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RESEARCH ARTICLE

Geoinformation analysis russian health system: modeling, visualization, analysis

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Abstract

In the Russian Federation, noticeable differences remain among its constituent entities in terms of citizens' access to high-quality medical care. The primary challenges in the development of the nation's healthcare system and its various regions are closely linked to demographic trends and the need to address mortality problems. The state of regional healthcare systems plays a pivotal role in influencing mortality rates, which, in turn, serves as a reflection of the regional and municipal healthcare systems' overall development. Consequently, the development of an algorithm or methodology for assessing the effectiveness of healthcare systems, as mandated by strategic and territorial planning documents at all administrative levels, has become a pressing scientific concern and the focal point of this research. The development of the algorithm involved a multifactor analysis and geoinformation mapping methods. The authors have developed specific criteria to evaluate the current state of healthcare systems in the constituent entities of the Russian Federation and municipalities, taking into account their impact on target socio-economic indicators and mortality rates aligned with the national objectives of the Russian Federation, as well as the goals outlined in the National Projects «Healthcare» and «Demography.» Through a comprehensive analysis of demographic and socio-economic factors, the research has unveiled distinctive characteristics in the spatial organization and structure of healthcare systems, both at the municipal and constituent entity levels within the Russian Federation. This analysis has facilitated the development of typologies for the constituent entities based on a comprehensive composite indicator that encompasses both medical and non-medical factors. The authors have introduced a system of cartographic indicators designed to evaluate the efficiency of the spatial organization of healthcare systems at various territorial levels, encompassing constituent entities of the Russian Federation, municipalities, and settlements. To support this evaluation, the authors have prepared a series of original cartographic materials for each level, featuring corresponding assessment indicators.

Keywords

geographic information methods, multivariate analysis, spatial organization of the healthcare system, strategic planning, territorial planning, typology

JEL codes: I18, I19

Introduction

Assessing the current status of the healthcare system within the context of spatial organization and its impact on the demographic and socio-economic development of the country and its regions is an active field of research. This relevance becomes even more pronounced when evaluating the efficiency of healthcare system spatial organization, especially within the framework of strategic and territorial planning.

An examination of foreign and Russian studies reveals that the analysis of the spatial organization of healthcare institutions and the evaluation of the effectiveness of the system, particularly at the regional and municipal levels, are intricate and often contentious issues. Notably, there is presently no unified and systematic approach for determining and assessing the effectiveness and sustainability of the Russian healthcare system.

Numerous attempts have been made to create ratings assessing the quality, accessibility of medical care, and healthcare system effectiveness at various territorial levels (regions/cities), both in Russia and abroad. Excluding foreign experiences due to the difficulty of comparing different healthcare systems, this discussion focuses on domestic developments. A comprehensive account of this experience can be found in a 2019 study by specialists from the National Research University Higher School of Economics (Rating of accessibility and quality... 2019). Table 1 provides information on the indicators used to construct ratings and assess the effectiveness of regional healthcare systems. Typically, mortality indicators are employed, including those for various causes and age groups. Other indicators vary widely and are rarely consistent across different ratings. The choice of indicators depends on the specific objectives of the researchers and the availability and comparability of data.

Notably, the comprehensive assessment of regional healthcare system efficiency and sustainability conducted by experts from the Ural Branch of the Russian Academy of Sciences and the Ural Federal University regarding the territorial healthcare system of the Sverdlovsk region (Chereshnev et al. 2021) deserves particular attention.

The authors evaluate the effectiveness of regional healthcare, considering sustainability, efficient resource utilization, and system efficiency. The research methodology is based on principles of system economics, sustainable development, and the utilization of a comprehensive set of interconnected research, modeling, and forecasting methods. During the study, a noteworthy methodological toolkit was developed to comprehensively assess the efficiency and sustainability of the regional healthcare system. This toolkit enables the examination of the reasons for changes in system dynamics using composite indicators, the assessment of interrelationships and influences between them, and the potential for achieving efficiency and sustainability within the healthcare sector.

The determination of relative efficiency, according to the authors' methodology, unfolds in three successive stages (Chereshnev et al. 2021):

Table 1. Indicators used to construct ratings for the quality and accessibility of healthcare in various projects

Independent Monitoring Foundation «Health»	1. Mortality rate 2. Mortality from circulatory system diseases 3. Mortality rate from neoplasms, including malignant ones 4. Mortality rate from tuberculosis 5. Mortality of the working – age population 6. Mortality of children aged 0–17 years 7. Mortality of the working – age population from the circulatory system diseases 8. Infant mortality 9. Mortality from road traffic accidents 10. Doctors per population 11. Paramedical personnel per population
Higher School of Healthcare Organization and Management	1. Life expectancy 2. Gross regional product per capita 3. Public financing of health care per capita 4. Sales of spirits per capita
Financial University under the Government of the Russian Federation	1. Ratio of annual deaths to the working-age population 2. Percentage of adult city residents who had reason and desire to sue a doctor or medical institution for errors, omissions, or negligence in their work in the past three years 3. Level of adult urban residents' satisfaction with the quality of medical care they receive in urban medical institutions 4. Percentage of residents who had to go to another region or abroad for necessary medical care in the past three years 5. Percentage of residents who believe that their city has an adequate number of medical facilities 6. Percentage of city residents who, in the past three years, faced situations where they lacked sufficient funds for necessary treatment 7. Percentage of city residents who, in the past three years, could not afford essential medication due to its high cost 8. The product of the percentage of low-income city residents and the percentage of those using paid medical services
National Research University Higher School of Economics	**I. Life expectancy and mortality (resulting indicators of the health status of the population):** 1. Life expectancy at birth; 2. Standardized mortality rate; 3. Mortality of the working age – population; 4. Mortality of children aged 0–17 years.

End of the table 1

II. Industry staffing: 5. Doctors per population (individuals); 6. Paramedical personnel per population (individuals); 7. Local therapists per population; 8. Local pediatricians per population; 9. General practitioners per population.
III. Medical care for cardiovascular diseases: 10. Standardized mortality rate from coronary heart disease; 11. Standardized mortality rate from cerebrovascular diseases.
IV. Medical care for cancer: 12. Percentage of malignant neoplasms patients registered for five years or more, among all registered patients with malignant neoplasms at the Moscow Oncology Research Institute named after P.A. Herzen; 13. Percentage of newly diagnosed malignant neoplasms patients at stages I–II, among all newly diagnosed malignant neoplasms patients; 14. One-year mortality rate of malignant neoplasms patients; 15. Standardized mortality rate from neoplasms (including malignant ones).
V. Maternal and child health protection: 16. Neonatal pathology department hospital mortality for newborns weighing 500–999 g; 17. Infant mortality rate; 18. Maternal mortality.
VI. Organization of palliative care: 19. Availability of beds for adult palliative care; 20. Availability of doctors providing palliative care.

*Source***:** (Shishkin et al. 2019)

The first stage entails an analysis of the fulfillment of indicators established by territorial programs (TP) for state-guaranteed free medical care for citizens. This includes target medical and demographic indicators, the volumetric aspects of state tasks (GZ) related to different types of medical care (MP) (emergency medical services (EMS), outpatient clinics(APC), round-the-clock (CSS) and day-care (DC) hospitals), the delivery of high-tech medical care (HTMC), as well as criteria for medical care accessibility and quality.

The second stage encompasses a comprehensive evaluation of the relative efficiency of the regional healthcare system. This stage involves the calculation of integrated coefficients for medical and social performance and the evaluation of territorial program financing (actual versus planned indicators).

The third stage delves into indicators that characterize the system's relative stability, including resource availability considerations.

The authors (Chereshnev et al. 2021) have introduced an interactive model for determining the risk level of a regional healthcare system. This model illustrates the capabilities of the regional healthcare system, depicting its status within a disaster zone, a pre-risk zone (degradation), at the border of a risk zone, or in a safe zone.

It's important to note that every experience in evaluating and rating regional healthcare systems, despite its thoroughness and detailed scientific analysis, remains somewhat subjective and overlooks two crucial aspects:

- the current demographic structure of the regional population and the results of objective demographic forecasting;
- the assessment of regulatory provision and projected healthcare institution needs, considering demographic forecasts and demographic development in Russian Federation constituent entities.

The analysis of the most successful experiences in rating and assessing regional healthcare systems in the Russian Federation in recent years highlights the complexity of the issue, necessitating scientific discussion and further research.

The analysis of the methods and results of constructing ratings (efficiency assessments) for regions based on healthcare development allows us to derive the following general conclusions:

1. In the examined projects for constructing ratings of Russian Federation constituent entities, two distinct approaches to selecting evaluation indicators are evident:

- comparison of predominantly outcome-based indicators related to the health status of the population, typically quantitative mortality indicators (both overall and for specific causes);
- utilization of a comprehensive set of quantitative parameters, encompassing not only the health status of the population, including mortality, but also the availability of resources and conditions for receiving medical care.

Each approach has its own advantages and disadvantages. Thus, the first approach ensures homogeneity among the compared parameters and facilitates data collection. However, it doesn't account for non-medical factors that influence mortality rates.

The second approach allows for the consideration of a wide range of factors related to the availability and quality of medical care, but it faces challenges in aggregating diverse parameters into a single comprehensive assessment. Considering the context of the Russian Federation, the second approach seems more suitable for two key reasons:

- Russian Federation constituent entities exhibit significant variation in the contribution of non-medical factors (such as ecology and income level) to mortality rates;
- preventable mortality indicators (e.g., from alcohol or tobacco consumption) are not consistently calculated for Russian regions. Therefore, assessments of constituent entities of the Russian Federation regarding medical care availability and quality should strive to eliminate non-medical public health factors as much as possible and concentrate on the characteristics of medical care provision itself.

2. A comparative analysis of medical care availability and quality across regions highlights the necessity of utilizing a wide array of assessment indicators, with a focus on precision and detail.
3. Determining the relative importance of composite evaluation indicators represents the most challenging aspect of the methodology.
4. It is advantageous to measure the state of healthcare systems and the dynamics of their characteristics over time using diverse assessment procedures, both static (based on the achieved level of development) and dynamic (based on the growth rate of the considered indicators).

