the difficulties in sorting out normal versus grade 1 goiter, especially among small children.

Two studies were carried out in Saudi Arabia to quantify the iodine content of water and foods. The first concluded that food consumed by Saudis appears to have an adequate iodine concentration.[14] The second study revealed low iodine concentration in all water samples.[15] The findings of the food study can be attributed to the fact that food samples were either collected from large cities such as Riyadh, Qassim, Taif, or imported in whole or in part.

Mapping Saudi Arabia for iodine deficiency through the epidemiological survey of schoolchildren has revealed adequate iodine status in all provinces except the Southern province. Within the Southern province, there are regions with adequate iodine status, such as Gizan and regions with a variable degree of iodine deficiency. There was a significant relationship between the prevalence of goiter and the urinary iodine concentration. There is a need to combat iodine deficiency in the Southern province through an iodination program. Salt iodination, at the present time, is not one of the official Saudi standards for salt manufacture and trading, where it is neither mandatory nor recommended. A universal salt iodination program needs to be instituted to control iodine deficiency in the affected areas and prevent IDDs in other parts of the country. Issues relating to the safety of universal salt iodination have been carefully examined by WHO and by FAO/WHO/ICCIDD/UNICEF expert groups,[16] where they agreed that universal salt iodination is feasible, cheap, safe, rapidly effective and sustainable.

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