Iodine deficiency disorders among primary-school children in Kafr El-Sheikh, Egypt

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اضطرابات عوز اليود بين تلاميذ المدارس الإبتدائية بمحافظة كفر الشيخ ، مصر

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خلاصة : تم تقدير معدل انتشار عوز اليود بين تلاميذ المدارس الإبتدائية في محافظة كفر الشيخ ، حيث اختير 2250 تلميذا بالمرحلة الإبتدائية ، تتراوح أعمارهم بين ثماني وعشر سنوات ، باستخدام طريقة الاعتيان العنقودي ذات المرحلتين . وأظهرت النتائج أن معدل انتشار الدراق بلغ 27.1% ، وكان انتشاره بين الإناث (29.2%) أعلى منه بين الذكور (25.1%) . كما تبين أن مستوى ناصف مقادير اليود في البول كان 6.7 ميكروغرام و3.9 ميكروغرام في الديسيلتر بين الأطفال المصابين بالدراق من الدرجتين الأولى والثانية على التوالي . وبناء على هذه النتائج اعتبر عوز اليود مشكلة صحية عمومية ذات خطورة متوسطة بين تلاميذ المدارس الإبتدائية في محافظة كفر الشيخ ، الأمر الذي يحتم وضع برنامج لمكافحته عن طريق إضافة اليود إلى ملح الطعام .

ABSTRACT The prevalence of iodine deficiency in primary-school children in Kafr El-Sheikh governorate was assessed. A total of 2250 primary school children aged 8 10 years were selected by a two-stage cluster sampling technique. The results revealed that the prevelance rate of goitre was 27.1% and it was significantly higher in females (29.2%) than males (25.1%). The median urinary iodine level was 6.7 µg/dl and 3.9 µg/dl for grade 1 and grade 2 goitre respectively. It was concluded that iodine deficiency is a public health problem of moderate severity in primary-school children in Kafr El-Sheikh governorate. This necessitates an intervention programme through salt iodization.

Les troubles dus à une carence en iode chez les élèves des écoles primaires à Kafr El-Sheikh (Egypte)

RESUME On a procédé à une évaluation de la prévalence de la carence en iode chez les élèves des écoles primaires dans le Gouvernorat de Kafr El-Sheikh. Au total, 2250 élèves des écoles primaires âgés de 8 à 10 ans ont été sélectionnés en utilisant la technique d'échantillonnage par grappes à deux degrés. Les résultats ont révélé que le taux de prévalence du goitre était de 27,1% et qu'il était considérablement plus élevé chez les filles (29,2%) que chez les garçons (25,1%). Les taux moyens d'excrétion urinaire d'iode s'élevaient à 6,7 µg/dl et 3,9 µg/dl pour les goitres du premier et deuxième degré respectivement. On est parvenu à la conclusion que la carence en iode pose un problème de santé publique de gravité moyenne chez les élèves des écoles primaires du Gouvernorat de Kafr El-Sheikh, ce qui nécessite un programme d'intervention utilisant l'iodation du sel.

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Received 29/08/96; accepted 11/02/97.

Introduction

One of the most important and well known global nutritional problems is iodine deficiency (ID). An estimated population of 1000 million are at risk because they live in an environment where the soil has been depleted of iodine [*1*]. Worldwide, over 600 million people have goitre and 20 million have some degree of brain damage (6 million are cretins) caused by the effects of iodine deficiency in pregnancy [*2*]. In the Eastern Mediterranean Region, at least 16 countries have alarming prevalence rates of iodine deficiency disorders (IDDs) [*3*].

Endemic goitre was reported in Egypt more than 60 years ago [*4*]. Most of the nutrition studies on goitre in Egypt have been done in what is now known as the New Valley in the Western Desert. Rates ranging from 7.6% to 82% have been reported, which illustrates the endemicity of goitre in this area [*5–8*]. However, endemic goitre has also been reported in other regions in Egypt. In Cairo, a prevalence of 13.5% has been reported in primary-school children [*9*]. In Aswan governorate, a rate of 17.5% in primary-school children (8–10 years) has recently been reported [*10*].

