

Natural and Anthropogenic Factors Determining the Population Health of the Southern Federal District (Regional Aspect)

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Abstract. The article presents rates of general morbidity and major noncommunicable diseases among the population of the Southern Federal District. It analyzes environmental factors that affect the population health of the district. It demonstrates that various natural and anthropogenic loads of the subjects of the Southern Federal District influence the regional features of population health. The article analyzes the regional specifics of the prevalence factors of noncommunicable diseases using the example of the Republic of Kalmykia. It revealed the most significant natural and anthropogenic factors of environmentally associated widespread noncommunicable diseases in different regions of Kalmykia. The authors conclude that it is necessary to create a local population's health version to develop territorial systems for assessing population health considering the industrial, agricultural, climatic and geocological specifics of municipalities of the Kalmykia Republic.

Keywords: *Southern Federal District, Republic of Kalmykia, noncommunicable diseases, the local population's health version, natural and anthropogenic factors*

I. INTRODUCTION

Russian Federation has a significant territorial differentiation of indicators of both the general incidence rate and individual nosological forms. The deterioration in the population health status in recent decades has led to negative population growth in Russia. Statistics indicate a decrease in the birth rate while increasing mortality. Over the 11 months of 2017 in Russia, mortality exceeded the birth rate by 193 thousand people [8].

Up to 77% of cases of diseases are mainly the result of adverse environmental changes influenced by anthropogenic activity [12].

This transfers the study of environmental impact on human health into the category of major problems. The health of the population based on the quality of life influenced by adverse environmental factors, natural and anthropogenic, has been called the local population's health version [14].

The elimination of all negative factors is almost impossible at present. It sharply raises the question of their comparative assessment and allocation of the most significant for a particular region among them [18].

This problem is directly related to the practical issues of assessing regional characteristics of population health and identifying local risk factors.

The discrepancies in incidence rates in individual macro- and micro-regions of Russia mainly depend on the composition of the population by age and sex, the completeness of registration of diseases, and the combination of the effects of various natural and anthropogenic environmental factors. Our work presents a comparative assessment of the population health of the subjects of the Southern Federal District (SFD). The identification of the prerequisites for the formation of local population health at the level of the subjects of the Southern Federal District is one of the urgent tasks for substantiating preventive measures to improve the health level and the life quality of the population of specific territories.

Based on world and foreign experience, the concept of the local population health will serve a constructive way for substantiating preventive measures to improve the health level and life quality of the population of specific territories [9,14,20].

The purpose of the study is to assess the natural and anthropogenic factors that determine the population health of the Southern Federal District in general and the Republic of Kalmykia, in particular.

II. MATERIALS AND METHODS (THE MODEL)

The object of study is the population of the Southern Federal District and the Republic of Kalmykia. The main research methods are analytical and desk methods. Reporting and statistical materials on the incidence of the population of Russia by class, disease group and individual disease, as well as reporting and analytical materials of the territorial body of the Federal State Statistics Service for the Republic of Kazakhstan served as an information base for assessing the population health of the Southern Federal District [3, 4, 8]. We used the information provided by the Ministry of Environmental Protection of Kalmykia to analyze environmentally significant factors in the spread of noncommunicable diseases in Kalmykia [6,7].

III. RESULTS AND DISCUSSION

A. Medical and environmental assessment of the Southern Federal District

The Southern Federal District covering an area of 416,840 km² (2.4% of the territory of Russia) includes the territories of the Republics of Adygea, Kalmykia and Crimea, the city of Sevastopol, Krasnodar Territory, Astrakhan and Volgograd Regions. Nature consists of steppes representing a large part of the district, also a desert, semi-desert, foothills and mountainous landscapes with mixed forests. The territories of the Kalmykia Republic, Astrakhan, Volgograd and Rostov regions cover a significant part of the arid and semi-arid lands of Russia.

The favourable geographical position of the Southern Federal District determined the main sectors of economic specialization: transport, fuel industry (oil, gas), electric power industry, non-ferrous metallurgy, mechanical engineering, chemicals, construction, agroindustrial, tourist and recreational complexes, etc. On the territory of the Southern Federal District, there are entities with significant industrial potential which have a high technogenic load and a very high level of environmental pollution.

