National study on the prevalence of iodine deficiency disorders among schoolchildren 8–12 years of age in Bahrain

K. Moosa[1], A.W.M. Abdul Wahab[2], J. Al-Sayyad[3] and B.Z.H. Baig[4]

دراسة على الصعيد الوطني حول انتشار الاضطرابات الناجمة عن عَوَز اليود بين تلاميذ المدارس الذين تتراوح أعمارهم بين 8 و12 سنة في البحرين

خيرية موسى، عبد الوهاب محمد عبد الوهاب، جمال الصيَّاد وبدر بيك

الخلاصة: أُجري مسح شمل تلاميذ المدارس الابتدائية في البحرين، لتقدير معدلات انتشار الدُّراق وعَوَز اليود موزَّعة بحسب السن والجنس والمنطقة السكنية. وفي خلال الفترة من كانون الثاني/يناير إلى أيار/مايو 1999 تم اختيار 1600 طفل اختياراً عشوائياً من جميع المدارس الحكومية، لمعرفة ما إذا كانوا مصابين بالدُّراق أم لا. وتم اختيار 50% من هؤلاء الأطفال عشوائياً لتقييم مستوى اليود في البول. وقد تبيَّن إصابة 26 فقط من هؤلاء الأطفال (1.7%) بالدُّراق. وعلى الرغم من أن متوسط مستوى اليود في البول كان أكثر من 100 مكروغرام باللتر، فإن مستويات اليود في البول لدى 121 طفلاً من 749 (16.2%) كانت منخفضة. ومع أن عَوَز اليود لا يمثِّل مشكلة من مشكلات الصحة العمومية في البحرين، فإن التثقيف فيما يتعلق بالقيمة التغذوية للملح المُيَوْدَن في الوقاية من هذا الاضطراب يمكن أن يزيد من وعي الجمهور.

ABSTRACT A cross-sectional survey of primary-school children in Bahrain was conducted to estimate the prevalence of goitre and iodine deficiency according to age, sex and area of residence. During January–May 1999, 1600 children were randomly chosen from all government schools. Children were examined for goitre and of those, 50% were randomly selected for urinary iodine level assessment. Only 26 children (1.7%) had goitre. Although median urinary iodine was above 100 µg/L, 121 of 749 children (16.2%) had low urinary iodine levels. Although iodine deficiency does not pose a significant public health problem in Bahrain, education about the nutritional value of iodized salts in the prevention of this disorder could increase public awareness.

Etude nationale sur la prévalence des troubles dus à une carence en iode chez des écoliers âgés de 8-12 ans à Bahreïn

RESUME Une enquête transversale a été réalisée auprès d' écoliers du primaire à Bahreïn pour estimer la prévalence du goitre et de la carence en iode en fonction de l'âge, du sexe et du lieu de résidence. De janvier à mai 1999, 1600 enfants ont été choisis au hasard dans toutes les écoles gouvernementales. Les enfants ont été examinés à la recherche de goitre et 50 % de ceux-ci ont été choisis au hasard pour une évaluation du taux d'iode urinaire. Seuls 26 enfants (1,7 %) avaient un goitre. Si la médiane pour l'iode urinaire était supérieure à 100 µg/L, 121 des 749 enfants (16,2 %) avaient un faible taux d'iode urinaire. Bien que la carence en iode ne pose pas de problème de santé publique majeur à Bahreïn, l'éducation sur la valeur nutritionnelle des sels iodés pour la prévention de cette carence pourrait accroître la sensibilisation du public.

[1]Nutrition Section; [2]Primary Care and Public Health; [3]Public Health Directorate; [4]Public Health Laboratory, Ministry of Health, Manama, Bahrain.
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Introduction

Iodine is an essential element for human survival. It is needed for growth and development, even before birth [*1*]. Although iodine is an important micronutrient, it is needed only in very small quantities. In order to prevent deficiency, a person needs only 250 µg of iodine per day, and over a lifetime, the total quantity of iodine needed is only one teaspoonful [*2*]. Healthy humans require iodine, an essential component of the thyroid hormones. Failure to have adequate iodine leads to insufficient production of these hormones, which may affect various parts of the body, resulting in a number of pathological conditions known as iodine deficiency disorders (IDD) [*2*].

