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Abstract of the dissertation
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Regional features of the elemental status in the formation of public health

Specialty «6D110200 –Public Health»

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ABSTRACT

Of Umarova Gulmira Arystangalyevna on the topic «Regional features of the elemental status in the formation of public health», presented for the degree Doctor of Philosophy (PhD) in the specialty «6D110200 –Public Health».

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RELEVANCE OF THE RESEARCH TOPIC

One of the conditions for the normal functioning of the body is the stability of its bioelemental composition, which in turn reflects the elemental background of the living environment. The impact of a number of anthropogenic factors, including excessive intake of heavy metals and deficiency of essential chemical elements, as well as unfavorable climatic and geographical living conditions for a large part of the population of the Western region of Kazakhstan, can contribute to the deterioration of health at the individual and population levels.

Excess or deficiency of chemical elements in soil and water, accompanied by changes in biogeocenoses, leads not only to a decrease in yield and deterioration in the quality of agricultural products, but also to a decrease (accumulation) of their content in the body of residents living in the area; contribute to the development of diseases associated with a chemical imbalance.

Given the raw orientation of the economy of the Western region of the Republic of Kazakhstan, the intensively developed mining and metallurgical industries, it becomes necessary to study the environmental situation in the region. The tense ecological situation contributes to shifts in the trace element balance of the biosphere, thereby contributing to the deterioration of the health of the population.

From the standpoint of hygienic and ecological-toxicological diagnostics, the study of the state of mineral metabolism, including hair, macro- and trace element analysis of biosubstrates as an objective criterion for a quantitative and qualitative assessment of the state of the environment and its impact on public health. It should be noted that the formation of prenosological and clinically manifested conditions and diseases are closely associated with insufficient or excessive accumulation of chemical elements in the body. Elemental status, its imbalance to a large extent reflect adaptation, the state of pre-pathology and pathology in relation to the most diverse chemical elements that have a toxic effect or are vital for the formation of homeostatic systems of the body.

Studies of chemical elements in the environment and in a living organism, along with the characteristics of climatic, socio-economic, biogeochemical factors specific to certain territories, should be considered as the most important indicator of the ecological well-being of the territory of residence, its recreational comfort for humans.

The elemental status associated with the excessive accumulation of conditionally irreplaceable and toxic chemical elements of the population, the

dynamics of its shifts in relation to the environment can affect not only somatic health, but also demographic indicators: birth rate, life expectancy and mortality. Therefore, the development and implementation of evidence-based regional programs to correct the elemental status of the population can become one of the effective measures to improve the health of the population, reduce morbidity, improve the demographic situation and improve the quality of life of the population.

Purpose of the research: Determining the value of the elemental status in the system of assessing the health of the adult population of arid territories.

Research objectives:

1. Assess the prevalence of imbalances of chemical elements among the adult population of the Western region of Kazakhstan.
2. Determine the relationship between the content of chemical elements in biosubstrates and the environment with the incidence of the population.
3. Study the influence of medical, social and environmental factors on the elemental status of the adult population of the Western region of Kazakhstan.
4. Compile cartograms of the elemental status of the population of the Western region of Kazakhstan.

Scientific novelty of the research.

The scientific novelty of the research is characterized by the fact that for the first time:

A large-scale study of the prevalence of chemical element imbalances among the adult population of the Western region of Kazakhstan was conducted.

Regional features of the elemental status of the adult population of Western Kazakhstan were determined.

The connections of the elemental status with the morbidity rates of the adult population of Western Kazakhstan were revealed.

The medico-social and environmental factors associated with the prevalence of chemical element imbalances in the Western region of the Republic of Kazakhstan have been identified.

Practical significance of the research.

The scientific and practical significance of the work is determined by the results of the study, which provide an objective assessment of the prevalence of chemical element imbalances in the Western region of Kazakhstan.

The study of the elemental status of the population and its reflection in the form of maps accessible to all will allow for early prenosological diagnosis of diseases and preventive measures of elemental imbalances.

