Iodine status and goiter prevalence in Turkey before mandatory iodization¹

G. Erdoğan*, M.F. Erdoğan*, R. Emral*, M. Baştemır*, H. Sav*, D. Haznedaroğlu**, M. Üstündağ**, R. Köse**, N. Kamel*, and Y. Genç***

*Ankara University Medical School, Department of Endocrinology and Metabolic Diseases, **Turkish Government Ministry of Health MCH and FP General Directorate, ***Ankara University Medical School, Department of Biostatistics, Ankara, Turkey

ABSTRACT. Endemic goiter is an important public health problem in Turkey. Legislation for mandatory iodization of household salt was passed in July 1999. Current study is aimed at ascertaining the goiter prevalence and iodine nutrition in school-age children (SAC) living in known endemic areas of Turkey. Sonographic thyroid volumes (STV) and urinary iodine concentrations (UIC) of 5,948 SAC from 20 cities were measured between 1997-1999. STV of 31.8% of the SAC examined stayed above the upper-normal limits for the same age and gender recommended by the World Health Organization (WHO). Goiter prevalence ranged between 5 to 56% and median UIC ranged between 14 to 78 µg/l, indicat-

INTRODUCTION

lodine deficiency (ID) and related iodine deficiency disorders (IDD) are still major, yet unresolved health concerns for the world. Universal salt iodization is the agreed strategy for its control (1). Available data indicate that, in 1999 approximately 2.2 billion people were at risk of IDD and that 13% of the earth's population, were affected by goiter (2). Endemic goiter, a progressive increase with age of goiter prevalence, thyroid nodularity, functional autonomy and occasionally endemic cretinism has been reported from iodine-deficient communities of Europe during the last century (2-5). Iodine supplementation, mostly by iodization of salt, has been used for decades. The situation has improved markedly during past

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ing severe to moderate iodine deficiency (ID) in 14 and mild ID in 6 of the cities surveyed. Neither of the cities was found to have sufficient median UIC levels. The current study shows that endemic goiter is an important public health problem and iodine nutrition is inadequate nationwide. It also provides reliable scientific evidence and shows the need for a controlled and effective iodine supplementation program nationwide. Mandatory iodization of household salt seems to be the essential measure taken for the moment, additional measures may be needed in the near future.

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years, but in 1992, ID was under control in only 5 European countries namely Austria, Switzerland, Finland, Norway and Sweden (6, 7). Consequently, additional measures were taken following an official document sent by the World Health Organization (WHO), the United Nations Children's Fund (UNICEF) and by the International Council for Control of Iodine Deficiency Disorders (ICCIDD), to all European governments. However in 1997, ID was still found in an important number of European countries, or at least in certain areas of these countries (8). A remarkable weak point about the ID in Europe has been very limited information on IDD from the eastern part of the continent. Although goiter has been known to be endemic in Turkey for decades, there has been no systematic national survey, evaluating iodine status nationwide until now and limited data evaluating iodine status were present. Recently, we showed that severe to moderate iodine deficiency is the major cause of the goiter endemics observed in the Black-Sea region and in the capital of Turkey (9). The current survey aimed to assess the status of iodine nutrition and goiter prevalence in known endemic goiter areas of Turkey nationwide.

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Correspondence: Dr. Murat Faik Erdoğan, Ibni- Sina Hastanesi, Endokrinoloji ve Metabolizma Hst., B.D., 10. Kat, D Blok, 06100 Sihhiye, Ankara, Turkey. *E-mail:* murat.erdogan@temd.org.tr

SUBJECTS AND METHODS

Subjects

The investigation included 5,948 school-age children (SAC) (2,984 girls and 2,964 boys) aged 9-11 yr. This number was the required sample size based on an anticipated prevalence of goiter according to the previous palpation data (10, 11) and on the desired precision of 4 to 9%. Study population from 20 cities represents a population of 9,096,458 nationwide (Table 1). Field studies started in 1997, were completed in May 1999, before the mandatory iodization of table salt in Turkey. However uncontrolled and weak iodine supplementation was started in some parts of Turkey 5 years ago. Ultrasound was performed and urine samples were collected from all of the children.

