- 45.8% of all reported cases are unemployed and housewives;
- 81.6% - the share of residents of districts and villages.

Given the high incidence of the disease among males, as well as the unemployed, teaching these people how to prevent disease when in contact with animals can help control the disease. Measures such as educating about the importance of proper handwashing with soap and water, using gloves and face masks when dealing with infected livestock and when cleaning pens for affected livestock, and proper air conditioning can prevent infection in these categories of people.

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FEATURES OF THE ELEMENTAL COMPOSITION OF THE HAIR OF CHILDREN LIVING IN AREAS WITH DIFFERENT ANTHROPOGENIC LOAD

Biological environments of the body serve as a reliable bioindicator reflecting the state of human health and its environment. The aim of the study was to study the accumulation of trace elements in the hair of children from birth to 6 years old, living in areas with different types and degrees of anthropogenic pressure. The content of (Ca, Mg, Fe, Zn, Cu, Cr, Ni, Mn, Pb, Cd) in the hair of newborns was determined by atomic absorption spectrometry; the dynamics of the content of heavy metals in the hair of children from birth to six years of age was assessed; a comparative analysis of the level of trace elements in the hair of preschool children living in different regions of the Republic of Bashkortostan was carried out. By the age of six, the hair of Ufa children revealed a reduced content of essential elements: Fe, Mn and Zn; toxic metals: Pb and Cd; conditionally essential: Ni and Cr compared with the average physiological level. In the hair of children living in a region with a developed mining industry, on the contrary, there is an accumulation of essential elements: Fe and Mn; conditionally essential element - Cu and Ni and toxic - Pb.

Keywords: heavy metals, biological media, children's hair, macroelements, microelements.

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Introduction. One of the key characteristics of society is the state of health of the population, which depends on the adverse effects of the environment [7, 8]. Every year, millions of tons of pollutants enter the atmosphere of settlements from various sources of emissions. The leading place among ecotoxicants belongs to heavy metals: lead, cadmium, chromium. Potential sources of environmental pollution with chemical elements are oil refineries, mining and processing plants, ore deposits, the industrial development of which contributes to environmental pollution and their accumulation in toxic concentrations in biological media [9].

The organism of children is most susceptible to adverse environmental influences, it has an increased sensitivity to insufficient or excessive intake of chemical elements, both toxic and essential, from outside [2, 5]. The routes of entry of chemical elements into the child's body are diverse, mainly metals are supplied with food and water, less with inhaled air and through the skin [14].

To assess the impact of a habitat with a high content of heavy metals on the human body, elemental analysis of hair is used [1, 4, 6, 10]. A characteristic feature of the child population is a more pronounced reaction to harmful environmental factors due to the low threshold of sensitivity to the effects of heavy metals, low mobility and greater attachment to a particular area.

Purpose of the work: to study the accumulation of elements, both essential and toxic, in the hair of children from birth to 6 years old, living in the Republic of Bashkortostan in areas with different ecological and natural geochemical situations.

Materials and methods. 834 samples of children's hair were analyzed by atomic absorption spectrometry, and a quantitative assessment was made of the accumulation of 10 microelements in the hair of preschool children living in various regions of the republic.

Hair samples of newborn children (n=129) were taken in maternity hospitals, hair samples of children of the first year of life (n=19) - in children's medical institutions, hair of children 3-6 years old (n=686) - in preschool institutions. Informed consent was obtained from the heads of institutions and parents of children to participate in the research. Analysis of hair samples was carried out in an accredited Testing Center of the Institute in accordance with current regulations. The content of chemical elements was determined by atomic absorption spectrometry on devices with flame and electrothermal atomization. The results of the analysis of the hair of newborn children were compared with the control group (Birsk), children aged 3-6 years - with the reference values given in the works of A.V. Skalny [12].