Iodine deficiency continues to be a significant public health problem in many countries. The deficiency not only causes goitre, it may also result in abortion, stillbirth, mental retardation, growth retardation, irreversible brain damage and retarded psychomotor development in the fetus, the infant and the child. It also affects reproductive functions and impedes learning ability [*3*]. Iodine deficiency is recognized as the most common preventable cause of brain damage in the world today [*4*].

Of the 191 Member States of the World Health Organization (WHO), 130 are affected by IDD. At least 2225 million people live in iodine deficient environments and are thus at risk of IDD. At least 740 million of these are thought to be affected by goitre. The Eastern Mediterranean Region of the WHO has the highest regional prevalence (32%) where approximately 348 million (74%) of the population is at risk of iodine deficiency [*5*].

We are unaware of any previous attempt to study the prevalence of IDD in Bahrain. Therefore, we conducted this national epidemiological survey among Bahraini schoolchildren aged 8–12 years during January–May 1999 to assess iodine status in Bahrain through the clinical assessment of the thyroid gland and urinary iodine estimation. We aimed to determine the prevalence IDD among schoolchildren in Bahrain and their distribution in relation to demographic characteristics, and to establish baseline data on IDD in Bahrain as this information is scarce or lacking.

Methods

Bahrain consists of several islands in the Gulf, situated 20 km east of Saudi Arabia. The total area of Bahrain is 706 km^2 [*6*]. The population of Bahrain was 0.64 million people in 1998, 39.2% of whom were expatriates. The population is young with 30.9% under the age of 15 years [*7*].

Health services in Bahrain are organized into primary, secondary and tertiary health care. Health services are provided free of charge to the population. With a view to making geographical access to health services more equitable and easier, the health authorities have divided the country into four catchment areas, each with a satellite of health centres.

Children aged 8–12 years were the target group of this survey. This group is highly vulnerable to IDD and a good representation of the group can be achieved from school attendance rosters in Bahrain since the default rate is low. The calculation of sample size was based on 50% prevalence of IDD in order to maximize the sample size, 95% confidence limits and 5% absolute precision; therefore, the initial sample size was determined to be 384 [*8*]. This figure was multiplied by 4 (bringing the sample size to 1536) to allow for design effects due to application of the cluster sampling method. The ultimate sample needed for the study was determined to be

1600 children. A multistage cluster sampling technique was applied to select 40 children from each of 40 cluster schools chosen at random. Clusters were identified using a random digit for the first cluster and the cluster interval to identify the subsequent clusters.

For each cluster school a list of students registered in the primary classes was obtained from the Ministry of Education. Forty children from the list were chosen by a systematic random method. Every second child interviewed in each cluster school was also chosen for the purpose of urinary iodine estimation, i.e. 50% of the 1600 schoolchildren.

Using a pre-designed questionnaire, sociodemographic data were recorded from the student's school record by nutritionists. A general surgeon examined the necks of the children for visible and palpable thyroid goitre [*9*].

Samples of urine were collected in sterile containers and were transported to the Public Health Laboratory in ice-boxes. These were stored at 4 °C and analysed within 10 days of collection. The WHO-recommended method was used without modification for the estimation of iodine in urine [*10*]. Although each assay was performed under exact conditions, blanks and standards of 20, 50, 100 and 150 µg/L were run in duplicate each time. An average of the two readings was used to construct a standard curve on graph paper by plotting iodine concentration of each standard on the abscissa against its optical density at 405 nm on the ordinate. Results were read off the plotted graph. Exact concentration was recorded when readings were between 20 and 100 µg/L. Samples outside of this range were recorded as < 20 or >100 µg/L. All samples with results of < 20 µg/L were repeated in duplicate for confirmation of the results. Data were entered and stored in a database file created on *Epi-Info*.

