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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

THE IMPACT OF NATURAL-GEOGRAPHICAL AND SOCIO-ECONOMIC CONDITIONS ON HUMAN HEALTH IN AZERBAIJAN

Speciality: 5403.01 – Human geography

Field of Science: Geography

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Baku – 2026

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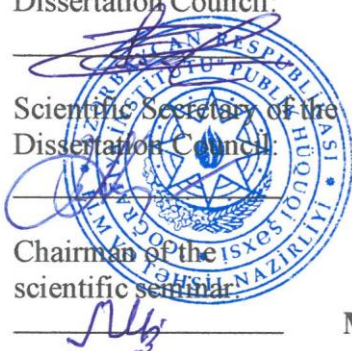
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GENERAL CHARACTERISTIC OF THE WORK

The actuality of the topic and level of research on the topic.

The protection and improvement of human health is one of the priority issues at the global level. The existence of a direct relationship between natural conditions and human health, as well as the influence of social and economic factors on the causes and spread of diseases, has been known from the 3rd century BC to the present day¹. The study of the relationship between humans and their living environment from a health perspective, the identification of the geographical patterns of disease distribution, and the development of methods to combat them are of significant scientific and practical importance and are highly relevant in terms of extending life expectancy, which is one of the main indicators of public health.

Natural-geographical factors such as climate, relief, geological structure, soil, water resources, etc. affect the human organism both directly and indirectly². The geographical location of the territory of the Republic along the seacoast, its inclusion in the seismically active Alpine fold belt, the complexity of its relief, characterized by mountain ranges and extensive plains, as well as its location within the subtropical and temperate climatic zones, with climate types ranging from semi-desert and dry steppe to mountain tundra, etc., make its natural conditions highly diverse and increase the importance of their analysis from the perspective of human health.

In the modern era, socio-economic conditions also play an important role among the factors affecting human health. Socio-economic factors, such as the employment level of the population, income status, educational attainment, and the availability of social infrastructure, have a significant impact on both the physical and

¹ Bashford, A., Tracy, S.W. Introduction: Modern Airs, Waters, and Places // Bulletin of the History of Medicine, – 2012, 86 (4), – pp. 495-514. (In Eng.)

² May, J. Medical Geography: Its Methods and Objectives // Geographical Review, – 1950, 40 (1), – pp. 9-41. (In Eng.)

mental health of individuals³. Low socio-economic conditions reduce life expectancy by an average of 25 months among the population aged 40-85 years⁴. Socio-economic status also plays an important role in determining overall mortality rates and mortality rates across individual age groups. There is an association between mortality rates due to myocardial infarction, cerebrovascular diseases, and pulmonary causes and the population's level of education and socio-economic status⁵.

The economic difficulties, low wages, and social decline observed in Azerbaijan during the 1970s and 1980s and the subsequent transition period, as well as the economic development observed since 1995 as a result of the transition to a free market economy, the signing of agreements with international oil companies, and the implementation of reforms, and other socio-economic changes, determine the relevance of a comprehensive study of their impact on population health, including morbidity and demographic indicators.

While industrial development creates the basis for economic growth on the one hand, on the other hand, it affects the environmental conditions of the living environment, resulting in negative effects on population health⁶. According to data from the World Health Organization, 24% of deaths worldwide are associated with environmental factors⁷. Studies show that the presence of harmful substances in the atmospheric air in Azerbaijan increases morbidity

³ Braveman, P., Gottlieb, L. The social determinants of health: it's time to consider the causes of the causes // Public health reports. – 2014, 129 (Suppl 2), – pp. 19-31. (In Eng.)

⁴ Stringhini, S. Socioeconomic status and the 25 × 25 risk factors as determinants of premature mortality: a multicohort study and meta-analysis of 1.7 million men and women / S.Stringhini, C.Carmeli, M.Jokela [et al.] //– The Lancet, – 2017, 389 (10075), – pp. 1229-1237. (In Eng.)

