Available online at www.ijpcr.com
International Journal of Pharmaceutical and Clinical Research 2016; 8(8): 1127-1131

ISSN- 0975 1556

Research Article

Monitoring of Iodine Deficiency Disorders for South Sinai Children (IDD Monitoring in South Sinai)

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Available Online:10th August, 2016

ABSTRACT

The aim of this work was to monitor IDD in South Sinai through standard indicators. Background: Iodine deficiency disorders are major public health problems worldwide. Goiter prevalence in S. Sinai children accounted 13.6%. WHO described two main groups of indicators to monitor IDD control programs. The first is to monitor salt iodization process. The second group was through assessing median urinary iodine, goiter assessment and measurement of levels of thyroglobulin in school-age children.

Methods: Through cross sectional study, we examined 1046 school children living at Ras Sidre district in S.Sinai. They were selected randomly to represent all population differences. All children were subjected for clinical thyroid volume assessment. Sub samples were selected for ultrasound thyroid examination, thyroid function status assessment, urinary iodine excretion evaluation and edible salt analysis for iodine content at household level.

Results: The mean value of salt iodine was 29.88±6.16 ppm at household level. All samples' levels were within accepted values. Goiter rate detected clinically was high. Goiter rate by U/S was 16.32%. UI deficiency was detected in 57.93% with different grades. More vulnerable groups were those of Urban origin, females and those aging ≥ 10 yrs ($p<0.05$). Thyroid function showed that serum T4 was below normal values for age in 32.43%, while serum Tg levels were higher than normal in 12.4% of examined subjects.

Conclusions: We concluded that IDD are manifesting in spite of adequate salt iodations. IDD monitoring is essential for elimination of ID. Nutritional and pollutant evaluation for goitrogenic factors is essential.

Keywords: Goiter, Iodine deficiency disorder (IDD), South Sinai, Thyroid functions, Urinary iodine (UI).

INTRODUCTION

Iodine deficiency disorders (IDD) are those consequences of iodine deficiency in a population that can be prevented by ensuring adequate iodine intake for the population[1]. Overall goiter prevalence in S. Sinai was 13.6%, Ras Sidre district showed the highest level counting 20.0% of their children[2]. Salt iodization is well established in Egypt for more than 20 years. World Health Organization guidelines described two main groups of indicators which are used for evaluation and monitoring of IDD control programmes. The first indicator is monitoring and evaluation of the salt iodization process which reflects salt iodine content at different stages till the household level. The second group of indicators includes assessing iodine status and monitoring the impact of salt iodization on the population through assessing median urinary iodine, goiter assessment by palpation or by ultrasound and measurement of thyroid stimulating hormone (TSH) levels in neonates or thyroglobulin in school-age children[1]. The aim of this work was to monitor IDD in S. Sinai through standard indicators regarding salt iodine levels in addition to goiter rate, UI and thyroid functions in children.

SUBJECTS AND METHODS

Subjects (children)

We examined 1046 school children living at Ras Sidre district in S.Sinai. They were selected randomly to represent all population differences regarding age (6-18 years), gender (male and female), geographic distribution (living at city, villages, Bedouin settlements), ethnic origin (Bedouin and urban) and social class (high, moderate and low). Cases were attendants of schools (primary, prep, and secondary schools). Total school children at Ras Sidre education directorate were 3554 (Records of ministry of education, South Sinai directorate. 2013, unpublished data). The most recent available published date accounted 2220 school children in Ras Sidre[3]. Table (1) presents data of the studied children regarding age group, gender and ethnic origin. The present study has been reviewed by the ethical committee of the National Research Center- Egypt. A written consent was obtained from every child's care-taker for those participating in the study prior to their inclusion.

Methods

Cross sectional study was designed. Eight schools were selected randomly (3 primaries, 3 prep and 2 secondary). Through field visits we interviewed 1046 children at their schools (representing 29.43% of all registered children in the studied area). The following was done: Collecting personal and medical history from child or parent. Birth

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Table 1: number, grade, gender and ethnic origin of studied children.