According to the World Health Organization (WHO), a total goitre rate of 5% or more in primary-school children (6–12 years) should signal the presence of a public health problem [*11*]. Therefore, it is apparent that IDD is a major public health problem in some areas of Egypt. The aims of the present survey were to assess the prevalence of IDD in schoolchildren aged 8–10 years in Kafr El-Sheikh governorate in Egypt and to estimate the iodine content in local food, water and salt.

Subjects and methods

Subjects

The study was carried out in Kafr El-Sheikh governorate from October 1995 to November 1995. The subjects were primary-school children aged 8–10 years selected from the ten zones of Kafr El-Sheikh governorate (Kafr El-Sheikh city, El-Riad, Desouk, Foa, Motobis, Kelein, Sidi Salem, Biala, El-Hamoul and Baltim).

Two-stage cluster sampling was used to select the study sample. In the first stage, a total of 30 clusters (schools) were selected based on probability proportionate to the size of the target population in the different zones. Thirty clusters were selected to ensure a valid estimate of the prevalence of the problem.

In the second stage, 75 children within each cluster (school) were selected. The number of children per cluster was based on the estimated prevalence of 50%, with 95% confidence interval, ±5% absolute precision, ±10% relative precision and considering "3" as the design effect. Based on this, a total of 2250 primary-school children aged 8–10 years constituted the sample of the study.

Methods

Goitre survey

Data were collected using a specially designed questionnaire, including information about name, zone, school, exact age of the child and sex. Clinical examination of the thyroid gland of each child was done through inspection and palpation. Classification of goitre grading was based on the criteria endorsed by WHO/United Nations Children's Fund/International Council for the Control of Iodine Deficiency Disorders [*2*], which is as follows.

Grade	Description
0	No palpable or visible goitre.
1	A mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in a neutral position. It also moves up in the neck on swallowing.
2	A swelling in the neck that is visible in a neutral position and is consistent with an enlarged thyroid when the neck is palpated.

The sum of grades 1 and 2 was taken as the total goitre rate.

Laboratory analysis

Urinary iodine. Random urine samples were taken from each fifth child after clinical examination of the thyroid gland was completed. A total number of 465 urine samples were collected. Each sample was collected in a sterile tube to which a few drops of high-performance liquid chromatography (HPLC) grade formaldehyde was added and kept at 4 °C until analysis was performed. Iodine in urine was determined based on the method of Moxon and Dixon [*12*], followed by HPLC quantification of iodine. All samples were analysed twice and the average of the two measurements was used.

Iodine in food and drinking water. Samples of locally consumed food items were taken from Kafr El-Sheikh local markets and were analysed for their iodine content. Samples of fish, meat, eggs, milk (fresh), cheese, some vegetables, fruits, bread, beans, usual cooking salt (El-Nasr Malla-hat) and samples of drinking water were collected from different zones. The iodine content of these foods was analysed using the same procedure as that for urinary iodine.

Data analysis

Data were analysed taking the overall estimate of prevalence of goitre (p) as:

$$p = \Sigma a_i / \Sigma m_i$$

where a_i = number of children in the cluster who had the disease, and m_i = number of children in the cluster.

The variance (V) for the estimate of cluster sample proportions was calculated as:

$$V(p) = \Sigma(p_i - p)^2 / n(n-1)$$

where n = number of sampled clusters, p_i = proportion with disease in cluster i and p = proportion with disease in the survey; 95% confidence interval (CI) was also calculated. Percentage agreement between grade of goitre and urinary iodine levels was also determined, using the kappa statistic (κ), which is a measure of agreement correlated with chance [*13*].

Results

Goitre prevalence and grade

The overall prevalence of goitre among schoolchildren (8–10 years) examined in Kafr El-Sheikh governorate was 27.1% (CI = 24.1–30.1) (Table 1). The prevalence ranged from 15.3% in Motobis to 36.0% in Kelein. The overall prevalence was significantly higher ($z = 2.2$) in females (29.2%) than males (25.1%). According to zone, a statistically significant difference between males and females was found only in Kafr El-Sheikh city.