The results of the research can be used by specialized authorized government bodies (Ministry of Health of the Republic of Kazakhstan, Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan), as well as within the framework of interagency cooperation, by other departments dealing with these problems. Solving the problems associated with macro- and microelementoses, in conjunction with the health of the population, will help reduce the burden of medical and social problems, environmental protection, and the elimination of

endemic and environmentally dependent diseases. The research materials and their methodological component will bring a certain novelty to preventive toxicology, medical geography, epidemiology of non-communicable diseases, and will be useful to hygienists, ecologists and doctors of all specialties.

Cartographic data visually displaying the content of chemical elements in the biosubstrates of the population of the Western region of Kazakhstan allow us to draw conclusions about the degree of anthropogenic influence on the accumulation of pollutants in the human body.

The developed cartograms can be used for further research on the prevalence, etiology, risk factors, possible mechanisms of the development of eco-dependent, endemic diseases in the region.

The results of the study can serve as a basis for the development of practical recommendations for the prevention and monitoring of elemental status among the adult population.

The obtained research data can be the basis for conducting research in the field of bioelementology.

The main provisions of the dissertation submitted for defense:

1. In the Western region of Kazakhstan, there is an imbalance of chemical elements in the adult population, with an excess content of lithium, potassium, iron, sodium, zinc, phosphorus and a lack of selenium, cobalt, iodine.

2. The content of chemical elements in biosubstrates and soil is associated with the morbidity rates of the adult population.

3. Complex medical and environmental factors associated with natural and anthropogenic conditions of environmental formation affect the content of elements in biosubstrates.

Personal contribution of the author. All the main sections of the research (collection of materials, their processing, analysis of research materials, interpretation of the results and their discussion) were carried out personally by the author.

Approbation and implementation of research results. The main provisions of the dissertation were reported at the International Scientific and Practical Conference "Aspects and innovations of Environmental biotechnology and Bioenergy" (Almaty, 2021); at the conference with international participation "New problems of medical science and prospects for their solutions" (Dushanbe, 2021); at the scientific and practical conference (69th annual) with international Participation "Achievements and problems of fundamental science and Clinical Medicine" (Dushanbe, 2021), at the XVI International Congress on Toxicology (Maastricht, the Netherlands, 2022). 17 acts of implementation were received in West Kazakhstan, Aktobe, Mangistau oblasts of the Western region of Kazakhstan.

Publications on the topic of the dissertation. 22 scientific papers have been published on the topic of the dissertation, including 2 articles in the journal indexed in the Web of Science information base ("Toxics" (Q2, IF – 4.47), "International Journal of Environmental Research and Public Health" (Q1, IF – 4.61)) and 1 article in the journal indexed in the Scopus information base ("Human Ecology", Percentile 30, GR=0.19); 4 - in journals recommended by the Committee for Quality Assurance in the Sphere of Education of the Ministry of Education of the Republic of Kazakhstan, 6 - in the materials of international

scientific conferences; a patent was obtained; certificate of entry of information into the State Register of Rights to objects protected by Copyright – 2; 25 cartograms, Atlas "Elemental status of the population of Western Kazakhstan" have been prepared. The work was carried out within the framework of a scientific project with grant funding from the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan "Development of an online atlas "Elemental status of the population of the Western region of the Republic of Kazakhstan"" (IRN AP08855535).

The volume and structure of the dissertation. The dissertation consists of an introduction, a literature review, a description of materials and methods, the results of our own research, a conclusion including findings, practical recommendations, a list of references and appendices. The total volume is 107 pages, including 23 figures and 17 tables. The bibliographic index includes 164 sources, of which 136 are foreign.

MATERIALS AND METHODS OF RESEARCH

Research design

The research was approved by the Bioethical Commission of the WKMOMU (Conclusion No. 9 dated 11/16/2020). According to the design of the study, it was a one-stage cross-sectional study conducted on the territory of Aktobe, West Kazakhstan, Mangystau regions of the Republic of Kazakhstan. The analysis was carried out in accordance with the principles of Good Clinical Practice. Informed consent was obtained from all participants of the study.

