Research paper

The Republic of Srpska Iodine Deficiency Survey 2006

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ABSTRACT

OBJECTIVE: A survey related to iodine deficiency in the Republic of Srpska was first conducted in 1999 and resulted in the adoption of regulations concerning the quality of salt for human consumption. In order to reassess iodine status, we conducted the Republic of Srpska Iodine Deficiency Survey in 2006. DESIGN: The survey was conducted in a sample of 1,200 schoolchildren using parameters recommended by WHO, UNICEF and ICCIDD: palpation of thyroid gland, iodine urinary excretion, thyroid utrasonography and content of iodine in salt. RESULTS: The goiter prevalence in the total group indicated mild iodine deficiency in the Republic of Srpska, whereas urinary iodine excretion suggested iodine sufficiency. Only 35.7% of salt samples were adequately iodinated, 51.2% were hypo-iodinated and 13.1% were hyper-iodinated. Of the salt samples tested, 40.9% were iodinated using potassium iodide, despite the fact that this method of salt iodination is forbidden by regulations related to the quality of salt for human consumption. Higher prevalence of goiter and lower urinary iodine content was found in rural areas compared to urban ones, although the iodine content of salt did not differ between these two areas. CONCLUSIONS: It seems that the Republic of Srpska has progressed from moderate (1999) to mild iodine deficiency with a wide range in the urinary iodine excretion values. However, the salt for human consumption is of low quality. The higher prevalence of goiter and the lower urinary iodine values in rural areas compared to urban ones may be attributed to differences in salt usage and/or nutritional factors.

Key words: Goiter, Iodine deficiency, Salt iodination, Schoolchildren, Thyroid gland

INTRODUCTION

Iodine deficiency is one of the most serious global public health problems. It is estimated that more than 36% of the general population has insufficient iodine intake, resulting in 15.8% of the total goiter prevalence (TGP).[1]

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The main factor responsible for iodine deficiency is a low dietary intake of iodine, resulting in hypothyroidism as well as in a series of functional and developmental abnormalities grouped under the heading of "Iodine Deficiency Disorders" (IDD).[2,3] The deleterious impact of insufficient iodine intake on fetuses, neonates and children, such as abortions, stillbirths, congenital anomalies, increased perinatal mortality, endemic cretinism, deaf mutism, neonatal goiter and hypothyroidism, endemic mental retardation and increased susceptibility of the thyroid gland to nuclear radiation are well documented.[3,4]

The World Health Organization recommends that the iodine status of the world population be regularly assessed[4] to ensure an optimal amount of iodine intake. Several indicators are used to assess the iodine status of a population: thyroid size by palpation and/or by ultrasonography, Urinary Iodine excretion (UI), TSH and thyroglobulin. Until the 1990s, Total Goiter Prevalence (TGP) was recommended as the primary means for assessment of IDD prevalence. It has been shown however that in endemic areas, TGP may not return to normal for months or years after correction of iodine deficiency but it is still useful for evaluation of the long-term impact of pertinent programmes. While IDD affects the entire population, a school-based sampling method is recommended for UI and TGP assessment as the most efficient and practical approach to monitor IDD, since this group is usually easily accessible and can be used as a proxy for the general population.[5] Iodine deficiency is considered to be a public health problem in populations of school-age children and is defined either as median UI value below100 μg/l or goiter prevalence above 5%.[5] UI is a sensitive indicator of recent changes in iodine intake (approximately 90% of daily iodine intake is eliminated by the kidney).[4] One of the criteria for monitoring progress towards sustainable IDD elimination is the proportion of households consuming adequately iodized salt, the recommendation being consumption of adequately iodized salt by more than 90% of households.[4]

The first Iodine Deficiency Survey in the Republic of Srpska (RS) was conducted in 1999 on a representative sample of children, aged 7-14 years. The total goiter prevalence in this survey was 23.5% indicating moderate iodine deficiency. The iodine content in salt was also inadequate in 54% of samples tested.[6] As a result of this survey, in January 2005 the government of the RS adopted a new regulation, setting the quality of salt for human consumption (salt must contain 33.7-50.5 mg of potassium iodide per 1 kg).[6]

Based on available publications, WHO recommendations, the RS regulation for the quality of salt for human consumption of January 2005 and on the results of the previous survey, we decided to conduct a new survey the aim of which was to assess the current iodine status of the population in the RS and hence the adequacy of measures taken for adequate iodine intake. Schoolchildren are a group of the population more vulnerable to iodine deficiency than adults while they constitute an easily accessible group for examination.

