

Analysis of epidemiological situation of iodine deficiency in Tomsk region from 1998 to 2014

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Abstract. The purpose of the present research is the comparative analysis of the epidemiological situation of iodine deficiency in the Tomsk region from 1998 to 2014. There were examined 9901 and 15174 children of the school age including within the medical examination of the children's population in 1998 and 2014 in Tomsk. At all school pupils there were analyzed anamnestic data and carried out anthropometrical measurements, ultrasonography of the thyroid gland was carried out using the portable scanner "Aloka SSD 500" with the linear sensor of 7,5 MHz frequency in the real time, the thyroid volume was evaluated according to Delange (1997). The excretion of inorganic iodine was determined at 264 in 1998 and at 120 children in 2014, respectively, in a one-time portion of urine by the cerium–arsenic method. There was additionally carried out the analysis of results of determination of TSH at 10717 in 1998, and at 15091 in 2014 in a spot of the whole blood at newborn children on the 4-5 day after birth at full-term and on the 7-14 day at prematurely born children. Neonatal TSH in the dried-up samples of capillary blood was determined by the method of the fluorometric immune-ferment analysis with the use of sets of TSH-Neonatal: Delfia, Finland. Statistical processing of the data obtained was carried out with the use of the applied software package pspp. The descriptive analysis included calculation of the median for the quantitative and the calculation of frequencies for qualitative data. The comparative analysis included calculation of distinctions reliability by the Mann-Whitney criterion for independent and to Wilcoxon's criterion for dependent data. The comparative analysis of epidemiological situation of iodine deficiency in Tomsk and the Tomsk region in 1998 and 2014 specifies decreasing the iodine deficiency diseases in the Tomsk region, increasing the iodine provision of the population within 15 years by 27%, decreasing neonatal hyperthyroidism by 1.5 times.

1. Introduction

A great medical social value of treatment and prophylaxis of iodine deficiency diseases is conditioned by the irreversible severe consequences of iodine deficiency for the health of rising generation [1-3]. In Russia by the beginning of 1990 there had not existed a system of prophylaxis of iodine deficiency, studies carried out in 1991-1998 confirmed the presence of iodine deficiency practically in the entire



territory of the country. The Siberian Federal district was attributed to the regions with the widest distribution of this microelement deficiency that was confirmed by the epidemiological study at the regional and federal levels [2].

In 1998, for the analysis of the epidemiological situation of iodine deficiency in the Tomsk region, the following criteria for the severity of iodine deficiency in the population were recommended by WHO (Table 1): clinical (the incidence of goiter in the population according to the palpation examination of the thyroid gland) and biochemical (iodine content in urine, the level of neonatal TSH) [3, 4].

Table 1. Epidemiological criteria of estimation the degree of iodine deficiency diseases severity.

Indicator	Population	IDD severity degree		
		mild	moderate	severe
Goiter incidence (palpation)	Schoolchildren	5.0-9.9%	20.0-29.9%	> 30.0%
Thyroid gland volume > 97 percentile (sonography)	Schoolchildren	5.0-9.9%	20.0-29.9%	> 30.0%
Median of the iodine renal excretion, $\mu\text{g/l}$	Schoolchildren	50-99	20-49	<20
TSH > 5mU/l	Schoolchildren	3.0-9.9%	20.0-39.9%	> 40.0%
Median of thyroglobulin (ng/ml)	Schoolchildren	10.0-19.9	20.0-39.9	>40

As a result of using these criteria in 1998 the endemic situation in the Tomsk region was not unambiguous (Table 2). In terms of TSH and iodine levels, the severity of iodine deficiency was mild, and the incidence of palpable goiter was severe.

Table 2. Estimation of the endemic situation in Tomsk in 1998.