Characteristics of the examined groups.

A cluster sample was used for the cross-sectional study. In each cluster, the survey group was formed by a random sample of persons aged 18-60 years, permanently residing in the studied territory of Western Kazakhstan. A total of 869 people were included in the study. In the study, the inclusion criteria were: age - adult population 18-60 years old, permanently residing in the study area, written informed consent before inclusion in the study; exclusion criteria: acute infectious, surgical and traumatic diseases, chronic somatic diseases in the decompensation stage, metal implants (including amalgam fillings), vegetarian diet, consumption of vitamin and mineral supplements, pregnancy, lactation.

Assessment of morbidity indicators.

To study the morbidity, statistical data were obtained from the regional branches of the RSE at the Republican Center for E-Health of the Ministry of Health of the Republic of Kazakhstan and medical organizations. The paper uses Form No. 12 "Report on the number of diseases registered in patients living in the service area of a medical organization and contingents of patients under dispensary supervision". The morbidity was distributed by ICD-10 classes. The calculation of morbidity rates was carried out per 100 thousand population.

Study of the elemental status of the population.

In order to assess the elemental status, a macro- and trace element analysis of the hair of adults 18-60 years old was carried out, while the content of twenty-five

chemical elements was estimated: Al, As, B, Be, Ca, Cd, Co, Cr, Cu, Fe, I, K, Li, Mn, Mg, Na, Ni, P, Pb, Se, Si, Sn, V, Hg, Zn. Hair samples were obtained by cutting with clean stainless steel scissors from 3-5 sections of the occipital part of the head in an amount of at least 0.1 g. Proximal parts of strands 3-4 cm long were used for elemental analysis of the hair. Samples were placed in envelopes with identification records.

The content of 25 trace elements in the obtained samples was evaluated using inductively coupled plasma mass spectrometry on a NexION 300D spectrometer (PerkinElmer Inc., USA) equipped with an ESI SC-2 DX4 sampler (Elemental Scientific Inc., USA). Hair samples were subjected to sample preparation by washing and microwave decomposition. The strands of hair were washed with acetone, then rinsed three times with deionized water, dried in air at a temperature of 60 °C. After preliminary preparation and sampling, samples of biosubstrates were transferred to chemically stable Teflon tubes with concentrated nitric acid. Microwave decomposition was carried out for 20 minutes at a temperature of 170-180 °C in the Berghof Speedwave 4 system (Berghof Products&Instruments, Germany). After cooling and equalizing the pressure in the system, the solutions obtained during decomposition were transferred to test tubes, the volume was brought to 15 ml of distilled deionized water. The final solution was used for chemical analysis. The system was calibrated using the Universal Data Acquisition Standards Kit (PerkinElmer Inc., USA). Internal online standardization was performed using a solution of the Yttrium-89 isotope obtained from the Yttrium (Y) Pure Single-Element Standard (PerkinElmer Inc., USA). The certified standard human hair sample GBW09101 "Human hair", issued by the Shanghai Institute of Nuclear Research (PR China), was used for quality control.

Study of trace elements in the soil.

To study the content of trace elements, sampling points were determined in accordance with the level of atmospheric air pollution by industrial emissions and taking into account the wind rose. Soil sampling was carried out by the envelope method in accordance with State Standard 12071-2014. The trace element composition of the soil is analyzed using the atomic absorption method on the atomic absorption spectrometer AAnalyst 200 (Perkin Elmer, USA). Analyses in the soil were carried out in accordance with M-MVI-80-2008 "Methodology for measuring the mass fraction of elements in samples of soils, grounds and bottom sediments by atomic emission and atomic absorption spectrometry". The content of copper, chromium, cobalt, manganese, lead, cadmium, and iron in the soil was studied. The total number of soil samples in the West Kazakhstan region - 119, Aktope region - 171, Mangystau region – 133.