The complexities of evaluating healthcare system performance at the level of Russian Federation constituent entities and municipalities are exacerbated by substantial variations among regional healthcare systems due to geographical, transportation, financial, personnel, organizational, and other factors.

In Russia, a three-tier model for organizing medical care has been established, categorizing medical organizations into three levels:

1. Primary health care.
2. Multidisciplinary and specialized medical care, with over five specialties, at the inter-municipal level.
3. High-tech medical care at the regional and federal levels.

Notably, the primary healthcare level presents the greatest challenges, particularly in the stages of strategic goal-setting and subsequent territorial planning. These challenges determine the subject and object of the study, its goals and objectives, as well as its future directions and outcomes.

Work's Goal:

The objective of this work is to develop an algorithm (methodology) for assessing the viability of constructing and renovating healthcare facilities, as outlined in the strategic and territorial planning documents of Russian Federation constituent entities and municipalities. This assessment is based on the impact on target socio-economic indicators and mortality rates of the population in the Russian Federation's constituent entities and municipalities.

Key Tasks:

- Develop criteria for evaluating the current state of the healthcare system within Russian Federation constituent entities and municipalities in the context of their impact on target socio-economic indicators and mortality rates.
- Formulate criteria for assessing the feasibility (potential effectiveness) of implementing healthcare development projects specified in the strategic and territorial planning documents of Russian Federation constituent entities and municipalities.
- Establish an algorithm for determining the effectiveness and priority of implementing healthcare development projects within Russian Federation constituent entities and municipalities.
- Identify target indicators for socio-economic development and demographic indicators to be used as benchmarks in the developed algorithm.
- Create the structure of a geodatabase, encompassing a list of quantitative indicators (factor characteristics), their composition and structure, data sources, mechanisms for data acquisition, update frequency, territorial levels (regional/municipal), and their correlation with socio-economic and/or demographic indicators (result-oriented characteristics) used in the algorithm.
- Develop a set of cartographic indicators for the algorithm.

Data and Methods

This section outlines the data sources and research methods used in the study. Both quantitative and qualitative data were employed, including theoretical and methodological developments related to the analysis of the spatial organization of the healthcare system. The data sources encompassed: Rosstat data, including information from the All-Russian Population Censuses, materials from the Federal State Information System for Territorial Planning (FSIS TP), data from industry statistics within the healthcare sector at various territorial levels (Russian Federation, constituent entities of the Russian Federation, municipalities), regulatory legal acts governing aspects of healthcare sector development, demography, and urban planning activities.

The selection of information sources aimed to facilitate their accessibility and utility for state and municipal authorities in conducting independent assessments of the healthcare system's state. Standardized mortality rates were not used in this study, but their inclusion in future research can help assess mortality in different regions based on the state of the regional and municipal healthcare systems, allowing for comparisons with the findings of this study.

The research employed various methods, including multidimensional comparative analysis, factor and structural analysis, expert assessments, statistical modeling, and identifying relationships. Additionally, thematic geoinformation mapping was used to visualize the data.

The obtained results are exploratory and research-oriented, and further in-depth research is necessary to confirm the validity of the conclusions and hypotheses. Subsequent research in the field of spatial organization of regional and municipal healthcare systems, their assessment of effectiveness and sustainability, particularly in the context of territorial planning, will refine the proposed methodological framework by expanding the list of factors influencing industry development.

The study focused on five regions within the Russian Federation as pilot subjects: Belgorod, Kaluga, Murmansk, Sakhalin, and Chelyabinsk. The selection of these key pilot regions was based on a set of characteristics, including

- geographic diversity, covering different natural and climatic conditions;
- settlement variety, including different regional settlement systems and population-based administrative center types.;
- administrative differences, encompassing regions at various stages of municipal reform. (for instance, the Sakhalin region, which includes city and municipal districts, regions currently undergoing municipal reorganization, like the Chelyabinsk region, featuring "new municipal formations" in the form of municipal districts alongside "traditional" municipal areas with urban and rural settlements, and regions like the Kaluga region that have retained their "traditional" municipal structure.)
- the selection of key regions where the authors have experience in organizing and conducting design, research, and scientific research work related to demography, territorial planning, and urban development.

The analysis was conducted at the municipal and individual settlement levels within these pilot regions. Research and calculations were carried out for 85 constituent entities of the Russian Federation, excluding new constituent entities included in 2022 due to the lack of complete, representative, and comparable data for these constituent entities.

The study chose the year 2019 as the chronological point of analysis, which predates the COVID-19 pandemic. This selection was motivated by several factors:

- the quality of quantitative indicators included in the of research indicator system;
- comparability of data on socio-economic, demographic and urban development of territories;
- the need to mitigate the influence of random factors when analyzing the dynamics of regional healthcare systems' states.

The authors acknowledge that the pandemic has significantly impacted overall mortality and healthcare system organization. The full extent of these consequences has yet to be assessed. While some aspects, like excess mortality rates, have been measured, a comprehensive evaluation of the pandemic's impact on the healthcare system remains a substantial and independent study, beyond the scope of this work. The reliability of COVID-19 mortality data and the specifics of morbidity diagnostics remain areas of ongoing research.

A portion of the pandemic's impact can be quantified through excess mortality rates. Notably, in 2020, the total number of deaths in Russia surged by nearly 20%, equivalent to an increase of 323.8 thousand people, and in 2021, it grew by 321 thousand (Number of registered deaths... 2023). Several works have explored the assessment of COVID-19's influence on mortality in Russian regions, such as (Zemtsov and Baburin 2020a 2020b; Korkhmazov and Perkhov 2022; Kuchmaeva et al. 2021).

However, evaluating the pandemic's impact on healthcare system changes is presently a complex task that necessitates an extensive and separate study. As such, these aspects were not addressed in this work.

Results and discussion

Criteria-based assessment of the current state of the healthcare system

The criteria-based assessment of the current state of the healthcare system in the constituent entities of the Russian Federation is primarily driven by the imperative to fulfill one of the national development goals of the Russian Federation for 2030, as the preservation of the population, its health and well-being (Presidential order... 2020). Additionally, it aligns with the targets (system goals and target indicators) set by the National Projects "Health" and "Demography."

A significant portion of efforts to modernize the healthcare system in Russia and its regions is dedicated to addressing demographic challenges and mitigating mortality rates. The level of development of regional healthcare systems plays a pivotal role in influencing mortality rates. Mortality, in turn, serves as an indicator of the health of regional and municipal healthcare systems.

Despite the pressing issue of mortality in the Russian Federation, the depth and severity of this problem vary across regions, driven by a range of influencing factors. The demographic landscape of the country is highly diverse, influenced by factors like overall socio-economic development, specific economic sectors (especially healthcare), quality of life, infrastructure, and the state of the living environment.

Mortality itself serves as a key metric for assessing the healthcare system's development in a region. Analyzing the quantitative and qualitative impact of various factors on overall mortality rates and mortality rates by disease categories not only reveals causal relationships but also provides a foundation for practical recommendations aimed at improving mortality rates in Russia and its regions, as well as enhancing primary healthcare.

The significance of the mortality problem, its varied manifestations across regions and municipalities, served as the primary criterion for assessing the development of territorial healthcare systems. This criterion guides the selection of factors that influence trends and the current state of mortality in the constituent entities of the Russian Federation, with a focus on detailed spatial analysis at the municipal level and individual settlements in pilot regions.

The selection of methodological tools for conducting a comprehensive analysis of the factors influencing the spatial organization of the healthcare system and mortality rates at both the municipal and constituent entity levels within the Russian Federation is driven by the necessity to acquire reliable data for formulating and evaluating the study's working hypotheses.

As a result, the factors have been categorized into two distinct groups:

- factors that determine mortality rates at the level of constituent entities and municipalities serving as an indicator of the healthcare system's spatial structure;
- factors that determine the spatial organization and structure of the health care system at the level of constituent entities and municipalities.

Developing a geodatabase structure

To structure a geodatabase for analysis at the level of constituent entities and municipalities, we utilized Rosstat data from 2019, encompassing:

1. Data related to the number of deaths, classified based on the following parameters:
- clinical and pathoanatomical diagnoses (according to the International Classification of Diseases, 10th revision (ICD-10) – regional and municipal cross-section (five pilot subjects);
- level of education;
- circumstances of death (at home/in an ambulance/in a hospital) – regional and municipal cross-section (for five pilot subjects);
- gender and age;
- death from acute conditions.
2. Factors affecting mortality rates, such as:
- alcohol and tobacco consumption;
- degree of involvement in sports and physical activity;
- ecological indicators;
- presence/absence of state and municipal healthcare organizations;
- availability of medical personnel, and medical examination coverage;
- transport accessibility of state healthcare system medical facilities;
- gender and age distribution of the population.
3. Data on the number of cases in the following sections:
- clinical diagnoses based on disease type – regional section;
- gender and age distribution of patients.

We also integrated data from various sources, including:

- Volume of food, alcohol and tobacco consumption (data from the Federal Tax Service of the Russian Federation and Rosstat);
- Citizens' involvement in physical activity (data from the Ministry of Sports of Russia);
- Quantitative and qualitative metrics of healthcare facilities in the state healthcare system and the municipal system, as well as quantitative measures of medical staff availability and medical examination coverage (sourced from the Ministry of Health of Russia);
- Natural (ecological) indicators (data from Rospotrebnadzor);

- Citizen appeals to authorities (data from social media and open sources of information);
- Rosstat population data, utilized as a fundamental parameter for computing various indicators (including the urbanization coefficient, the proportion of urban and rural population, etc.).

Geospatial data from Rossreestr (public cadastral map) were used for geodatabase purposes.

The provided data is categorized into two thematic blocks, aligned with the study's objectives and rationale:

1. Mortality-related values;
2. Factor-related values.

Within each block, we organized statistical indicators (territorial coverage) into three hierarchical levels

- Russian Federation: to identify and analyze overarching trends in the study parameters;
- subjects of the Russian Federation (including 5 pilot subjects): to identify macro-regional characteristics, trends, and disparities in the development of the phenomena under investigation;
- municipalities within the pilot subjects of the Russian Federation – for the purpose of recognizing intraregional characteristics, trends, and disparities in the development of the phenomena under investigation, as well as conducting statistical tests on hypotheses and assumptions.