Table 2 illustrates the percentage distribution of schoolchildren examined by zone and grade of goitre. Grade 1 goitre was the most prevalent form of thyroid enlargement (25.6%), while grade 2 was observed in only 1.5%. Baltim had the highest prevalence of grade 2 goitre (6.0%); no cases of grade 2 goitre were recorded in El-Riad and Motobis.

Table 1 **Prevalence (%) of IDD sample examined by zone and sex**

Zone	Sex				Number examined	Goitre prevalence (%) (95% CI)	z ratio
	Male		Female				
	No.	Prevalence (%)	No.	Prevalence (%)			
Kelein	118	32.2	107	40.2	225	36.0 (27.0–45.0)	1.2
Foa	38	31.6	37	37.8	75	34.7 (34.7–34.7)	0.6
El-Riad	92	33.7	58	25.9	150	30.7 (19.4–41.9)	1.0
Baltim	75	28.0	75	33.3	150	30.7 (23.1–38.2)	0.7
Sidi Salem	148	31.1	152	29.6	300	30.3 (26.4–34.3)	0.3
Kafr El-Sheikh city	229	24.5	221	33.0	450	28.7 (21.3–36.0)	2.0[a]
El-Hamoul	109	23.9	116	26.7	225	25.3 (22.8–27.8)	0.5
Biala	79	19.0	71	25.4	150	22.0 (21.1–22.9)	0.9
Desouk	186	17.1	189	23.8	375	20.8 (16.1–25.5)	1.5
Motobis	74	13.5	76	17.1	150	15.3 (14.4–16.3)	0.6
Total	1148	25.1	1102	29.2	2250	27.1 (24.1–30.1)	2.2[a]

[a] *Significant at 95% level of significance*

Table 2 **Percentage distribution of sample examined by zone and grade of goitre**

Zone	No.	Grade of goitre		
		0	1	2
Kelein	225	64.0	35.6	0.4
Foa	75	65.3	33.4	1.3
El-Riad	150	69.3	30.7	–
Baltim	150	69.3	24.0	6.0
Sidi Salem	300	69.7	28.7	1.6
Kafr El-Sheikh City	450	71.3	27.3	1.4
El-Hamoul	225	74.7	23.6	1.7
Biala	150	78.0	20.0	2.0
Desouk	375	79.2	19.2	1.6
Motobis	150	84.7	15.3	–
Total	2250	72.0	25.6	1.5

– denotes no cases

Urinary iodine excretion

Table 3 illustrates the levels of median urinary iodine in a subsample of 465 children according to goitre grade in the different zones. The overall median urinary iodine was 15.1 µg/dl. In non-goitrous children, the total median urinary iodine was 16.8 µg/dl, ranging from 12.6 µg/dl in Kelein to 18.9 µg/dl in Baltim. In grade 1 goitre, the total median urinary iodine level was 6.7 µg/dl, ranging from 5.2 µg/dl in Desouk to 12.5 µg/dl in El-Riad. In grade 2 goitre, the level was 3.9 µg/dl, ranging from zero in four zones to 11.1 µg/dl in Kelein.

The prevalence of IDD in the subsample of schoolchildren examined according to urinary iodine is shown in Table 4 by zone and sex. The overall goitre prevalence was 28.0%, ranging from 17.2% in Motobis to 33.3% in El-Riad. In males, the prevalence was 24.2% ranging from 13.3% in Biala to 37.5% in Foa, while in females, the prevalence was higher (32.1%), ranging from 14.3% in Foa to 45.5% in El-Riad. In the majority of zones, the prevalence was higher in females than males.

