Analysis of the 1997-98 Salt Iodization Levels in Croatia

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Abstract

Iodine goiter deficiency is one of the major public health problems in Croatia and some other countries. In this country important studies were done in the period 1951-61, when in some places as many as up to 85% of the medically examined school children had goiter. At the time, the introduction in kitchen salt of iodine goiter prophylaxis by the addition of 10 mg KJ iodine/kg salt proved highly instrumental in reducing goiter (1). Nevertheless, the 1986-87 studies showed that goiter was still a current national problem. The then national mean of 25% among school children indicated that the problem had obviously been slightly neglected (2). Next, the 1995-96 epidemiological goiter surveys' finding that for this reason the prescribed concentration of 10 mg KJ/kg salt was too low compared with the limits prescribed by the developed countries has hastened a revision of salt iodization criteria. Such endeavors have resulted in new regulations requiring the addition of 25 mg KJ/kg and in the monitoring of the method of implementation of the new regulation. This was accomplished by systematic assays of the salt for human diet in 1997 in 1998, whose results are shown below.

1. Introduction

Iodine deficiency is one of the most important causes of brain lesions and mental retardation. In the estimate of the World Health Organization (WHO), the United Nations International Children's Emergency Fund (UNICEF) and the International Council for Control of Iodine Deficiency Disorders (ICCIDD), in the early nineties at least 1,572 million people worldwide were at risk of Iodine Deficiency Disorders (IDD) and at least 655 million were affected by goiter. An estimated 43 million people were afflicted by some degree of mental retardation and 11 million people by overt endemic cretinism (3).

It has been established that failure in psychomotor function, poor eye-arm coordination, partial paralysis, dwarfism, deaf-mutism, face and body deformations, stunted growth and development, reduced intellectual ability, and the already mentioned cretinism can be due not only to goiter (Lat. struma), but also to the deficiency of iodine in the body. If iodine deficiency is present in a pregnant woman's body, the incidence of stillbirths or premature births can increase significantly. Equally, iodine deficiency causes irreversible brain damage in the fetus and newborn (4).

All these diseases have prompted the General Assembly of the WHO at its 1990 New York World Conference on Children and the International Conference on Nutrition held in Rome in 1992 to set the elimination of IDD by the year 2000 as one of their main objectives.

Food is man's main source of iodine, drinking water and air being less important in this respect. The main sources of iodine are sea fish, other fruits of the sea, meat and meat products of the animals whose diet is richer in iodine, and milk, milk products, as well as the eggs and meat of the poultry fed with fish flour. Among vegetables, kale, spinach, cabbage, potato and corn have the highest iodine contents. Iodine is an ingredient of some medicines and mineral-vitamin preparations. It is also present in powdered additives used in making bread, buns and rolls and cakes (5).

Insufficient bodily intakes of iodine have led to the "enrichment" of salt with iodine, because salt is consumed in roughly equal daily amounts by the entire population. Most often, the addition of iodine to salt (NaCl) is made in the form of potassium iodide (KJ) or potassium iodate (KJO_3).

Until 1992 iodine deficiency-related health disorders had been a chronic problem in the developed countries, primarily Switzerland and some parts of the US. By introducing iodine goiter prophylaxis through salt iodization Switzerland almost eliminated the goiter problem.

Although goiter will be discussed in other papers, we would note that in the early 50s the incidence of goiter in the inland parts of Croatia varied from approximately 46% in Zagreb to 80% in the regions of Slavonia and Lika. In 1949 as many as up to 85% of the school children in the Rude village near Zagreb were found to be affected with goiter (1).

A law passed in 1953 made the iodization of salt for human food and animal feed with 10 mg KJ/ kg compulsory. Ten years after the introduction of iodine goiter prophylaxis the prevalence of goiter in school children was nearly halved: from 83 to 57% in Osijek, from 75 to 37% in Pozega, from 51 to 35% in Bjelovar, from 70 to 52% in Varazdin, from 80 to 20% in Sisak, and from 62 to 21% in Karlovac (1).

More recent studies run 40 years after the introduction of iodine goiter prophylaxis have pointed to the continued currency of the goiter problem among the school children of individual towns and places: Zagreb 19%, Rude (Zagreb) 35% (85% in 1949), Dakovo 22%, Rijeka 13% and Split 8%, versus a 25% national mean for goiter (2).

Moreover, a survey of iodine contents in the salt produced by Croatian manufacturers (salt plants at Pag, Nin and Ston), covering more than 160 samples, showed the mean iodine level per assay to be 5.39 mg KJ/kg salt, which was considerably below the prescribed level of 10 mg KJ/kg salt (6-8).