Mortality rates are calculated based on final clinical and pathological diagnoses derived from the International Statistical Classification of Diseases and Related Health Problems ICD-10. (the territorial coverage given above).

Mortality rates serve as the primary indicator of the regional healthcare system's condition. Among the most critical are the statistical indicators and data that describe medical factors affecting mortality, both in terms of major categories and specific causes of death. The provision of medical personnel and the state of the material and technical infrastructure, including medical facilities, are of paramount significance.

Quantitative aspects related to the provision of medical facilities include:

- Bed availability, per 10 thousand people.
- The count of emergency medical care stations (departments), per 10 thousand people.
- Ambulance services, per 10 thousand people.

Statistical indicators concerning the "Provision of Medical Personnel" encompass:

- Availability of doctors, per 10 thousand people.
- Staffing levels for medical positions in outpatient care units, as a percentage.
- Ambulance Paramedic Unit (APU) capacity, measured in visits per shift.

The second set of factors focuses on the state of the environment and the population's quality of life. This category comprises a total of 13 statistical indicators:

Economic and Lifestyle Factors:

- Consumer basket (RUB per person).
- Sugar consumption (kg per 1000 people).
- Tobacco consumption (pcs per 1000 people).
- Alcohol consumption (liters per 1000 people).
- Volume of housing construction (m2 per person).
- Gross Regional Product (GRP) at basic prices (thousand rubles per person).

- Unemployment rate (ILO, %).
- Average urban environmental quality index (score).
- Number of equipped public spaces (units).

Ecological Indicators:

- Air pollution from motor vehicles (thousand tons).
- Air pollution from railway transport (thousand tons).
- Number of unauthorized landfills (units).

The third category encompasses indicators related to infrastructure factors, specifically the transport accessibility of medical facilities and healthcare services for residents in various localities.

Statistical indicators within the "Transport Accessibility of Medical Organizations" factor include:

- The percentage of the population residing outside the reach of medical institutions.
- The percentage of the population residing within the areas with access to medical institutions.
- The percentage of settlements located beyond the zones with transport accessibility.
- The percentage of settlements situated within the zones with transport accessibility.

The fourth category encompasses demographic factors that are, in one way or another, related to the age distribution of the population and the demographic characteristics of the region:

- Coverage of citizens older than working age with preventive examinations, including medical check-ups (RS) (%).
- Proportion of the population over working age (%).
- Total fertility rate.
- Incidence rate of the population (number of diseases initially registered among the population per 1,000 people).
- Life expectancy (years).

These indicator factors have been selected and generalized at the initial phase of the study. A total of 28 statistical indicators were selected to represent the most influential factors for further analysis, based on their significant impact on mortality rates in the Russian Federation and pilot regions.

The source of information regarding the causes of death is derived from the records found in medical death certificates, which are typically compiled by a physician (Number of deaths... 2019).

To delve into regional disparities, we conducted an analysis of overall mortality and mortality rates categorized by the causes of death in urban and rural settings. This approach was chosen because the correlation between specific categories of death (causes) and corresponding indicators can vary significantly depending on the geographical context, whether urban or rural. Discrepancies in mortality rates within urban and rural areas, including the designated pilot regions, formed the foundation for developing hypotheses for our research.

To illustrate, the availability of ambulance services in a particular region plays a crucial role in preventing deaths from external causes in rural areas.

The primary analytical techniques employed in this study were correlation-regression analysis and the integral scoring method.

In the initial phase of identifying indicators for each group, we first compile a list of relevant indicators. Subsequently, we calculate the Pearson linear correlation coefficient for each indicator within a given factor, and this coefficient is assessed in relation to the mortality rates of the population across major categories and specific causes of death. In this context, the values of the factor blocks' indicators serve as characteristic features of the factors themselves, while the mortality indicators function as outcomes. It's important to note that the pair linear correlation coefficient's value ranges from -1 to +1.

The assessment of the coefficient value was carried out based on two key aspects:

- The sign of the correlation coefficient (+/-) indicates the direction of the relationship – a positive coefficient signifies a direct connection, while a negative coefficient suggests an inverse connection.
- The strength, or the degree of tightness, of the connection was determined using the Chaddock scale.

In addition to these assessments, to gauge the level of certainty in the linear relationship between variables, we calculated the coefficient of determination. This coefficient reveals the proportion of variation in mortality values that can be attributed to changes in factor values. It not only helps in identifying and establishing the significance of individual indicators (factors) in influencing mortality rates but also serves as a criterion for selecting the most influential factor characteristics.

In order to ensure comparability and compute a comprehensive assessment of regional mortality, all gathered indicators are first standardized and transformed into a uniform scale. Subsequently, the principal component method is applied to condense the number of variables to the most significant ones. The selection of this method for information aggregation (comprehensive assessment) is based on its capacity to identify the maximum dispersion within the correlation matrix, allowing for a reduction in the number of indicators without sacrificing valuable information pertaining to the characteristics of territorial units' variability.

The subsequent step involved computing the values of the identified mortality-influencing factors for each subject. The subsequent logical reasoning and calculation algorithm are elaborated upon in a series of sequential steps, with a focus on the overall process rather than delving into the mathematical intricacies of the calculations.

In the initial phase, a multidimensional typology algorithm was employed, encompassing the normalization of the initial indicators by considering their variances.

Each of the 85 operational territorial units (OTUs) in Russia is associated with a consistent set of initial indicators. The normalized indicators are structured as a matrix to facilitate the calculation of Euclidean distances, determined through the application of the Pythagorean theorem, which measures the dissimilarity between every pair of territories considered in the analysis.

This approach effectively captures distinctions between territorial units concerning statistically independent indicators. However, when dependent indicator features are utilized in the calculation, Euclidean distances may be distorted. To mitigate this effect, the original normalized indicators were pre-adjusted, for example, by assigning "weights" based on the component loads identified through the principal components method.

This process allowed for the reduction of the original normalized indicators into independent values. After eliminating components responsible for a small percentage of the variance, data simplification was conducted, effectively removing minor or random variations within the initial indicator system.

In several instances, an objective numerical method was applied to standardize and normalize nonlinear pairwise monotonic correlations. This procedure helps bring the initial normalized indicators closer to a normal distribution and enhances the reliability of the calculations.

The division of the general population into homogeneous groups or types was performed based on the selection of a similarity measure for territorial units. These groups were established with the aim of minimizing intragroup differences, as indicated by the sum of Euclidean distances (connections) between all pairs of units incorporated into each group.

In the second stage (when forming three groups), a similar algorithm is employed to distribute the remaining territorial units among the three core groups, akin to the previous stage. For each potential grouping option, the total intragroup differences are computed, and the option yielding the smallest sum is selected as the final choice. The territorial unit that served as the core is then established as the ultimate third core.

This procedure continues in a similar fashion to create four, five, six, and so forth, homogeneous groups. At each step, a new core is identified, and a new group is established.

It is practical to analyze the results by utilizing the arithmetic average values of each indicator concerning all territorial units included in one type or another. In some cases, it may also be valuable to identify extreme values for all initial indicators within each group. These characteristics can be employed to semantically describe the types. This typology algorithm, as described, categorizes territorial units into groups as long as they meet the criteria for homogeneity.

The weight of each factor was determined subsequent to the calculation of the integral assessment for each group of factors, which was derived from the final score known as the "Integral Assessment of Mortality Factors at the Regional Level" (IS), as detailed in Appendix 1. This factor weight is expressed as a percentage and signifies the extent of influence or participation of the factor in the region's mortality rate.

To calculate indicators within the infrastructure block, particularly related to transport accessibility, the methodology employed involved the use of a transport accessibility calculation method. The task of computing transport accessibility was addressed through the utilization of the GIS (QGIS) module "v.isochrones" (GIS-Lab 2022). This method involved the creation of isochrones, which are lines representing equal time intervals (e.g., 20 minutes) required to reach specific locations (e.g., medical institutions) from designated points.

The time interval for medical institution accessibility aligns with the requirements established by the Order of the Ministry of Health of Russia dated February 27, 2016, as stipulated for the treatment of acute diseases necessitating the arrival of an ambulance within 20 minutes (Order of the Ministry of Health of Russia... 2013 and Order of the Ministry of Health of Russia.. 2016).

Isochrones were created, considering specific parameters such as the average travel speed on individual roads. This average speed was determined by taking into account the road network's characteristics, including the type of road surface (asphalt, dirt, or earthen) and the number of traffic lanes. To carry out this task, OpenStreetMap vector data was utilized.

Table 2 presents the road categories and the associated accepted average speeds for these categories.

Subsequently, road congestion leading to populated destination points was assessed in accordance with GOST (State Standard) guidelines. The analysis involved calculating the surplus of vehicles on specific road sections during peak hours, which typically span from 07:00 to 10:00 and from 17:00 to 20:00. This calculation considered the road sections' capacity, aligning with GOST P 52398-2005 (2005). The findings from this analysis were factored into the calculation of average vehicle speeds on particular roads, thereby enabling the adjustment of ambulance travel times along the entire road network.

Table 2. Characteristics of Highways in OpenStreetMap Used for Transport Accessibility Calculation

Road designation in OpenStreetMap	Road category	Accepted average speed, km/h
trunk	the most important and largest roads	90
primary	major highways	90
secondary	relatively large roads	60
tertiary	ordinary roads between small settlements	60
living_street	residential areas favoring pedestrians	15
residential	roads in residential areas	40
service	service entrances, access points, etc.	30
road	road of unknown type	60
track	dirt roads, typically for agricultural machinery	30
raceway	roads for motor sports	90
tertiary_link	sections connecting a tertiary with other tertiaries or other types of roads	40
secondary_link	sections connecting secondary with other secondary or roads of other types	40
primary_link	sections connecting primary with other primary or other types of roads	40
trunk_link	sections connecting the trunk with other trunks or roads of different road types	40
unclassified	roads without a specific tag	40

Source: (Baseline assessment (Bazovaya otsenka)… 2023)

Algorithm cartographic indicators system development

The application of the selected methodology yielded several outcomes, including the “Weight of Factors Influencing Population Mortality in the Russian Federation, 2019” calculation table, a series of maps depicting territorial mortality characteristics, and a comprehensive integrated assessment of the healthcare system development across the constituent entities of the Russian Federation.