Statistical calculations were performed using the IBM Statistics 21.0 software package (IBM, USA). The distribution was checked for normality using the Kolmogorov-Smirnov test. The data obtained during the analysis were processed using one-way analysis of variance. Differences were considered statistically significant at $p<0.05$.

Results and discussion. The paper studied the hair of newborn children living in a large industrialized city - Ufa, a mining geochemical province - the city of Sibay and a small city with a favorable environmental situation - Birsk (control group). The results of the determination are presented in table 1.

The ecological situation in Birsk is much better than in Ufa, but drinking water in the city is highly hard. This is confirmed by the peculiarities of accumulation of calcium and magnesium in the hair of children, revealed in our studies, depending on the place of residence. Due to the increased level of calcium in the drinking water of Birsk, this element accumulates in the hair of newborns - 1.8 times higher than the content of this element in similar samples from the cities of Ufa and Sibay. In addition to calcium, the hair of newborn children from the city of Birsk and Ufa accumulates magnesium, the content of which is 2.2 times higher than in the hair of children living in the city of Sibay.

Zinc is the most important element, its biological role was established more than 100 years ago, it is part of the composition of enzymes involved in all types of metabolism: skin regeneration processes, hair and nail growth, secretion of sebaceous glands, maintaining the body's immune defense [1, 13]. With a lack of zinc in children, spatial thinking is disturbed, memory and learning ability deteriorate, as protein and nucleic acid synthesis slows down. Excess intake of zinc is accompanied by a decrease in the level of calcium not only in the blood, but also in the bones, while the absorption of phosphorus is disrupted; which leads to osteoporosis. In the studied hair samples, there is a difference in the content of zinc. There is 3.7 times more zinc in the hair of newborns from the city of Ufa than in the hair of children from the city of Birsk. The maximum content of zinc in the hair of newborns in Sibay is two times lower than in Birsk, eight times lower than in Ufa, but the minimum concentration is three times higher than in Birsk, and Ufa - 12 times.

Iron is a critical element that is involved in a number of biological reactions: energy release processes, enzymatic reactions, cholesterol metabolism [1]. Both deficiency and excess of iron adversely affect human health. Iron deficiency in children leads to iron deficiency anemia, in which there is developmental delay and behavioral abnormalities, an increased risk of atherosclerosis, liver and heart disease, arthritis, and diabetes [1, 3]. Excess iron can be caused by a genetic defect and also occur in some types of anemia or porphyria. An imbalance of copper and nickel can lead to low iron levels. The average content of iron in the hair of newborn children in Sibay is 2.5 times lower than in Ufa and almost 5 times lower than in Birsk. Iron deficiency states in newborns can be associated with the corresponding state of the mother, or due to living in a geochemical province.

Chromium plays an important biological role in the body: biomolecules containing chromium are involved in the regulation of fat synthesis and carbohydrate metabolism, interact with insulin in carbo-

Table 1

The content of chemical elements in the hair of newborns. mcg/g

Element	Statistical parameters				
	Locality	M	±m	Min	Max
Ca	Sibay	717.0	60.0	217.10	1239.9
	Birsk	1339.0	258.6	351.4	3366.7
	Ufa	729.8	18.9	19.8	2483.8
Mg	Sibay	700.9	54.9	163.8	1052.7
	Birsk	1554.5	6.8	327.0	3983.3
	Ufa	1547.0	4.5	93.11	5205.5
Fe	Sibay	28.9	5.8	10.5	122.6
	Birsk	132.6	2.6	18.5	716.7
	Ufa	71.9	2.6	14.3	229.3
Zn	Sibay	184.3	10.2	98.3	268.1
	Birsk	148.3	12.6	29.9	558.3
	Ufa	550.5	11.4	8.1	2202.7
Cu	Sibay	7.10	0.36	3.94	9.69
	Birsk	8.06	1.20	1.07	30.60
	Ufa	5.76	1.32	0.19	21.20
Ni	Sibay	3.00	0.41	0.86	6.68
	Birsk	4.23	0.90	0.38	20.60
	Ufa	5.88	0.46	0.38	23.80
Cr	Sibay	61.00	8.03	11.74	140.36
	Birsk	47.49	0.90	6.66	200.00
	Ufa	54.73	0.09	0.59	179.50
Mn	Sibay	1.21	0.21	0.18	3.11
	Birsk	2.92	0.10	0.31	16.60
	Ufa	2.64	0.87	0.22	75.90
Pb	Sibay	2.30	0.37	0.83	7.29
	Birsk	1.30	0.09	0.37	5.90
	Ufa	12.08	0.11	0.00	40.50
Cd	Sibay	0.090	0.010	0.020	0.240
	Birsk	0.210	0.001	0.010	1.540
	Ufa	0.080	0.040	0.000	0.730

