Brief Report

The Prevalence of Goiter and Hypothyroidism among School Children 6 Years after Introduction of a Mandatory Salt Iodination Program in a Severely Iodine-Deficient Area of the West Black Sea Region of Turkey

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Summary

The objective of the current study was to determine the prevalence and the degree of iodine deficiency after mandatory salt iodization in Yığılca's school-aged children. A total of 806 school children aged 6–19 years were evaluated. The prevalence of goiter in children aged 6–12 and 13–19 years was 20.3 and 23.8%, respectively. The prevalence of hypothyroidism in children aged 6–12 and 13–19 years was 10.4 and 18.9%, respectively. The median serum free tetraiodothyronine (fT4) levels in children aged 6–12 and 13–19-years were 1.16 ng/dL and 0.91 ng/dL, respectively. The median urinary iodine concentration levels in children aged 6–12 and 13–19 years were 83 μg/l and 78 μg/l, respectively. The frequency of autoimmune thyroid disease was 2.1% in Yığılca's SAC. Goiter and iodine deficiency problems remain in rural areas of the West Black Sea Region of Turkey.

Key words: Iodine deficiency, goiter prevalence, children.

Introduction

Iodine deficiency (ID) is a common public health problem worldwide. Turkey was generally accepted to be a country with a severe-to-moderate ID problem before the launch of a mandatory salt iodization program (MSIP). Many prior studies had shown that severe ID was evident among school-aged children (SAC) in Turkey [1–5].

Assessment of the prevalence of goiter, using either palpation or ultrasonography, and measurement of urinary iodine concentration (UIC), serum thyroid-stimulating hormone (TSH) level and serum thyroglobulin level are the methods most commonly used to explore the prevalence and severity of ID in SAC [6].

The UIC levels among SAC in the city of Yığılca averaged 13 μg/l exhibit severe ID [4]. The prevalence of goiter, determined by palpation, was as high as 71% in 2003. ID indicators in this region have not been measured since the introduction of the MSIP, and the present study thus sought to determine goiter prevalence and urinary iodine excretion levels in the SAC of Yığılca.

Methods

We performed a cross-sectional epidemiological study in Yığılca, located 350 m above sea level in the province of Duzce of the West Black Sea Region of Turkey. A total of 3300 people live in the city, and 15 000 more in nearby (rural) mountain villages. In socioeconomic terms, Yığılca ranks 749 of 872 districts across Turkey.

The present study on SAC was conducted during the 2009–2010 school years. Approvals were obtained from the Duzce University Ethics Committee and the National Education Directorate of the province. A total of 3106 students attending 23 primary schools and 1 secondary school in Yığılca were evaluated. Not all students were evaluated (second- and last--grade students were evaluated) to render our research cost-effective. First-grade students lacked the literacy skills required to understand the questionnaire, and were thus not enrolled. A total of 826 students in the 2nd, 8th, 9th and 12th grades were enrolled. Written informed consent was obtained from the parents of all 806 students, who completed questionnaires

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exploring the consumption of iodized salt. Selected students underwent routine clinical examinations by two experienced physicians, who explored thyroid enlargement. Goiter was graded using the WHO/UNICEF/ICCIDD classification system (used in epidemiological surveys; [6]). Three categories were defined: (i) Grade 0: no goiter, (ii) Grade 1: an enlarged palpable thyroid that was not obvious when the neck was in a normal position and (iii) Grade 2: a goiter clearly visible when the neck was in a normal position.

Blood samples were collected from all 806 students for measurement of serum TSH and free tetraiodothyronine (fT4) levels, determined via chemiluminescence immunoassays run on an automated Immulite Hormone Analyzer 1000 (Immulite 1000, DPC Diagnostics, Los Angeles, CA). Hypothyroidism was diagnosed if the TSH level was >5 μIU/ml or if the fT4 level was <0.8 ng/dl [7].

Spot urine samples were collected from all children in the morning, placed in covered plastic tubes and refrigerated at 2°C before transporting it to the laboratory; the samples were stored at −20°C before analysis (within 2 weeks). UIC levels were directly measured with the aid of an Agilent 7500 CX high-performance inductively coupled plasma mass spectrometer (ICP-MS). All data are given in microgram per liter. UICs were categorized as follows: >100 μg/l optimal, 50–99 μg/l indicative of mild ID, 20–49 μg/l indicative of moderate ID and <20 μg/l indicative of severe ID [6]. Anti-thyroid peroxidase (anti-TPO) and anti-thyroglobulin (anti-TG) levels were measured using an enzyme immunoassay generating chemiluminescence (Automatic Immulite Hormone Analyzer 1000).