The study was conducted in the laboratory of Aliya & Co LLP (State license No.19024334 dated 20.12.2019, Certificate of accreditation No.KZ.I.05.0455 dated 03.07.2019 "Testing laboratory").

Drawing up cartograms. The cartograms were compiled using the QGIS cross-platform geoinformation system (QGIS 3.18). Vector data were taken from open sources. The color designation of the legend is determined by the indicators of the median content of ChE in the hair (Me ($\mu\text{g} / \text{g}$)).

Statistical data processing

Statistical data processing was performed using the STATISTICA 10.0 software package from StatSoft, Inc. USA. The null hypothesis of the absence of differences between the observed distribution of the trait and the theoretical expected normal distribution was tested using the Kolmogorov-Smirnov test. Differences between the samples were assessed:

- with normal distribution of paired variables using Student's t-test; data were presented as M(SD), where M is the arithmetic mean, SD is the standard deviation;
- in the absence of a normal distribution and in the case of paired independent groups using the Mann-Whitney U-tests (Mann-Whitney); data were presented as Me - median and (Q1; Q3) - lower and upper quartiles.

To identify dependencies between the studied parameters, a correlation analysis was performed using the Spearman rank correlation coefficient (r).

To assess the influence of independent factors on the binary response variable of the presence of an excess or deficiency of an element, multiple logistic regression analysis (LRA) was used using the method of sequential elimination of variables (backward: LR). The criterion for inclusion in the multivariate analysis was the presence of a statistically significant relationship with the predicted event, determined in the univariate analysis. Results are presented as unadjusted (nOR) and adjusted odds ratios (aOR) and 95% CI.

Linear regression analysis was used to assess the relationship between the content of chemical elements in the hair and the remoteness of the settlement from the place of oil and gas production. In model 0, the distance from the place of residence to the point of oil and gas production was entered as a predictor variable. Model 1 was adjusted for age and gender. Model 2 was made taking into account age, gender, BMI. Model 3 adjusted for age, gender, BMI, and smoking.

All analyzes were performed using the SPSS statistical software package (version 25.0, IBM Corp., USA) and STATISTICA (StatSoft v.10).

The critical significance level for all statistical procedures was <0.05 .

RESEARCH RESULTS

1. Assessment of the prevalence of chemical element imbalance. To identify imbalances in the content of elements, a comparative analysis of the content of trace elements with reference values was carried out (Skalny A.V., 2003, 2004; Iyengar V., Woittiez J., 1988). Thus, according to the results of the study, there is an imbalance of elements in the Western region of Kazakhstan: a deficit of Co, Se, I and an excess of K, Li, Na, Fe, Zn, P. In particular, in the West Kazakhstan region, the adult population has an excess of K, Li, Na, Mn, Mg, Fe, Zn, P and the deficit of Co, Se, I; in Aktobe region there is an excess of K, Li, Na, Mg, Fe, Zn, P and a deficit of Co, Se, I, Mn, Zn; in Mangystau region there is an excess of K, Li, Na, Fe, Zn, P, Al and a deficit of Co, Se, I, Mg, Mn, Zn, Ca, Cu, Si.

2. Assessment of regional features of the prevalence of ChE imbalance according to the analysis of hair of residents of Aktobe, West Kazakhstan, Mangystau regions. A comparative analysis of the prevalence of imbalance frequencies using the Pearson chi-squared criterion coefficient depending on the region of residence was carried out. The analysis showed significant differences in

the prevalence of the frequencies of excess and deficiency of ChE in Aktobe, West Kazakhstan, Mangistau regions. The highest differences in the prevalence of ChE imbalances are expressed in the Aktobe region with a deficit of Co, Ca, Se, Cr, Si, Zn and an excess of K, Li, Na, P, Zn. In the Mangystau region, there is a shortage of Cu, I, Mn, Mg and an excess of Al. There is an excess of Cd, Ni, Pb in the West Kazakhstan region. According to the results of the study, 25 cartograms were compiled reflecting the content of ChE in the biosubstrates of the studied population. The presented cartograms visually demonstrate regional differences in the content of ChE of the population of Western Kazakhstan.

