National Study On The Prevalence of Iodine Deficiency Disorders Among School Children Aged 8-12 years old in Bahrain

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2000

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Acknowledgements

This study was partially supported by Joint Ministry of Health and World Health Organization Regional Office (JPRM) fund.

The staff of the nutrition section (Ms. Ghada Al-Raees, Mrs. Manal Al-Sairafi and Mrs. Mariam Al-Amer) have cooperated and assisted fully in the field work, data entry and analysis.

We are indebted to Dr. Mohammed Rafie, General Surgeon at Salmaniya Medical Complex for his cooperation in conducting neck examination at schools.

Sincere thanks to the Ministry of Education officials and school administrators for their support and cooperation.

Abstract

Background

Iodine deficiency disorder (IDD) Continues to be an important public health problem in many countries. In the Eastern Mediterranean Region, 348 million (74% of the population) are considered to be at risk of iodine deficiency. The main objective of this study was to estimate the prevalence of goitre and iodine deficiency among school children in Bahrain.

Methods

A cross-sectional survey of primary school children was carried out. A total of 1600 children were chosen at random from all government schools using the multistage cluster sampling method. Selected children were examined for goitre by a surgeon and 50% of them were chosen at random for urinary iodine level assessment. Prevalence estimates of goitre and IDD (mild, moderate, severe) was illustrated according to age, sex and area of residence.

Results

Out of 1600 children examined, only 26 (1.7%) were found to have goitre. On the other hand, 121 out of 749 (16.5%) children tested had low urinary iodine levels. This prevalence of IDD was slightly lower for boys (15.8%) compared to girls (16.5%), and showed some geographic variation.

Conclusions

IDD does not seem to constitute a public health problem in Bahrain, yet IDD is affecting some children. Health education can help in increasing public awareness about the nutritional value of iodized salts in the prevention of this disorder in order to maintain this low level and to ensure that IDD remains under control..

1- 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, which is an essential component of the thyroid hormones. Failure to have adequate iodine leads to insufficient production of these hormones, which affect many different parts of the body, resulting in a number of pathologic conditions known as the Iodine Deficiency Disorders (IDD) [2].

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

Of WHO's 191 member states, 130 are affected by IDD. At least 2,225 million people, live in iodine deficient environments and are thus at risk of IDD, and at least 740 million of these (13%) are considered to be affected by goiter. The highest regional prevalence is the Eastern Mediterranean Region (32%), and in this region about 348 million (74%) of the population is considered to be at risk of iodine deficiency [5].

As far as we are aware, no previous attempt has been made to study the prevalence of IDD in Bahrain. Therefore, we have conducted this national epidemiological survey among Bahraini school children aged 8-12 years old for assessing the iodine status in Bahrain, through clinical assessment of thyroid gland, and urinary iodine estimation.

2- Aim of the study

Data regarding Iodine Deficiency Disorders (IDD) in Bahrain are scarce and even lacking. Therefore, this study aims at establishing baseline data for planning, monitoring and evaluating the nutrition intervention program.

3- Specific Objectives

1- To determine the Prevalence of Iodine Deficiency Disorders (IDD) among school children in Bahrain.

2- To determine the distribution of IDD if present, in relation to demographic characteristics.

4- Subjects & Methods:

4.1. The setting

The State of Bahrain consists of several islands in the Arabian Gulf, situated 20 km. east of Saudi Arabia. The total area of Bahrain is 706 sq. km. The island is arid, receiving as low as 22 mm of rain annually [6].

The population of Bahrain was 0.64 million in 1998 of whom 39.2 were expatriates, mostly from the Indian subcontinent. The population is young, with 30.9% under the age of 15 years [7].

Oil and gas, aluminum products, banking, tourism, and food industries are the mainstay of the economy. In 1998, statistics indicated that the Gross Domestic Product (GDP) in US$ 8957 and the Gross National Product (GNP) in US$ 8043 [7].

In the past two decades, there has been a progressive change in socioeconomic development due to oil revenues. This has led to a shift in the way Bahrainis earn their livings from agriculture and fishing to sedentary jobs in the oil and service sectors.