SUBJECTS AND METHODS

Subjects

Data obtained from the Ministry of Education of RS, showing school enrolment to be 95%, indicated that this group is highly representative for such a survey.[7] In order to obtain data reliability, we decided to include 1,200 schoolchildren aged 7-10 years from 30 schools (clusters) and to examine 20 pupils of the second grade and 20 pupils of the third grade in each school (approximately the same number of boys and girls).

Having obtained a list of schools and the number of pupils in each school from the RS, we decided to use the PPS method (proportionate to population size) for selection of schools. The same method (PPS) was used to select schoolchildren of each class.[7]

Permission to examine the children was obtained from parents and from the RS Ministry of Education.

We planned to perform thyroid gland palpation, to collect samples of urine and salt from the household of every child and to perform ultrasonographic measurement of thyroid gland volume in at least 20% of the total population of children. The sample that we used in this survey was highly representative for estimation of iodine status in the RS

Methods

Palpation of the thyroid gland

Palpation of the thyroid gland was done consecutively by two experienced examiners, both using the same method. In the event of a different finding (which occurred extremely rarely), a third examiner who performed ultrasonographic measurement of the volume of the thyroid gland was asked to perform palpation, following which all three examiners decided how to classify the result of the palpation.

The results of the palpation were classified into three grades: grade 0 - thyroid gland was not palpable and visible, grade 1 - thyroid gland was palpable but not visible in its normal position of the neck, grade 2 - thyroid gland was palpable and visible in its normal position of the neck.[8]

Measurement of thyroid gland volume by ultrasonography

Measurement of thyroid gland volume by ultrasonography was performed by one examiner, by a real time ultrasound portable Mindray DP -1100 device (linear probe 7.5 MHz, length 4cm) while the child was lying on her/his back with the neck in an extended position. The examination technique is described in the IDD Newsletter.[9] The volume of each lobe was estimated according to the formula for rotating ellipsoid.[10]

The results of measurements were compared with the latest norms for the size of the thyroid gland determined ultrasonographically, as reported by the Zimmermann group.[11]

The Body Surface Area (BSA) was obtained using the children's height and weight measurements.

Methods used for determining urinary iodine excretion

Urine samples (1.5ml) were collected from the children, transported in refrigerator and frozen the same day at -20^{0}C. At the end of the field work we sent the collected samples to the Institute of Pathophysiology and Nuclear Medicine, Faculty of Medicine, University of Skopje, FYROM. They were examined by Method A, described on pages 163-167 of the publication "The correction of iodine deficiency in FYROM".[12]

Iodine salt content

Salt samples (150 mg) were brought by children from their households during the examination, transported and stored in a dry, dark and cold place. They were analyzed at the Public Health Institute RS, employing customarily used methods for KJ[13] and KJO_3.[14]

Data collecting and processing methods

The personal data of every child – date of examination, school name and location, child's name and surname, sex, age, nationality, height and weight, thyroid gland palpation findings (grade 0, 1 or 2), serial number of urine and salt sample – were registered on a specially designed questionnaire. The data of the questionnaires were recorded on a specially designed EXCEL table and processed in it.

The data were processed for four parameters relevant to iodine deficiency: palpation of thyroid gland, iodine urinary excretion, thyroid gland volume measured by utrasonography and content of iodine in salt. The results were derived and presented in tables. Statistical significance (t-test and chi-square) was set at 0.05. The results for each school were also derived separately.