hydrate metabolism, and regulate blood sugar levels [1]. Chromium deficiency can provoke the development of diabetes mellitus, lead to the development of atherosclerosis, coronary heart disease, anxiety, insomnia, and headaches. The toxic effect of chromium depends on its valency: hexavalent chromium is more dangerous for the body, it has a general toxic, nephrotoxic and hepatotoxic effect. An excess of chromium in the body leads to asthmatic bronchitis, bronchial asthma and cancer [3]. The increased concentration of chromium in the biological environment of newborns usually decreases rapidly during the first months of life. In the hair of children from Sibay, the concentration of chromium is 1.3 times higher than in the control group. The minimum concentration of chromium in the hair of newborns in Sibay is almost twice as high as in Birsk, and 20 times in Ufa.

Copper - plays an important role in maintaining a healthy immune system, is part of vitamins, hormones, enzymes, and is involved in processes that strengthen bone tissue. It increases the body's resistance to infections, binds microbial toxins and enhances the action of antibiotics, promotes the absorption of iron [1]. Copper deficiency develops against the background of prematurity, malnutrition, treatment with iron and zinc preparations and can cause iron deficiency anemia, osteoporosis, arterial aneurysms. A comparative assessment of the copper content revealed that the average content of copper in the hair of newborns from Ufa is 1.4 times less than in similar samples of the control group. The maximum copper content in the hair of newborns in Sibay is 2-3 times lower than in Birsk and Ufa, the minimum concentration is three times higher than in Birsk, and in Ufa - 20.7 times.

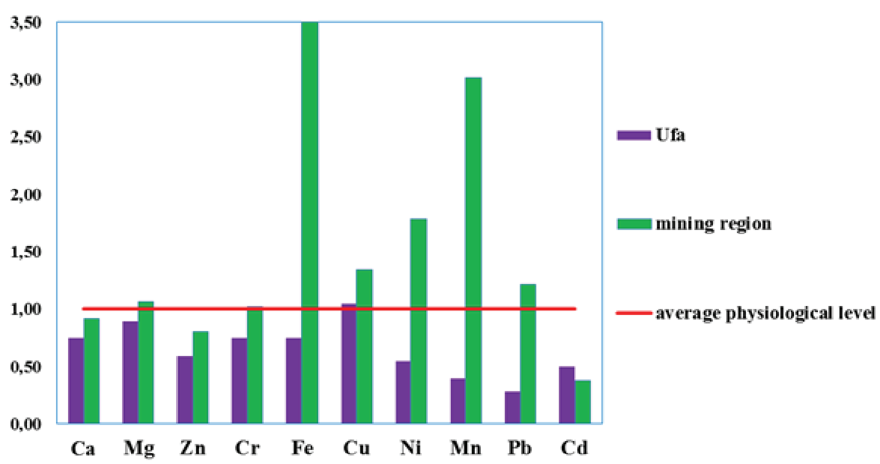
Lead is one of the most toxic trace elements with the ability to accumulate in the human body. Elevated lead levels negatively affect the nervous and cardiovascular systems, kidneys. Excess lead leads to a decrease in calcium, iron, zinc, selenium in human organs and tissues. Since zinc and calcium are lead antagonists, its elevated concentrations displace zinc, calcium, iron, disrupting their physiological role in the body. With the simultaneous intake of zinc and lead, the accumulation of lead in the body decreases [11].