Health services in Bahrain are organized into primary, secondary and tertiary health care hospitals, including high technology medicine. Health services are provided free of charge to the population. With a view to making geographical access to health services equitable and easier, the health authorities have divided the country into four catchment areas (health regions), each with a satellite of health centers.

Socio-economic conditions have improved a lot during the past years, which caused a dramatic fall in the infant mortality rate from 18 per 1000 in 1993 to 8.5 per 1000 in 1998, and an under – 5 mortality rate from 22 per 1000 in 1993 to 11.1 per 1000 in 1998. This was mainly due to the improvement of the health services provided by the country, as both primary, secondary and tertiary health care services. The maternal

mortality rate was 0.15 per 1000 live births in 1998, as well as a relatively high life expectation of 72.9 years in 1998. The crude birth rates and death rates during 1998 were 20.3% and 3.1% respectively [8].

4.2. Population & Sampling Design

4.2.1. Study population

Children aged 8 to 11 years were the target group of this survey. This group is highly vulnerable to IDD and good representation of the group can be achieved from school attendance roster in Bahrain since the defaulter rate is considerably low.

4.2.2. Sample size

Sample size was calculated using the equation

$N = Z^2 P(1-P)/d^2$ where

Z = the standard normal deviate at confidence level $_1 - \propto/^2$

P = the prevalence of IDD

d = absolute precision

Based on 50% prevalence of IDD (in order to maximize the sample size), 95% confidence limits and 5% absolute precision, the sample size was calculated to be 384.

This was multiplied by 4 (bringing the sample size up to 1536) to allow for design effect due to application of cluster sampling method as recommended by Lawaya and Lemeshow [9]. The ultimate sample size required for the study was determined at 1600 children.

4.2.3. Sampling method

Multi-stage cluster sampling technique was applied to select 40 children from each of 40 cluster schools chosen at random as follows :-

a. A list showing names of all government boys and girls primary schools, the number of students in each school and the cumulative number of students was prepared.
b. The total number of students in all of the schools was 27453. This was divided by 40 to obtain the cluster interval (686).
c. A random digit between 1 and 686 was produced. The first cluster school was the one in which the

corresponding cumulative number contained the random digit.

d. The class interval value was added to the random digit value in point (c) and the second cluster school was the next school in which the corresponding cumulative number contained the resulting summed value.
e. The following clusters were identified by keeping adding the cluster interval to the total summed value which identified the previous cluster.
f. For each cluster school a list of students actually registered in the primary classes targeted by the study was obtained from the Ministry of Education. Forty children from the list were chosen by systematic random method.
g. Every 2nd child interviewed in each cluster school was also chosen for the purpose of the Urine Iodine Study (i.e. 50% of the 1600 school children).

4.3. Data collection

Data collection was divided into 3 main parts:-

4.3.1. Socio-demographic data:

Using a pre-designed questionnaire, socio-demographic data were recorded from the student school record by nutritionists (Appendix A).

4.3.2. Thyroid gland examination:

Children underwent neck examination for visible and palpable thyroid goiter, that was carried out by a general surgeon as described elsewhere [10].

4.3.3. Laboratory procedure

Urine samples were sent to the Public Health Laboratory for iodine estimation. This is one of the methods used in assessing the IDD and considered as a good marker of dietary iodine intakes.

A urine sample was taken from every second child in the cluster. Samples of urine collected in sterile containers were transported to the laboratory in ice boxes. These were stored at 4^{o} C and analyzed within 10 days of collection.

The method used required the sample to be digested with chloric acid and the iodine determined spectrophotometrically by its catalytic role in the reduction of ceric ammonium sulphate in the presence of arsenious acid. The method is described in details elsewhere [11].

A 36 place heating block under perchloric acid safety cabinet was used. A maximum of 36 samples including blanks and standards in duplicate were run in each assay.
Although each assay was carried out 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 for plotting the graphs.

We found that an analog stop watch was more convenient to use than a digital one in exact timing of the intervals between reagent addition and taking of readings.