Table 3 **Median urinary iodine (µg/dl) in the subsample examined by zone and grade of goitre**

Zone	Goitre grade						Total	
	0		1		2			
	No.	Median (µg/dl)	No.	Median (µg/dl)	No.	Median (µg/dl)	No.	Median (µg/dl)
Kelein	30	12.6	14	10.5	1	11.1	45	12.2
Foa	12	14.8	3	5.3	–	–	15	14.2
El-Riad	22	16.0	8	12.5	–	–	30	16.0
Baltim	22	18.9	9	7.6	3	4.1	34	17.7
Sidi Salem	43	16.1	17	5.6	1	3.2	61	14.2
Kafr El-Sheikh city	68	18.2	27	7.0	2	3.5	97	16.7
El-Hamoul	37	16.2	11	5.8	–	–	48	15.6
Biala	23	17.1	4	8.5	1	3.8	28	16.7
Desouk	59	16.8	17	5.2	2	5.2	78	14.3
Motobis	22	18.0	7	7.3	–	–	29	15.9
Total	338	16.8	117	6.7	10	3.9	465	15.1

Table 4 **Prevalence (%) of IDD according to median urinary iodine in the subsample examined**

Zone	Sex				Total	
	Male		Female			
	No.	Prevalence (%)	No.	Prevalence (%)	No.	Prevalence (%)
Kelein	23	30.4	22	31.8	45	31.1
Foa	8	37.5	7	14.3	15	26.7
El-Riad	19	26.3	11	45.5	30	33.3
Baltim	18	33.3	16	31.3	34	32.4
Sidi Salem	30	23.3	31	38.7	61	31.1
Kafr El-Sheikh city	47	25.5	50	32.0	97	28.9
El-Hamoul	23	21.7	25	28.0	48	25.0
Biala	15	13.3	13	23.1	28	17.9
Desouk	45	20.0	33	30.4	78	24.4
Motobis	16	18.8	13	15.4	29	17.2
Total	244	24.2	221	32.1	465	28.0
Median urinary iodine (µg/dl)		*15.8*		*14.4*		*15.1*

As regards severity of IDD based on urinary iodine levels, 72.0% of the children examined in the subsample had urinary iodine levels of ≥10 µg/dl. Mild, moderate and severe deficiency were detected in 20.9%, 6.5% and 0.6% respectively. Agreement

between clinical examination and urinary iodine was 87%; $\kappa = 0.69$ (Table 5).

Table 6 shows the iodine content of selected food items in the zones examined. Fish is the richest natural source of iodine (32/100g µg), followed by eggs, cheese, milk and yoghurt. Plant foods are usually poor in iodine content. Average iodine content of drinking water in different zones at Kafr El-Sheikh ranged from 0.18 µg/dl in Kelein to 0.34 µg/dl in Desouk.

Table 5 **Distribution of cases by goitre grade and urinary iodine in the subsample examined**

Goitre grade	Urinary iodine (µg/dl) < 2	2–	10+	Total
2	0	9	1	10
1	3	93	21	117
0	0	25	313	338
Total	3	127	335	465

Agreement = 87%, κ = 0.69 (good agreement beyond chance)

Table 6 Iodine content of selected food items in Kafr El-Sheikh

Food item	Average iodine content (µg/100g)
Animal foods	
Fish (freshwater)	32.00
Salted fish (sardines)	30.28
Eggs	26.43
Cheese (cottage)	20.86
Yoghurt	18.61
Milk (fresh)	18.30
Meat	4.89
Plant foods	
Bread	10.20
Beans	6.89
Dates	4.56
Potatoes	4.20
Green leafy vegetables	3.82
Non-iodized salt (El-Nasr Mallahat)	15.00

Discussion

Iodine deficiency disorders are still a major public health problem in many countries of the world in spite of the fact that the technology available for their prevention makes the problem the most amenable of the nutritional deficiencies to quick and effective control. The prevention and control of IDD, because of its dramatic impact on the quality of life, productivity and educibility of millions, would make a major contribution to the development of countries whose people are at risk of developing IDD. In addition, it would contribute significantly to the attainment of the World Health Organization's goal of health for all by the year 2000 [*14*].

Implementing practical and effective surveillance is essential to control micronutrient deficiencies successfully. One of the main purposes of IDD surveillance is to determine the prevalence of such disorders and to identify high-risk populations and risk factors. This is important in order to develop and monitor programmes aimed at eliminating IDD.

The present study revealed that the prevalence of goitre was 27.1% in Kafr El-Sheikh governorate. This rate is higher than that reported by the Cairo Nutrition Institute in 1992, which was 15.3% in primary-school children examined in Kafr El-Sheikh [*7*]. This difference could be attributed to the variability in sampling method, sample size and interobserver variations [*13*].

