IJMS
Vol 35, No 1, March 2010

Original Article

Continuous Adequate Iodine Supplementation in Fars Province: The 2007 Goiter and Urinary Iodine Excretion Survey in Schoolchildren

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Received: 8 August 2009
Revised: 23 December 2009
Accepted: 10 January 2010

Abstract

Background: The iodine deficiency elimination program that began two decades ago resulted in Iran becoming an iodine deficiency disorders free country in the Middle East region. The present study was performed to evaluate the adequacy of iodine supplementation after 17 years of universal salt iodization in Fars province.

Methods: In a cross-sectional study, 1200 schoolchildren (480 girls and 720 boys) aged 8 to10 years, were randomly selected from Fars province and evaluated in 2007. Goiter prevalence, urinary iodine excretion, and iodine content of household salts were measured and the data were compared with those obtained in 1996 and 2001.

Results: Total prevalence of goiter was 1.3% (CI: 0.53-2.47) and no grade 2 goiter was found. One-tenth of the children enrolled for goiter assessment, were randomly selected for urinary iodine measurement. The median urinary iodine in these 120 schoolchildren was 159.4 µg/L (85.6-252.3), with 14.8% having urinary iodine excretion less than 50 µg/L. 98% of households were using purified iodized salt. 70% of households had appropriate salt storage and none of the household salts contained less than 15 µg iodide.

Conclusion: Goiter prevalence has significantly decreased in the Fars province, 17 years after universal salt iodization. The median urinary iodine of schoolchildren was adequate as that reported in 1996 and 2001, indicating a well established sustainable iodine deficiency elimination program in the province.
Iran J Med Sci 2010; 35(1): 16-20.

Keywords ● Thyroid ● goiter ● iodine ● iodized salt

Introduction

Iodine is an essential element required for the thyroid gland to produce thyroid hormones. This element is ingested and absorbed in the gut almost completely in different forms. In a healthy person, 90% of ingested iodine is excreted through urine. If iodine deficiency is present, the ingested iodine is retained by the body, reducing the levels of excreted urinary iodine. Therefore, the level of urinary iodine is used as an indicator for the assessment of iodine deficiency disorder (IDD).[1]

Based on the last WHO/ UNICEF reports, an estimated 31.5% of school-age children (266 million) worldwide have insufficient iodine intake.[2,3] In the general population, two billion people have insufficient iodine intake.[2,3] In 47 countries, iodine deficiency is a public health problem.[2,3] However, iodine intake is more than adequate, or even excessive, in 34 countries: an increase from 27 in 2003. Iodine intake is under the requirement in 73 million children in South-East Asia and in 57.7 million children in Africa.[2,3] In the European, Eastern Mediterranean, and Western Pacific regions, the figure is approximately 40 million children, whereas in the United State, 12 million children do not have enough iodine in their diet.[2,3] The greatest proportions of children with inadequate iodine intake live in the regions of Europe (52.4%) and the Eastern Mediterranean (48.8%), and the smallest proportions are found in the Western Pacific (22.7%) and the United State (10.6%).[3,4] The number of countries in which iodine deficiency is a public health problem decreased from 110 to 54 during 1993-2003, and is now a problem in 47 countries.[2,3]

Two decades ago, Iran was among countries affected by IDD, although it was only until 1989 that this was officially recognized as a serious public health problem.[5] The Islamic Republic of Iran began to study the prevalence of goiter and other IDDs in the 80's and conducted a national survey in 1989 that clearly indicated hyperendemic and endemic goiter in almost all regions. The study showed that approximately 20 million people had iodine deficiency, and urgent measures were needed for prevention of IDDs.[6]

Iodine deficiency disorder has since been classified as a health priority in the country. The Iranian National Committee for Control of IDD (INCCI) prepared a national plan, detailing objectives and strategies for IDD control. Following salt iodization in 1990, it became mandatory for salt factories to produce only iodized salt. Sustained surveillance has shown that, I.R. Iran currently fulfills all programmatic indicators set by WHO/ UNICEF/ ICCIDD. Based on these criteria, our country appears to have achieved a sustainable IDD control program since 1990, a milestone officially recognized by WHO-EMRO in the year 2000.[7]