⁵ Galea, S. Estimated deaths attributable to social factors in the United States / S.Galea, M.Tracy, K.J.Hoggatt [et al.] // American Journal of Public Health, – 2011, 101 (8), – pp. 1456–1465. (In Eng.)

⁶ Ryumina, E.V. Environmental Aspects of Assessing Quality of Life // – Yekaterinburg: Economy of Region, – 2016, 12 (4), – pp. 1113-1122. (In Russ.)

⁷ Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks / A.Prüss-Üstün, J.Wolf, C.Corvalán. [et al.] – Geneva: World Health Organization, – 2016. – 147 p. (In Eng.)

among the population by 30-40%. In particular, the acceleration of the urbanization process and environmental pollution make it necessary to analyse the relationship between population morbidity in Baku and pollutants emitted into the atmospheric air⁸. The substances that most pollute the atmosphere include carbon, sulfur, nitrogen oxides, hydrocarbons, etc., and numerous scientific studies have examined the effects of these compounds on human health⁹. From a practical perspective, it is also important to scientifically investigate the effects of these pollutants on human health, identify risk factors, and conduct comparative analyses across regions.

When considering the degree to which the topic has been studied, it becomes evident that the scientific and theoretical-methodological foundations of this field are extensively reflected in the international literature. In Azerbaijan, however, research in this area is relatively recent and has gained momentum in recent years. Local and foreign scholars, including J.M.May, E.I.Ignatyev, A.A.Keller, B.I.Davydov, Z.A.Semenova, E.V.Ryumina, S.V.Tromp, M.G.Tujar, R.A.Kearns, B.A.Budagov, A.H.Ahmadov, G.I.Rustamov, A.J.Ayyubov, Z.N.Eminov, Kh.Sh.Rahimov, U.R.Tagiyeva, J.N.Ahmadova, Ch.S.Aliyev, F.F.Mahmudova, F.I.Ibrahimov, G.Sh.Mammadov, M.Y.Khalilov, Sh.I.Mammadova, S.I.Rzayeva, and others have studied the geographical characteristics of population health in their research using various approaches.

Unlike other studies conducted in the Republic, this dissertation gives preference to an ecological approach based on generalization and synthesis, which analyses the interrelationships between individual components of a system and the system as a whole (human-environment). Along with the influence of socio-economic factors, natural-geographical factors were also a major focus in studying the

⁸ Mammadova, Sh.I. Evaluation of Impact of Pollution of the Atmospheric Air on Health of Population in Large Cities of Azerbaijan // – Brooklyn: Journal of Agriculture and Life Sciences, – 2015, 2 (1), – pp. 133-139. (In Eng.)

⁹ Rigas, M.L., Ben-Jebria, A., Ultman, J.S. Longitudinal distribution of ozone absorption in the lung: Effects of nitrogen dioxide, sulfur dioxide, and ozone exposures // Archive of Environmental Health, – 1997, 52 (3), – pp. 173-178. (In Eng.)

geographical distribution of diseases. At the same time, the use of Geographic Information Systems to visually represent the database of disease-related data and to systematically map the identified patterns is of particular importance. These aspects determine the relevance of the present research.

Object and topic of the research. The object of the research is the population of the Republic of Azerbaijan, while the subject of the research is the study of the impact of the natural-geographical and socio-economic conditions of the territory of Azerbaijan on population health.

The purpose and the missions of investigation. The main objective of the research is to comprehensively assess the impact of natural-geographical, socio-economic, and ecological factors on the health status of the population of the Republic of Azerbaijan, as well as to develop proposals and maps aimed at implementing preventive measures.