S. No.	School Grade	Age range	Total no*	Gender		Ethnic origin	
				Male no %	Female no %	Bedouin no %	Urban no %
1.	Primary	6-12	498	233 46.79%	265 53.21%	154 30.92%	344 69.08%
2.	Prep.	>12-15	306	149 48.69%	157 51.31%	68 22.22%	238 77.78%
3.	Secondary	>15-18	242	124 51.24%	118 48.76%	62 25.62%	180 74.38%
	Total		1046	506 48.37%	540 51.63%	284 27.15%	762 72.85%

no*, means number

Table 2: Goiter rate clinically and by ultrasound at different age groups.

School grade	Age range	clinical examination by palpation (Thyroid grade)					Enlarged thyroid (ultrasound exam.)	
		0 no %	1 no %	2 no %	1+2 no %	Total	no %	Total
1ry	6-12	338 63.30%	183 34.27%	13 2.43%	196 36.70%	534 100%	15 15.0%	100
Preparatory	>12-15	121 48.02%	108 42.86%	23 9.13%	131 51.98%	252 100%	16 17.78%	90
Secondary	>15-18	123 47.31%	114 43.85%	23 8.85%	137 52.69%	260 100%		
Total		582 55.64%	405 38.72%	59 5.64%	464 44.36%	1046 100%	31 16.3 %	190

date was taken from official school records. Ethnic origin was recorded (Bedouin or urban).

Thorough clinical examination

Clinical thyroid volume assessment according to standard WHO- UNICEF technique[4].

Thyroid size was categorized clinically into 3 grades as follows:

Grade 0 Thyroid gland is neither palpable nor visible

Grade 1 The gland is palpable when the neck is in the normal position but not visible

Grade 2 A clearly visible swelling with the neck is in the normal position.

Anthrpometric measuring of weight and height using standard techniques using high accurate balance and scale (Secca)

Ultrasound examination of thyroid for 190 children.

Ultrasound volume was measured according standard technique[5] using Human portable ultrasound unit with a standard 5.0 MHz transducer. The volume of each lobe was calculated by the standard formula:

V [ml] = 0.000479 × length × width × thickness [mm].

The volume of thyroid was calculated as the sum of the two lobes' volumes. The isthmus volume was not added. Classification into normal or enlarged gland was done using the WHO references, thyroid volume-for-age and thyroid volume-for-BSA[6]. The cut off value of 97th percentile was utilized to consider those less than or equal to the 97th percentile as normal, while higher values are enlarged.

Collection of blood samples of 151 children selected randomly for assessment of thyroid function status levels and thyroglobulin levels. Thyroid functions (T3, T4 and TSH) were assessed in serum quantitatively using Immunoassay Elisa kits. With Cat no REFE1003 for TSH (mg/dl), Cat no REFE1001 for T3 (ng/ml) and Cat no REFE1002 for T4 (µg/dl). Quantitative assessment of thyroglobulin in human serum (ng/ml) was performed using DIAMETRA Elisa kit Cat no REFDKO048.

Collection of random urine samples of 164 children for assessment of urinary iodine excretion rates. Assessment of urinary iodine excretion was done biochemically using ammonium persulfate method[7].

Sixteen edible salt samples were collected at different sites at household for analysis to iodine content. Assessment of iodine content was done biochemically[8].

t- test was used for comparison between groups. P-value ≤ 0.05 means significant difference.

RESULTS

Salt iodine content of 16 samples ranged between 24.55 and 39.6 ppm (mg/Kg) with mean value of 29.88±6.16 ppm at household level. All samples' levels were within accepted values. Table (2) presents goiter rate detected clinically. The overall rate was 44.36%. It was 36.70% in 1ry schoolchildren aging 6-12 years. Goiter rate by U/S was 15.0% for 1ry schoolchildren, while the total rate was 16.32%. Table (3) illustrates UI excretion. The range of UI excretion was 4.70 - 217.92 µg/ L; with mean value of 95.61± 49.01 µg/ L. UI deficiency was present in 57.93% with different grades (37.80% mild, 17.07% moderate and 3.05% severe). More vulnerable groups were those of Urban origin ($p<0.05$), females ($p<0.05$) and those aging ≥ 10 yrs ($p<0.05$) as seen in table (4). Table (5) presents thyroid function and Tg values of studied children. Serum T4 was below normal values for age in 48 subjects (32.43%). Serum Tg levels were higher than normal in

Table 3: Degrees of urinary iodine deficiency among tested children.