Anti-TG levels of >35 U/ml and anti-TPO levels of >45 U/ml, associated with goiter and elevated TSH levels, were considered to indicate the presence of autoimmune thyroid disease (AITD) [8, 9].

Statistical Analysis

Students were separated into two groups by age (6–12 years and 13–19 years). Data were analysed using SPSS version 18 (SPSS, Chicago, IL). Distributions of continuous variables were evaluated via graphical construction of histograms. Data from the two groups were compared using the Mann-Whitney U-test. All continuous data are presented as medians (with minima and maxima). The chi-squared test was used to compare categorical between-group data, and results were expressed as frequencies (thus, in percentages). The Spearman correlation test was used to explore correlations between TSH, fT4 and UIC level, age and UIC level and AT. A p value <0.05 was considered significant. Prevalence was computed using standard formulae.

Results

A total of 806 students aged 6–19 years were enrolled [451 boys (56%); 355 girls (44%)]. A total of 335 (41.6%) students were aged 6–12 years and 471 (58.4%) were aged 13–19 years. The prevalence of goiter in these two age groups was 20.3% [68 cases (65 Grade 1, and 3 Grade 2)] and 23.8% [112 cases (105 Grade 1, and 7 Grade 2)], respectively (Table 1). Boys with goiter were 83 (79 Grade 1, and 4 Grade 2). Girls with goiter were 97 (91 Grade 1, and 6 liter Grade 2). This difference was statistically significant ($p = 0.023$).

The overall prevalence of goiter in SAC was 22.5%. The prevalence of hypothyroidism in children aged 6–12 and 13–19 years was 10.4% (35 cases) and 18.9% (89 cases), respectively (Table 1). The overall prevalence of hypothyroidism in SAC was 15.3% (124 cases).

The median UIC level in SAC was 80 μg/l (range, 30–197 μg/l). The median UIC levels in children aged 6–12 and 13–19 years were 83 μg/l (range, 42–187 μg/l) and 78 μg/l (range, 30–197 μg/l), respectively (Table 1). The median UIC level was 76 μg/l (range, 32–169 μg/l) in children with both goiter and hypothyroidism. The questionnaire responses suggested that 84.2% (678) of surveyed children consumed iodized salt. The parameters of iodine status in 2003 and 2009 in Yığılca are given in Table 2.

TABLE 1
Prevalence of goiter and laboratory findings in subjects

Parameters	Age			Sex		
	6–12-year-olds	13–19-year-olds	p	Boy	Girl	p
Goiter prevalence (%)	68 (20.3)	112 (23.8)	0.310	83 (18.4)	97 (27.3)	**0.004***
Hypothyroidism prevalence (%)	35 (10.4)	89 (18.9)	**0.002***	77 (17.1)	47 (13.2)	0.14
Autoimmune thyroiditis (%)	5 (1.5)	12 (2.5%)	0.3	7 (1.6%)	10 (2.8%)	0.6
TSH μIU/ml median (min-max)	3.2 (0.94–8.1)	5.2 (0.67–8.5)	**0.010***	5.4 (0.698–.5)	3.1 (0.67–8.1)	0.145
FT4 ng/dl median (min-max)	1.16 (0.7–1.73)	0.91 (0.62–2)	**0.000***	0.94 (0.62–2)	1.0 (0.7–1.73)	0.06
Urine iodine excretion μg/l median (min-max)	83 (42–187)	78 (30–197)	0.289	81 (32–197)	79 (30–187)	0.534

*$p < 0.05$

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The frequency of AITD in children aged 6–12 years with goiter was 1.5% (5 cases), and that in 13–19 years with goiter was 2.5% (12 cases) (Table 1). The overall AITD frequency was 2.1%. AITD was noted in 9.4% of children with goiter (17 cases). The median UIC level of AITD children was 93 μg/l (range, 35–182 μg/l). Negative correlations were evident between all of TSH, fT4 and UIC levels; and age ($p = 0.014$, $r = -0.093$; $p = 0.000$, $r = -0.203$ and $p = 0.045$, $r = -0.121$, respectively). A positive correlation was noted between urinary iodine level and AITD ($p = 0.006$, $r = 0.195$). Yığılca was thus considered to be a mildly iodine-deficient area.

Discussion

Iodine is a micronutrient. It is found in trace amounts in the human body, in which its only known role is in the synthesis of thyroid hormones. The health effects of severe ID, termed as ID disorders, include endemic goiter, hypothyroidism, cretinism and mental retardation. Iodine stores within the thyroid increase with age in pediatric cases. Hence, infants and young children are inclined to have higher iodine uptake levels than do adults. Moreover, newborns and infants are much more severely affected by iodine deficiencies than adults, and they are more likely to develop clear cases of hypothyroidism and goiter [10, 11].