The optical density was read at 405nm using a Zeiss DM4 spectrophotometer.

Standards of 0, 20, 50, 100 and 150µg/L were run with each assay. An average of the two optical density 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 to 100 µg/L. Samples out of this range were recorded as <20 or > 100 µg/L. All samples giving results of < 20 µg/L were repeated in duplicate for confirmation of results.

4.4. Data Analysis

Data were entered and stored on a computer data base file created from Epi-Info software, CDC, Atlanta.

The result of thyroid gland examination was graded based on modified WHO goiter classification system, [11] as following:

Grade 0 : 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 also 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.

The IDD severity was calculated based on goiter prevalence in school-age children as in the following [11]:

Mild IDD	:	5.0 - 19.9%
Moderate IDD	:	20.0 - 29.9%
Severe IDD	:	$\geq$ 30.3%

The criteria used for assessing severity of IDD based on median urinary iodine levels was based on the cutoff points and prevalence levels proposed for the classification of iodine deficiency into different degrees of public health significance as follows [11]:-

Severe IDD with median	< 20 µg/1
Moderate IDD with median	20 – 49 µg/1
Mild IDD with median	50 – 99 µg/1
No deficiency with median	$\geq$ 100 µg/1

5- Results:

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

The distribution of the sample according to the eleven geographic regions is given in Table 2. The frequency distribution ranges from as low as 40 (2.5%) from Eastern region to as high as 247 (15.4%) from Hamad Town region.

The results of neck examination as graded according to the modified WHO classification [11] , are given in Table 3. Only 1 (0.1%) subject was found to have a thyroid swelling of grade 2, while 25 (1.6%) exhibited grade 1 and 1574 (98.4%) did not present any abnormality and were graded as "zero".

Table 4 shows the distribution of goitre according to the geographic regions. The 1.6% of grade 1 goitre were mainly from the Jidhafs, Central, and Isa Town regions, while 0.1% with grade 2 goitre were from the central region. The total goitre rate i.e. goitre grade 1 and 2 was around 1.7% which means no deficiency at the population or national level according to WHO classification.

The age and sex distribution of goiter as shown in Figure 1 indicates that the goiter is more common among boys than girls in the 8 – 12 years old age group.

Of the 800 subjects (50% of the total sample) selected for the urinary iodine estimation, 51 (6.4%) of them refused to provide urine sample. Results of the remaining 749 subjects (93.6%) based on sex, age and geographic distribution are shown in Tables 5, 6 and 7, respectively.

Table 5 shows the overall prevalence of iodine deficiency, which was around 16.2%, with prevalence rate of 15.8% for boys and 16.5% for girls. However, the sex difference was statistically not significant p value = 0.864 and $x^2 = 0.06$.

The prevalence of iodine deficiency based on age distribution is shown in Table 6, which ranges from 11.9% among the age group of 12 years and 18.7% among the age of 10 years. Nevertheless these differences were statistically not significant p value = 0.281.

With regard to the geographic distribution of iodine deficiency it was most common in Central region (35.8%), followed by Manama region (24.5%) and Isa Town region (20.0%). This geographic distribution was statistically significant (p value = < 0.001, x^2 = 37.08) as shown in Table 7.

The median urinary iodine was above 100 µg/l i.e. no deficiency at the population level according to WHO classification. However, at the individual level still 16.2% have had low urinary iodine concentration of which 13.4% of them presented with mild deficiency, 2.3% with moderate deficiency and only 0.5% with severe deficiency as shown in Table 7. Most of these were from Jidhafs, Northern and Hamad Town regions.

The correlation of iodine deficiency with presence of goiter is given in Table 8. Of the 121(16.2%) subjects with low urinary iodine level 4 (3.3%) had goiter of grade 1 and only 1 (0.8%) with goiter grade 2, while 116 (95.9%) had no goiter.

The prevalence and grade of goiter in different geographic regions with their corresponding urinary iodine concentration results are given in Table 9.