3. Analysis of the influence of medical, social and hygienic factors on the prevalence of ChE imbalances. Further, we carried out a logistic regression analysis on the ChE, for which an imbalance and statistically significant correlations with the morbidity of the population were revealed. When conducting multiple LRA in a model adjusted by gender, age, the chances of having an excess of lithium were higher for people who use water from wells by 3.3 times, tap water by 5.5, tap water in combination with bottled water by 3.2 times. The presence of a statistically significant direct relationship between iodine deficiency and secondary special education, in which, compared with the average, deficiency was 2.0 times more common. People of European ethnicity were diagnosed with iodine deficiency almost 4 times less often, without a family 1.6 times more often. The use of tap water reduced the adjusted odds ratio by 1.6 times. In men, the adjusted odds ratio of cobalt deficiency was 1.7 times higher, and in persons with European nationality 2.1 times lower. Significant associations of selenium with the male sex were obtained, compared with women, men have an adjusted ratio of the chances of selenium deficiency 2.5 times lower. The presence of a statistically significant feedback between excess and the age of 46-55 years and ≥ 55 years, in which, compared with the age of 18-25 years, excess zinc was 2.3 and 2.8 times less frequent, respectively. Male gender and BMI are associated inversely with the risk of excess zinc. A statistically significant directly proportional relationship was found between the presence of zinc deficiency and age, zinc deficiency occurs 2.3 times in 46-55-year-olds, 3.3 times more often in ≥ 55 -year-olds than in 18-25-year-olds. BMI is also positively associated with zinc deficiency adjusted odds ratio = 1.083 (95%CI:1.047-1.121). Zinc deficiency is almost 2.4 times more common among workers and highly qualified specialists than among the unemployed. With an income of 50-100 thousand tenge by 2.2 times, with an income of 150-200 thousand tenge, the risk of deficit decreases by 5 times compared to persons with minimal income. A statistically significant directly proportional relationship was found between the presence of excess sodium and age, the chances of developing excess sodium increase over the years. Excess sodium occurs in 26-35 year olds 2 times, in 36-45 year olds 2.8 times, in 46-55 year olds 7.2 times, in ≥ 55 years 8.6 times more often than in 18-25 year olds. In persons with higher education, excess occurs almost 2 times less often than in persons with secondary education. When drinking water from a well, the risk of excess sodium increases by 2.5 times.

4. The relationship of the elemental status with the morbidity of the population. In the study of morbidity among the adult population of the Western

region of Kazakhstan, it was found that in the West Kazakhstan region, the first positions are occupied by diseases of the respiratory system, diseases of the circulatory system, diseases of the genitourinary system, diseases of the digestive system, diseases of the blood, hematopoietic organs and individual disorders involving the immune mechanism. When studying the morbidity of the Aktobe region, diseases of the circulatory system, respiratory diseases, diseases of the genitourinary system, diseases of the digestive organs, diseases of the eye and its accessory apparatus are in the first positions. In the Mangystau region, diseases of the circulatory system, respiratory diseases, diseases of the genitourinary system, diseases of the musculoskeletal system and connective tissue, diseases of the digestive system are in the first positions in terms of morbidity. The content of chemical elements in hair was associated with morbidity rates: in Aktobe region, with diseases of the digestive system ($r=-0.55$), diseases of the skin and subcutaneous tissue ($r=-0.57$), with diseases of the eye and its accessory apparatus ($r=-0.63$), with diseases of the genitourinary system ($r=-0.58$); Se – with diseases of the respiratory system ($r=-0.64$), with diseases of the eye and its accessory apparatus ($r=-0.66$); Zn – with diseases of the digestive system ($r=-0.62$), with diseases of the skin and subcutaneous tissue ($r=-0.60$); Li with mental disorders and behavioral disorders ($r=-0.62$). In the Mangystau region, deficiency of I is associated with diseases of the genitourinary system ($r=-0.94$); Co – with diseases of the digestive system ($r=-0.83$), diseases of the musculoskeletal system and connective tissue ($r=-0.89$); Se - with respiratory diseases ($r=-0.89$), skin diseases and subcutaneous tissue ($r=-0.83$); Zn – with diseases of the digestive system ($r=-0.83$), with diseases with diseases of the eye and its accessory apparatus ($r=-0.83$); Li with mental disorders and behavioral disorders ($r=-0.83$).