This approach allowed for the categorization of the Russian Federation’s constituent entities into typological groups based on the nature and characteristics of their healthcare system’s spatial organization.

The factors shaping the spatial organization and structure of the healthcare system at both the regional and municipal levels are expressed through a set of quantitative indicators that capture the fundamental attributes of territorial organization.

Among these factors, several key elements define the sustainability of established settlement systems:

1. Urbanization level – the proportion of the urban population within the total population.
2. Urban population distribution – the distribution of the urban population across cities of varying population sizes, such as small (up to 50 thousand people), medium (50-100 thousand), large (100-250 thousand), very large (250-500 thousand), and the largest cities (500-1000 thousand), as well as “millionaire” cities with over 1 million inhabitants.

3. Urbanization coefficient of the Territory – the percentage of the population residing in the city serving as the administrative center of the constituent entity, relative to the total population.
4. Rural settlement characteristics – the distribution of the population among rural settlements of different population sizes (super-small, small, medium, large), alongside the ratio between the number of such settlements and the proportion of the population residing in them within the total rural population. This information aids in determining the type of rural settlement (large, medium, small) and the nature of rural settlement in the region, such as large-settled, medium-settled, small-settled, continuous, dispersed, focal, etc.
5. Settlement density – the number of settlements per 1000 square kilometers of territory, computed separately for urban and rural areas.
6. Average and maximum distance between settlements – the average distance between settlements and the maximum distance from the administrative center of the constituent entity to the most remote settlement within the regional settlement system. These values provide insights into the geographical organization of the region's settlement network.

These factors enable us to consider the unique characteristics of the territorial spatial organization, which inevitably have a profound impact on the spatial arrangement of the healthcare system within each constituent entity.

Classification of regions and municipalities based on mortality rates, spatial organization, and Healthcare system structure

To evaluate the impact of the spatial organization and structure of the healthcare system (medical factors) on mortality trends across the regions of Russia, statistical indicators were carefully chosen and organized into two key categories: "Availability of Medical Organizations" and "Provision of Medical Personnel."

Within the "Availability of Medical Organizations" category, three vital indicators were utilized for analysis:

- Bed Availability in Hospital Facilities (per 10 thousand permanent population of the region)
- Number of Emergency Medical Care Stations (Departments) (units)
- Quantity of Ambulances (units per 1000 population)

In the "Provision of Medical Personnel" category, three essential indicators were considered:

- Doctor Availability (per 10 thousand population)
- Staffing Levels of Medical Positions in Outpatient Care Units
- Outpatient Clinic Capacity (outpatient clinic visits per shift per 10 thousand population)

These statistical indicators serve as the factor characteristics for correlation and regression analysis, allowing us to assess their statistical significance in influencing mortality rates.

Mortality rates, measured as the overall mortality rate (per 1000 population) and mortality rates for specific causes (per 100,000 population), as determined by the final clinical and pathological diagnoses aligned with the International Classification of Diseases, 10th revision (ICD-10), serve as key indicators of significance.

These mortality rates, encompassing both the total mortality and rates for individual categories of causes of death, are further categorized by urban and rural areas, including for each of the designated pilot regions. For the primary categories of causes of death, as per the ICD-10, the following mortality rates for the year 2019 were employed:

- Respiratory diseases
- Diseases of the digestive system

- Diseases of the circulatory system
- External causes
- All types of transport accidents
- Neoplasms
- Malignant neoplasms
- Infectious and parasitic diseases
- Coronary heart disease
- Suicides
- Homicides
- Cases of alcohol poisoning
- Cerebrovascular diseases

The assessment of the influence of factor characteristics within the "Availability of Medical Organizations" and "Provision of Medical Personnel" blocks was conducted through the utilization of correlation and regression analysis techniques.

To unveil characteristic features and identify the causal relationships between these phenomena, the following preliminary working hypotheses were formulated at the initial stage of the analysis:

- medical factors, in general, exert a substantial impact on mortality rates across all regions of the Russian Federation, including the pilot regions.
- the degree of influence for each of the medical factor categories, "Availability of Medical Organizations" and "Provision of Medical Personnel," is roughly equal and significant.
- there exists an inverse correlation between medical factors and mortality rates, meaning that higher values of "Availability of Medical Organizations" indicators and "Provision of Medical Personnel" indicators in the pilot regions are associated with lower mortality rates.
- the "Availability of Medical Organizations" and the provision of medical personnel in the pilot regions tend to be higher in areas with a higher overall level of socio-economic development.
- the most pronounced differentiation in the significance of the influence of medical factors is observed in the "urban-rural" context, with medical factors having a more significant impact in rural areas, particularly in the pilot regions.
- geographically, there is a discernible increase in the influence of medical factors on overall mortality rates from the central regions toward the periphery in the pilot regions.
- the impact of medical factors on mortality for specific disease categories in pilot regions may not exhibit a significantly pronounced statistical nature and may only become evident at the level of general values.
- variations in the statistical impact of medical factors on mortality rates among pilot regions are primarily attributed to the varying levels of overall socio-economic development within each territory.

Visualization and Analysis of the Results

The results obtained from the correlation and regression analysis were organized according to the working hypotheses. Detailed results of the final calculations for the pilot constituent entities of the Russian Federation can be found in Appendix 2.

In the pilot regions of the Russian Federation, an inverse relationship was observed between the factor and resultant characteristics in the Belgorod region (r = -0.61), the Kaluga region (r = -0.35), and the Chelyabinsk region (r = -0.18).

Conversely, in the Murmansk region (r = 0.10) and the Sakhalin region (r = 0.01), a direct correlation was noted between mortality rates and indicators from the "Availability of Medical Organizations" block. The quantitative value of the correlation coefficient is significant only for the regions of the Central Federal District, specifically Kaluga and Belgorod.

This unequal distribution of correlations is likely attributable not only to the quantitative parameters within the "Availability of Medical Organizations" block but also to the effectiveness of these institutions in the respective regions.

It is important to highlight that the indicators within the "Availability of Medical Organizations" block have a positive impact on reducing mortality in pilot regions characterized by higher levels of socio-economic development, situated in the primary zone of settlement and economic function concentration. Conversely, peripheral pilot regions exhibit an opposite trend.

Furthermore, the Sakhalin and Murmansk regions exhibit distinctive spatial characteristics in their territory organization, settlement systems, and, consequently, healthcare systems. These distinctive features have influenced the coefficient values in the following ways:

1. Geographic location: both regions are situated within the Far North or regions with equivalent characteristics.
2. Settlement structure: the settlement systems in these regions are characterized by a focal nature, with small-settled forms predominating.
3. Urban population share: special natural and climatic conditions have led to a notably high proportion of the population residing in urban areas.
4. Concentration in administrative centers: a substantial portion of the population in these regions is concentrated in the administrative center of each subject, accounting for 40.5% in the Murmansk region and 40.4% in the Sakhalin region.
5. Geographic layout: these regions encompass extensive areas with asymmetrical positions of the administrative centers, resulting in significant distances between the center and peripheral territories.

Out of the total statistical indicators within the structure of medical factors, one indicator has displayed a significant influence on overall mortality rates (CMR). Specifically, the staffing of medical positions in units providing medical care in outpatient settings (an indicator of staffing shortages in medical personnel) has the most substantial impact on overall mortality rates compared to other medical factor indicators, with a correlation coefficient of r = -0.63.

In the pilot regions, the most significant positive impact of the staffing of medical positions in units providing medical care in outpatient settings on reducing mortality rates was also observed in the Belgorod, Kaluga, and Chelyabinsk regions.

To establish standard values for the medical factors "Provision of medical personnel" and "Availability of medical organizations," the values of the corresponding correlation coefficients obtained at the national level were adopted for comparison.

Consequently, the calculation of the correlation coefficient between the integral values of medical factor indicators and the overall mortality rate (r = -0.27) suggests a connection between these phenomena. However, the statistical significance of this connection is relatively weak, approaching a moderate level. Nonetheless, only two pilot regions consistently exhibited coefficients exceeding the national level, along with a relatively strong influence of medical factors on mortality rates – the Belgorod and Kaluga regions.

The sign of the coefficient for these regions indicates an inverse relationship, meaning that the more a region is equipped with medical organizations and the lower the rate of staffing shortages of medical personnel, the lower the overall mortality rate (ACS). This confirms the hypothesis of an inversely proportional relationship between these phenomena.

When comparing the national indicator of the relationship between the level of socio-economic development and the factors "Availability of medical organizations" and "Provision of medical personnel" with the corresponding coefficients in the pilot regions, it is evident that all pilot regions align with the national trends.

Additionally, it has been determined that this phenomenon exhibits a distinct spatial correlation on a national scale. It reaffirms a high degree of correlation, whereby a subject's elevated level of socio-economic development typically corresponds to a lower rate of medical personnel shortage and a higher level of medical position staffing.