Indicator	Number of examined persons	Degree of iodine deficiency diseases severity		
		mild	moderate	severe
Goiter (enlargement of the thyroid gland >0st.), %	9637	-	-	41.2
Ioduria median, $\mu\text{g/l}$	264	73.1	-	-
TSH of the whole blood >5 mME/l, %	10761	11.7	-	-

Taking into account that the more objective indicators are indicators of TSH and ioduria, Tomsk was officially assigned to the regions with iodine deficiency of mild severity.

In 1999 the Government of the Russian Federation adopted Decree No. 1119 «On Measures for Prevention of Iodine Deficiency Diseases» that provided for increasing the production of iodine-fortified foods, the most important of which is increasing the production of iodized salt. As a result of implementing the Decree, the output of iodized salt in Russia increased from 20 000 tons to 140 000 tons within 5 years, large-scale measures were taken to eliminate iodine deficiency: there was organized medical examination of the main risk groups, there was conducted educational work among the population and medical workers of various specialties, methodological manuals were developed that permitted to increase the level of primary health care physicians in prevention and treatment of iodine deficiency disorders [3].

In 2001 joint efforts of the WHO, the UNISEF and the ICCIDD proposed the criteria of monitoring actions for liquidation of IDD [2, 5, 6] (Table 3).

Table 3. Parameters of estimating iodine deficiency diseases and their control by means of salt iodination.

Parameter	Target indicators
Salt iodination	>90%
Ioduria median	100-3000 $\mu\text{g/l}$
Share with the value less than 100 $\mu\text{g/l}$	< 50%
Share with the value less than 50 $\mu\text{g/l}$	<20%
Thyroid gland volume At 6 to 12 years old schoolchildren Share of the enlarged thyroid gland determined by palpation or ultrasonography	<5%

Note: in the table there are summed up all epidemiologic criteria in various degrees used for estimating the iodine deficiency manifestation.

The purpose of the study is the comparative analysis of epidemiological situation of iodine deficiency in the Tomsk region in 1998 and 2014, determining the basic directions of improving prophylaxis of iodine deficiency diseases.

2. Materials and methods of studies

In order to clarify the situation in 1998 and 2014 in Tomsk there were examined 50 888 children among whom 9 901 and 15 174 were school-age children including those under the medical examination of the children's population. At all schoolchildren there were analyzed the anamnestic data, performed anthropometric measurements, performed ultrasound examination of the thyroid gland by the portable scanner Aloka SSD 500 with the linear 7.5 MHz real-time sensor, the thyroid volume was estimated according Delange (1997). The excretion of inorganic iodine in urine was determined in 264 children in 1998 and in 120 children in 2014, respectively, in a single portion of urine by the cerium-arsenic method. In addition, there was carried out the analysis of the results of determining TSH at 10761 children in 1998 and at 15091 children in 2014. In a spot of the whole blood in newborn infants on the 4-5 after birth in term infants and on 7-14 days in premature infants. TSH-neonatal in dried samples of capillary blood was determined by fluorometric immune-ferment TSH-Neonatal Delfia, Finland.

Statistical processing of the obtained data was carried out using the applied software package pspp. The descriptive analysis included the calculation of the median for quantitative, and the calculation of frequencies for qualitative data. The comparative analysis included the calculation of the reliability of the differences by the Mann-Whitney criterion for independent and the Wilcoxon test for dependent data.

3. Results

At present the excretion of iodine in urine is considered as the main epidemiological indicator characterizing the iodine supply to the population of a particular region or a whole country. This indicator is highly sensitive, reacts quickly to changes in the level of iodine intake and is therefore of paramount importance not only for assessing the epidemiological situation, but also for monitoring the effectiveness of IDD prevention programs [2, 3, 6].

With urine there is removed 80-90% of iodine consumed with food. The concentration of iodine in a single portion of urine correlates well with the level of iodine in daily urine and reflects the intake of iodine into the body directly at the time of the study. Since the level of iodine in the urine of a particular person varies not only daily, but also within the day, these iodine determinations can be used only to assess the iodine availability to the population as a whole. This method is suitable only for epidemiological studies. Due to the high fluctuation of the iodine level in urine samples, it is preferable to evaluate the median rather than the arithmetic mean value of the iodine concentration in the urine.