At the end of the twentieth century, many regions of Russia have an unfavourable environmental situation [12].

In this period, B.B. Prokhorov conducted an integrated assessment of the territory of Russia on a wide range of indicators including the comfort of natural conditions for the population's life, the level of environmental pollution and the quality of public health, etc., and identified 20 medical and ecological regions [13].

According to the medical and environmental assessment of B. Prokhorov, the Southern Federal District is a region with accurate environmental problems. Most of the population of the Southern Federal District, except for the Republic of Adygea, have a low level of health. The revealed health levels were directly dependent on the value of the technogenic load index (TLI) of the subject's territory (Table 1).

The Republic of Kalmykia, despite the small TLI, has a very low level of the urban population's health and a low level of the rural population.

To date, the environmental situation in the Southern Federal District continues to be tense. The Volgograd region produces the largest volume of harmful emissions into the atmosphere from stationary sources in the Southern Federal District, which is 221.3 thousand tons, or 25% of emissions from all stationary sources [2].

Over the past decade, road transport has gradually become the main source of air pollution in Russian cities including the Southern Federal District. Emissions from mobile sources increase annually due to an increase in the number of vehicles and gasoline consumption. The leaders of total emissions of harmful substances into the atmosphere from vehicles and stationary sources in the Southern Federal District are Krasnodar region (23%), Rostov (19%) and Volgograd (15%) regions.

TABLE I. INTEGRAL MEDICAL AND ECOLOGICAL EVALUATION OF SUBJECTS OF THE SFD BY B.B. PROKHOROV [13]

№	Subject	Health level		TLI
		urban population	rural population	
1	Republic of Adygea	Satisfactory	Satisfactory	10
2	Republic of Kalmykia	Very low	Low	11
3	Krasnodar region	Low	Low	32-91
4	Astrakhan region	Low	Reduced	50
5	Volgograd region	Satisfactory	Reduced	42-100
6	Rostov region	Low	Reduced	32-91

The share of all constituent entities of the Federation in the Southern Federal District is 2.3 million tons of pollutant emissions into the air from vehicles and about 0.9 million tons of emissions from stationary sources. The Astrakhan region has the highest rate of harmful substances into the atmosphere from all sources of emissions per inhabitant, which is 275 kg/person. The specific volume of harmful emissions per person exceeds the average for the Southern Federal District in the Volgograd and Rostov regions, the Republic of Kalmykia and the Krasnodar Territory. The highest levels of air pollution are in the cities of Volgograd, Volgogradsk, Volzhsky. In 2006, they entered the Priority List of Russian Cities with the highest level of air pollution.

In the Southern Federal District indicators of the neutralization and capture of harmful substances have a wide range: in the Republic of Adygea, the indicator reaches 88%, in the Rostov Region and Krasnodar Territory is about 80% but in the Republic of Kalmykia is about 3%, in the Astrakhan Region is 12% with an average value in Russia of 74.8%.

Among the subjects of the Russian Federation, the Krasnodar Territory has the largest volume of polluted wastewater discharged into water bodies (907.4 million m³). Among the regions of the Southern Federal District, Rostov (271.0 million km³) and Volgograd (216.8 million km³) regions are leaders in this indicator. The regions with the largest discharges of polluted wastewater per person are the Krasnodar Territory (178 m³ / person) and Kalmykia (141 m³ / person).

The state monitoring data of the subsoil condition of the Southern Federal District indicate 824 sections of groundwater pollution which is 13.8% of their total number in the country. The main cause of groundwater pollution is industrial enterprises (274 sites or 33%), agricultural enterprises (154 sites or 19%), and utilities (74 sites or 9%).

Presented in Figure 1, the general morbidity rates of the population of the Southern Federal District subjects for 2016-2017 are ambiguous.

For Rostov and Astrakhan regions, as well as for the whole district, the analysis revealed the highest rates of the general morbidity of the population exceeding all-Russian indicators which is consistent with the high anthropogenic and technogenic load in these territories. The Republic of Kalmykia has a high prevalence of general morbidity but, as noted earlier, it has a low level of technogenic load.