The agreement between clinical examination and urinary iodine (87%, $\kappa = 0.69$) supports the prevalence rates found in the present study and it is apparent that IDD is

a public health problem of moderate severity in Kafr El-Sheikh governorate.

The rate reported in the present study is in the intermediate range compared with total goitre rates estimated in primary-school children in Aswan (17.5%) [*10*] and the New Valley (82.3%) [*8*]. In the Eastern Mediterranean Region, the prevalence rate of goitre ranges from 15% in Lebanon to 73% in the Syrian Arab Republic [*2*]. IDDs affect both sexes; however, the prevalence is higher in females from adolescence onwards. The findings of the present work revealed a significant difference between males and females ($z = 2.2$) (Table 1). This is consistent with other recent studies in Egypt [*8–10*].

The level of iodine in urine correlates well with the level of its intake, so it can be used as an index for estimating iodine intake [*15*]. Despite the large variation in daily iodine excretion, assessment of iodine concentration in casual urine samples remains a valuable method for evaluating iodine status [*16*]. The present study shows that median urinary iodine concentrations were 16.8 µg/dl for non-goitrous children and 6.7 µg/dl and 3.9 µg/dl for grade 1 and 2 goitrous children respectively. Severe, moderate and mild ID is present when the concentration of iodine in urine is less than 2.0 µg/dl, 2–5 µg/dl and 5–10 µg/dl respectively [*15*]. Therefore it is apparent that ID is of mild to moderate severity in grade 1 and 2 goitre in the present study, which may indicate that iodine excretion is inversely related to the severity of goitre [*16*]. The overall median urinary iodine (15.1 µg/dl) in the present study is higher than that reported in the New Valley (8–9 µg/dl) [*8*] and Aswan governorate (10.8 µg/dl) [*10*]. A good agreement between clinical examination and urinary iodine (87%, $\kappa = 0.69$) was found in the present study.

The present study shows that both the prevalence and grades of goitre varied in the different zones of Kafr El-Sheikh governorate. This could be explained by differences in environmental factors affecting iodine availability as well as primary deficiency of iodine intake. Although it has always been thought that goitre occurred mainly in areas remote from the sea, the results of the present study revealed high goitre rates in some coastal zones (Sidi Salem 30.3% and Baltim 30.7%). This may suggest the involvement of other factors in the genesis of thyroid enlargement besides iodine deficiency [*15*].

The scope of the present study did not extend to investigation of the different factors involved in the development of iodine deficiency disorders in Kafr El-Sheikh governorate. However, analysis of the iodine content of some selected food items from different localities in the governorate revealed that it was lower than values reported for the Middle East [*17*] and Britain [*18*]. However, the values found in the present study were comparable to those reported in other governorates in Egypt [*8–10*].

Levels of iodine in local drinking water in different zones of Kafr El-Sheikh correlate with goitre prevalence figures. Kelein recorded the highest prevalence of goitre (36.0%) and the lowest level of iodine in drinking water (0.18 µg/dl), whereas in Desouk, the goitre prevalence recorded was 20.8% and the iodine level in drinking water was 0.34 µg/dl. The levels of iodine in drinking water in the New Valley ranged from 0.16 µg/dl to 0.19 µg/dl [*8*].

Conclusions

Goitre in primary-school children (27.1% prevalence) is of moderate severity in Kafr

El-Sheikh governorate which indicates that IDDs are a public health problem in this area. The prevalence was significantly higher in females than males ($z = 2.2$). Grade 1 was the most prevalent form of thyroid enlargement (25.6%). The median urinary iodine was 16.8 µg/dl in non-goitrous children and 6.7 µg/dl and 3.9 µg/dl in grade 1 and 2 goitre respectively. Based on urinary iodine, the overall goitre prevalence was found to be 28%. Agreement between clinical examination and urinary iodine was 87% ($\kappa = 0.69$).

Recommendations

Based on the results of the present work the following recommendations are suggested for areas with IDD :

- An intervention programme through salt iodization is a necessity to combat IDD.
- Further studies are needed to investigate the different factors involved in the genesis of thyroid enlargement.