An examination of the impact of the indicators "Availability of medical organizations" and "Provision of medical personnel" in the pilot regions of the Russian Federation leads to the following conclusions:

- The relatively modest influence of medical factors can be attributed not so much to the low value of the factor itself but to the more substantial influence of other non-medical factors. This is corroborated by the coefficient of determination, which indicates that only 7.3% of the variance in overall mortality rates in the pilot regions of the Russian Federation is attributable to medical factors.
- The results of statistical analysis reveal that mortality rates are impacted not only by the "Availability of medical organizations" indicator but also by the effectiveness of these organizations. This explains the consistent feedback loop observed in relatively more developed pilot regions within the primary settlement zones compared to peripheral pilot regions.
- Achieving complete staffing of medical organizations in the pilot regions is expected to result in a noticeable reduction in overall mortality. This factor is responsible for a potential 39.7% reduction in mortality rates.
- The degree of influence of medical factors exhibits polarization in the "center-periphery" direction, both on a national scale and at the level of individual regions, including pilot regions, as evident from the maps (Fig. 1-3).
- This characteristic highlights the imperative need to enhance and support the material and technical resources of medical organizations and medical staffing for the population in peripheral areas of the country and regions.
- In terms of specific mortality categories, a discernible pattern of medical factor influence emerges. Notably, in the pilot regions, the staffing of medical positions in units providing outpatient care has the greatest impact on mortality rates from circulatory system diseases and neoplasms, which are the two leading causes of mortality. Consequently, prioritizing full staffing of medical organizations is crucial for the development of regional healthcare systems, particularly in rural areas.
- When assessing the block of medical factors, it becomes evident that the structure of their influence is heterogeneous and varies among different regions. The study also highlights that the reliability of the influence of statistical indicators of medical factors is more pronounced when working with relative mortality rates, both overall and for specific disease categories.
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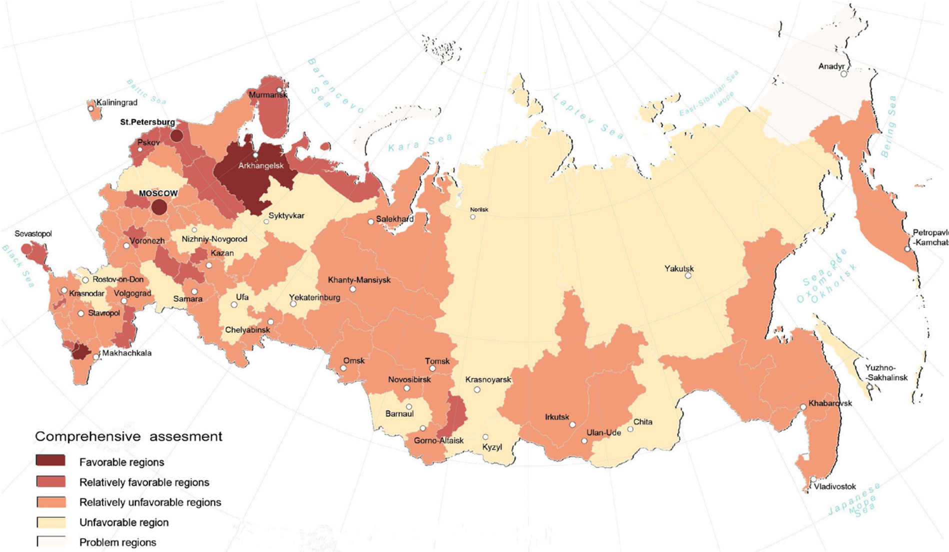

Figure 1. Integral assessment of security (shortage) of medical organizations in 2019. *Source*: compiled by the authors. *Note*: administrative division, the state borders of the Russian Federation are depicted as of Desember 2020

Figure 2. Integral assessment of security medical personnel in 2019. *Source*: compiled by the authors. *Note*: administrative division, the state borders of the Russian Federation are depicted as of Desember 2020

Figure 3. Integrated assessment of transport availability of medical facilities in 2019. *Source*: compiled by the authors. *Note*: administrative division, the state borders of the Russian Federation are depicted as of Desember 2020

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To evaluate the influence of transport accessibility of medical care on mortality rates in the constituent entities of the Russian Federation, the following statistical indicators were employed:

- percentage of the population residing outside the transport accessibility zones of medical institutions.
- percentage of the population residing within the transport accessibility zones of medical institutions.
- percentage of settlements situated outside transport accessibility zones.
- percentage of settlements situated within the transport accessibility zones of medical institutions.

In order to identify the distinctive characteristics and mechanisms of the "Transport Accessibility" indicator on ACS and mortality by specific cause of death classes (ICD-10), the following preliminary working hypotheses were formulated:

- a higher indicator of transport accessibility of medical organizations leads to lower mortality rates in the pilot regions.
- transport accessibility of medical organizations uniformly influences mortality rates for the primary classes of causes of death within the general mortality trend in the region (building upon the first hypothesis).
- the transport accessibility indicator has the most significant impact on mortality rates in regions characterized by extensive territory and a sparse settlement network.

Correlation analysis of the transport accessibility factor with overall population mortality unveiled a weak direct relationship, with a correlation coefficient of r = 0.14. Nevertheless, this factor exerts a noteworthy impact on mortality within specific cause of death categories.

The analysis of the influence of medical institution accessibility on mortality rates in the regions of the Russian Federation indicated that accessibility is a more pressing concern in regions characterized by extensive territories, low settlement density, and limited overall development. This pattern is distinctly illustrated on the map (Fig. 4).

The Murmansk region exhibits the highest correlation coefficient between the factor characteristic and ACS within this group, with a value of r = 0.69. This coefficient indicates a pronounced connection between the proportion of the population residing outside the

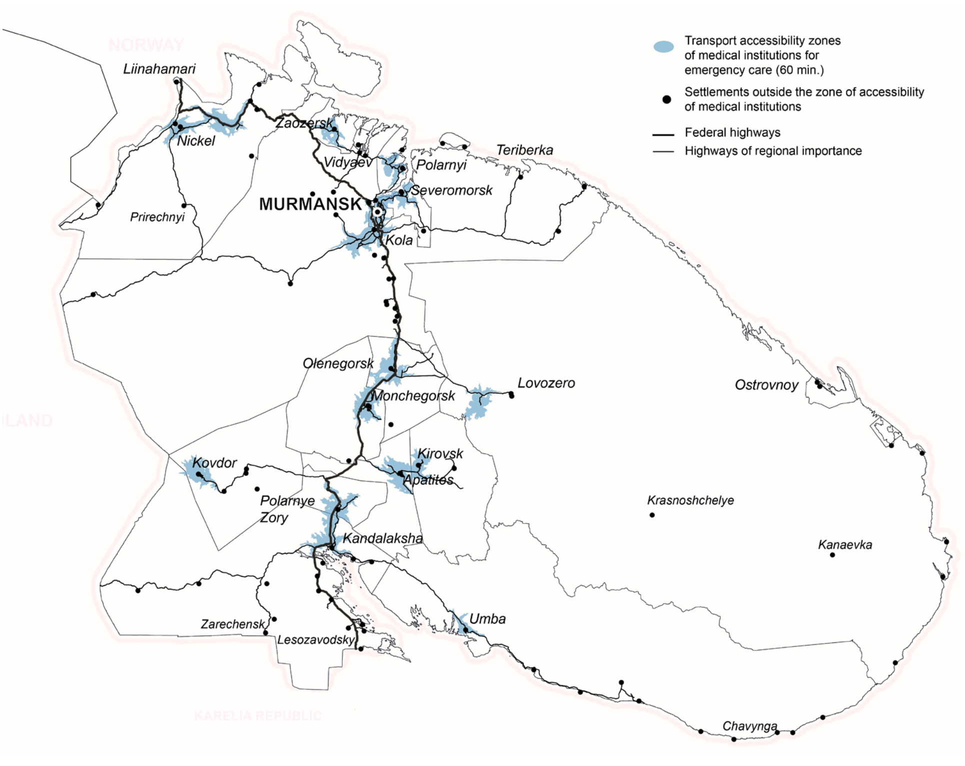

Figure 4. Transport Accessibility of Medical Institutions for Settlements in the Murmansk Region. *Source*: compiled by the authors

20-minute transport accessibility zones and ACS. Furthermore, the quantitative value of the coefficient approaches a strong level of connection (0.7 or more).

In the pilot regions, a moderate relationship in the correlation coefficients between factor and resultant characteristics is observed, with Sakhalin, Kaluga, and Chelyabinsk regions displaying coefficients in the range of 0.30-0.31. A weak connection is noted in the Belgorod region (r = 0.27).

Comparison of these coefficients with similar indicators for Russia as a whole, derived from a comprehensive assessment, yields the following values: r = 0.07 for the overall mortality rate (indicating a negligible connection) and r = 0.18 for mortality from circulatory system diseases.

Significant correlation indicators are observed in three categories:

- r = 0.58 for mortality from external causes.
- r = 0.62 for suicide mortality.
- r = 0.69 for mortality from homicides.

Similar correlation coefficient values were obtained based on the comprehensive assessment for the pilot regions and the corresponding mortality rates for the primary classes of causes of death.

Consequently, the factor of transport accessibility significantly influences mortality from external causes (r = 0.62), homicides (r = 0.54), suicides (r = 0.44), transport accidents, accidental poisonings, and more (r = 0.43) across all pilot regions.

The pilot regions facing the most significant challenges in terms of transport accessibility of medical organizations are characterized by challenging natural and climatic conditions and/or expansive territories, which, to some extent, accounts for the underdeveloped state of the transport infrastructure.

Furthermore, the specific regional administrative subordination of medical institutions can exacerbate the issue of their actual transport accessibility.

To assess the efficiency of the regional healthcare systems, an analysis of the plans for the expansion of the medical organization network in the pilot regions of the Russian Federation was conducted.

The primary documents utilized for this analysis included strategies for the socio-economic development of pilot regions, territorial planning schemes, master plans for settlements and urban districts, programs for the socio-economic development of constituent entities of the Russian Federation, as well as plans and programs for the comprehensive socio-economic development of municipalities.

During this analysis, various aspects of the contemporary overall and spatial organization of the regional healthcare system, as well as the intended locations for medical facilities, were taken into consideration.

In all the pilot regions, several common challenges related to healthcare institution network development planning were identified in strategic and territorial planning documents:

1. Inconsistencies exist among various documents, including territorial planning schemes of constituent entities of the Russian Federation, socio-economic development strategies, and state healthcare development programs, in terms of content, validity periods, and the list and characteristics of regional importance objects planned for healthcare facilities.
2. Demographic forecasts are not adequately considered in the planning of healthcare institutions, and regional territorial planning schemes often suffer from low-quality demographic forecasting.

3. The need for essential healthcare facilities is not adequately calculated in the justifications provided in territorial planning schemes for constituent entities. These schemes require updated information regarding existing and planned healthcare facilities. The strategic documents lack a detailed project roadmap, development directions, and target indicators that are not tied to calculations.
4. Healthcare institutions are frequently planned to be located in municipalities with relatively favorable mortality rates (see Figure 5).