RESULTS

Results of thyroid gland palpation

The thyroid gland was palpated in 1,196 children, out of a planned 1,200 (601 males and 595 females). The total goiter prevalence determined by palpation of the thyroid gland was 7.5% (5.9% goiter grade 1 and 1.6% goiter grade 2). Table 1 shows the prevalence of goiter separately in boys and girls, and in children living in urban and rural areas.

There was statistically significant difference in the prevalence of goiter between boys (5.3%) and girls (9.8%) ($p<0.001$) as well as between children living in urban (5.7%) and rural areas (10.2%), ($p<0.001$).

The percentage of children with goiter showed a wide range in the various schools (from 0% to 40%). Out of 30 schools, 12 had a percentage of children with goiter less than 5%, while 18 had >5%.

Results of measurement of thyroid gland volume by ultrasonography

The thyroid gland volume was measured by ultrasonography in 992 children (504 males and 488 fe-

Table 1. Prevalence of goiter determined by palpation according to gender and area of living (urban or rural)

	Total number of examinees	Number of examinees with goiter	Prevalence of goiter (%)
Boys	601	32	5.3
Girls	595	58	9.8
Urban area	718	41	5.7
Rural area	478	49	10.2
Total	1196	90	7.5

males) and the results are shown in Tables 2 and 3.

The thyroid gland volume in 131 children (13.2%) was greater than the 97th percentile for age (males: 13.1%, females: 13.3%).

The thyroid gland volume in 163 children (16.4%) was greater than the 97th percentile according to BSA (males: 13.9%, females: 19.1%).

The children in all age/gender groups whose thyroid gland volume was greater than the 97th percentile were in the range of mild iodine deficiency.

The children in all BSA/gender groups whose thyroid gland volume was greater than the 97th percentile were in the range of mild iodine deficiency, with the exception of a percentage of females with BSA 0.8 and 0.9 m^2 that was in the range of moderate iodine deficiency.

In Table 3 the thyroid gland volume and prevalence of goiter is shown according to BSA and gender.

Results of urinary iodine excretion

Urinary iodine excretion was determined in 1,191 children out of the 1,200 planned (599 males and 592 females).

The median value of urinary iodine excretion was 164.4 µg/l, and the range 7.0 to 558 µg/l.

Table 4 shows the urinary iodine excretion according to gender and area of living. Table 5 shows the distribution of iodine excretion according to iodine status was well as the expected risk for thyroid disease.

There was a statistically significant difference ($p<0.001$) in the urinary iodine excretion between

Table 4. Urinary iodine (UI) excretions (µg/l) according to gender and area of living (urban or rural).

	Number of examinees	Median UI value (µg/l)	Range (µg/l)
Boys	599	170.5	7-540
Girls	592	154.7	7-558.1
Urban area	714	169.6	7-558.1
Rural area	477	158.8	7-507.8
Total	1.191	164.4	7-558.1

Table 2. Thyroid gland volume (ml) determined by sonography and percentage of children with goiter according to age and gender.

Age	Males				Females			
(years)	N*	P50**	P97***	%****	N*	P50**	P97***	%****
7	239	2.24	4.14	16.5%	225	2.27	4.25	12.7%
8	244	2.49	4.56	10.6%	240	2.63	4.83	14.2%
9	21	2.48	4.52	9.5%	23	2.83	4.74	13.0%

* Number of examiniees, ** 50th percentile (median) of thyroid gland volume, *** 97th percentile of thyroid gland volume,
**** Percentage of children who have thyroid gland volume greater than the 97th percentile of normal volumes according to Zimmermann et al[11]

Table 3. Thyroid gland volumes (ml) and prevalence of goiter % according to BSA (m^2) and gender.