Thyroid volume

Thyroid volumes were estimated using real-time ultrasonography with a General Electric[®] (Logic

100 α) apparatus, using a 7.5 MHz linear array transducer. Longitudinal and transverse scans were performed, 3 dimensions were obtained from each thyroid lobe and thyroid volume was calculated according to the formula of the ellipsoid model proposed by Brunn *et al.* (12) and proved to be effective for assessment of goiter in children (13). Upper-normal limits (percentile 97) for the age and gender matched iodine-replete European children were used to define the goiter (14, 15).

Urinary-iodine determinations

Urine samples were kept covered up and frozen at –20 C, in deionized tubes until the day of analysis. Urinary iodine excretion was determined by a colorimetric method recommended by WHO-ICCIDD (Calorimetric ceric ion arsenous acid wet ash method based on Sandell Kolthoff Reaction). Fisher[®] reagents and spectronic 20, Genesis autoanalyzer

Table 1 - Goiter prevalence, median urinary iodine concentrations (UIC) and mean±SD sonographical thyroid volumes of 5,948 school age children (SAC) surveyed according to the anticipated goiter prevalence from 20 cities of Turkey.

City	Population	Goiter prevalence % (no.*)	Thyroid volume mean±S.D. (ml)	UIC median (µg/l)
Ankara	2.984.099	25 (no.=303)	7.16±3.85	25.5
Kastamonu	59.145	40 (no.=303)	7.69±3.21	30.5
Bayburt	38.453	42 (no.=306)	8.48±4.59	16.0
Trabzon	177.904	39 (no.=314)	8.22±2.86	14.0
Burdur	87.568	27 (no.=394)	7.24±3.15	21.0
Isparta	158.930	25 (no.=394)	7.37±3.19	28.0
Konya	702.842	15 (no.=187)	6.59±3.35	41.0
Erzincan	159.093	22 (no.=394)	7.63±2.21	48.0
Erzurum	325.396	33 (no.=383)	8.17±2.63	19.0
Van	289.081	17 (no.=386)	6.09±2.43	37.0
Diyarbakır	641.616	17 (no.=243)	6.39±2.77	43.5
Malatya	465.807	45 (no.=151)	8.31±3.98	78.0
Samsun	409.268	34 (no.=151)	7.50±3.78	20.0
Çorum	207.195	8 (no.=230)	5.30±2.21	61.5
Bolu	129.627	5 (no.=187)	5.02±1.87	53.0
Kütahya	201.913	6 (no.=178)	4.56±1.93	59.5
Bursa	1.160.395	7 (no.=385)	5.12±2.79	51.0
Edirne	134.400	42 (no.=384)	8.32±2.11	78.0
Aydın	195.350	56 (no.=394)	9.24±2.70	46.5
Kayseri	568.376	33 (no.=288)	8.24±2.69	25.5
Total	9.096.458	31.8 (no.=5.948)		

*Required sample size based on an anticipated prevalence of goiter determined according to the previous palpation data (9, 10). Desired precision was 4 to 9% decided according to the predicted goiter prevalence for the individual city.

(16, 17) were used. The results were calculated as micrograms of iodine per liter urine (μ g/l) and are expressed as a median.

Statistical methods

Commonly used statistical methods (mean, median and proportions) were applied to analyze the data. The Kolmogorov-Smirnov test indicated that the distribution of thyroid volumes and urinary iodine were not normal. As regards urinary iodine, normalization did not occur after a logarithmic transformation and as advised by WHO-ICCIDD recommendations the medians were used rather than mean values (1). The normal value for urinary iodine concentration (UIC) in school children are medians varying from 100 to 200 μ g/l (1).