Iodine status	Urinary iodine (ug/L)	Number of children	%
Severe iodine deficiency	< 20	5	3.05
Moderate iodine deficiency	20 – 49	28	17.07
Mild iodine deficiency	50 – 99	62	37.80
All iodine deficiency	< 100	95	57.93
Adequate iodine intake	100 – 199	67	40.85
Over dose	≥ 200	2	1.22
All examined		164	100.00

Table 4: Effect of ethnic origin, gender and age on UI excretion.

Item	Type	Urinary Iodine (ug/L)			p- value
		no	x̄	S.D	
Origin	Bedouin	72	105.23	50.35	< 0.05
	Urban	92	88.08	46.85	
Gender	Males	94	109.38	46.53	< 0.05
	Females	70	77.12	46.39	
Age	< 10 yrs	38	122.01	48.75	< 0.05
	≥ 10 yrs	126	87.65	46.40	
Total		164	95.61	49.01	

12.4% of subjects. Correlation analysis between T4 and TSH showed negative significant value (n=137; R= -0.2312; p= 0.0066).

DISCUSSION

Iodine deficiency has lead millions of people to a life of few prospects and continued underdevelopment. IDD are considered the easiest and least expensive of all nutrient disorders to prevent. The elimination of IDD is a critical development issue, and should be given the highest priority by governments and international agencies[1]. Iodine deficiency disorders are a major public health problem worldwide, It affects 246 million school-aged children who have insufficient iodine intake (data from 2012)[9]. WHO and UNICEF have recommended universal salt iodization since 1993 as the main strategy for IDD elimination[10]. WHO described monitoring and evaluation of salt iodization process which reflects salt iodine content at different stages till the household level as the first indicator for IDD control programs[1]. In the present study; the mean salt iodine level was 29.88±6.16 mg/Kg (ppm). All examined samples ranged between 24.55 and 39.36 ppm. These values are satisfactory as recommended salt iodine at household level is 15-40 ppm. This level will supply about 150 µg iodine/day, provided that the daily personal consumption is about 10 grams of salt[11]. The second group of indicators recommended by WHO to evaluate the impact of salt iodization on the population included assessing median urinary iodine, goiter assessment by palpation or by ultrasound and some serological markers as measuring thyroid stimulating hormone (TSH) levels in neonates and of thyroglobulin in school-age children[1]. Clinical palpation of thyroid in our study showed that goiter rate accounted 38.72% for palpable goiter and 5.64% for visible goiter as shown in table (2) using WHO-UNICEF grading scores[4]. It is well known that palpation of thyroid is associated with high rate of false positive cases. Yet, it gives an indication about iodine status. Results presented increase of goiter cases as age advances for both palpable and visible goiter. This observation is expected as physiologic goiter increases with development of puberty.

Table (2) presents goiter measured by U/S. It was 15.0% and 17.78% for children at 1ry and prep schools respectively. The mean rate of goiter was 16.32%. U/S is an accurate reliable method to diagnose goiter[5]. The present value is higher than normal value that should not exceed 5%. Data demonstrate mild risk for iodine deficiency. It is recommended that a total goiter rate (number with goiters of grades 1 and 2 divided by total examined) of 5% or more in schoolchildren 6 to 12 years of age be used to signal the presence of a public health problem. This recommendation is based on the observation that in normal, iodine-replete populations, the prevalence of goiter should be quite low. The cut-off point of 5% allows both for some margin of error of goiter assessment, and for goiter that may occur in iodine-replete populations due to other causes such as goiterogens and autoimmune thyroid diseases[1]. Results stress the need for intervention program and close follow up for this community. Table (3) shows urinary iodine excretion of 164 children. The mean value for excretion was 95.61 ± 49.01. The present data demonstrates mild ID of the total population as the normal accepted value for UI ranges between 100- 200 µg/L for adequate iodine intake[1]. The epidemiological criteria for assessing iodine nutrition are based on median UI content as mild, moderate or severe deficiency (50–99, 20–49 and < 20 µg/l, respectively)[12]. 57.93% of the studied subjects showed iodine deficiency with different grades (3.05% severe, 17.07% moderate and 37.8% mild deficiency. Table (4) illustrates urinary iodine excretion of different ethnic origin. Mean UI for urban children was significantly lower compared to Bedouin children (p < 0.05). Females had lower mean UI compared to males with p < 0.05. Children aging ≥ 10 years had lower mean UI compared to younger children with p < 0.05. Urinary iodine excretion clearly confirms that Iodine status for our school children is inadequate. It shows that children with urban origin, female gender and children older than 10 years at higher risk for ID. Assessing thyroid function provides information about whether the thyroid gland is responding to adequate iodine intake, and is the ultimate measure of whether a population is protected from iodine deficiency. Assessing the thyroid status of a population answers the question: "Is there evidence of thyroid dysfunction that may reflect inadequate iodine intake?" Thyroid function reflects the ability of the thyroid to produce thyroid hormone, which is essential for normal development. Thyroid size and various measures of status such as TSH[13]