Basing himself on the significant number of goiter cases and relatively low iodine contents of the salt used for human diet, our minister of health first set up a Government Commission on Goiter Control and Iodine Prophylaxis Monitoring, and issued a Salt Iodization Guideline (Official Journal of the Republic of Croatia 84/96). This was soon followed by a Basic Requirements for Human Diet Salt Regulation (Official Journal of the Republic of Croatia 15/97) prescribing the addition of 25 mg KJ/kg salt (or corresponding amounts of either NaJ, $NaJO_3$ or KJO_3), also restricting the salt iodine levels to a minimum of 20 and a maximum of 30 mg KJ (or 15-23 mg of iodine) per kilogram salt (9, 10).

2. Materials and methods

2.1 Study objective

In view of the importance of examining the concentrations of iodine in the salt designed for human diet the following objectives were set:

a) Determination of iodine concentrations in the samples of salt from various sources (of different origin) during 1997/98;

b) Assessment of the extent of sample compliance with the Croatian new regulations of 1996/97;

c) Introduction of continuous monitoring of iodine levels in the salt designed for human diet.

2.2 Materials

The assayed salt samples submitted to the Croatian National Institute of Public Health in Zagreb included:

a) Samples referred to us via the Sanitary Border Inspectorate, Croatian Ministry of Health, whose concern is inspecting the food deliveries that pass our border crossings. We analyzed the samples submitted between January 1997 and December 1998, totaling 144 samples of imported salt originating from Austria, Belgium, Bosnia-Herzegovina, Hungary and Slovakia;

b) During the monitoring and consultations, on four occasions (twice annually) the samples were collected in domestic salt plants Pag, Nin and Ston by the staff of the Croatian National Institute of Public Health from Zagreb. Fifty samples were gathered in this fashion.

c) Samples were also collected from households, schools and shops. At schools, they were collected during the medical examinations of school children in individual towns. The collecting was also done by local sanitary inspections and by shopping in various shops. A total of 120 samples was collected in the

towns named below Tables 1 and 2. All together, 314 samples were collected.

2.3 The method

To assess salt iodine levels we used the AOAC's (American Official Analytical Chemists) official method, the titrimetric method (11).

Briefly, iodide oxydizes into iodate catalyzed by bromide water, to then have KJ in excess added to the developed iodate. The released iodine is titrated by means of the standard sodium thiosulfate solution with starch as an indicator.

3. Results

All assay results on iodine concentrations in the samples of salt intended for human diet (totaling 314) are shown in Tables 1 and 2, as well as in Graph 1.

Table 1
Iodine concentration monitoring of salt for human consumption (mg/kg) in Croatia for 1997.

No.	Sample origin	No. samples	Range min. max.	Mean	Irregular %	No.
1	Imported salt	89	9.51-30.0	25.92	15.73	(14)
2	Domestic salt plants Pag, Nin, Ston	30	1.10-28.20	19.31	6.66	(2)
3	Households, schools, shops[a]	42	2.77-29.30	19.80	30.95	(13)
	Total	161	1.10-30.00	21.67	19.2	(29)

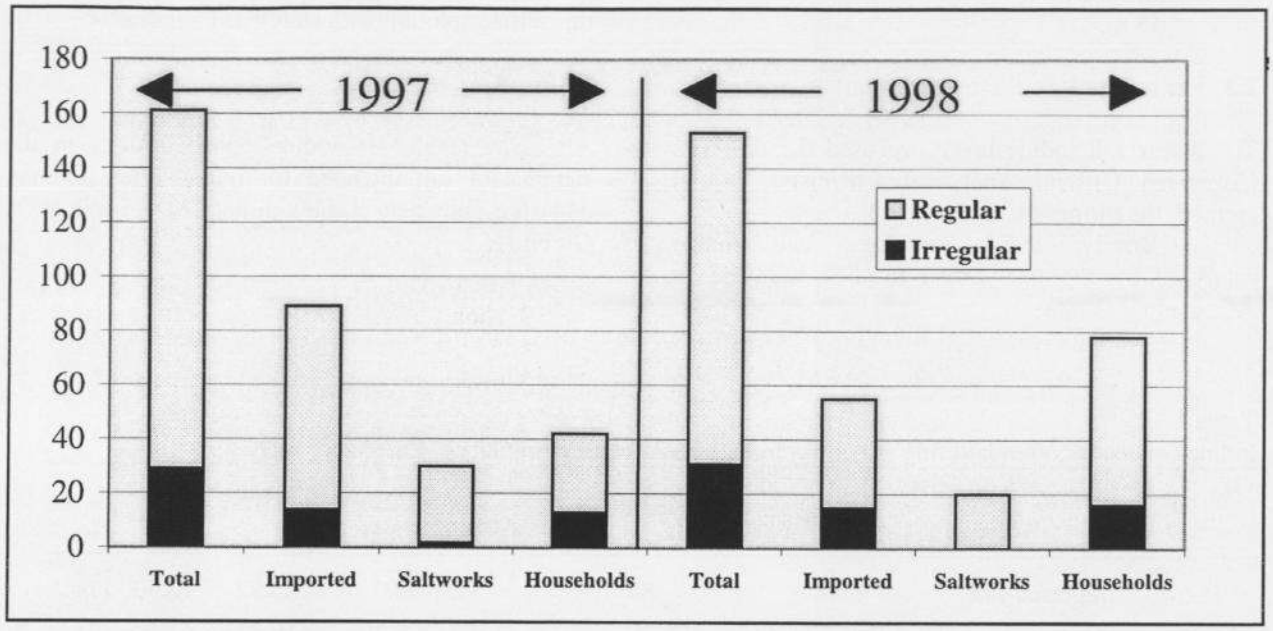
[a] Bednja, Dubrovnik, Osijek, Pazin, Pula, Rijeka.