Although the importance of proper iodine intake has been recognized by many governments, people in many developed and industrialized countries still suffer from iodine deficiency.[8,9] Lack of monitoring programs for IDD control, and/or the production and consumption of non-iodized salt are the main causes of failure in control and preventive programs.[10,11]

Since 1996, after universal salt iodization in Iranian population, monitoring of IDD control has been done every 5 years to evaluate the sustainability of the program. The present study is a part of the 4th national survey, conducted in 2007 in all provinces in Iran, to ensure the sustainability of iodine sufficiency in Fars province.

Subjects and Methods

In this cross-sectional study, using a random cluster sampling, 8-10-year-old schoolchildren were chosen and enrolled as the target population. Those children with history of thyroid disorders or using any thyroid related medications were excluded. In Fars province, households were designated by 20 codes, using which 20 children were randomly selected and by direct questioning their school addresses were obtained. From each subject's school, three clusters each contain 20 schoolchildren were randomly selected, thus 60 clusters containing 1200 (600 rural/ and 600 urban) schoolchildren were enrolled.

Children were examined at school in the morning. Based on WHO classification, thyroid size was assessed by a trained general practitioner to determine goiter grading.[1]

One-tenth of the children enrolled for goiter assessment, were randomly selected for urinary iodine concentration (UIC) measurements; therefore 120 (equal numbers in rural and urban areas) urine samples were examined. Spot urine samples (10 ml) were collected between 8:00 AM and 11:00 AM. Urine iodine concentrations were quantitatively measured by acid-digestion method.[12]

According to WHO criteria UIC levels <100 µg/L represent iodine deficiency, and UIC levels ranging 50-99, 20-49, and <20 µg/L, indicate mild, moderate, and severe iodine deficiency, respectively.

A total of 400 households were selected for assessment of table salt iodine. Qualitative assessment of salt iodine was performed on site by health workers using (field) test kits. Twenty samples were transferred to the laboratory for quantitative assessment of salt iodine by iodine metric titration assay. Values were reported in parts per million (PPM). The study was approved by the human research review committee of the Ministry of Health and Medical Education.

Statistical Analysis

Iodine status was recorded based on the median values obtained from urinary iodine excretion.

Mann Whitney test was used to compare

medians and to identify significant differences in iodine contents between values and groups. Statistically difference between sex or age groups was significant for $P<0.05$. SPSS (version 15) was used to perform statistical analyses.

Results

The total prevalence of goiter was 1.3% (CI: 0.66-1.94). The prevalence of grade 1 goiter was 1% (CI: 0.20-1.8) and 1.5% (CI: 0.53-2.47) in urban and rural areas respectively. There was no grade 2 goiter in the province. No differences were found in the prevalence of goiter between girls and boys in rural and urban areas. The goiter rates was 1.7% (0.54-2.86) and 1% (0.27-1.73) in girls and boys, respectively. In 8, 9, and 10 year-old school children, goiter rate was 0.8% (0-1.67), 1% (0.02-1.98) and 2% (0.63-3.37) respectively (table 1).

Overall median UIC was 159.4 (interquartile range [IQR]: 85.6-252.3) µg/L. Median UIC was 124.7 (81.8-202.7) µg/L in girls and 174.5 (90.8-285.5) µg/L in boys. Median UIC was 152 (85.9-250.7) and 161.5 (84.7-261) µg/L in urban and rural areas respectively (table 2).

UIC was over 100 µg/L in 67.8% (CI: 59.3-76.4), between 50 and 100 µg/L in 17.4% (CI: 10.5-24.3) and less than 50 µg/L in 14.8% (CI: 8.3-21.3) of the study population (table 3). 98% of households were using purified iodized salt, 70% of households had appropriate salt storage, and none of the household salts contained less than 15 µg iodide.

Discussion

The fourth national survey on iodine nutrition status in 2007, found decreased goiter rate and median UIC over 100 µg/L in both urban and rural areas of Fars province.