To study the impact of natural-geographical and socio-economic conditions on human health in Azerbaijan, the following tasks were set:

- Analysis of the long-term trends in diseases observed among the population, identification of regional differences in the main causes of morbidity (respiratory diseases), and mapping of the results;
- determination of the mean elevation of settlements (cities and administrative districts) above sea level and conducting regression analyses between elevation and the morbidity rate (respiratory diseases);
- determination of the morbidity level in coastal areas with high relative humidity in the atmospheric air and estimation of the relative risk of respiratory diseases associated with residence in areas with high relative humidity;
- determination of the estimated relative risk of morbidity from respiratory diseases associated with residence in areas with high levels of pollutants released into the atmospheric air;
- analysis of the relationship between population morbidity in Baku and the pollutants released into the atmospheric air, population density, and population growth rate;

- analysis of the dependence between the formation of the main causes of mortality among the population, depending on socio-economic conditions, and population income;
- determination of the regional and demographic characteristics of deaths caused by diseases of the circulatory system;
- Creation of a database on population morbidity and causes of mortality using ArcGIS software, mapping, and development of a geographical model aimed at improving population health in the region.

Research methods. In the course of the research, along with spatiotemporal, system-structural, comparative analysis, cartographic representation, and geographical modelling methods, statistical methods such as retrospective analysis, correlation, regression, percentile, and estimation of relative risk were used, while generalization techniques available in software packages such as ArcGIS, MedCalc, and others were applied.

The main provisions to be defended:

1. The Impact of Regional Characteristics of Natural-Geographical Conditions on Population Morbidity in Azerbaijan;
2. The Impact of Socio-Economic Conditions on the Formation of the Main Causes of Mortality among the Population in Azerbaijan;
3. Statistical Relationships between Pollutants Released into the Atmospheric Air and Population Morbidity and Mortality Indicators.

The scientific innovations of the dissertation. Scientific innovations obtained as a result of studying the effects of natural-geographical and socio-economic conditions on human health in Azerbaijan:

- the regional characteristics of respiratory diseases, the most frequently observed class of diseases among the population, were studied across five natural-geographical regions differing in their natural and socio-economic characteristics (Greater Caucasus, Lesser Caucasus, Kura intermontane depression, Lankaran, and Middle Aras), significant differences were identified, and the results were mapped;

- for the first time, the mean elevation of settlements above sea level was obtained by conducting spatial analysis using ArcGIS software in order to determine the influence of natural conditions on the geographical distribution of respiratory diseases. Regression analyses were performed to quantitatively assess the existence and direction of the relationship between elevation and morbidity, and both inverse and direct relationships were identified analytically;

- for the first time, the estimated relative risk indicators of morbidity from respiratory diseases associated with residence in areas with high relative humidity in the atmospheric air in Azerbaijan were determined. It was found that high relative humidity increases the incidence of diseases. At the same time, the incidence of respiratory diseases in the coastal area with high relative humidity was calculated, and it was determined that the morbidity level in this area is high;

- unlike previous studies, the estimated relative risk indicators of morbidity from respiratory diseases associated with residence in areas with high levels of pollutants released into the atmospheric air were determined;

- for the first time, the effects of pollutants released into the atmospheric air (carbon, nitrogen, and sulfur compounds) on morbidity from respiratory diseases in Baku, depending on environmental conditions, were determined; the existence of a correlation was identified, the relationship was found to be strong and stable, and the results were mapped;

- the impact of socio-economic factors on the formation of causes of mortality among the population in Azerbaijan was studied, and the relationship between the trends in mortality due to diseases of the circulatory system, respiratory diseases, and certain infectious and parasitic diseases and per capita income, one of the main indicators determining the socio-economic situation in the Republic, was analysed. It was established that socio-economic factors have a strong influence on the structure and dynamics of causes of mortality;

- for the first time, the share of deaths caused by diseases of the circulatory system, which are the main cause of mortality among the population in the Republic, was determined by economic and administrative territorial units, as well as the distribution patterns of

these diseases among urban and rural populations and by sex and age composition; the results were mapped.

The theoretical and practical significance of the investigation. The scientific results and recommendations obtained in the course of the research can be used to assess the environment from the perspective of human health, to implement measures aimed at improving the sanitary and hygienic conditions of territories, and to develop programs for the protection of population health. The analyses conducted may be important for the educational process in the fields of medicine and higher education.