6. Discussion and Recommendations

This study which was the first on this subject in Bahrain was designed to address the public health importance of Iodine Deficiency Disorders (IDD). It is also 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 thyroid gland together with urinary iodine estimation. Although use of ultra-sonography is considered to be a more precise and objective method for assessing the thyroid size it was not used because of it's high cost [12].

The prevalence rate of goiter using the traditional clinical method for determining thyroid gland size by inspection and palpation showed that only 1.7% of the examined subjects were with goiter grades of 1and 2 (total goiter rate (TGR) as defined by the WHO goiter classification system [11] .

According to the WHO criteria of classification, 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 to 12 years of age be used to signal the presence of a public health problem [11]. This recommendation is based on the observation that in a normal iodine replete population the prevalence of goiter should be quite low. The cut – off of 5% allows some margin of inaccuracy of goiter assessment and for goiter that may occur in iodine replete populations due to other causes such as goitrogens and autoimmune thyroid disease.

This rate is very low compared to the prevalence rates in other Gulf countries. For example when in Oman 3061 school children of 9-12 years age group were examined for the presence of goiter and graded according to the old WHO classification system, the results revealed that 10% of the population showed signs of goiter grades 1a, 1b and 2. Cases of grade 3 were not seen, and 88.1% of the sample did not show goiter [13]. However, in Saudi Arabia, the highest prevalence rate of goiter among school children of 8-10 years age in southern province mainly in Assir region was found to be 22% for grade 1 goiter and 8% for grade 2 goiter. On the other hand, the lowest prevalence of goiter 8% grade 1 was found in Riyadh city [14]. However when this figure is compared to those in the endemic areas like India, it was found that the TGR among school children in Delhi was 20.5% even after five years implementation of salt iodization program [15].

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

Although statistically insignificant goiters were more common among boys as compared to girls of the same age. This difference in the two sexes is something which might need further studies.

Contrary to the difference in rate of goiter between the two sexes no difference was observed in terms of iodine deficiency. The overall IDD in the two sexes is 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 which was the youngest in the study group.

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

In conclusion, using WHO criteria in this study for defining IDD as a public health problem, our estimated prevalence indicated that such a problem does not exist in Bahrain as the median urinary iodine level was above 100 µg/l. Nevertheless 16.6% had urinary iodine level < 100 µg/l. However, further investigations and market research is needed to assess the availability and accessibility of iodized salt thus ensuring that IDD remains under control. On the other hand more awareness among the population through dietary health education will help improve whatever little iodine deficiency has been noted during this study.

Table 1: Age and sex distribution of the sample.

Age (yrs)	Sex				Total	
	Males		Females			
	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
Total	**800**	**50.0**	**800**	**50.0**	**1600**	**100**

Table 2: Distribution of the sample according to the geographic regions.

Geographic region	Frequency	Percentage (%)
Muharraq	243	15.2
Manama	215	13.4
Jidhafs	137	8.6
Northern	113	7.1
Sitra	122	7.6
Central	113	7.1
Isa Town	129	8.1
Riffa	156	9.8
Western	85	5.3
Eastern	40	2.5
Hamad Town	247	15.4
Total	**1600**	**100**

Table 3: Prevalence of goiter among the sample.

Grade	Frequency	Percentage
0	1574	98.4
1	25	1.6
2	1	0.1
Total	**1600**	**100**

Figure 1: Prevalence of goiter among the sample by age and sex.