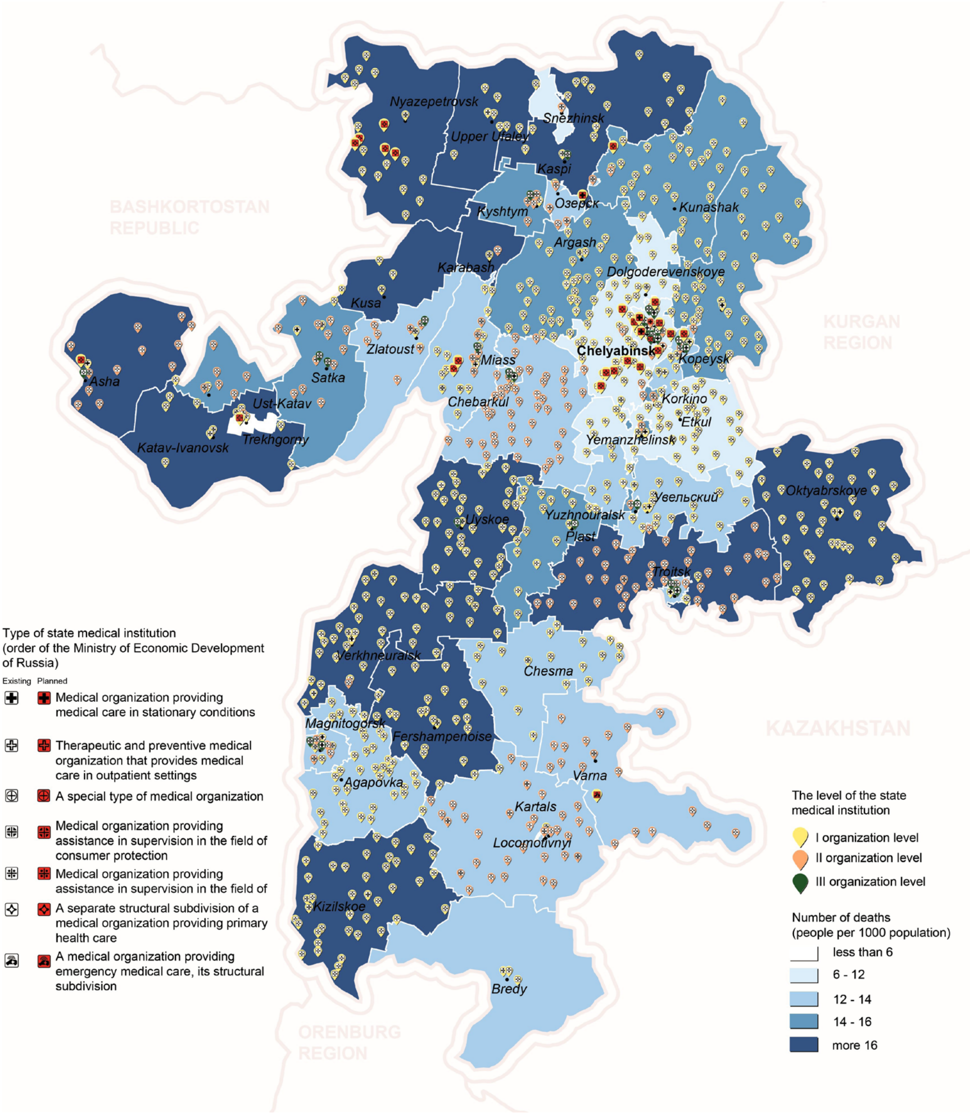

Figure 5. Existing and Planned Medical Institution Network in Municipalities of the Chelyabinsk Region. *Source*: compiled by the authors

Conclusion

For a more in-depth exploration of the aforementioned issues and the formulation of specific regional solutions, it is essential to conduct thorough research and analysis at the municipality and individual settlement levels. This research should aim to identify specific problem areas, regions, and zones. Such studies can be integrated into the development of territorial planning documents for municipalities and settlements.

During the correlation and regression analysis, the working hypotheses formulated during the preliminary stage of the study exhibited varying degrees of confirmation. For instance, it's important to note that as the proportion of the population living outside the 20-minute transport accessibility zone of medical organizations increases, mortality rates also tend to be higher.

However, the hypothesis suggesting that transport accessibility of medical organizations in pilot regions uniformly influences mortality rates for the main classes of causes of death within the overall mortality trend was not confirmed.

The transport accessibility indicator does indeed have the most significant impact on mortality rates in regions characterized by large areas and a sparse network of settlements.

The comprehensive calculation matrix resulting from the in-depth analysis of mortality factors and the spatial organization of the healthcare system in pilot regions enabled the application of an integrated indicator and facilitated the creation of a typology of constituent entities of the Russian Federation based on a comprehensive integrated assessment of healthcare system spatial organization and mortality rates (see Figure 6).

This typology is established through multifactor analysis, enabling the simultaneous consideration of the combined impact of a complex set of medical and non-medical factors on the spatial organization of healthcare and mortality systems. All constituent entities are categorized into 5 typological groups, and details about each group are provided in Table 3.

Figure 6. General integral assessment of the spatial organization of the health system and mortality rates. *Source*: Compiled by the Authors. *Note*: administrative division, the state borders of the Russian Federation are depicted as of Desember 2020

Table 3. Typology of Russian Federation Constituent Entities Based on the Overall Integrated Assessment of Healthcare System Spatial Organization and Mortality Rates

Group number	Type name	List of subjects of the Russian Federation
I	Prosperous regions	Moscow, Kabardino-Balkarian Republic, Kursk region, Republic of Dagestan, Republic of North Ossetia-Alania, St. Petersburg, **Belgorod region**, Bryansk region, Sevastopol, Kaliningrad region, Karachay-Cherkess Republic, Lipetsk region, Moscow region, Oryol region, Republic of Adygea, Republic of Ingushetia, Chechen Republic, Chuvash Republic – Chuvashia
II	Relatively prosperous regions	Voronezh region, Kirov region, Penza region, Republic of Bashkortostan, Republic of Crimea, Rostov region, **Sakhalin region**, Stavropol region, Tula region, **Chelyabinsk region**, Vladimir region, Ivanovo region, Krasnodar region, Nizhny Novgorod region, Republic of Mari El, Republic of Mordovia, Ryazan region, Samara region, Smolensk region, Tambov region, Udmurt Republic, Yaroslavl region
III	Relatively disadvantaged regions	Amur region, Irkutsk region, **Murmansk region**, Novgorod region, Omsk region, Primorsky Territory, Altai Republic, Kalmykia Republic, Komi Republic, Tyva Republic, Tomsk region, Tyumen region, Chukotka Autonomous District, Yamalo-Nenets Autonomous District, Altai Territory, Astrakhan region, Volgograd region, **Kaluga region**, Kamchatka region, Kemerovo region – Kuzbass, Kostroma region, Krasnoyarsk region, Magadan region, Novosibirsk region, Orenburg region, Perm region, Republic of Tatarstan, Saratov region, Sverdlovsk region, Tver region, Ulyanovsk region, Khabarovsk region, Khanty-Mansi Autonomous Okrug
IV	Disadvantaged regions	Vologda region, Jewish Autonomous region, Kurgan region, Leningrad region, Republic of Buryatia, Republic of Karelia, Republic of Sakha (Yakutia), Republic of Khakassia
V	Problem regions	Arkhangelsk region, Transbaikal region, Nenets Autonomous Okrug, Pskov region

Source: compiled by the authors

Prosperous and relatively prosperous regions exhibit high levels of spatial organization in their healthcare systems and relatively low mortality rates. These regions are situated within the main settlement zone of the European part of the country, characterized by a small and compact territory. On the other hand, the problematic area encompasses the republics of the Siberian and Far Eastern federal districts and the economically challenged territories of the European part.

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Appendix 1. Calculation table of the integral assessment of mortality factors for the constituent entities of the Russian Federation*

Region	BLOCKS OF FACTORS			TOTAL SCORE BY BLOCKS	INTEGRAL ASSESSMENT OF MORTALITY FACTORS AT THE REGIONAL LEVEL					
	I. Medical factors	II. Non-medical factors	III. Transport accessibility		I. Integral assessment of personnel and material and technical base	I.1 Integral assessment of medical workers	I.2 Integral assessment of material and technical base	I.3 Integral assessment of transport accessibility	II.1 Integral assessment of environmental pollution	II.2 Integral assessment of quality of life
Altai region	0,5	0,5	0,4	**0,6**	0,5	0,36	0,57	0,4	0,3	0,4
Amur region	0,4	0,6	0,6	**0,5**	0,4	0,47	0,41	0,6	0,2	0,4
Arhangelsk region	0,3	0,6	0,6	**0,3**	0,3	0,41	0,2	0,6	0,2	0,4
Astrakhan region	0,4	0,6	0,3	**0,6**	0,4	0,51	0,26	0,3	0,2	0,4
Belgorod region**	**0,4**	**0,7**	**0,2**	**0,9**	**0,4**	**0,36**	**0,39**	**0,2**	**0,1**	**0,5**
Bryansk region	0,4	0,7	0,2	**0,9**	0,4	0,32	0,42	0,2	0,1	0,4
Vladimir region	0,3	0,6	0,2	**0,8**	0,3	0,26	0,35	0,2	0,1	0,4
Volgograd region	0,4	0,6	0,4	**0,6**	0,4	0,38	0,44	0,4	0,2	0,4
Vologda Region	0,3	0,7	0,5	**0,4**	0,3	0,32	0,3	0,5	0,0	0,4
Voronezh region	0,4	0,6	0,3	**0,7**	0,4	0,38	0,36	0,3	0,2	0,5
Moscow	0,3	0,7	0,0	**1,0**	0,3	0,56	0,04	0,0	0,3	0,7
Saint Petersburg	0,5	0,7	0,0	**1,2**	0,5	0,63	0,45	0,0	0,1	0,5
Sevastopol	0,2	0,7	0,0	**0,9**	0,2	0,27	0,13	0,0	0,0	0,4
Jewish Autonomous Region	0,3	0,6	0,5	**0,4**	0,3	0,16	0,41	0,5	0,2	0,4
Transbaikal region	0,5	0,6	0,8	**0,3**	0,5	0,34	0,56	0,8	0,1	0,4
Ivanovo region	0,3	0,7	0,2	**0,8**	0,3	0,33	0,31	0,2	0,0	0,4
Irkutsk region	0,4	0,6	0,5	**0,5**	0,4	0,37	0,44	0,5	0,1	0,4
Kabardino-Balkarian Republic	0,4	0,7	0,1	**1,0**	0,4	0,39	0,32	0,1	0,0	0,5
Kaliningrad region	0,3	0,7	0,1	**0,9**	0,3	0,3	0,31	0,1	0,1	0,4
Kaluga region**	**0,3**	**0,7**	**0,3**	**0,6**	**0,3**	**0,27**	**0,3**	**0,3**	**0,1**	**0,4**
Kamchatka Krai	0,4	0,6	0,4	**0,6**	0,4	0,39	0,44	0,4	0,1	0,4
Karachay-Cherkess Republic	0,4	0,7	0,2	**0,9**	0,4	0,38	0,41	0,2	0,0	0,5
Kemerovo region	0,3	0,6	0,3	**0,6**	0,3	0,27	0,34	0,3	0,1	0,4
Kirov region	0,4	0,6	0,4	**0,7**	0,4	0,41	0,47	0,4	0,1	0,4
Kostroma region	0,3	0,6	0,4	**0,6**	0,3	0,21	0,4	0,4	0,0	0,3