BSA	Males				Females			
(m2)	N*	P50**	P97***	%****	N*	P50**	P97***	%****
0.8	113	1.94	4.10	15.0%	122	2.17	3.69	20.5%
0.9	171	2.37	4.46	16.4%	170	2.38	4.19	25%
1.0	122	2.55	4.37	9.0%	129	2.67	5.17	14.7%
1.1	58	2.9	4.39	6.9%	43	3.02	4.82	13.9%
1.2	32	2.81	4.3	3.1%	20	3.44	5.37	5.0%
1.3	8	2.72	3.84	0%				

* Number of examiniees, ** 50th percentile (median) of thyroid gland volume, *** 97th percentile of thyroid gland volume,
**** Percentage of children who have thyroid gland volume greater than the 97th percentile of normal volumes according to Zimmermann et al[11] BSA, Body surface area.

Table 5. The distribution of urinary iodine excretion values (μg/l) according to iodine status, as defined by Epidemiological criteria of assessing iodine nutrition in school-age children[1] as well as the expected risk for thyroid disorder.

<20 μg/L (severe iodine deficiency)		20-49 μg/L (moderate iodine deficiency)		50-99 μg/L (mild iodine deficiency)		100-199 μg/L (optimal iodine nutrition)		200-299 μg/L (more than adequate iodine intake)***		>300 μg/L (excessive iodine intake)****	
N*	%**	N*	%**	N*	%**	N*	%**	N*	%**	N*	%**
8	0.7	54	4.5	180	15.1	535	44.9	317	26.6	97	8.1

* Number of examinees, ** Percentage of examinees, *** Risk of iodine-induced hyperthyroidism within 5–10 years following introduction of iodized salt in susceptible groups, **** Risk of adverse health consequences (iodine induced hyperthyroidism, autoimmune thyroid diseases)

boys and girls as well as between urban and rural areas.

The median values of urinary iodine excretion in children from various schools ranged from 115.7 to 245μg/l. Thus, all median values of urinary iodine excretion in children from various schools were higher than 100μg/l, while the median values in 3 schools were higher than 200μg/l.

Results of iodine content in salt samples

Household salt samples were collected from 1,186 children out of the 1,200 planned.

Tables 6 and 7 show the iodine content in salt samples.

Table 6. Iodine content (mg/kg) in salt samples (total sample and according to the type of fortification).

	Number of samples	<20 mg/kg (hypo-iodinated)	20-30 mg/kg (adequately iodinated)	>30 mg/kg (hyper-iodinated)
All samples	1,186	51.2%	35.7%	13.1%
Samples iodinated by KJ	485	85.1%	4.7%	10.2%
Samples iodinated by KJO3	701	27.7%	57.2%	15.1%

Table 7. Iodine content (mg/kg) in salt samples from urban and rural areas.

Urban areas			Rural areas		
Number of samples	Median	Range	Number of samples	Median	Range
714	19.35	0.52-76.2	472	20.1	0.95-64.5

Only 35.7% of the salt samples were adequately iodinated, 51.2% were hypo-iodinated and 13.1% hyper-iodinated. A large number of salt samples (40.9%) were iodinated using potassium iodide (KJ), despite the fact that it is not allowed by the RS's regulation as salt for human consumption. The remaining were iodinated using KJO_3. The range of iodine content in the salt samples was very wide (0.52-76.2 mg/kg).

There was no significant difference between median values and range of iodine content in salt samples collected in urban and rural areas.

DISCUSSION

Iodine deficiency is a major public health problem worldwide.[4] Numerous endocrine and metabolic disorders are caused by insufficient iodine intake,[2,3] this resulting in multiple health, social and economic problems. Based on these facts, WHO, UNICEF ICCIDD and PAMM have introduced various recommendations for the reduction or elimination of iodine deficiency.

Various studies that assessed iodine status in former Yugoslavia have shown that the territory of the RS is an area of endemic goiter.[15,16]

The first survey in the RS, conducted in 1999 in accordance with WHO/UNICEF/ICCIDD recommendations, resulted in the adoption of a Plan of Action for the elimination of IDD.[6]

The first task was to form a national body responsible to the government for IDD elimination, and this was achieved in August 2006. The adoption by the government of the Action Plan for the children of the RS in the year 2002 is evidence of political commitment to USI and elimination of IDD. Another task was the adoption of the new regulation of the quality of salt for human consumption in January 2005.