In the study of iodine at schoolchildren the data obtained for the districts of the city of Tomsk for 1998 and 2014 are given in Table 4.

Table 4. Iodine excretion with urine at schoolchildren.

District of study	Number of examined persons, 1998	Ioduria median, $\mu\text{g/l}$, 1998	Number of examined persons, 2014	Ioduria median, $\mu\text{g/l}$, 2014
Tomsk, Lenin district	n =106	88	n =30	79
Tomsk, Kirov and Soviet districts	n=100	61.5	n=60	98
Tomsk, Oktyabrsky district	n=58	68	n=30	99

According to the results of our study, the ioduria median at schoolchildren was 72.5 $\mu\text{g/l}$ in 1998, and 92 $\mu\text{g/l}$ in 2014 in Tomsk that indicates both an increase in the iodine provision of the population within 15 years by 27%, and the ioduria level corresponding to mild iodine deficiency according to the WHO criteria. It should be noted that the normative indicators of the ioduria median in the city (more than 100 $\mu\text{g/l}$) was not been achieved [5, 6].

The most common manifestation of goiter endemic is the size of the thyroid gland enlargement. According to the research in 1998, the incidence of palpable goiter at school-age children was 41.8% (n = 5177) of the region children, and in the city 41.2% (n = 3970), according to the criteria proposed by the WHO (2001) that made a severe degree of iodine deficiency. According to the results of the study of the goiter incidence at children of school age in Tomsk in 2014, the incidence rate was reduced to 1.39% that according to the WHO criteria corresponds to a mild degree of iodine deficiency (Table 5).

Table 5. Incidence rate of the endemic goiter at children in Tomsk in 2014.

District of study	Number of examined school-age children	Goiter (enlargement of the thyroid gland), absolute number	Goiter (enlargement of the thyroid gland), % of the examined school-age children
Tomsk, Lenin district	3732	82	2.19
Tomsk, Kirov and Soviet districts	3460	33	0.95
	5567	30	0.53
Tomsk, Oktyabrsky district	2295	65	2.83
Total	15054	210	1.39

When analyzing the incidence of goiter at schoolchildren in 1998 and 2014 (Table 6) there was noted a significant decrease in the incidence of goiter in the population from 41.2% in 1998 to 1.39% in 2014 that indicates the achievement of normative epidemiological criteria (less than 5%). According to the literature, the authors also note a decrease in the incidence of goiter in Moscow to 5.2% for the period from 1992 to 2006, compared with the original data [5]. That significant improvement in the indicator can be explained by the expansion of the possibilities of ultrasound examination of the thyroid gland, changes in the norms of thyroid volume parameters recommended by the WHO in 1997, and implementation of the project aimed at increasing iodine supply to the population of the Russian Federation.

Table 6. Comparative characteristic of goiter incidence at school-age children in Tomsk within 15 years.

Year	Number of school-age children examined	Goiter (enlargement of the thyroid gland), absolute number	Goiter (enlargement of the thyroid gland), %
1998	9637	3971	41,2
2014	15054	210	1,39

One of the epidemiological indicators of the effectiveness of IDD prophylaxis is the incidence of neonatal hyperthyroidism (TSH>5 mU/l) in total screening of newborns for congenital hypothyroidism. The effectiveness of neonatal screening for congenital hypothyroidism increased significantly due to the discovery of the indicator role of neonatal hyperthyroidism in the evaluation of iodine deficiency diseases [4, 14]. In territories free from iodine deficiency, the incidence of TSH>5 mU/ml does not exceed 3%. A mild degree of iodine deficiency is defined in the territories with the incidence of TSH>5 mU/ml from 3 to 19.9%, medium from 20 to 39.9%, severe 40% or more.