References

1. Hetzel BS. The control of iodine deficiency. *American journal of public health*, 1993, 83:494–5.
2. World Health Organization; Micronutrient Deficiency Information System Project. *Global prevalence of iodine deficiency disorders*. Geneva, World Health Organization, 1993 (MDIS working paper, No. 1).
3. *Iodine deficiency. What it is and how to prevent it.* Alexandria, World Health Organization, Regional Office for the Eastern Mediterranean, 1995.
4. Ibrahim A. Endemic goitre in Dakhla Oasis in Egypt. *Journal of the Egyptian Medical Association*, 1932, 15:401.
5. Gallioungui P. A short medical survey of the Kharga and Dakhla Oases. *Bulletin of the Clinical Science Society, Abbassiah Faculty of Medicine, Cairo*, 1965, 6:1–5.
6. Abdou IA. *Nutritional status in the New Valley*. Cairo, Egypt, National Information and Documentation Centre, 1965:238–51 (in Arabic).
7. *Report on the prevalence of iodine deficiency disorders among schoolchildren in Egypt*. Cairo, Nutrition Institute in collaboration with the World Health Organization, 1992.
8. *Report on the assessment of the prevalence of iodine deficiency disorders in New Valley governorate*. Alexandria, High Institute of Public Health in collaboration with the United Nations Children's Fund, 1993.
9. El-Gayed NA et al. Assessment of the prevalence of iodine deficiency disorders among primary-school children in Cairo. *Eastern Mediterranean health journal*. 1995, 1:55–63.
10. *Report on the assessment of the prevalence of iodine deficiency disorders in Aswan governorate*. Alexandria, High Institute of Public Health in collaboration with the United Nations Children's Fund. 1995.
11. *Indictors for assessing iodine deficiency disorders and their control through salt iodization*. Geneva, World Health Organization, 1994 (Document No. WHO/NUT/94.6).
12. Moxon RE, Dixon EJ. Semiautomatic method for determination of total iodine in food. *Analyst*, 1980, 105:344–52.

13. Tonglet R et al. Interobserver variation in the assessment of thyroid enlargement: a pitfall in surveys of the prevalence of endemic goitre. *Food and nutrition bulletin*, 1994, 15:64–9.

14. Hetzel BS. Progress in the prevention and control of iodine deficiency disorders. *Lancet*, 1987,1:266.

15. Lamberg BA. Iodine deficiency disorders and endemic goitre. *European journal of clinical nutrition*, 1993, 47:1–8.

16. Bourdoux P et al. A new look at old concepts in laboratory evaluation of endemic goitre. In: Dunn JT et al., eds. *Towards the eradication of endemic goitre, cretinism and iodine deficiency*. Washington, DC, Pan American Health Organization, 1986:115–29.

17. Pellet PL, Shardarevian S. *Food composition tables for use in the Middle East*, 2nd ed. Beirut, Lebanon, American University of Beirut, 1970.

18. Wenlock BW et al. Trace nutrients: iodine in British foods. *British journal of nutrition*, 1982, 47:381–3.

By the end of 1996, 14 countries had carried out a survey of iodine deficiency disorders (IDD) to assess whether IDD was a problem in their countries. As a result of these studies and other data, 16 countries have identified IDD as a public health problem and have decided to iodize their salt. Universal salt iodization (USI) is a reality now in eight countries (Egypt, Islamic Republic of Iran, Jordan, Lebanon, Libyan Arab Jamarhiya, Oman, Tunisia and Syrian Arab Republic), while in Iraq all salt in the ration is iodized. In Djibouti, Morocco, Pakistan, Sudan and Republic of Yemen, efforts are underway to achieve USI, while most of the countries of the Arabian Peninsula have also opted for iodized salt, whether imported or locally produced.

A survey is being carried out in the Islamic Republic of Iran to monitor the impact of the universal salt iodization programme, which has now been going on for several years. First results suggest that iodine deficiency has in fact been eliminated in this country.

Source: The Work of WHO in the Eastern Mediterranean Region. Annual Report of the Regional Director. 1 January - 31 December 1996. *Page 77.*