Until two decades ago Iran was among countries with IDDs, although this had not been recognized as a serious public health problem until 1989. The first national survey in 1989 revealed a prevalence of goiter up to 80%.[6] Many studies conducted in the 60s, reported the median UIC to be between 12 µg/L and 82 µg/L.[6]

The second national survey was carried out in 1996, 7 years after iodized salt legislation. In that survey, the prevalence of goiter in Fars province was 50%, which had decreased in comparison with previous studies.[13] In the third national study, conducted in 2001, 12 years after salt iodization program, the total goiter rate in Fars province was 11.8%, much lower than the goiter prevalence in 1996.[14] In the present study, the prevalence of goiter was 1.3%, less than previous study (figure 1). This important finding shows that despite adequate and sustainable salt iodization, iodine deficiency disorders take a long time to eliminate, sometimes months, even years.[15]

In a study to describe the time, course, and pattern of changes in thyroid size and goiter rate in response to the introduction of iodized salt in an area of severe endemic goiter, Zimmerman and colleagues showed that four years after the introduction of iodized salt and

Table 1: Prevalence of goiter in 8-10-year-old schoolchildren in Fars province in 2007

Gender	Age (Year)			
	8	9	10	Total
Girls	1.3 (0-3.06)*	0.6 (0-1.8)	3.1 (0.41-5.79)	1.7 (0.54-2.86)
Boys	0.4 (0-1.2)	1.3 (0-2.73)	1.3 (0.2.73)	1 (0.27-1.73)
Total	0.8 (0-1.67)	1 (0.02-1.98)	2 (0.63-3.37)	1.3 (0.66-1.94)

*Numbers in parenthesis show confidence Interval (CI)

Table 2: Median urinary iodine excretion in 8-10-year-old boys and girls in rural and urban areas of Fars province in 2007

Area	Median urinary iodine excretion (µg/L)		
	Girls	Boys	Total
Urban	128.3 (84.2-205.4)*	180.2 (90.8-297.6)	152 (85.9-250.7)
Rural	121.1 (49.3-186.2)	169.8 (89.4-284.5)	161.5 (84.7-261)
Total	124.7 (81.8-202.7)	174.5 (90.8-285.5)	159.4 (85.6-252.3)

*IQR=Interquartile range

Table 3: Distribution of urinary iodine concentration in 8-10-year-old schoolchildren in rural and urban areas of Fars province in 2007

Area	Median urinary iodine excretion (µg/L)		
	>100	50-100	<50
Rural	67.3 (54.9-79.7)*	16.4 (6.6-26.1)	16.4 (6.6-26.1)
Urban	68.3 (56.6-80.1)	18.3 (8.5-28.1)	13.3 (4.7-21.9)
Total	67.8 (59.3-76.4)	17.4 (10.5-24.3)	14.8 (8.3-21.3)