5. Analysis of the impact of living in the region of oil and gas production on the content of ChE. Western Kazakhstan is the largest oil and gas producing region of the country. In this regard, the next necessary stage of our research was to study the influence of ecological and hygienic factors of living in an ecologically disadvantaged region on the elemental status. The surveyed population was involved in the study from the settlements of Western Kazakhstan. In the next step, we performed multiple linear regression analysis. The natural logarithm of the concentration of chemical elements was introduced into the analysis as a dependent variable, the distance from the place of residence to oil and gas production facilities, age, gender, BMI and smoking were introduced as independent variables. The analysis showed that regardless of age, gender, BMI and smoking, with the remoteness of the place of residence (every 100 km) from the place of oil and gas production, the concentration of Li, Pb, Sn, Cu, I. increases in the hair of the study participants. The inverse relationship is observed for Al, B, Ni, Cr, Hg.

CONCLUSIONS

1. According to the results of the study, the population of the Western region of Kazakhstan is characterized by imbalances of chemical elements caused by an excess of Li and a deficiency of Co, Se, I, Zn. The highest prevalence of deficiency of I is in the Mangystau region; Co, Se, Zn is in the Aktobe region. The highest prevalence rates of excess Li in the Aktobe region.

2. The content of chemical elements in hair was associated with morbidity rates: in Aktobe region, with diseases of the digestive system ($r=-0.55$), diseases of the skin and subcutaneous tissue ($r=-0.57$), with diseases of the eye and its accessory apparatus ($r=-0.63$), with diseases of the genitourinary system ($r=-0.58$); Se – with diseases of the respiratory system ($r=-0.64$), with diseases of the eye and its accessory apparatus ($r=-0.66$); Zn – with diseases of the digestive system ($r=-0.62$), with diseases of the skin and subcutaneous tissue ($r=-0.60$); Li with mental disorders and behavioral disorders ($r=-0.62$). In Mangystau region, deficiency of I is associated with diseases of the genitourinary system ($r=-0.94$); Co – with diseases of the digestive system ($r=-0.83$), diseases of the musculoskeletal system and connective tissue ($r=-0.89$); Se - with respiratory diseases ($r=-0.89$), with diseases of the skin and subcutaneous tissue ($r=-0.83$); Zn – with diseases of the digestive system ($r=-0.83$), with diseases with diseases of the eye and its accessory apparatus ($r=-0.83$); Li with mental disorders and behavioral disorders ($r=-0.83$).

A correlation was revealed between the content of elements in the soil and morbidity indicators: in the Mangystau region, between the content of Fe and diseases of the blood, hematopoietic organs and individual disorders involving the immune mechanism ($r=0.93$, $p=0.076$), Cu and infectious diseases ($r=0.94$, $p=0.005$), Pb and diseases of the bonemuscular system ($r=0.89$, $p=0.018$); in Aktobe region between Cd content and diseases of the nervous system ($r=0.83$, $p=0.021$), Cu and diseases of the circulatory system ($r=0.78$, $p=0.036$), Mn and diseases of the respiratory system ($r=-0.89$, $p=0.024$); Co and diseases of the eye and its appendages ($r=0.81$, $p=0.027$).

