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Effectiveness of the iodine prophylaxis model adopted in Poland

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ABSTRACT. ***Objective:*** **Most of the Polish territory has been classified as an iodine-deficient and endemic goiter area according to the International Council for Control of Iodine Deficiency (ICCIDD) criteria. In 1997 the obligatory model of iodine prophylaxis was implemented. Our investigations were aimed at the effectiveness of iodine prophylaxis in Poland.** ***Methods:*** **We assessed urinary iodine excretion and goiter prevalence in 5663 children aged 6-12 yr. The population of children from the same 27 schools was investigated from 1992 to 1994 (1406 girls and 1244 boys) and from 1999 to 2005 (1563 girls and 1450 boys) using identical laboratory and ultrasound methods.** ***Results:*** **We found significant increase in iodine urinary concentration (median 52 µg/l *vs* 93 µg/l, *p*<0.001) with accompanying drop in goiter prevalence (29.6% *vs* 5.2%, *p*<0.001) after implementation of iodine prophylaxis. Iodine excretion distribution changed significantly after 1997 with an increase in the percentage of children with iodine urinary concentration above 100 µg/l from 10.8% to 45.4%, respectively. A significantly higher iodine urinary concentration was observed in lowlands compared to uplands both before and after implementation of iodine prophylaxis (median, 50 µg/l *vs* 57 µg/l and 86 µg/l *vs* 114 µg/l, respectively, *p*<0.001). The goiter prevalence did not differ between girls and boys from 1992 to 1994 (28.8% *vs* 30.5%, *p*=0.35) and 1999 to 2005 (5.5% *vs* 4.9%, *p*=0.45).** ***Conclusions:*** **Implementation of the new model of iodine prophylaxis in Poland in 1997 has led to significant increase in iodine urinary concentration and decrease in goiter prevalence among Polish schoolchildren. In the youngest group of children (6-8 yr olds), prevalence of goiter decreased to 3.2% – i.e. below endemic levels.**
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INTRODUCTION

Iodine prophylaxis in Poland (implemented as a voluntary model) was terminated in 1980, resulting in decrease in iodine intake (mirrored by urinary iodine concentration in schoolchildren - 51 µg/l), accompanied by a sharp rise in goiter prevalence, which varied from 3.4% in seaside areas to 56.6% in the Carpathian and Sudeten Mountains. Furthermore, the prevalence of goiter in the third trimester in pregnant women reached 80% (1-2). According to the criteria of International Council for Control of Iodine Deficiency Disorders (ICCIDD), Poland was classified as a moderate iodine-deficient area (3). Following the recommen-

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dation of the Polish Council for Control of Iodine Deficiency Disorders (PCCIDD), in 1996/1997 the Minister of Health introduced mandatory iodization of household salt with 30±10 mg KI/kg of salt (4). In consequence, global annual production of iodized household salt increased from 4000 tons in 1991 to 116,000 tons in 2005.

The goal of Thyromobil action, launched in 1999, 2000 and 2001, was to evaluate effects of iodine prophylaxis in Polish schoolchildren. The results showed that prevalence of goiter decreased in comparison to 1992/1993 from 14.5% to 5.2% and ioduria (median) increased from 56 μg/l to 103 μg/l (5). The Polish system of iodine supply is based on daily household salt consumption, which is one of the highest in Europe (6). Therefore, similarly to other European countries with comparable models of iodine prophylaxis, we expect gradual decrease in daily salt consumption and, consequently, daily iodine intake.

The aims of the investigations were: 1) to assess the long-term effectiveness of iodine prophylaxis adopted in Poland; 2) to evaluate the geographical differences in iodine deficiency; 3) to summarize the Thyromobil action in Poland (1994-2005).

MATERIALS AND METHODS

A group of 5663 children aged 6-12 yr (median 10 yr) in 27 schools, 2969 girls (52.4%) and 2694 boys (47.6%), were investigated in our study. The subset of 2650 children (1244 boys and 1406 girls) was examined prior to the implementation of the obligatory iodine prophylaxis, as a part of the nation-wide survey conducted between 1992-1994 and the international project under the ICCIDD, UNICEF, World Health Organization (WHO) auspices, in which the Thyromobil ambulance was used (the van equipped with Siemens ultrasonograph with linear probe 7.5 MHz and refrigerator, provided by Merck KGaA, Darmstadt, Germany). The second part of the survey was carried out between 1999-2005, after the implementation of mandatory household salt iodisation. This part included 3013 children (1450 boys and 1563 girls) of the same age groups, from the same schools. The Thyromobil ambulance again was used. For all participants parental informed consent was obtained. Additionally, questionnaire-based information on thyroid pathology and iodine intake was gathered. To further evaluate the goiter prevalence and iodine urinary concentration, the territory of Poland was divided into two geographical regions – uplands in the southern part and lowlands in the northern part.