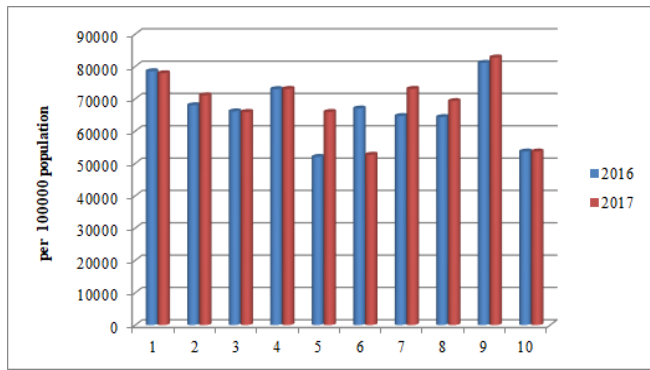


Fig. 1. The total incidence of the population in the subjects of the Southern Federal District in 2016-2017 years.

Symbols hereinafter for Fig. 2:

1 - Russian Federation, 2 - Southern Federal District, 3 - Republic of Adygea, 4 - Republic of Kalmykia, 5 - Republic of Crimea, 6 - Krasnodar Territory, 7 - Astrakhan Region, 8 - Volgograd Region, 9 - Rostov Region, 10 - Sevastopol

Comparing individual microregions of the district, we note that in the Republic of Kalmykia, Astrakhan and Volgograd regions, the total morbidity of the population is higher than in the district with a clear upward trend in 2017 compared to 2016. In the Rostov region, the total incidence of the population significantly exceeds the all-Russian rates. The population of the Republic of Crimea and the city of Sevastopol has the lowest indicators.

The idea of the influence of environmental factors in the spread of the well-known massive noncommunicable diseases (NCDs): oncological, cardiovascular, chronic respiratory diseases, has been widely used in recent years [18].

Although lifestyle is of great importance in the development of NCDs, the influence of environmental factors is also significant [4]. The environmental impact on human health reaches 30% [17].

An analysis of the regional characteristics of the prevalence of NCDs in the Southern Federal District showed a higher level of the spread of circulatory system diseases compared with the data for Russia. Along with these data, the population of the Southern Federal District has a high prevalence of environmentally associated diseases: neoplasms, anaemia, diseases of the thyroid gland and urinary system.

Figure 2 shows the prevalence structure of the main environmentally associated NCDs among the population of the Southern Federal District.

The highest rates of all NCDs, exceeding the national and of the whole district, are noted in the Krasnodar Territory, Rostov Region, and the Republic of Kalmykia, and the lowest in Sevastopol. The population of Kalmykia, Volgograd and Rostov regions have a particularly high prevalence of respiratory diseases. As for the diseases of the endocrine system, the Astrakhan, Volgograd and Rostov regions, the city of Sevastopol has their highest prevalence. The population of Sevastopol and Krasnodar Territory has the highest level of neoplasms in the district, higher than in Russia as a whole.

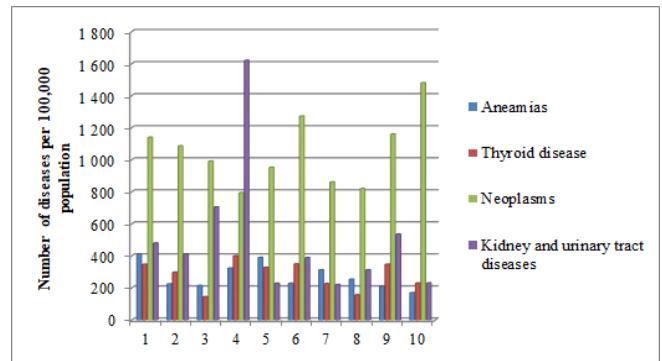


Fig. 2. The prevalence of major noncommunicable diseases among the population of the Southern Federal District in 2016-2017

Anaemia and thyroid disease are more common among the population of the Republic of Kalmykia, Krasnodar Territory and Rostov Region. Diseases of the kidneys and urinary tract registered in Kalmykia exceed the all-Russian indicators by more than three times.