Nearly 800 health professionals were educated about IDD, using adult learning principles.

A programme of public education and social mobilization on the importance of IDD and the consumption of iodized salt was prepared. Two intensive media campaigns were used to educate the population, as well as direct education by health professionals. This has to be continued.

Our study results on the palpation of the thyroid gland (TGP 7.5%) categorize the RS population as one suffering from mild iodine deficiency.[6] Comparing present results with those from the last survey conducted in 1999 (TGP 23.5%), progress from moderate to mild iodine deficiency is evident.[17] In FYROM, which was also an endemic goiter area in former Yugoslavia, TGP was 13% in 1998[18] and 4.7% in 2003.[12] Higher TGP in the RS might be explained by the fact that its population consumed salt of very low quality in the years 1992 to 1995.

However, the results of thyroid gland volume measured by ultrasonography in the present study indicate a higher prevalence of goiter than that detected by palpation. Similar results were obtained in FYROM and the authors' comment was that comparison of the thyroid gland volume of FYROM children with the norms of Zimmermann would reveal an unrealistically high percentage of children with goiter.[12]

Females were found to have a much higher prevalence of goiter compared to males ($p<0,001$) as well as lower urinary iodine excretion than males. These findings have been detected in almost all surveys conducted in iodine deficient regions.[12,18,19] There is also a considerable difference between the various schools in goiter prevalence (0-40%), though the low numbers of examinees in certain schools does not allow firm conclusions. They nevertheless indicate that regional studies may be advisable.[20]

The higher prevalence of goiter rates and the lower median values of urinary iodine excretion in rural areas compared to urban areas cannot easily be explained but should not be attributed to the lower quantity of iodine in the salt used in rural areas, since the salt iodine content was not different between urban and rural areas. Therefore, the only logical explanation for the differences in median values of urinary iodine excretion between urban and rural areas might be different habits related to salt usage in urban and rural households, the quality of salt used and/or nutritional factors. Conducting surveys on habits related to usage of salt in households would thus be of great interest. Analogous differences between urban and rural areas were shown in other surveys conducted in the Balkans.[12,18,19] The results of median urinary iodine excretion categorize our population as one with optimal iodine nutrition.[5] Looking at the range of results (7.0 - 558 μg/l), it becomes evident (Table 5) that in 26.6% of the children examined, urinary iodine excretion was in the range of 200-300μg/l and in 8.1% urinary iodine excretion was higher than 300μg/l, indicating risk of iodine-induced hyperthyroidism within 5–10 years following introduction of iodized salt and excessive risk of adverse health consequences such as auto-immune thyroid diseases as well as other risks.[1]

It must be stressed that only 35.7% of salt samples were adequately iodinated, 51.2% were hypo-iodinated and 13.1% were hyper-iodinated. Many salt samples (40.9%) were iodinated with potassium iodide, despite the fact that it is not allowed by our regulations on the quality of salt for human consumption. This indicates that various sectors of the population of the RS use salt of uncertain quality and that there is, therefore, a need for more efficient quality control. Analogous results were shown in the Federation of Bosnia and Herzegovina[19] and in the survey conducted in the RS in 1999.[6] Overall, TGP derived by palpation and ultrasonographic measurement of thyroid gland volume point to the existence of a mild iodine deficiency in the RS, although median values of urinary iodine excretion indicate optimal iodine intake in this population. This discrepancy might be explained by the observation that preventive actions normalize urinary iodine excretion fairly quickly, while a correction of thyroid gland volume needs far more time to occur.[20] Comparison with the results from the last survey conducted in 1999 (TGP 23.5%) indicates progress from moderate to mild iodine deficiency.[6]

The Republic of Srpska is likely to face various problems related to the fact that the salt available for human consumption is of low quality. Therefore, we adopted a new National Strategy for control of iodine deficiency that is based on the Criteria for monitoring progress towards sustainable IDD elimination.[4]

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