Determination of thyroid volume

Thyroid volume was assessed by ultrasound (7.5 MHz linear probe). To evaluate prevalence of goiter the international age specific standard for thyroid volume was used (7-8). All examinations were performed by experienced doctors under the supervision of the coordinating centre headed by a person trained by ICCIDD. Inter-observer and intra-observer variations in ultrasound measurement were 9.8% and 6.4%, respectively.

Determination of iodine concentration in urine

Iodine urinary concentration was determined using Sandell-Kolthoff method in the casual morning urine sample taken from each child.

Statistical evaluation

The statistical analysis was performed with STATISTICA package, version 7.0. The results were presented as median [interquartile range (IQR)]. As data deviated from a normal distribution, U-Mann Whitney test (for continuous variables) or Chi-square test (categorical variables) were used. Differences were considered significant at $p<0.05$.

RESULTS

We found that after implementation of iodine prophylaxis in 1997, iodine urinary concentration increased significantly [median: 52 μg/l (IQR 45 μg/l) in 1992-1994 *vs* 93 μg/l (IQR 78 μg/l] in 1999-2005; $p<0.05$) and goiter prevalence decreased (29.8% *vs* 5.21%, respectively; $p<0.05$). Iodine urinary excretion distribution changed significantly after 1997, with increase in percentage of children with iodine urinary concentration above 100 μg/l from 10.8% to 45.4% ($p<0.05$) (Fig. 1). A significantly higher urinary iodine concentration was observed in lowlands compared to uplands both before [median: 57 μg/l (IQR 42 μg/l) *vs* 50 μg/l (IQR 46 μg/l), respectively; $p<0.001$] and after increased iodine intake [median: 114 μg/l (IQR 85 μg/l) *vs* 86 μg/l (IQR 71 μg/l), respectively; $p<0.001$].

Goiter prevalence was lower in lowlands than in uplands, the difference after the implementation of iodine prophylaxis barely reaching statistical significance (16.6% *vs* 35.1% in 1992-1994, respectively, $p<0.01$; 4.5% *vs* 5.4% in 1999-2005 respectively, $p=0.04$). Girls and boys did not differ in goiter prevalence (in the whole group: 16.5% *vs* 16.7%, respectively, $p=0.84$). The group of older children (9-12 yr) presented higher goiter prevalence than the younger one (6-8 yr). This effect was found only after implementation of iodine prophylaxis (Table 1).

DISCUSSION

Mandatory iodization of household salt with KI is still a basis for iodine prophylaxis in Poland (the use of iodized salt in the food industry is not allowed) (4). This model of prophylaxis corresponds to additional intake of 36-146 μg of iodine/day and, together with mean daily consumption of this microelement in diet, meets daily requirement of iodine recommended by WHO and ICCIDD. From 1997 to 2005 there was a significant decline in the prevalence of goiter among school-aged children, and in the group of 6-8 yr-old children the prevalence decreased to 3.2%. Thus, for the first time in Poland,

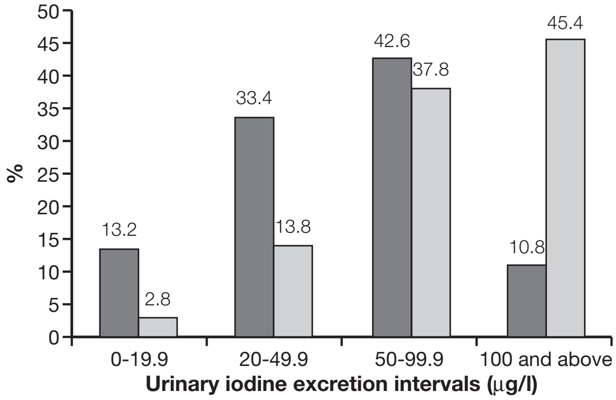

Fig. 1 - *Urinary iodine excretion distribution before and after implementation of the obligatory iodine prophylaxis in Poland (p<0.0001).*

the prevalence was below the endemic level. The frequency of urinary iodine concentration over 100 μg of iodine increased in schoolchildren from 10.8% in 1992-1994 to 45.4% in 1999-2005 and increased urinary iodine concentration observed in evaluations in 2001 (9) and 2003 (5) is still sustained. In the opinion of ICCIDD, Poland joined the group of European countries which safely assure a sufficient amount of iodine in the population (10).