3. The factors associated with the prevalence of ChE imbalances are: male sex (aOR=4.19), 36-45 years old (AOR=1.88), 46-55 years old (aOR=3.35), ≥ 55 years old (aOR=4.72), use of water from wells (aOR=3.31), tap water in combination with bottled water (aOR=3.17), tap water (aOR=5.50).

The presence of zinc deficiency is directly proportional to age 46-55 (aOR=2.35), ≥ 55 years (aOR=3.36), BMI (aOR=1.08), skill level (aOR=2.44), and inversely proportional to per capita income of 50-100 thousand tenge (aOR=0.46), 150-200 thousand tenge (aOR =0.20).

The presence of excess zinc has an inverse relationship with the male sex (aOR=0.64), age 46-55 years (aOR=0.44), age ≥ 55 years (aOR=0.36), BMI (aOR=0.95).

The presence of selenium deficiency has an inverse relationship with the male sex (aOR =0.40).

The presence of cobalt deficiency has a direct connection with the male sex (aOR = 1.71), with the European ethnicity aOR = 0.47.

The presence of iodine deficiency has a direct connection with secondary special education (aOR= 2.07), the status of "unmarried" (aOR= 1.58) and the reverse with European ethnicity (aOR = 0.26), the use of tap water (aOR= 0.59).

The presence of excess sodium is directly proportional to the male sex (aOR=1.93), age 26-35 years (aOR=1.96), age 36-45 years (aOR=2.81), age 46-55 years (aOR=7.20), ≥ 55 years (aOR=8.65), drinking water from the well (aOR=2.47), and inversely proportional to higher education (aOR=0.57).

4. According to the results of linear regression analysis in a model adjusted by gender, age, BMI, smoking, residents of the oil and gas production region of Western Kazakhstan have Li (0.103, (95%CI:0.046; 0.159), $p<0.000$), Pb (0.111,

(95%CI:0.045; 0.177), $p=0.001$), Sn (0.129, (95%CI:0.052; 0.205), $p=0.001$), Cu (0.072, (95%CI:0.050; 0.094), $p<0.000$), I (0.121, (95%CI:0.058; 0.185), $p<0.000$) in hair is associated with an increase in distance and the content of Al (-0,126, (955CI:-0,174; -0,077), $p<0.000$), B (-0,064, (955CI:-0,106;-0,021), $p=0.003$), Ni (-0,080, (95%CI:-0,134; -0,027), $p=0.003$), Cr (-0,196, (95%CI:-0,233; -0.160), $p<0.000$), Hg (-0.065, (95%CI:-0.129;0.001), $p=0.045$) with a decrease in the distance to oil and gas fields.

5. Cartograms of the content of ChE in the hair of the adult population of Western Kazakhstan have been compiled. At the same time, it was revealed that the elemental status in all three regions has fundamental differences in the territorial content of essential and conditionally essential, as well as toxic and potentially toxic ChE. This dynamics is predetermined by the peculiarities of the geophysical, topographic and technogenic formation of the environment.

PRACTICAL RECOMMENDATIONS

According to the results of the study and analysis of literature data, it is recommended to monitor the bioelemental status of the population in order to develop scientific and practical measures to prevent the imbalance of the elements of the population's body and its correction.

Doctors of primary care organizations, guided by bioelement status cartograms, use bioelement status assessment as a tool for prenosological diagnosis of diseases, as well as to increase attention to this problem in order to reduce medical, social and environmental risk factors for the development of chemical element imbalance.

Taking into account the identified factors, PHC doctors should pay attention to risk groups: patients older than 46 years with a possible deficiency of zinc, excess of lithium, sodium; male patients with a possible excess of lithium, cobalt deficiency, selenium; low-income patients with a possible zinc deficiency.

To carry out hygienic monitoring of trace elements in the environment with a detailed description of the existing trends of ChE imbalances in a particular region.

To include bioelementology in the training process of medical universities with the study of the influence of complex medical, social and environmental factors of the development of an imbalance of chemical elements.