The result of the thyroid gland examination was graded based on a modified WHO goitre classification system, i.e. grade 0 = no goitre; grade 1 = visible but not palpable goitre; and grade 2 = visible and palpable goitre [*10*].

IDD severity was calculated based on goitre prevalence among school-age children (mild IDD = 5.0%–19.9%; moderate IDD = 20.0%–29.9%; and severe IDD = 30.0% or higher) [*10*].

The criteria used for assessing severity of IDD based on median urinary iodine levels used the cut-off points and prevalence levels proposed for the classification of iodine deficiency into degrees of public health significance (severe IDD with median < 20 µg/L; moderate IDD with median 20–49 µg/L; mild IDD with median 50–99 µg/L; and no deficiency with median ≥ 100 µg/L) [*10*].

Results

A total of 1600 school children aged 8–12 years were included in the study. The male-to-female ratio was 1:1. Nearly an equal number of children in each age group was examined (Table 1).

Table 2 shows the distribution of goitre according to grade and geographic region. Grade 1 goitre (1.6%) was mainly found in Jidhafs, Central, Hamad Town and Isa Town regions, while grade 2 goitres (0.1%) was found in the Central region. The total goitre rate, i.e. goitre grade 1 and 2, was approximately 1.7%, which meant no deficiency at the population or national level according to WHO classification [*10*].

The age and sex distribution of goitre (Figure 1) indicates that goitre was more

Table 1 **Age and sex distribution of the 1600 schoolchildren**

Age (years)	Males		Females		Total	
	No.	%	No.	%	No.	%
8	169	47.3	188	52.7	357	22.3
9	161	50.0	161	50.0	322	20.1
10	162	48.2	174	51.8	336	21.0
11	179	51.9	166	48.1	345	21.6
12	129	53.8	111	46.3	240	15.0

common among males than females in the 8–12 years age group.

Of the 800 children (50% of the total sample) selected for the urinary iodine estimation, 51 (6.4%) refused to provide a urine sample. Results from the remaining 749 subjects (93.6%) based on sex, age, geographic distribution as well as the degree of urinary iodine deficiency are shown in Tables 3, 4 and 5 respectively. Table 3 shows the overall prevalence of iodine deficiency, which was approximately 16.2%, with a prevalence rate of 15.8% for males and 16.5% for females. However, the sex difference was not statistically significant ($\chi^2 = 0.60$, $P = 0.711$).

The prevalence of iodine deficiency according to degree and age distribution ranged from 11.9% among children aged 12 years and 18.7% among children aged 10 years (Table 4). These differences were also not statistically significant.

With regard to geographic distribution of iodine deficiency (Table 5), IDD were most common in the Central region (35.8%), followed by the Manama region (24.5%) and the Isa Town region (20.0%). This geographic distribution was statistically significant ($\chi^2 = 37.08$, $P < 0.001$).

The median urinary iodine was above 100 µg/L, i.e. there was no deficiency at the population level according to WHO

Table 2 **Prevalence and grade of goitre according to geographic region**

Region	Grade of goitre						Total	
	0		1		2			
	No.	%	No.	%	No.	%	No.	%
Muharraq	242	99.6	1	0.4	0	0.0	243	100.0
Manama	213	99.1	2	0.9	0	0.0	215	100.0
Jidhafs	130	94.9	7	5.1	0	0.0	137	100.0
Northern	111	98.2	2	1.8	0	0.0	113	100.0
Sitra	121	99.2	1	0.8	0	0.0	122	100.0
Central	108	95.6	4	3.5	1	0.9	113	100.0
Isa Town	126	97.7	3	2.3	0	0.0	129	100.0
Riffa	154	98.7	2	1.3	0	0.0	156	100.0
Western	85	100.0	0	0.0	0	0.0	85	100.0
Eastern	40	100.0	0	0.0	0	0.0	40	100.0
Hamad Town	244	98.8	3	1.2	0	0.0	247	100.0
Total	1574	98.4	25	1.6	1	0.1	1600	100.0