Approbation and application of the research. The main content and results of the research were presented at international and national scientific-practical conferences. These include the scientific conference dedicated to the 98th anniversary of the birth of National Leader Heydar Aliyev, entitled “The Power of the Unity of the People, State and Army in Azerbaijan” (Lankaran, 2021); The XIII International Scientific Symposium “Science and Education: Preserving the Past, Creating the Future” (Kars, 2021); the scientific-practical conference entitled “Organization and Management of Natural-Economic Systems in the Economic Regions of Karabakh and Eastern Zangazur” (Baku, 2022); the Republican scientific conference entitled “Modern Problems of University Science and Education”, dedicated to the 60th anniversary of Sumgayit State University (Sumgayit, 2022); The XXXIII International Scientific Symposium “Dialogue of Sciences and Cultures in the Modern World” (Bishkek, 2022); the II International Scientific-Practical Conference entitled “Modern Problems of Geography: Integration of Science and Education”, dedicated to the 100th anniversary of the National Leader Heydar Aliyev (Baku, 2023); the III International Scientific-Practical Conference entitled “Modern Problems of Geography: Integration of Science and Education”, dedicated to the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29) (Baku, 2024); the International Scientific Conference “Cities on the Way from the Present to the Future” (V Geo-Urban Studies) (Moscow, 2025); the II All-Russian Conference with International Participation “Spatial

Organization of Society: Theory, Methodology, Practice” (Perm, 2025), and others.

19 articles and conference proceedings related to the dissertation topic have been published.

The name of the organisation where the dissertation was implemented: The dissertation was carried out at the “Population Geography and Toponymy” Laboratory of the Institute of Geography P.L.E., Ministry of Science and Education of the Republic of Azerbaijan.

The volume, structure, and primary content of the dissertation. The dissertation consists of an introduction, four chapters, a conclusion, and a list of references. The total volume of the dissertation is 166 pages. The dissertation contains 2 figures, 4 maps, 27 graphs, 5 formulas, 24 tables, and a list of 216 references. The Introduction comprises – 7 pages, Chapter I – 44 pages, Chapter II – 12 pages, Chapter III – 54 pages, and Chapter IV – 25 pages. Excluding tables, graphs, the list of references, and spaces, the dissertation comprises 201565 characters.

A BRIEF SUMMARY OF THE DISSERTATION

The Introduction substantiates the relevance of the topic and presents the aim and objectives of the research, its object and subject, research methods, the main provisions submitted for defense, scientific novelty, as well as theoretical and practical significance.

The first chapter of the dissertation is devoted to the **“Theoretical Foundations of Studying the Impact of Geographical Conditions on Human Health”**. In this chapter, scientific approaches to studying the geographical characteristics of population health in medical-geographical research were analysed, and the studies were grouped according to their objectives. At the same time, the results of fundamental studies conducted worldwide and in Azerbaijan on the impact of natural-geographical and socio-economic factors on human health were analysed and extensively presented.

Analysis of the literature sources shows that the scientific

foundations of this field began to take shape at the beginning of the 20th century. The International Society of Pathology and the American Geographical Society operating in the United States conducted some of the earliest studies on the geographical distribution and mapping of diseases. In 1952, the Commission on Medical Geography of the International Geographical Union was established, and its first meeting was held in Washington. The report of the Commission, published in 1956, is valuable as it reflected information on the state of medical geography in the Netherlands, Japan, and the United States. In 1954, the “Commission on Medical Geography”, consisting of physicians and geographers, was established in the Soviet Union, and projects related to disease mapping and atlas compilation were developed at the conference organized by the Commission¹⁰. Thus, studies conducted in different countries of the world, addressing the relationship between humans and their living environment from the perspective of health and having a global scope, contributed to the development of the theoretical and methodological foundations of medical geography.

In this chapter of the dissertation, the studies were grouped into two main directions from the perspective of scientific and methodological approaches. The first and earliest direction to emerge is referred to as “geographical epidemiology”, “geographical pathology”, or “disease ecology”. The second direction involves the territorial assessment of the allocation of medical services and is referred to as the geography of health care or the geography of medical services. Geographical epidemiology examines the relationship between diseases and the environment. The geography of health care, in turn, aims to address issues such as the location of medical services, accessibility to these services, and their planning.