Lead was found at a high level (12.08 μg/g) in hair samples from children from the city of Ufa, which is 9.3 times higher than the content in biological samples of children's hair in the control group (1.30 μg/g). Since lead is a calcium antagonist,

Table 2

The content of metals in the hair of newborns and preschool children living in Sibai, mcg/g

Element	Statistical parameters				
	Age	M	±m	Min	Max
Ca	At birth	717.0	60.0	217.1	1239.9
	A year later	1315.8	258.6	138.1	6434.6
	At the age of 3-6 years	522.1	18.9	492.8	567.5
Mg	At birth	700.9	54.9	163.8	1052.7
	A year later	143.8	6.8	30.3	299.2
	At the age of 3-6 years	43.3	4.5	33.4	51.2
Fe	At birth	28.91	5.8	10.5	122.7
	A year later	10.31	2.6	2.0	34.9
	At the age of 3-6 years	46.55	2.6	42.6	52.1
Zn	At birth	184.3	10.2	98.3	268.1
	A year later	135.0	12.6	58.3	259.7
	At the age of 3-6 years	106.10	11.4	82.5	128.1
Cu	At birth	7.1	0.4	3.9	9.7
	A year later	8.5	1.2	3.5	14.7
	At the age of 3-6 years	10.2	1.3	7.8	13.3
Ni	At birth	3.0	0.4	0.9	6.7
	A year later	2.2	0.9	0.3	6.1
	At the age of 3-6 years	1.5	0.5	0.6	2.3
Cr	At birth	61.0	8.0	11.7	140.4
	A year later	5.5	0.9	2.1	10.5
	At the age of 3-6 years	1.1	0.1	1.0	1.3
Mn	At birth	1.2	0.2	0.2	3.1
	A year later	0.9	0.1	0.3	2.2
	At the age of 3-6 years	3.5	0.9	2.4	5.7
Pb	At birth	2.3	0.4	0.8	7.3
	A year later	4.9	0.1	0.2	16.0
	At the age of 3-6 years	2.7	0.1	2.6	3.0
Cd	At birth	0.10	0.01	0.02	0.24
	A year later	0.400	0.001	0.030	1.690
	At the age of 3-6 years	0.10	0.04	0.07	0.23



The level of trace elements in the hair of preschool children, in shares of the average physiological level

Table 3

The content of chemical elements in the hair of children 3-6 years old living in a large industrial city and in a region with a developed mining industry, mcg/g

Element	Hair of children 3-6 years old		
	Average physiological level (by A.V. Skalny, 2003)	Large industrial Ufa	A region with a developed mining industry, Sibai
Ca	498.2	372.0	457.9
Mg	47.0	42.1	49.9
Fe	26.0	19.4	91.1
Zn	138.7	81.9	111.2
Cu	9.5	9.9	12.8
Cr	0.99	0.74	1.01
Ni	0.55	0.30	0.98
Mn	1.01	0.40	3.05
Pb	2.66	0.74	3.23
Cd	0.24	0.12	0.09

with an increased lead content in the hair of Ufa newborns, there is a reduced accumulation of calcium. It is important to note that at a low concentration of iron in the body (in the studied hair samples of newborns from Ufa and Sibay, it was contained less than in the control group), the risk of toxic effects of lead increases (lead content in bioassays of children's hair in the city of Ufa is increased).

Manganese protects the body from the harmful effects of peroxide radicals, is responsible for the stability of the structure of cell membranes, muscle and connective tissue. The role of manganese in cell metabolism and enzymatic reactions is known. Manganese deficiency causes anemia, growth retardation, and weight loss. Hypomanganosis in children leads to a violation of carbohydrate metabolism, which is manifested by allergies, dermatitis, impaired muscle tone, lethargy, fatigue, stunted hair and nail growth. [11]. In the hair of newborn children of Sibay, the concentration of manganese is 1.7 times lower than in the control group.