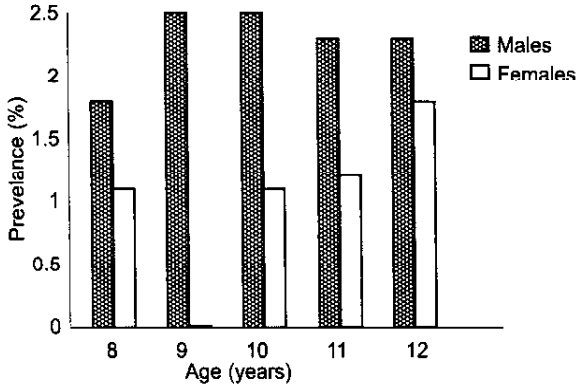

Figure 1 **Prevalence of goitre among the sample by age and sex**

Table 3 **Prevalence of iodine deficiency among the sample by degree and sex**

Sex	Total		Degree						Overall prevalence	
			Mild		Moderate		Severe			
	No.	%	No.	%	No.	%	No.	%	No.	%
Male	385	51.4	52	13.5	7	1.8	2	0.5	61	15.8
Female	364	48.6	48	13.2	10	2.7	2	0.5	60	16.5
Total	749	100.0	100	13.4	17	2.3	4	0.5	121	16.2

$\chi^2 = 0.68$, P = 0.711.

Table 4 **Prevalence of iodine deficiency among the sample by degree and age**

Age (years)	Total		Degree						Overall prevalence	
			Mild		Moderate		Severe			
	No.	%	No.	%	No.	%	No.	%	No.	%
8	182	24.3	18	9.9	5	2.7	3	1.6	26	14.3
9	142	19.0	21	14.8	3	2.1	0	0.0	24	16.9
10	155	20.7	23	14.8	6	3.9	0	0.0	29	18.7
11	161	21.5	25	15.5	3	1.9	1	0.6	29	18.0
12	109	14.6	13	11.9	0	0.0	0	0.0	13	11.9
Total	749	100.0	100	13.4	17	2.3	4	0.5	121	16.2

Table 5 **Prevalence of iodine deficiency among the schoolchildren by degree and geographic region**

Region	Total		Degree						Overall prevalence	
			Mild		Moderate		Severe			
	No.	%	No.	%	No.	%	No.	%	No.	%
Muharraq	115	15.4	10	8.7	1	0.9	0	0.0	11	9.6
Manama	102	13.6	21	20.6	4	3.9	0	0.0	25	24.5
Jidhafs	65	8.7	7	10.8	2	3.1	2	3.1	11	16.9
Northern	55	7.3	5	9.1	1	1.8	1	1.8	7	12.7
Sitra	56	7.5	10	17.9	0	0.0	0	0.0	10	17.9
Central	53	7.1	15	28.3	4	7.5	0	0.0	19	35.8
Isa Town	55	7.3	8	14.5	3	5.5	0	0.0	11	20.0
Riffa	77	10.3	4	5.2	0	0.0	0	0.0	4	5.2
Western	39	5.2	4	10.3	0	0.0	0	0.0	4	10.3
Eastern	20	2.7	0	0.0	0	0.0	0	0.0	0	0.0
Hamad Town	112	15.0	16	14.3	2	1.8	1	0.9	19	17.0
Total	749	100.0	100	13.4	17	2.3	4	0.5	121	16.2

classification. However, at the individual level 16.2% had low urinary iodine concentration. Of these, 13.4% presented with mild deficiency, 2.3% with moderate deficiency and only 0.5% with severe deficiency (Table 5). Most of these were from Jidhafs, Northern region and Hamad Town.

Table 6 **Cross comparison of urinary iodine level and goitre status**

Urinary iodine level	Goitre				Total	
	Absent		Present			
	No.	%	No.	%	No.	%
Normal	618	98.4	10	1.6	628	83.8
Iodine deficient	116	95.9	5	4.1	121	16.2
Total	734	98.0	15	2.0	749	100.0

$\chi^2 = 3.33$, P = 0.06.