RESULTS

Results obtained from 20 cities are presented in Table 1 and a map summarizing goiter prevalence and median UIC is given in Figure 1. Actual goiter prevalence found excedeed 30%, indicating severe ID in 9 of the cities (*i.e.* Kastamonu, Bayburt, Trabzon, Erzurum, Malatya, Samsun, Edirne, Aydın and Kayseri, Table 1, Fig. 1) (1). Ankara, the capital, Burdur, Isparta and Erzincan showed goiter prevalence between 20 and 29.9%, indicating moderate ID. Seven of the cities displayed goiter prevalence from 5 to 19.9% indicating mild ID (*i.e.* Konya, Van,

Diyarbakır, Çorum, Bolu, Kütahya and Bursa, Table 1, Fig. 1). Median UIC indicated severe ID in Bayburt, Trabzon and Erzurum (*i.e.* <20 µg/l, Table 1, Fig. 1). Eleven of the cities studied revealed moderate ID having median values between 20-49 µg/l (i.e. Ankara, Kastamonu, Burdur, Isparta, Konya, Erzincan, Van, Diyarbakır, Samsun, Aydın and Kayseri, Table 1, Fig. 1). Six cities showed mild ID, UIC in between 50-100 µg/l (i.e. Malatya, Çorum, Bolu, Kütahya, Bursa and Edirne, Table 1, Fig. 1). Median UIC were comparable with the severity of goiter endemics in 11 of the cities studied. However, in 6 cities (i.e. Kastamonu, Malatya, Samsun, Edirne, Aydın and Kayseri, Table 1, Fig. 1) median UIC values reported were relatively higher, and in 3 cities (*i.e.* Konya, Van, Diyarbakır, Table 1, Fig. 1) relatively lower than what would be accepted for the observed goiter prevalence.

Goiter prevalence found in 8 of the studied cities was lower than the predicted prevalence and a larger sample size may be needed to find the actual goiter prevalence in these areas (Table 1). None of the cities showed sufficient UIC (*i.e.* >100 μ g/l) and the overall goiter prevalence among the 5,948 SAC surveyed was 31.8% (Table 1, Fig. 1).

DISCUSSION

This study attempted to evaluate goiter prevalence and iodine nutrition in 9-11 year-old SAC from 20



Fig. 1 - Prevalence (%) and median urinary iodine concentrations of the school age children (SAC) surveyed from 20 cities of Turkey.

known endemic cities of Turkey. 5,948 SAC surveyed represents a population of 9,096,458 living nationwide. Two standard methods, namely sonographic thyroid volumes (STV) measured by ultrasonography and UIC were used.

Severe to moderate ID was remarkable in 14 of the cities studied. Median UIC was comparable with the severity of goiter endemics, observed in 11 of the cities surveyed. Relatively higher median UIC, even higher than the elevate goiter prevalence observed in 6 cities, seems to be a conseguence of an inadequate iodine supplementation program which was started 5 years ago with the iodization of table salt. In three of the cities where goiter prevalence stayed relatively low when compared to the moderate ID determined (*i.e.* Konya, Van, Diyarbakır, Table 1, Fig. 1), goiter prevalence found was also lower than the predicted values and increasing the sample size would be appropriate for these cities. In four of the cities (i.e. Corum, Bolu, Kütahya and Bursa, Table 1, Fig. 1) although the goiter prevalence reported was relevant with the mild ID observed, the predicted prevalence stayed well over the prevalence found. This may reflect the improving situation in these areas in the last decade or it might be due to the misleading palpation data from older studies conducted in these areas (11). An increment of the sample size may also be needed in these areas.

None of the cities studied, showed sufficient median UIC (*i.e.* >100 μ g/l). Similarly, sonographic goiter prevalence reported was systematically higher than 5% in the study areas, which indicates that goiter is endemic nationwide. This survey also showed that severe to moderate ID is the major cause of the goiter endemics observed in Turkey. Other more dramatic consequences of ID, like endemic cretinism are beyond the scope of this study and are not being thoroughly investigated in Turkey. Median UIC indicating the severe ID reached in some cities is relevant in those parts of the world where endemic cretinism had been reported (18).

This study provides reliable epidemiological data regarding goiter prevalence and iodine nutrition in Turkey. The results of the current study point toward the necessity of a controlled and effective iodine supplementation program in Turkey. Legislation for the mandatory iodization of the household salt with 50-70 mg/kg KI or 25-40 mg/kg KIO₃ was passed in 1999 and strictly enforced in July 2000. This seems to be the only measure taken for the moment. The enforcement of iodized salt production and use, and the monitoring of iodine con-

centration in salt and urine of individuals, are currently being undertaken. Additional measures may be needed in the near future.

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