According to the World Health Organization in 2016, about 23% are deaths directly related to environmental risks: air, soil, water pollution, the influence of chemical agents, etc. [9].

All these factors take place in Kalmykia. The territory of the Republic of Kazakhstan has a pronounced heterogeneity in many environmental factors of anthropogenic and -technogenic character. The territory of Kalmykia covers a significant part of arid and semi-arid lands (deserts, semi-deserts, dry steppes) of Russia with intensive agricultural use. The republic has a sharply continental climate, extreme dryness and extremely high temperatures in summer (over +40 °C), as well as sharp fluctuations in air and soil temperatures in the winter (from +10 to -40 °C), long dusty period in March-June, and a shortage of drinking high hardness water.

It is important to note that while the high risk of NCDs incidence in large industrialized subjects of the district resulted from environmentally significant adverse factors of economic activity in these territories, Kalmykia, despite the relatively low TLI, has a significant prevalence of some environmentally associated NCDs [15].

Recently, rates of rural and urban cancer incidence become close due to the action of similar risk factors. In the structure of the morbidity of the republic's population, the largest share is diseases of the respiratory system, urinary system, and biliary tract. Respiratory diseases are especially common among children and adolescents; anaemia and thyroid disease are common among women. The latter are endemic diseases due to the biogeochemical specifics of the territory of Kalmykia, which is deficient in iron and iodine [15, 16].

According to the report from Rospotrebnadzor: 28 regions of the country exceed the average Russian mortality rate from diseases of the digestive system, kidneys and urinary tract associated with the water quality of the drinking water supply system, 10 territories have the highest levels including two regions of the Southern Federal District - the Republic of Kalmykia and the Rostov region [2].

B. Medical and environmental assessment of the territory of the Kalmykia Republic

Because most of Kalmykia is located on the Caspian lowland below sea level, as well as due to the prevailing winds of the north-eastern and eastern directions, transboundary transport from adjacent territories makes up the bulk of pollution. Technological sources of air pollution in the republic are the enterprises of the fuel and energy, metallurgical, chemical, gas condensate, oil refining and agricultural complexes of the Volgograd, Astrakhan, Rostov Regions and Stavropol Territory adjacent to Kalmykia [11]. Located at the borders of the republic, they annually discharge about 3 million m³ of industrial wastewater containing more than 200 types of compounds of various hazard classes. There is an accumulation of substances through groundwater throughout the republic [3, 5-7].

Undoubtedly, technogenic factors create various deviations from average biospheric norms: some have no fundamental differences from local natural anomalies like the biosphere, while others are completely different, fundamentally new both for the biosphere and for the human body. New chemical compounds are biologically inadequate for the body and penetrate the skin, lungs, digestive tract, leading to the development of many diseases: allergic, respiratory, oncological [14, 19].

Human economic activities create new biogeochemical provinces and regions. Around enterprises, without appropriate treatment facilities, there is a dispersal area for its waste. During airborne dispersion, such ranges are usually in the form of ellipses elongated in the direction of the prevailing winds. On average, their small radii are close to 5 km, and large ones are close to 20 km. In some cases, smoky trains stretch for hundreds and thousands of kilometres. Within such pollution areas, yields and the number of agricultural products usually, and human health deteriorates [1].

The example is the periodic increase in concentrations of pollutants in the air in the Kalmykia Republic due to volley emissions of the Astrakhan gas condensate plant.

Given that in the Republic of Kalmykia the level of concentrations of pollutants in the atmospheric air periodically increased due to volley emissions of the Astrakhan gas condensate plant, monitoring the level of risk of short-term exposure is especially important since it gives the possibility to quickly respond to changes in the environmental situation.

The results obtained by A.B. Menglinova are of interest in the context of the integrated assessment of the health state and the analysis of the territorial variability of the prevailing NCDs of the republic's Population [10].