***IQR=Interquartile range

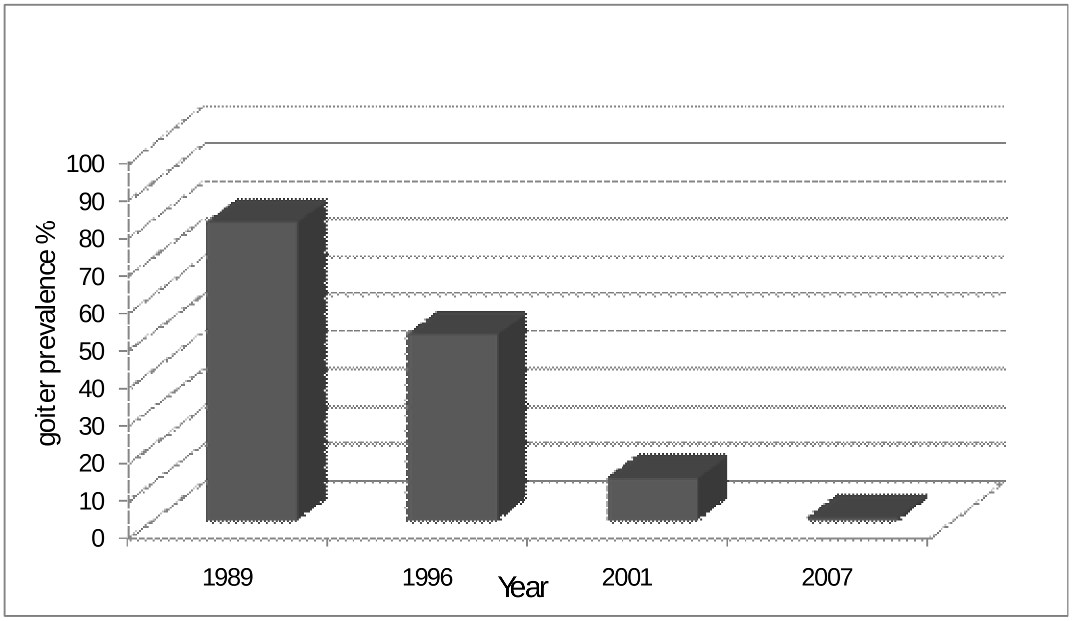

Figure 1: Comparison of goiter prevalence in schoolchildren of Fars province during 1989-2007.

normalization of the median UIC, mean thyroid size had decreased 56%.[16] They concluded that goiter rate in school-age children might remain sharply elevated for up to 4 years after successful introduction of iodized salt, primarily because of persistent goiter in older children.[16] Vejbjerg and co-workers in two separate cross-sectional studies performed before and after iodization in year 2000 in two areas with mild and moderate iodine deficiency, reported that median thyroid volume was lower in all age groups after salt iodization. The most decline was seen in the area with moderate iodine deficiency where the equal volumes among the younger age groups indicated approximation to an optimal iodine intake.[17] Zhao and others showed that consumption of salt with uniform iodine content maintained a UIC above 100 µg/L and thyroid volume returned to normal sizes after 12–18 months.[18]

Another study in 1996 revealed that median urinary iodine in schoolchildren of Fars province was 500µg/L, much higher in comparison with previous studies. Median UIC was over 100 µg/L in 94% of the children. In 2001, another study showed that median UIC was 220 µg/L, being over 100µg/L in 87% of the children. The main cause of decrease in UIC between years 1996 and 2001 was iodized oil injection during the early years of IDD program in Iran.

In the present study, median UIC was 159 µg/L. 68% of population had UIC more than 100 µg/L and only 4.2% had median UIC less than 50 µg/L. In 2001, the national IDD control program showed that median UIC was above the WHO/UNICEF/ICCIDD optimal level.[1] The results of the present and previous studies determined that iodized salt was one effective way toward IDD elimination.

Sustainability of iodine elimination through three consecutive national programs of monitoring iodine deficiency was a result of precise quality control. The lessons from the global experience on the prevention of IDD are that implementation of an adequate and sustainable program of IDD control requires certain specific and effective programmatic steps, in particular the integration of IDD control into the health network and mandatory iodization of household salt.

In several countries in which IDD had been eliminated by universal salt iodization, control programs faltered and IDD recurred.[19] In a 1970 national survey of the former USSR regions, the goiter rate was less than 5%, but between 1995 and 1970 previously successful, long-term iodized salt programs have failed with recurrence of IDD.[19]

IDD may well be re-emerging in industrialized countries that previously considered iodine deficiency free, such as Australia and New Zealand.[20] In these countries, decrease in the consumption of iodized salt and lack of utilization of iodized salt by food producing factories led to recurrence of iodine deficiency disorders.[20] In 1992, median urinary iodine was more than 200 µg/L in Australia. However, recent studies have reported median UIC less than 100 µg/L in some parts of this country such as Victoria, Tasmania, and New South Wales.[20] Increasing awareness and educational level of the populations, in terms of how to keep iodized salt, and when to add it to foods are effective measures towards keeping them free of iodine deficiency.

In conclusion, because of the fragility of IDD control programs, effective monitoring and surveillance are imperative for the control of IDDs. Ensuring program sustainability is one of the great remaining challenges in the fight to eliminate IDD. An effective iodine supplementation program, such as salt iodization, should be the cornerstone of any strategy to tackle IDD among population.

Conflict of Interest: None declared

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