The natural-geographical conditions of the territory occupied by each state play an important role in the health of its population. In this chapter of the research, the results of studies conducted on the impact of geographical conditions on human health were grouped according to the geological, geomorphological, climatic, soil, and hydrological

¹⁰ Korkut, J. Introduction to Medical Geography / C. Korkut. – Izmir: Hurefe Printing House, – 1998. – 93 p. (In Turk.)

characteristics of the geographical space, and the territory of Azerbaijan was analysed from the perspective of human health based on these geographical characteristics.

Leading factors such as the level of development of countries, the quality of life of the population, socio-cultural living conditions, dietary patterns, and medical services play an important role in determining the main causes of mortality among the population, as well as the age structure of mortality¹¹. According to data from the World Health Organization (WHO), of the 55.4 million deaths that occurred worldwide in 2019, 74% (40.7 million) were attributed to non-communicable diseases (NCDs), of which 77% (31.4 million) were observed in low- and middle-income countries. Of all deaths associated with non-communicable diseases, 36.8% occurred among people aged 30-70 years (15 million), the majority of which, namely 85%, occurred in low- and middle-income countries (12.8 million). While 40.8% of deaths associated with NCDs in low- and middle-income countries occurred among people aged 30-70 years, this indicator was 23.8% in high-income countries¹².

The oil industry has been the driving force of the Azerbaijani economy since earlier periods. The hydrocarbon resources of the Caspian Sea have resulted in oil and gas extraction being carried out in the coastal areas around Baku for more than 100 years, which, in turn, has led to environmental problems¹³. Studies show that air pollution and eco-geographical problems in the major cities of Azerbaijan are the greatest environmental risk factors for the health of people of all age groups¹⁴. Large quantities of carbon compounds (carbon dioxide, carbon monoxide, etc.) are emitted into the

¹¹ Eminov, Z.N. The Current State of Quality of Life of the Population in the Republic of Azerbaijan / Z.N. Eminov, S.I. Rzayeva. – Baku: Region Press, – 2022. – 240 p. (In Aze.)

¹² Eminov, Z.N., Masimov M.O., Mammadova, A.R. Medical and geographical problems of non-communicable diseases in the world and Azerbaijan // – Kyiv: Scientific Notes of Ternopil Volodymyr Hnatiuk National Pedagogical University. Series: Geography, – 2022. № 52 (1), – pp. 87-95. (In Eng.)

¹³ Ismayilov, Ch.N. Ecology of the Caspian Sea and Coastal Areas / Ch.N. Ismayilov. – Baku: Ayna Press House, – 2005. – 127 p. (In Aze.)

¹⁴ Rzayeva, S.I. The Current Ecological State of Atmospheric Air in Baku and Sumgayit Cities and Its Impact on Population Health // – Baku: Proceedings of the Azerbaijan Geographical Society, – 2012, Vol. 17, – pp. 512-516. (In Aze.)

atmosphere by industrial enterprises in Absheron, which affects the health of people living in the cities of Baku and Sumgayit¹⁵. Dense smog formed over cities creates conditions conducive to the development of various diseases. According to the studies conducted by Sh.I.Mammadova, the presence of harmful substances in the atmospheric air increases morbidity among the population by 30-40%¹⁶. The analysis shows that the study of the health of the urban population and the environmental factors affecting it is of continuous scientific-theoretical and practical significance.

Studies show that health problems have not only a biophysical spectrum but also social and economic aspects. More importantly, they are the result of interactions occurring in the environment. Taking this into account, the main objective of our research was to identify geographical differences in population morbidity in the Republic and the natural-geographical and environmental factors causing them, as well as to reveal the dependence of the main causes of mortality among the population on socio-economic conditions.

The second chapter of the dissertation is devoted to the **“Materials and Methods of the Research”** used in the course of the study.