Table 5: Thyroid function testing and thyroglobulin levels of the studied group.

Item	Examined children			serum levels values			
	no	x̄	S.D	Standard value	Normal no	High no (%)	Low no (%)
T4 (µg/ dl) *	148	7.40	3.76	5.0-13.0	94	6	48 (32.43%)
Tg (ng/ L) Ʈ	150	16.8	16.18	2.7-41	129	16 (12.40%)	5
T3 (ng/ ml) ±	151	1.64	0.25	0.8-2.4	151	0	0
TSH (mg/ d) §	151	2.75	1.34	0.7-6.7	148	2	1

T4* = Thyroxine; TgƮ = Thyroglobulin; T3± = Tri iodo thyronine; TSH§ = Thyroid Stimulating hormone.

and Tg are the most common measures of thyroid function[14]. In the present work serum Tg levels were higher than normal in 12.40% of examined children. Tg is a protein that is a precursor in the synthesis of thyroid hormone, and small amounts of Tg can be detected in the blood of all healthy individuals. ID results in thyroid hyperplasia and goiter with subsequent increases in serum Tg levels. Serum Tg reflects iodine nutrition over a period of months or years. This is in contrasts to urinary iodine concentration, which assesses more immediate iodine intake[1]. In nontoxic nodular goiters elevated serum Tg concentrations were observed which correlated with goiter size[15]. T4 levels were low in 32.43% of examined children (Table 5). This low T4 alarms for the liability for development of hypothyroid manifestations for such children. The results of the present work declare that salt iodine in the studied area is sufficient. Yet, all manifestations of IDD are present including high goiter rate, decreased UI excretion, increase percentage of children with high Tg and decreased T4 levels. This data could be explained by low salt intake which is unlikely; especially in dry and hot regions (South Sinai lies in the hyper arid zone). The second more reasonable explanation is the presence of goitrogenic factors in their diet, water or in the community as thiocyanates, nitrites or perchlorates[16].

CONCLUSIONS

- Goiter is still a health problem among S. Sinai children.
- Iodine deficiency is the apparent cause of goiter in spite of adequate salt iodations. Urban origin, females and children ≥ 10 yrs are more vulnerable for IDD.
- IDD seems to affect thyroid functions with significant % with low T4 and high Tg.
- IDD monitoring is essential for elimination of ID.
- Pollutant evaluation for goitrogenic factors is essential.

ACKNOWLEDGMENT

Dr. Mohammed Abdel moula, Mostafa Abdel Kader and Hasanein Mohammed have shared actively in the field work and organization of study at remote area.

DISCLOSURE

The authors declare no conflict of interest Author contribution G.Y. designed the study; G.Y., M.S. and M.E. committed field visits in South Sinai, performed clinical examination, biological samples collection and sonar testing of the thyroid; M.I. did all lab tests including thyroid functions, thyroglobulin, urinary iodine and salt iodine determination; All authors read and approved the final manuscript and contributed to the conception and design of this study; G.Y. performed the statistical analysis and drafted the manuscript; M.S. and M.I. critically reviewed the manuscript and supervised the whole study process; All authors read and approved the final manuscript.

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