Continuation of the table

Region	BLOCKS OF FACTORS			TOTAL SCORE BY BLOCKS	INTEGRAL ASSESSMENT OF MORTALITY FACTORS AT THE REGIONAL LEVEL					
	I. Medical factors	II. Non-medical factors	III. Transport accessibility		I. Integral assessment of personnel and material and technical base	I.1 Integral assessment of medical workers	I.2 Integral assessment of material and technical base	I.3 Integral assessment of transport accessibility	II.1 Integral assessment of environmental pollution	II.2 Integral assessment of quality of life
Krasnodar region	0,4	0,7	0,3	**0,8**	0,4	0,3	0,41	0,3	0,1	0,5
Krasnoyarsk region	0,5	0,6	0,5	**0,6**	0,5	0,44	0,5	0,5	0,2	0,5
Kurgan region	0,2	0,7	0,5	**0,4**	0,2	0,13	0,35	0,5	0,1	0,4
Kursk region	0,4	0,7	0,1	**1,0**	0,4	0,4	0,42	0,1	0,1	0,4
Leningrad region	0,3	0,6	0,5	**0,4**	0,3	0,33	0,21	0,5	0,2	0,5
Lipetsk region	0,3	0,7	0,2	**0,9**	0,3	0,34	0,3	0,2	0,1	0,5
Magadan Region	0,5	0,6	0,6	**0,6**	0,5	0,57	0,49	0,6	0,0	0,3
Moscow region	0,3	0,6	0,1	**0,9**	0,3	0,3	0,38	0,1	0,2	0,4
Murmansk region**	**0,3**	**0,7**	**0,5**	0,5	**0,3**	**0,32**	**0,27**	**0,5**	**0,0**	**0,4**
Nenets Autonomous Okrug	0,4	0,7	0,8	**0,3**	0,4	0,47	0,23	0,8	0,0	0,5
Nizhny Novgorod Region	0,4	0,6	0,2	**0,8**	0,4	0,29	0,49	0,2	0,1	0,4
Novgorod region	0,3	0,6	0,5	**0,5**	0,3	0,29	0,34	0,5	0,1	0,4
Novosibirsk region	0,4	0,6	0,5	**0,6**	0,4	0,43	0,38	0,5	0,1	0,4
Omsk region	0,4	0,6	0,5	**0,5**	0,4	0,39	0,36	0,5	0,1	0,4
Orenburg region	0,4	0,6	0,5	**0,6**	0,4	0,44	0,44	0,5	0,2	0,4
Oryol Region	0,4	0,7	0,1	**0,9**	0,4	0,34	0,42	0,1	0,1	0,4
Penza region	0,3	0,7	0,3	**0,7**	0,3	0,31	0,22	0,3	0,1	0,4
Perm region	0,4	0,5	0,3	**0,6**	0,4	0,36	0,38	0,3	0,3	0,4
Primorsky Krai	0,3	0,5	0,3	**0,5**	0,3	0,27	0,4	0,3	0,3	0,4
Pskov region	0,2	0,6	0,6	**0,3**	0,2	0,15	0,29	0,6	0,1	0,4
Republic of Adygea	0,3	0,7	0,1	**0,9**	0,3	0,36	0,21	0,1	0,0	0,4
Altai Republic	0,4	0,7	0,6	**0,5**	0,4	0,43	0,33	0,6	0,1	0,4
Republic of Bashkortostan	0,5	0,6	0,4	**0,7**	0,5	0,4	0,49	0,4	0,1	0,4
The Republic of Buryatia	0,4	0,6	0,7	**0,4**	0,4	0,34	0,44	0,7	0,1	0,4
The Republic of Dagestan	0,4	0,7	0,1	**1,0**	0,4	0,36	0,43	0,1	0,1	0,5
The Republic of Ingushetia	0,3	0,7	0,1	**0,9**	0,3	0,54	0,14	0,1	0,0	0,4

Continuation of the table

Region	BLOCKS OF FACTORS			TOTAL SCORE BY BLOCKS	INTEGRAL ASSESSMENT OF MORTALITY FACTORS AT THE REGIONAL LEVEL					
	I. Medical factors	II. Non-medical factors	III. Transport accessibility		I. Integral assessment of personnel and material and technical base	I.1 Integral assessment of medical workers	I.2 Integral assessment of material and technical base	I.3 Integral assessment of transport accessibility	II.1 Integral assessment of environmental pollution	II.2 Integral assessment of quality of life
Republic of Kalmykia	0,4	0,7	0,7	**0,5**	0,4	0,41	0,4	0,7	0,0	0,4
Republic of Karelia	0,4	0,6	0,6	**0,4**	0,4	0,41	0,32	0,6	0,2	0,3
Komi Republic	0,5	0,6	0,6	**0,5**	0,5	0,44	0,47	0,6	0,1	0,3
Republic of Crimea	0,3	0,7	0,2	**0,7**	0,3	0,34	0,23	0,2	0,1	0,4
Mari El Republic	0,4	0,7	0,2	**0,8**	0,4	0,38	0,34	0,2	0,0	0,4
The Republic of Mordovia	0,4	0,7	0,3	**0,8**	0,4	0,51	0,31	0,3	0,1	0,4
The Republic of Sakha (Yakutia)	0,6	0,6	0,8	**0,4**	0,6	0,6	0,53	0,8	0,1	0,4
Republic of North Ossetia-Alania	0,5	0,7	0,2	**1,0**	0,5	0,66	0,25	0,2	0,0	0,5
Republic of Tatarstan	0,3	0,6	0,3	**0,6**	0,3	0,31	0,37	0,3	0,3	0,5
Tyva Republic	0,5	0,7	0,7	**0,5**	0,5	0,54	0,48	0,7	0,0	0,5
The Republic of Khakassia	0,3	0,7	0,6	**0,4**	0,3	0,4	0,25	0,6	0,1	0,4
Rostov region	0,4	0,6	0,3	**0,7**	0,4	0,3	0,48	0,3	0,2	0,4
Ryazan Oblast	0,4	0,7	0,3	**0,8**	0,4	0,44	0,33	0,3	0,1	0,4
Samara Region	0,3	0,7	0,2	**0,8**	0,3	0,35	0,31	0,2	0,1	0,4
Saratov region	0,4	0,6	0,4	**0,6**	0,4	0,31	0,46	0,4	0,2	0,4
Sakhalin region**	**0,5**	**0,5**	**0,4**	**0,7**	**0,5**	**0,54**	**0,48**	**0,4**	**0,3**	**0,4**
Sverdlovsk region	0,4	0,5	0,3	**0,6**	0,4	0,31	0,49	0,3	0,4	0,4
Smolensk region	0,5	0,7	0,3	**0,8**	0,5	0,4	0,5	0,3	0,1	0,4
Stavropol region	0,3	0,6	0,3	**0,7**	0,3	0,27	0,41	0,3	0,2	0,5
Tambov Region	0,4	0,7	0,2	**0,8**	0,4	0,4	0,33	0,2	0,1	0,5
Tver region	0,4	0,6	0,4	**0,6**	0,4	0,27	0,46	0,4	0,1	0,4
Tomsk region	0,4	0,6	0,5	**0,5**	0,4	0,36	0,41	0,5	0,1	0,3
Tula region	0,3	0,7	0,2	**0,7**	0,3	0,19	0,37	0,2	0,1	0,4
Tyumen region	0,4	0,7	0,7	**0,5**	0,4	0,53	0,33	0,7	0,1	0,6
Udmurt republic	0,4	0,7	0,2	**0,8**	0,4	0,39	0,33	0,2	0,1	0,4
Ulyanovsk region	0,3	0,7	0,3	**0,6**	0,3	0,28	0,3	0,3	0,1	0,4
Khabarovsk region	0,4	0,7	0,5	**0,6**	0,4	0,41	0,44	0,5	0,0	0,4

End of the table

Region	BLOCKS OF FACTORS			TOTAL SCORE BY BLOCKS	INTEGRAL ASSESSMENT OF MORTALITY FACTORS AT THE REGIONAL LEVEL					
	I. Medical factors	II. Non-medical factors	III. Transport accessibility		I. Integral assessment of personnel and material and technical base	I.1 Integral assessment of medical workers	I.2 Integral assessment of material and technical base	I.3 Integral assessment of transport accessibility	II.1 Integral assessment of environmental pollution	II.2 Integral assessment of quality of life
Khanty-Mansi Autonomous Okrug	0,5	0,6	0,5	**0,6**	0,5	0,53	0,4	0,5	0,2	0,4
Chelyabinsk region**	**0,4**	**0,6**	**0,3**	**0,7**	**0,4**	**0,31**	**0,38**	**0,3**	**0,1**	**0,4**
Chechen Republic	0,3	0,7	0,1	**0,9**	0,3	0,33	0,17	0,1	0,1	0,5
Chuvash Republic	0,4	0,7	0,2	**0,9**	0,4	0,52	0,27	0,2	0,0	0,4
Chukotka Autonomous Okrug	0,8	0,7	1,0	**0,5**	0,8	0,82	0,71	1,0	0,0	0,5
Yamalo-Nenets Autonomous Okrug	0,4	0,7	0,6	**0,5**	0,4	0,47	0,34	0,6	0,1	0,5
Yaroslavl region	0,4	0,7	0,2	**0,8**	0,4	0,46	0,37	0,2	0,1	0,4
Total for Russian Federation	**0,4**	**0,6**	**0,4**	**0,7**	**0,4**	**0,38**	**0,37**	**0,4**	**0,1**	**0,4**