In the research, the concept of morbidity rate (incidence) was used to more accurately determine the effects of changes occurring in the environment on population health. The purpose of calculating incidence is to determine the frequency at which a disease is newly observed in addition to the existing cases. It is obtained by dividing the number of new cases recorded during the study period by the total population living in the respective area. The value is mainly expressed as a ratio¹⁷:

¹⁵ Rzaeva, S.I. Classification of Environmental Factors Affecting Human Health in Cities // International Scientific-Practical Conference “Globalization and Geography”, dedicated to the 85th anniversary of Professor M.A. Museyibov, – Baku: Proceedings of the Baku State University Branch of the Azerbaijan Geographical Society, – 2012, – pp. 555-561. (In Aze.)

¹⁶ Mammadova, Sh.I. Ecogeographical Problems of Air Pollution in the Big Cities of Azerbaijan // – Nizhnevartovsk: Bulletin of Science and Practice, – 2020, 6 (2), – pp. 20-41. (In Eng.)

¹⁷ Ecological Epidemiology: Applications and Research Methods. Textbook / ed. Samaya Ismayilova. – Baku: Khazar University Press, – 2003. – 354 p. (In Aze.)

$$\text{Incidence rate} = a/(a + b) \times 10000 \quad (1)$$

where,

a – is the number of patients registered with a newly established diagnosis,

b – is the number of people who have not been exposed to the disease.

During the research, the method of calculating the estimated relative risk was used to assess the effect of the exposure under study by comparing morbidity events between exposed and unexposed groups. These comparisons result in a quantitative assessment of risk. When the ratio is equal to 1, there is no association between the exposure and the disease; when it is greater than 1, the exposure increases the risk of disease; and when it is less than 1, the exposure reduces the risk of disease. The Odds Ratio (OR) values were calculated according to the following formula¹⁸:

$$OR = \frac{a/b}{c/d} \quad (2)$$

where,

a – is the number of patients living in the area with greater exposure,

c – is the number of patients living in the area with lower exposure,

b və d – are the number of healthy people living in the respective areas in whom the diseases in question have not been identified.

The standard error of the Odds Ratio and the 95% confidence interval were calculated according to the respective formulas, while the test statistic (z) was used to calculate the value of the significance level (P). The study was considered statistically significant at $P < 0.05$.

The third chapter of the dissertation is devoted to the **“Geographical Characteristics of Human Health in Azerbaijan”**. In this chapter, the dependence of morbidity from diseases of the respiratory organs, which are the main cause of morbidity among the population in Azerbaijan, on natural-geographical conditions was studied by natural regions. The role of such factors as the geographical

¹⁸ Altman, D.G. Practical Statistics for Medical Research / – D.G.Altman. – London: Chapman & Hall, – 1991. – 611 p. (In Eng.)