The cross comparison of urinary iodine level and the status of goitre is given in Table 6. Of the 121 (16.2%) children with low urinary iodine level, 5 (4.1%) had goitre of grade 1 and 2, while 116 (95.9%) had no goitre. This correlation was not statistically significant ($\chi^2 = 3.33$, $P = 0.068$).

Discussion

The study was designed to address the public health importance of IDD in Bahrain. It was the first of its kind in this country to assess iodine status among school-age children by using at least two indicators as recommended by WHO, combining both the clinical examination of the thyroid gland together with urinary iodine estimation. Although use of ultrasonography is

considered to be a more precise and objective method for assessing thyroid size, it was not used because of the high cost [*11*].

The prevalence rate of goitre using the traditional clinical method of determining thyroid gland size by inspection and palpation found that only 1.7% of the examined children had goitre grades of 1 and 2, i.e. total goitre rate (TGR) was 1.7%.

According to the WHO criteria, the TGR in Bahrain does not seem to be a public health problem. WHO recommends that a TGR of 5% or more in primary-school children of 6–12 years of age be used to signal the presence of a public health problem [*10*]. This recommendation is based on the observation that in a normal iodine-replete population the prevalence of goitre should be quite low. The 5% cut-off point allows for some margin of inaccuracy in goitre assessment and for goitre that may occur in iodine-replete populations due to other causes such as goitrogens and autoimmune thyroid disease.

The goitre rate determined in our study was very low compared with the prevalence rates of other neighbouring countries. For example, in Oman, 3061 schoolchildren aged 9–12 years were examined for the presence of goitre and graded according to the old WHO classification system. It was determined that 10% showed signs of goitre grades 1a, 1b and 2. Cases of grade 3 goitre were not seen and 88.1% of the sample did not have signs of goitre [*12*]. In Saudi Arabia, the highest prevalence rate of goitre among schoolchildren aged 8–10 years in the southern province, mainly in the Asir region, was found to be 22% for grade 1 goitre and 8% for grade 2 goitre. On the other hand, the lowest prevalence of grade 1 goitre was found in Riyadh (8%) [*13*]. In an endemic area such as India, it was found that the TGR among schoolchildren in Delhi was 20.5% even 5 years after the implementation of a salt iodination programme [*14*].

The sample distribution among the 11 geographic regions of Bahrain was proportional to the concentration of the population in those regions. The prevalence rate for goitre in 8 of the 11 regions was 0.0% to 1.8%. Only in Jidhafs was the prevalence 5.1%, slightly higher than the 5.0% total goitre rate recognized by WHO as a signal for a public health problem [*10*]. The overall rate for the country of Bahrain was much less than 5.0%.

Although statistically insignificant, goitre was more common among boys than girls of the same age. This difference between the sexes warrants further study. Although there was a difference in rate of goitre between the sexes, no difference in iodine deficiency was observed. The overall IDD for the two sexes were very similar.

There was no difference by age for overall prevalence of IDD, although 3 of the 4 children with severe iodine deficiency were 8 years of age, i.e. they belonged to the youngest age group in the study.

Although IDD prevalence by geographic region was statistically insignificant, the rates for some of the regions, such as the Central and Manama regions at 35.8% and 24.5% respectively, were higher than for other regions. In fact, mild to moderate deficiency was highest for both the Central and Manama regions. Considering the small size of the country, it is difficult to attribute these differences to geographic location or availability of different types of food in the two regions. The only derivable conclusion is the possible predilection of the populations for different types of foods.

Bahrain does not meet the WHO criteria for defining IDD as a public health problem since our estimated prevalence rate of median urinary iodine level was above 100 µg/L. Nevertheless, 16.2% of schoolchil-

dren had a urinary iodine level < 100 µg/L, which requires further assessment and continuous monitoring for possible exposure to goitrogenic substances. Further investigations to assess and promote the availability and accessibility of iodized salt are necessary in order to ensure that IDD remain under control.

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