Source: authors' calculations

Note:
* The list of subjects of the Russian Federation is given without taking into account newly included subjects due to lack of data
**Pilot study regions

Appendix 2. Final calculations of the relationships between factor and performance characteristics for pilot subjects of the Russian Federation

	Correlation coefficient (r)							Determination coefficient (r^2)						
	Medical	Environment	Infrastructure				Demographic	Medical	Environment	Infrastructure				Demographic
	Number of treatment and preventive organizations, units	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age	Number of treatment and prevention organizations, unit	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age
Deaths (total) ‰ 2019	**-0,03**	**0,00**	**0,16**	**0,00**	**0,16**	**-0,16**	**0,63**	**0**	**0**	**2**	**0**	**2**	**2**	**40**
Deaths, acute diseases, ‰ 2019	**-0,02**	**-0,03**	**0,12**	**0,01**	**0,11**	**-0,11**	**0,57**	**0**	**0**	**1**	**0**	**1**	**1**	**33**
Symptoms, signs and abnormalities identified by clinical and laboratory tests, not classified elsewhere (R00-R99)	-0,05	0,06	0,10	0,00	0,06	-0,06	0,33	0	0	1	0	0	0	11
Neoplasms (C00-D48)	0,00	0,02	0,13	-0,02	0,14	-0,14	0,60	0	0	2	0	2	2	36
Diseases of the circulatory system (I00-I99)	-0,01	-0,05	0,16	-0,03	0,17	-0,17	0,61	0	0	3	0	3	3	38
Diseases of the nervous system (G00-G99)	0,00	0,05	0,00	0,04	0,01	-0,01	0,26	0	0	0	0	0	0	7
Diseases of the digestive system (K00-K93)	-0,04	0,03	0,08	0,00	0,14	-0,14	0,56	0	0	1	0	2	2	32

Continuation of the table

	Correlation coefficient (r)							Determination coefficient (r^2)						
	Medical	Environment	Infrastructure				Demographic	Medical	Environment	Infrastructure				Demographic
	Number of treatment and preventive organizations, units	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age	Number of treatment and prevention organizations, unit	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age
Respiratory diseases (J00-J99)	-0,04	-0,01	0,15	0,10	0,12	-0,12	0,50	0	0	2	1	1	1	25
External causes of morbidity and mortality (V01-Y98)	-0,06	0,05	0,23	-0,01	0,21	-0,21	0,54	0	0	5	0	4	4	29
Deaths (total) ‰ 2019 by pilots:														
Belgorod region	-0,61	-0,39	0,21	0,56	-0,10	0,10	0,86	37	15	5	32	1	1	74
Kaluga region	-0,35	-0,23	0,31	0,11	0,17	-0,17	-0,13	12	5	9	1	3	3	2
Murmansk region	0,10	0,28	0,46	-0,43	0,53	-0,53	0,93	1	8	21	19	28	28	87
Sakhalin region	0,01	-0,47	0,09	0,36	0,20	-0,20	0,96	0	22	1	13	4	4	91
Chelyabinsk region	-0,18	-0,25	0,34	-0,11	0,34	-0,34	0,59	3	6	12	1	11	11	34
Deaths, acute diseases, ‰ 2019 by pilots:														
Belgorod region	0,00	-0,13	0,18	0,17	0,33	-0,33	0,25	0	2	3	3	11	11	6
Kaluga region	0,01	-0,14	-0,08	-0,01	-0,04	0,04	0,10	0	2	1	0	0	0	1
Murmansk region	0,24	0,14	0,44	-0,36	0,45	-0,45	0,89	6	2	19	13	20	20	79
Sakhalin region	0,13	-0,55	0,00	0,41	0,26	-0,26	0,84	2	30	0	16	7	7	71
Chelyabinsk region	-0,25	-0,25	0,13	0,08	0,12	-0,12	0,21	6	6	2	1	1	1	4

Continuation of the table

	Correlation coefficient (r)							Determination coefficient (r^2)						
	Medical	Environment	Infrastructure				Demographic	Medical	Environment	Infrastructure				Demographic
	Number of treatment and preventive organizations, units	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age	Number of treatment and prevention organizations, unit	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age
Symptoms, signs and abnormalities identified by clinical and laboratory tests, not classified elsewhere (R00-R99)														
Belgorod region	-0,56	-0,34	-0,04	0,45	-0,16	0,16	0,53	31	11	0	21	3	3	28
Kaluga region	-0,35	-0,23	0,31	0,11	0,17	-0,17	-0,13	12	5	9	1	3	3	2
Murmansk region	0,10	0,28	0,46	-0,43	0,53	-0,53	0,93	1	8	21	19	28	28	87
Sakhalin region	0,01	-0,47	0,09	0,36	0,20	-0,20	0,96	0	22	1	13	4	4	91
Chelyabinsk region	-0,18	-0,25	0,34	-0,11	0,34	-0,34	0,59	3	6	12	1	11	11	34
Neoplasms (C00-D48)														
Belgorod region	0,37	0,47	-0,32	-0,47	-0,22	0,22	-0,38	14	23	10	22	5	5	14
Kaluga region	-0,01	-0,27	0,00	-0,16	-0,08	0,08	-0,05	0	7	0	3	1	1	0
Murmansk region	0,09	0,48	0,49	-0,45	0,52	-0,52	0,84	1	23	24	21	27	27	70
Sakhalin region	0,01	-0,26	-0,21	0,50	0,06	-0,06	0,82	0	7	4	25	0	0	68
Chelyabinsk region	-0,05	-0,18	0,16	-0,11	0,19	-0,19	0,35	0	3	2	1	4	4	12
Diseases of the circulatory system (I00-I99)														
Belgorod region	-0,20	0,13	-0,19	-0,17	-0,36	0,36	0,22	4	2	3	3	13	13	5

Continuation of the table

	Correlation coefficient (r)							Determination coefficient (r^2)						
	Medical	Environment	Infrastructure				Demographic	Medical	Environment	Infrastructure				Demographic
	Number of treatment and preventive organizations, units	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age	Number of treatment and prevention organizations, unit	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age
Kaluga region	-0,21	-0,41	0,20	-0,06	0,14	-0,14	-0,04	4	17	4	0	2	2	0
Murmansk region	0,02	0,16	0,47	-0,44	0,56	-0,56	0,91	0	2	22	20	31	31	83
Sakhalin region	0,08	-0,67	0,07	0,36	0,35	-0,35	0,79	1	45	1	13	12	12	63
Chelyabinsk region	-0,18	-0,21	0,11	0,01	0,18	-0,18	0,52	3	5	1	0	3	3	27
Diseases of the nervous system (G00-G99)														
Belgorod region	-0,10	0,02	0,26	0,07	0,41	-0,41	0,21	1	0	7	1	16	16	4
Kaluga region	0,00	0,23	-0,22	0,00	-0,31	0,31	-0,09	0	5	5	0	9	9	1
Murmansk region	-0,06	-0,13	-0,39	0,36	-0,30	0,30	0,15	0	2	16	13	9	9	2
Sakhalin region	-0,14	0,02	0,19	-0,05	0,16	-0,16	0,77	2	0	4	0	2	2	59
Chelyabinsk region	0,09	-0,05	-0,17	0,18	-0,14	0,14	-0,04	1	0	3	3	2	2	0
Diseases of the digestive system (K00-K93)														
Belgorod region	-0,05	0,15	0,19	0,07	0,08	-0,08	0,22	0	2	4	0	1	1	5
Kaluga region	-0,13	-0,15	0,00	0,13	-0,07	0,07	0,00	2	2	0	2	0	0	0
Murmansk region	0,17	-0,09	0,02	0,00	0,13	-0,13	0,66	3	1	0	0	2	2	44

End of the table

	Correlation coefficient (r)							Determination coefficient (r^2)						
	Medical	Environment	Infrastructure				Demographic	Medical	Environment	Infrastructure				Demographic
	Number of treatment and preventive organizations, units	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age	Number of treatment and prevention organizations, unit	Commissioned residential buildings sq. m. per person	Proportion of the population living outside the transport accessibility of medical institutions	Proportion of the population living within the transport accessibility zones of medical institutions	Share of settlements located outside transport accessibility zones	Share of settlements located within transport accessibility zones of medical institutions	Proportion of population over working age
Sakhalin region	-0,13	-0,51	0,11	0,26	0,25	-0,25	0,74	2	26	1	7	6	6	54
Chelyabinsk region	-0,03	-0,01	0,10	-0,03	0,08	-0,08	0,36	0	0	1	0	1	1	13
Respiratory diseases (J00-J99)														
Belgorod region	-0,21	0,10	0,25	-0,06	0,22	-0,22	0,19	5	1	6	0	5	5	4
Kaluga region	-0,06	-0,41	0,41	0,18	0,35	-0,35	0,08	0	17	17	3	12	12	1
Murmansk region	0,08	0,50	0,03	-0,02	0,22	-0,22	0,57	1	25	0	0	5	5	33
Sakhalin region	0,19	-0,48	-0,06	0,39	0,05	-0,05	0,70	4	23	0	15	0	0	48
Chelyabinsk region	-0,17	-0,10	0,26	-0,20	0,12	-0,12	0,43	3	1	7	4	1	1	18
External causes of morbidity and mortality (V01-Y98)														
Belgorod region	-0,27	0,09	0,22	-0,13	-0,17	0,17	0,33	7	1	5	2	3	3	11
Kaluga region	-0,18	-0,14	0,55	-0,05	0,59	-0,59	-0,04	3	2	30	0	35	35	0
Murmansk region	0,27	0,48	0,52	-0,53	0,38	-0,38	0,50	8	23	27	28	14	14	25
Sakhalin region	-0,18	-0,13	0,34	0,06	0,10	-0,10	0,81	3	2	11	0	1	1	66
Chelyabinsk region	-0,09	0,04	0,35	-0,24	0,40	-0,40	0,56	1	0	12	6	16	16	31

Source: authors' calculations

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