Nickel belongs to conditionally essential elements, but at the same time is the most dangerous environmental pollutant. The concentration of nickel in the biological media of children from the city of Ufa is 1.7 times higher than in the control group, and in the hair of children from the city of Sibay it is 1.4 times lower. Petrochemical enterprises are a source of nickel entering the environment. This may explain the high concentrations of this metal in the hair of newborns in Ufa compared with the control group.

If an excess or deficiency of macroelements and essential microelements can still be considered physiological or associated with the activation of redox processes in the body of a newborn during growth and development, then the accumulation of toxic metals (cadmium, lead) is rather pathological. In samples of children's hair in Sibay and Ufa, the content of cadmium was 2.3-2.6 times ($p<0.05$) less than in similar samples of the control group. Hair is an additional excretion pathway for cadmium. The high concentrations of cadmium in the hair of children gradually decrease over the course of life.

For further in-depth study of macro- and microelements in the body of children, we conducted a study of their content a year after the initial study and at the age of 3-6 years, analyzed the dynamics of their changes. The main statistical parameters of the distribution of metal content in the hair of a child were studied using the example of children living in the city of Sibay. Data on the content of metals in the hair of children from birth to preschool age (3-6 years) are presented in Table 2.

Judging by the average concentrations, by the end of the first year of life, the content of ecotoxicants and metals in the hair of children increased due to living in a geochemical province, i.e. lead, cadmium and copper. But by preschool age, the content of lead and cadmium decreases by 1.8 and 3.1 times, respectively. Perhaps there is an adaptation of the body to the environment.

In children, by the age of 3-6 years, there is a decrease in the content of chromium, nickel, magnesium and zinc. The average level of chromium decreased by almost 11 times by the first year of life and 55 times by the age of 3-6 years; magnesium is almost five times a year and 16 times by the age of 3-6 years; nickel - about 2 times; zinc - 1.7 times. The average copper content increased 1.4 times. The average level of lead, cadmium and calcium increases by the first year of life, but gradually decreases by 3-6 years. The level of iron and manganese in the child's hair decreases by the end of the first year of life, but increases again by preschool age, which may be due not only to an increased need for iron in the body, but also to the formation of other “tissue” iron depots.

Table 3 presents the results of studying the elemental composition of the hair of preschool children and the average physiological level according to the literature data.

A comparative characteristic of the level of trace elements in the hair of preschool children living in a large industrial city (Ufa), in a region with a developed mining industry, was carried out in comparison with the reference values obtained by A.V. Skalny [12]. The results obtained are shown in Figure 1.

In the hair of Ufa children, a reduced content of iron (by 6.6 times), lead (by 3.6 times), manganese (by 2.5 times), cadmium (by 2.0 times), nickel (by 1.8 times) was revealed, zinc (1.7 times), calcium (1.3 times) and chromium (1.3 times) compared with the average physiological level.

In the hair of children living in a region with a developed mining industry, an increased content of iron (3.5 times), manganese (3.0 times), copper (1.3 times), lead (1.2 times) was found and somewhat reduced - zinc. The revealed high level of iron in hair samples may be associated with a low content in the blood due to malnutrition. The elevated level of copper is probably associated with the geochemical features of the region under study.

The present study did not analyze the morbidity of the child population associated with elemental homeostasis and the sex of the child. These issues may be the subject of further study.

Conclusion. The conducted studies revealed the features of the elemental homeostasis of the child population living in regions of the republic with different ecological conditions. The elemental composition of children's hair depends on the region of residence, the degree and type of environmental pollution, the quality of drinking water, the synergy and antagonism of elements in the body, and changes with the age of the child.

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