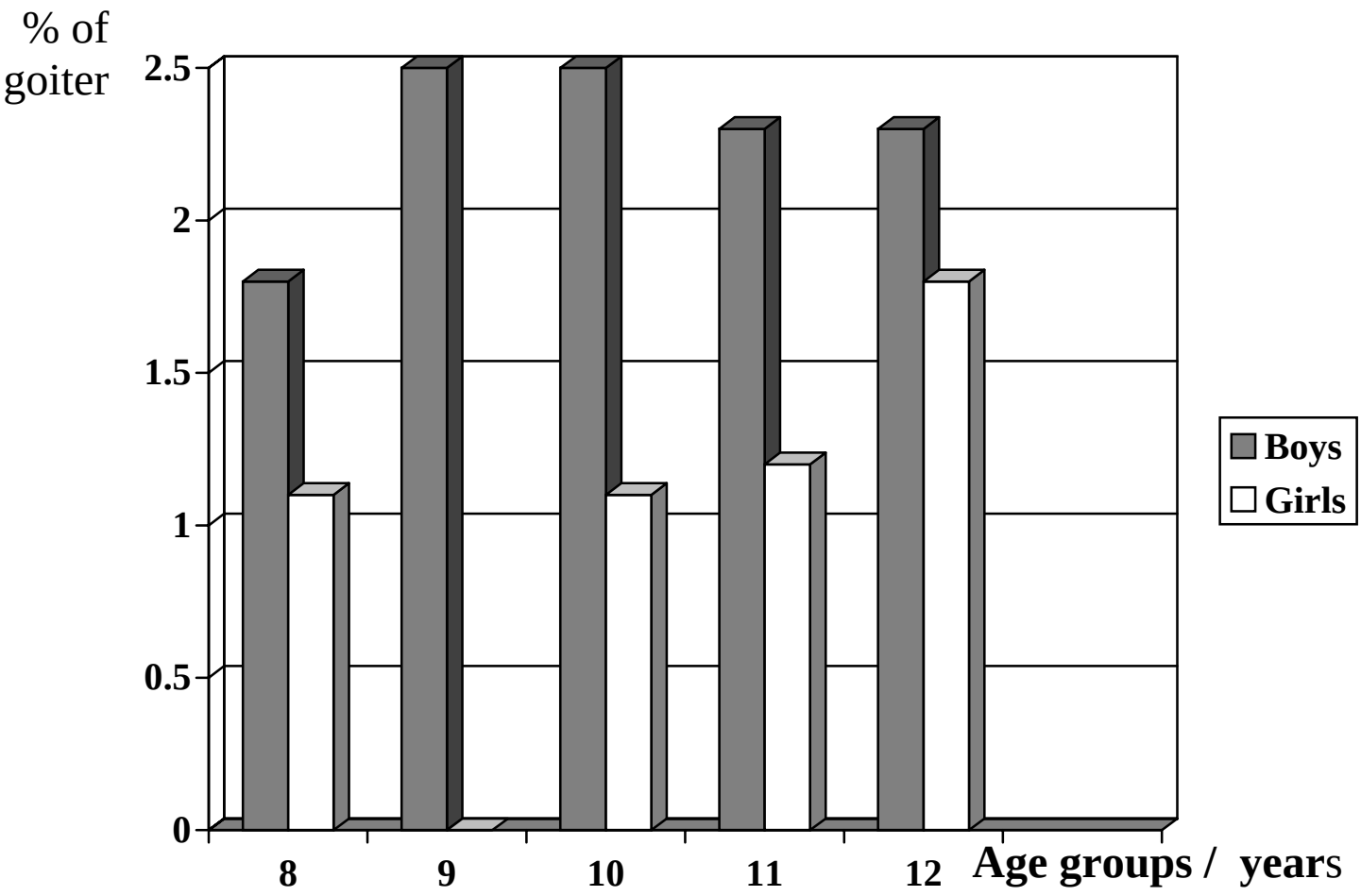

Table 4: Prevalence and grade of goiter in different geographic regions.

Geographic Region	Grade of goiter						Total	
	0		1		2			
	No.	%	No.	%	No.	%	No.	%
Muharraq	242	99.6	1	0.4	0	0.0	243	15.2
Manama	213	99.1	2	0.9	0	0.0	215	13.4
Jidhafs	130	94.9	7	5.1	0	0.0	137	8.6
Northern	111	98.2	2	1.8	0	0.0	113	7.1
Sitra	121	99.2	1	0.8	0	0.0	122	7.6
Central	108	95.6	4	3.5	1	0.9	113	7.1
Isa Town	126	97.7	3	2.3	0	0.0	129	8.1
Riffa	154	98.7	2	1.3	0	0.0	156	9.8
Western	85	100	0	0.0	0	0.0	85	5.3
Eastern	40	100	0	0.0	0	0.0	40	2.5
Hamad Town	244	98.8	3	1.2	0	0.0	247	15.4
Total	**1574**	**98.4**	**25**	**1.6**	**1**	**0.1**	**1600**	**100**

Table 5: Prevalence of iodine deficiency among the sample by sex.