The TSH concentration is the main indicator of the detection of neonatal hypothyroidism, but its effectiveness as a criterion for IDD in older age groups is controversial. The cause of the TSH increasing can be a thyroid disease, using a number of medications, etc. In addition, at adults from endemic areas the TSH level may be lower than that of iodine-containing ones due to the formation of an autonomously functioning thyroid tissue.

In 1998, on the basis of the genetic clinic of the Research Institute of Medical Genetics of the Scientific Center of the Siberian Branch of the Russian Academy of Medical Sciences, 10761 newborns were registered in the course of neonatal screening for congenital hypothyroidism. 10717 of them were covered by neonatal screening that made in the percent ratio 99.6%. At the same time, the number of detected cases of TSHG> 5 mU/ml was 1258 people (11.7%).

In 2014, on the basis of the genetic clinic of the Research Institute of Medical Genetics of the Tomsk Scientific Center of the Siberian Branch of the Russian Academy of Medical Sciences, 15152 newborns were recorded in the course of neonatal screening for congenital hypothyroidism, of whom 15091 were covered by neonatal screening that in the percent ratio corresponds to 99.6%.

The number of detected cases of TSH> 5 mU/ml in 2014 was 1162 (7.7%).

The concentration of TSH above the level of 100 mU / l was detected in 17 (0.15%) of those born in Tomsk and the Tomsk region in 1998, in 21 people, in 0.13% of those surveyed in 2014.

When comparing the results of the analysis with the WHO recommendations on the use of screening indicators as one of the indicators of the severity of iodine deficiency in the region, the following result was obtained: primary hyperthyroidism with the highest incidence up to 11.7% was registered in newborns in 1998, and with incidence up to 7.7% in newborns in 2014. The obtained results fit into the mild degree of iodine deficiency and show the effectiveness of prevention, but at the same time the epidemiological criterion of iodine deficiency liquidation in the region there is considered the level of neonatal hyperthyroidism less than 3% [5, 6].

4. Discussion

Table 7. Comparative estimation of the endemic situation in Tomsk in 1998 and 2014.

Indicator	1998	2014	1998	2014	Target values for liquidation of IDD
Goiter (enlargement of the thyroid gland), %			Severity degree of iodine deficiency diseases		<5%
Number of examined persons	9637	15054			
	41.2	1.39	severe	mild	
TSH of the whole blood more than 5 mME/l, %			Severity degree of iodine deficiency diseases		

Number of examined persons	10717	15091			<3%
	11.7	7.7	mild	mild	
Ioduria median, µg/l			Severity degree of iodine deficiency diseases		100
Number of examined persons	264	120			
	73.1	94	mild	mild	

1. The analysis of changes in the prevalence of diffuse goiter at school-age children (from 41.2% to 1.39% over the 15-year period) indicates decreasing the incidence of iodine deficiency diseases in the Tomsk region and achieving normative epidemiological criteria (less than 5%).

2. The dynamics of the median level of ioduria at children living in the Tomsk region as a whole is indicative of 27% increase of the iodine provision of the population within 15 years. The indicators of iodine levels show a mild case of iodine deficiency according to the criteria of the WHO, demanding continuation of IDD prevention work in the region.

3. Decreasing neonatal hyperthyroidism by 1,5 times, from 11.8% (1998) to 7.7% (2014) testifies to the effectiveness of preventive measures in maternity groups (pregnant women).

5. Conclusion

The introduction of the system of iodine deficiency prevention of in Russia has made it possible to improve iodine provision in the Tomsk region. The revealed changes in the epidemiological situation of iodine deficiency in the Tomsk region confirmed the need for the further group and individual prevention of iodine deficiency, identification of the factors of iodine deficiency severity in the population of the Tomsk region that hamper the achievement of normative epidemiological criteria and, possibly, consideration of the issue of increasing preventive doses of iodine by 25%.

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