The WHO/ICCIDD recommends that the total goiter rate (TGR) for a population should be <5%. Mild, moderate and severe IDs indicate TGRs in the ranges of 5.0–19.9, 20.0–29.9 and 30% and above, respectively [12].

Today, goiter remains a great socio-sanitary problem in Turkey. An MSIP was launched by the Turkish Ministry of Health in 1998 and revised in 2010 to state that the recommended iodine concentration should be 25-45 mg/kg of potassium iodate. Although salt iodization is now legally enforced [13], which helps to decrease iodine deficiency enormously [14], ID remains an important public health problem, especially in rural areas of Turkey.

In our study, the overall prevalence of goiter by palpation among SAC was 22.3%. The median UIC was 80 μg/l (30–197). In the present study, the prevalence of goiter increased with age. The prevalence of goiter in children aged 6-12 and 13-19 years was 20.3% (68 cases) and 23.8% (112 cases), respectively. The frequency of hypothyroidism was greater in 13–19-year-olds than in the other groups. This could be due to the higher demand for iodine during adolescence. Goiter prevalence among girls was significantly higher than in boys. This difference may be explained by the facts that puberty comes 1-2 years earlier for girls than for boys and that AITD is more common in girls.

TABLE 2
Comparison of some parameters between 2003 and 2009

Parameters	2003	2009
Urine iodine excretion μg/L	13	80
TSH (μIU/ml)	4.2	2.3
FT4 (ng/dl)	0.94	1.9
Goiter prevalence (%)	71%	22.5%

The UIC was measured as 13 μg/l among SAC in Yığılca in a previous study that was performed before the MSIP; Yığılca was considered a severely iodine-deficient area [4]. The prevalence of goiter, determined by palpation, was reported at 71% in 2003. ID indicators showed dramatic improvement when compared with reports from 6 years ago. However, studies performed in various parts of Turkey have shown that even after the use of iodized salt, goiter prevalence continues to be a serious problem, especially in rural areas. In these regions, the prevalence of goiter is reported to be around 26-30% [15, 16]. The most important reason for this situation is the insufficient consumption of iodized salt in rural areas because people in such areas can use unrefined salt from other sources. The iodized salt consumption rate was 84.2% in Yığılca. In a nationwide study, UIC increased from 53 μg/l to 164 μg/l among SAC in the city center of Bolu (nearest neighbor city, Duzce) after MSIP [14]. We think that the average UIC is >100 μg/l in the town center of Duzce.

The prevalence of goiter shows that Yığılca is still moderately iodine-deficient, but UIC levels show it to be a mildly iodine-deficient area. This difference may be explained via the observation that more than a decade of iodine prophylaxis is needed to eliminate goiter among SAC in a moderately iodine-deficient region [17]. UIC is a good marker of recent dietary iodine intake, but goiter due to ID develops over a long time and depends on many factors [6].

The frequency of AITD has been reported to be between 0.3% and 9.6% in children and adolescents [8, 18]. Inoue *et al.* [18] reported the frequency of AITD to be 0.3% in healthy school children in Japan. In two studies performed in Greece at two different periods, the frequencies of AITD were reported to be 3.3 and 9.6% [8]. The frequency of AITD was found to be 3.6% in a study from the eastern part of Turkey [19]. In our study, we determined that the frequency of AITD was 2.1% in SAC. The frequency of AITD found in our study was consistent with other reports in the literature.

The etiology of AITD is still unclear. Despite some known genetic factors that cause sensitivity, stress, infections, trauma, smoking, drugs and excessive iodine intake in particular have all been held responsible [20]. In the literature, increased iodine intake via diet for endemic goiter prophylaxis has been shown to be one of the reasons for the higher frequency of

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AITD in recent years [21]. In our study, the mean UIC was 93 μg/l (35–182) in children with AITD.

A limitation of our study was that thyroid volumes in children have not been evaluated via ultrasound techniques. Thyroid volumes that were compared with WHO/ICCIDD normative volume values could be used to obtain more reliable results.

Conclusion

The total goiter prevalence rate remains higher among SAC in rural areas of the West Black Sea region of Turkey. The prevalence of goiter in SAC was 22.5% in Yığılca. The regular use of iodized salt in rural areas should be ensured to totally eliminate ID disorders. To maintain elimination of ID, it is important to continue to enforce legislation and sustain MSIP.

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