She studied certain features of the population health of Kalmykia and estimated the regional population health index (RPHI). To obtain this indicator, we used morbidity and mortality rates from neoplasms and congenital anomalies over ten years, from 2002 to 2011. It served as the basis for the distribution of regions of the republic into groups. Summarizing our own and literary data, we compared the indicators of RPHI and prevalence of the main NCDs in the

municipalities of Kalmykia presenting the most significant environmental factors (Table 2).

TABLE II. ENVIRONMENTALLY SIGNIFICANT FACTORS OF NCD PREVALENCE IN KALMYKIA

No	Group of municipalities	RPHI The most common NCDs	Environmentally relevant NCD factors
1	Tselinny, the city of Elista Ketchenerovskiy, Iki-Burul'skiy, Tselinny, Yashkul'skiy, Oktyabr'skiy districts	More than 0.67 - satisfactory Neoplasms, diseases of the respiratory system, thyroid gland, urinary system, biliary tract	Air pollution by boiler houses and motor vehicles for the city of Elista and transboundary transport from the territory of the Volgograd regions, salt, dust transfer, dust storms, radiation pollution, soil pollution: animal waste
2	Gorodovikovskiy, Laganskiy, Chernozemskiy, Justinskiy areas	0.61-0.66 –reduced Neoplasms, diseases of the respiratory system, blood circulation, thyroid gland, urinary system, biliary tract, anaemia, allergies	Air pollution by transboundary transport from the territories of Astrakhan, Volgograd, Rostov regions, soil pollution of gas and oil fields, soil deflation and degradation, high hardness drinking water, biogeochemical features of the territory: trace elements deficiency
3	Elista, Maloderbetovskiy district	0.56-0.60 - low Neoplasms, diseases of the respiratory system, thyroid gland, urinary system, biliary tract	Air pollution by transboundary transport from the territories of the Volgograd region, soil deflation and degradation, drinking water of high hardness
4	Priyutnenskiy, Sarpinskiy, Yashkul'skiy districts	0.45-0.55-extremely low Neoplasms, diseases of the respiratory system, musculoskeletal system, skin, thyroid gland, urinary system, biliary tracts,	Air pollution by transboundary transport from the territories of the Stavropol Territory, Rostov and Volgograd Regions, soil pollution by pesticides in rice sowing, radiation pollution

The analysis of population health in the municipalities of Kalmykia made it possible to present ecologically associated diseases of the population of Kalmykia in a regional context.

The most significant environmental factors are: atmospheric air pollution by transboundary transport from the territories of the Astrakhan, Volgograd, Rostov regions, soil pollution of gas and oil fields, soil deflation and degradation, high rigidity drinking water, biogeochemical features of the area: trace elements deficiency, soil deflation and soil degradation, soil pollution by pesticides in rice sowing, radiation pollution.

IV. CONCLUSION

A. The subjects of the Southern Federal District have a high degree and territorial variability of the prevalence of NCDs. Evaluation of the population health of the Southern Federal District and environmentally related risk factors for noncommunicable diseases suggests the need for targeted measures to assess the calculation of exposures and risks which may result in revealing the features of the formation of a local variant of population health depending on local conditions.

B. The territory of the Republic of Kalmykia has extreme environmental conditions and pronounced heterogeneity in

some environmental factors of anthropogenic and technogenic nature affecting the population's health. Moreover, the prevalence of major NCDs exceeds similar indicators in the Southern Federal District, and in some cases, all-Russian, despite the rather low level of anthropogenic load.

C. The results of the study demonstrate that it is necessary to organize risk monitoring to successfully solve medical and environmental problems in the Southern Federal District and to implement effective targeted and economically sound preventive measures considering the industrial, agricultural, climatic and geocological specifics of municipalities. For this, each region should organize monitoring of the risk to public health from pollution of atmospheric air, soil, plant products, and sources of water supply. Sources of information for determining exposures and risks may include monitoring data on the level of pollutants in the sight points of atmospheric air pollution, inventory materials of emission sources, and data from special studies. The result of these studies may be the formation of local variants of population health at the level of the subjects of the Southern Federal District.

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