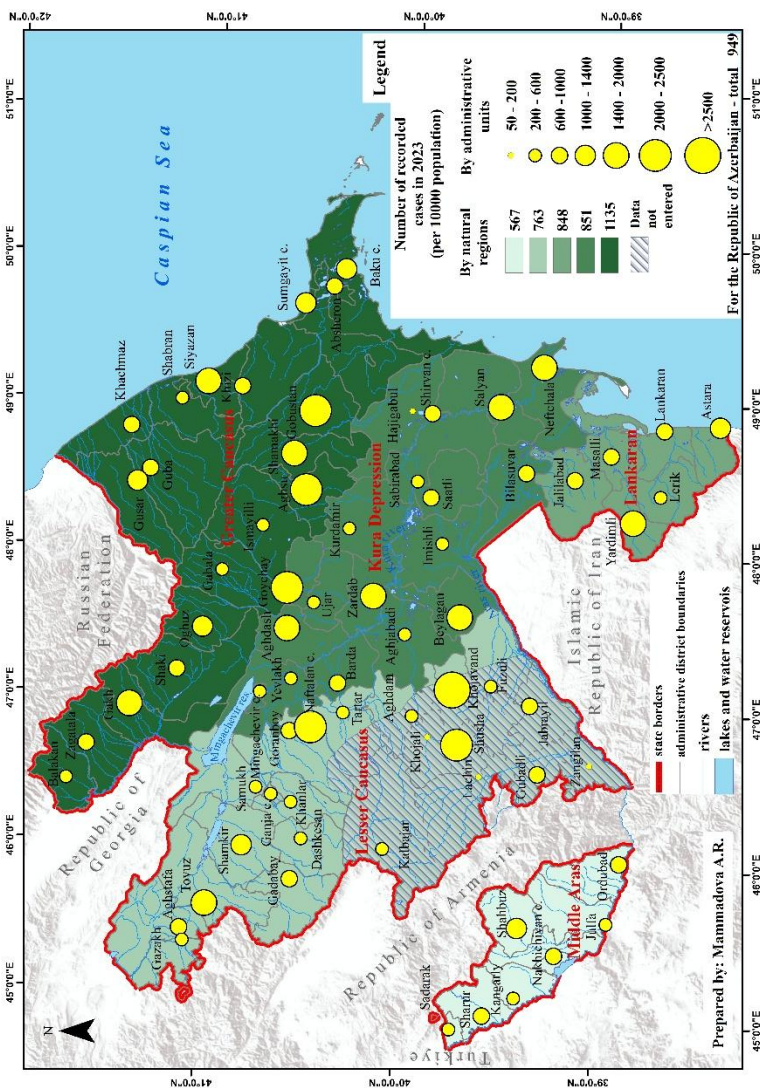
location of the territory, relative humidity of the air, elevation above sea level, amount of precipitation, hydrological conditions of the territory, natural and anthropogenic pollution of the atmosphere, and others in the geographical distribution of diseases was determined. In addition, the influence of socio-economic conditions on the formation of causes of mortality among the population in Azerbaijan was studied in this chapter, and the dynamics, demographic and regional characteristics of deaths caused by diseases of the circulatory system, which are the leading cause of mortality in the Republic, were examined.

The study of morbidity from diseases of the respiratory organs by natural regions shows that there are sharp regional differences among them. Thus, in 2023, of the 963610 patients registered with a newly established diagnosis in Azerbaijan (949 per 10000 population)¹⁹ 55.4% were observed in the Greater Caucasus, which also includes the large industrial cities of Baku, the capital, and Sumgayit, while only 2.7% were observed in the Middle Aras region. These diseases are observed more frequently in the Greater Caucasus region, with 1135 cases per 10000 population. The morbidity rate in the Kura intermontane depression (851 per 10000 population) and Lankaran (848 per 10000 population) regions is also significantly higher than in the Lesser Caucasus (763 per 10000 population) and Middle Aras (567 per 10000 population) regions (Figure 1).

Our research shows that both environmental influences and the role of breathing humid air, caused by the high average annual relative humidity (75-80%) in coastal areas, contribute to the emergence of this difference by activating the nerves that narrow and constrict the bronchi of the lungs.

Thus, a comparison of Lankaran, which is characterized by the highest number of days with high relative humidity (80% or more) during the year (140-150 days), and the Middle Aras region, distinguished by its continental climate, where relative humidity in the air does not exceed 55-60% throughout the year, showed that humidity increases the risk of morbidity by 1.54 ± 0.16 times ($p < 0.0001$) (Table 1).

¹⁹ Healthcare, Social Protection and Housing Conditions in Azerbaijan / Statistical Yearbook. – Baku: SSC, – 2024. – 262 p. (In Aze.)



Source: Compiled by the author in ArcGIS based on data from the State Statistical Committee¹⁹.

Figure 1. Morbidity of the population from diseases of the respiratory organs by natural

In the coastal administrative districts of the Lankaran region, the morbidity rate increases 2.5-fold as relative humidity and precipitation increase further from north to south.

Furthermore, of the 3848.2 thousand people living in 11 settlements located along the seacoast of the Republic, 441501 sought medical care at hospitals for the diseases in question, indicating that diseases of the respiratory organs are frequently observed in coastal areas, with a morbidity rate of 1147.3 cases per 10000 population (11.5%)²⁰.