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

Table 6: Prevalence of iodine deficiency among the sample by age.

Age (yrs)	Total		Mild		Moderate		Severe		Overall prevalence of IDD	
	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**	**100**	**13.4**	**17**	**2.3**	**4**	**0.5**	**121**	**16.2**

Table 7: Prevalence of iodine deficiency among the sample by geographic region.

Health region	Total		Mild		Moderate		Severe		Overall prevalence of IDD	
	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**	**100**	**13.4**	**17**	**2.3**	**4**	**0.5**	**121**	**16.2**

Table 8: Cross comparison of urinary iodine level and the grade of goiter:

Urinary iodine level	Goiter grade						Total	
	0		1		2			
	No.	%	No.	%	No.	%	No.	%
Normal	618	98.4	10	1.6	0	0.0	628	83.8
Iodine deficient	116	95.9	4	3.3	1	0.8	121	16.2
Total	**734**	**98.0**	**14**	**1.9**	**1**	**0.1**	**749**	**100**

Table 9: Prevalence of goiter and iodine deficiency among the sample by geographic regions.

Geographic region	Goiter grade						Total		Iodine deficiency				Total	
	0		1		2				No		Yes			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Muharraq	242	99.6	1	0.4	0	0.0	**243**	**15.2**	104	90.4	11	9.6	**115**	**15.4**
Manama	213	99.1	2	0.9	0	0.0	**215**	**13.4**	77	75.5	25	24.5	**102**	**13.6**
Jidhafs	130	94.9	7	5.1	0	0.0	**137**	**8.6**	54	83.1	11	16.9	**65**	**8.7**
Northern	111	98.2	2	1.8	0	0.0	**113**	**7.1**	48	87.3	7	12.7	**55**	**7.3**
Sitra	121	99.2	1	0.8	0	0.0	**122**	**7.6**	46	82.1	10	17.9	**56**	**7.5**
Central	108	95.6	4	3.5	1	0.9	**113**	**7.1**	34	64.2	19	35.8	**53**	**7.1**
Isa Town	126	97.7	3	2.3	0	0.0	**129**	**8.1**	44	80.0	11	20.0	**55**	**7.3**
Riffa	154	98.7	2	1.3	0	0.0	**156**	**9.8**	73	94.8	4	5.2	**77**	**10.3**
Western	85	100	0	0.0	0	0.0	**85**	**5.3**	35	89.7	4	10.3	**39**	**5.2**
Eastern	40	100	0	0.0	0	0.0	**40**	**2.5**	20	100	0	0.0	**20**	**2.7**
Hamad Town	244	98.8	3	1.2	0	0.0	**247**	**15.4**	93	83.0	19	17.0	**112**	**15.0**
Total	**1574**	**98.4**	**25**	**1.6**	**1**	**0.1**	**1600**	**100**	**628**	**83.8**	**121**	**16.2**	**749**	**100**

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Appendix (A)

National Study on The of Iodine Deficiency Disorders Among School Children Aged 8-12 years old in Bahrain

(Questionnaire)
1999

1- Socioeconomic Data:

1 . Serial No. ☐☐☐☐

2 . Date (d/m/y) ☐☐☐☐☐☐

3 . Date of Birth ☐☐☐☐☐☐

4 . Name: _____

5 . C.P.R. ☐☐☐☐☐☐☐☐☐

6 . School Name: _____

7 . Block No. _____ .

8 . Health Region : ☐

9 . Geo. Region : ☐

10. Sex:

Male ☐
Female ☐

11. Age: ☐☐

12. Class : ☐

2. Physical Examination:

13. Thyroid gland palpation

- Grade 0: 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 also 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. ☐

3. Laboratory Test:

14. Urinary Iodine Level: ☐☐☐
(μ / l)