Table 2
Iodine concentration monitoring of salt for human consumption (mg/kg) in Croatia for 1998.

No.	Sample origin	No. samples	Range min. max.	Mean	Irregular %	No.
1	Imported salt	55	0.10-30.0	19.45	27.27	(15)
2	Domestic salt plants Pag, Nin, Ston	20	20.0-27.67	24.69	0	
3	Households, schools, shops[b]	78	0.20-52.50	21.72	21.51	(16)
	Total	153	0.10-52.50	21.97	20.26	(31)

[a] The Ston salt plant is under reconstruction.
[b] Bednja, Dubrovnik, Dakovo, Osijek, Rijeka, Varazdin, Vukovar.

Fig. 1. Total number of samples and their relationship to samples of stated origin.



4. Discussion

Tables 1 and 2 show the results of salt sample assays by their origin, the 1997-98 sample total, range (min., max.), mean, as well as the percentage and number of samples either contravening the new regulatory requirements, the 25 mg KJ/kg salt criterion or the 20-30 mg KJ/kg salt range.

The following is evident from Table 1:

- of the total of 161 samples examined 18.01% (29 samples) failed to meet the regulatory requirement: The mean and range were 21.67% and 1.10-30.00 mg KJ/kg salt, respectively;

- of the 89 salt import samples 15% (14 samples) were irregular. The mean and range were 25.92 and 9.51-30.00 mg, respectively;

- of the 30 salt samples collected in domestic salt plants Pag, Nin and Ston 6.66% (2 samples) were irregular. The mean and range were 19.31 and 1.10-28.2 mg KJ/kg, respectively;

- of the 42 salt samples from shops, households and schools 30.95% (13 samples) contravened the regulation. The mean and range were 19.80 and 2.77-29.30 mg KJ/kg salt, respectively.

The following is evident from Table 2:

- of the total of 153 samples examined 20.26% (31 samples) also contravened the regulation. The mean and range were 21.97 and 0.10-52-50 mg/kg, respectively;

- of the 55 salt import samples 27.27% (15 samples) contravened the regulation. The mean and range were 19.45 and 0.10-30.0 mg KJ/kg salt, respectively;

- of the 78 salt samples from shops, households and schools 21.51% (16 samples) contravened the regulation. The mean and range were 21.72% and 0.20-52.50 mg KJ/kg, respectively.

The sample which contained 52.50 mg KJ/kg salt came from Vukovar, and originated from the World Food Programme. Noncompliance with the regulation is suitably illustrated in Graph 1 showing the relationships between sample total, samples of imported salt, and between domestic saltworks and samples from shops, households and schools. It also shows the number of noncompliant samples.

Considering that in the 161 sample total shown in Table 1, 14 (15.73%) samples of imported salt did not comply with our regulations resulting at import in a ban on their sale, the situation in Croatia was more favorable, leaving 15 (9.32%) of the 161 samples irregular.

In correcting this figure in Table 2 as well, of the 153 total 15 irregular import samples were deducted from this total, which left 16 (10.46%) deficient samples. Applying this calculation to the total of 314 samples analyzed produced 31 (9.87%) noncompliant samples, or an iodization of salt for human consumption greater than 90%. Considered in this light, Croatia's salt iodization situation appears considerably more favorable and could thus meet the WHO/UNICEF/ICCIDD recommendations maintaining that more than 90% of the salt consumed by the population should be adequately iodized (12, 13).

5. Conclusion

Based on Croatia's goiter situation, salt iodine level monitoring, introduction of new iodization regulations modeled on those of the developed countries and the recommendation of international organization the following conclusions can be made:

- our salt safety and iodization regulations have been harmonized with the WHO/FAO-, UNICEF- and ICCIDD-recommended criteria;

- in the 1997-98 period, the implementation of new regulations was effective as confirmed by the findings of this study;

- the criterion requiring 90% of the salt for human diet to be adequately iodized has seen its near fulfillment;

- the adding of 25 mg/kg KJ to salt (beyond its natural iodine level) fully satisfies the RDA (recommended daily allowance) of 150-300 µgr iodine/day, amounting to approximately 190 µgr/day for the general population (13-15).

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