However, 3 geographical areas with different levels of iodine deficiency can be found in Poland: The Bay of Gdansk (Hel, Jastarnia) – the area without iodine deficiency for many years (excluded from present evaluation), uplands with former Carpathian and Sudeten endemic area, and lowlands covering the rest of the country. A significantly lower iodine urinary concentration in children residing in the uplands area was observed both before and after implementation of the present model of iodine prophylaxis, and did not reach the recommended value over 100 μg/l even in 1999-2005. Possible explanations include various levels of selenium deficiency (11), the influence of dietary habits, geochemical conditions, the contents of iodine and other microelements in drinking water. These issues still need to be addressed. In spite of these differences, the prevalence of goiter in both areas has fallen below endemic levels (5%) in the youngest schoolchildren.

The efficacy of similar models of iodine prophylaxis developed in other European countries has been reported previously (12-15). However, the system based on the household salt consumption [daily salt intake in Poland is excessive and together with the salt "hidden" in other products comes to 10 g per day (6)] barely provides required amounts of iodine, particularly in uplands. We must take into consideration the intense campaign for reduction of salt consumption, which might cause the decrease in the daily iodine intake (16). Other data indicate the decrease in consumption of other iodine carriers like sea fish and milk in the Polish population (Szponar L., personal communication). This emphasizes the urgent need to introduce new sources of iodine supplementation.

Table 1 - *Goiter prevalence (GP) before and after implementation of iodine prophylaxis according to age and sex.*

	Before prophylaxis				After prophylaxis				Total
	Age [yr]	No.	GP [%]	*p*	Age [yr]	No.	GP [%]	*p*	
Girls	6-8	402	29.3	ns	6-8	632	2.9	<0.001	1034
	9-12	1004	28.6		9-12	931	7.3		1935
Subtotal	6-12	1406	28.81		6-12	1563	5.5		2969
Boy	6-8	372	31.5	ns	6-8	604	3.5	<0.05	976
	9-12	872	30.1		9-12	846	5.9		1718
Subtotal	6-12	1244	30.47		6-12	1450	5.5		2694
Total	6-8	774	30.4	ns	6-8	1236	3.2	<0.001	2010
	9-12	1876	29.3		9-12	1777	6.6		3653
	6-12	2650	29.58		6-12	3013	5.21		5663

ns: not statistically significant.

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The current model of iodine prophylaxis in Poland also includes iodization of neonates formula with 10 μg of iodine per 100 ml and recommends additional voluntary supplementation of 100-150 μg of iodine per day for pregnant and breast feeding women. Additional iodization of animal farm fodder may also be a complementary source of iodine, resulting in an increase of iodine concentration in milk and meat (17).

In order to maintain high quality, safety and flexibility of the Polish model of iodine prophylaxis, the National Program for Elimination of Iodine Deficiency in Poland financed by the Ministry of Health from 1998 to 2001 (18) and approved for the years 2006 to 2008 includes the following: control of iodization of household salt and neonate formula, nation-wide neonates TSH screening, periodical assessment of goiter prevalence and urinary iodine concentration in schoolchildren and pregnant women (18-21), evaluation of iodine induced thyrotoxicosis (22) and assessment of the incidence rate of differentiated thyroid cancer (23-24).

The presented data (including over 5000 subjects - i.e. about 100 examinations daily) confirm that the easiest and the most convenient way to investigate iodine deficiency among schoolchildren is Thyromobil action, which enables mass screening of the population at risk of iodine deficiency disorders (25).

CONCLUSIONS

1. The current model of iodine prophylaxis in Poland has resulted in a significant rise in iodine urinary concentration from 52.0 μg/l in 1992-1994 to 93.0 μg/l in 1999-2005 (median values) and an increase in frequency of ioduria over 100 μg/l from 10.8% to 45.4%.
2. Preventive measures caused the significant drop in the prevalence of goiter in schoolchildren, particularly aged 6-8 yr (irrespective of sex and geographic area), in whom goiter prevalence decreased from 30.36% before to 3.16% (below the endemic level) after implementation of iodine prophylaxis based on mandatory iodization of household salt.
3. In Poland, there are 3 geographic areas with different levels of iodine deficiency. The cause of the lesser effectiveness of the current model of iodine prophylaxis in uplands still needs to be evaluated.
4. Thyromobil action is a very effective approach of addressing the problem of iodine deficiency on the population level, particularly in schoolchildren.
5. The data presented strongly support the need for further assessment of the methods of iodine supplementation presently used in Poland. They also indicate the necessity to develop new strategies, providing adequate amounts of this important microelement in the population.

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APPENDIX

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