Table 1

Odds Ratio indicators for the distribution of respiratory diseases associated with residence in areas with high average annual relative humidity of the air

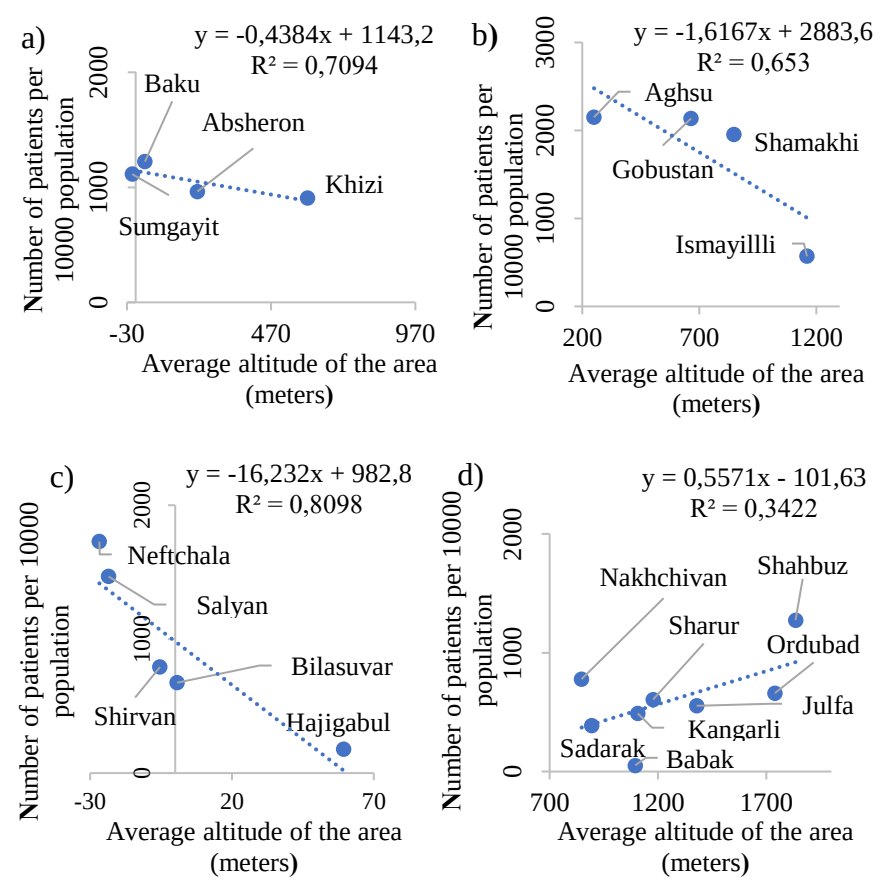
Respiratory diseases		The relative humidity of the air		Total	Odds Ratio	P
		75-80 %	less than 60%			
Groups	Number of people diagnosed with the disease, persons	848 (a)	567 (c)	1415	1.5415 95% CI (1.3807-1.7210)	<0.0001
	Number of people not diagnosed with the disease, persons	9152 (b)	9433 (d)	18585		
	Total	10000	10000	20000		

Source: Calculated by the author based on the data of the State Statistical Committee¹⁹ using Formula 2.

In the dissertation, regression analyses were conducted between the average elevation of administrative districts and cities above sea level, obtained through spatial analysis using ArcGIS 10.3 software, and the morbidity rate of the population. Analytically, inverse relationships were identified in the Baku, Absheron-Khizi, and Mountainous Shirvan economic regions of the Greater Caucasus region and in the Shirvan-Salyan economic region of the Kura

²⁰ Mammadova, A.R. The impact of natural and environmental conditions in the coastal settlements of Azerbaijan on population health // International scientific conference “Cities on the way from the present to the future” V Geourbanistic readings, – Moscow: – 15 – 17 May, – 2025, – pp. 232-238. (In Eng.)

intermontane depression, while a direct relationship was identified in the Middle Aras region (Graph 1).



Source: The graphs were prepared by the author based on data from the State Statistical Committee¹⁹ and data obtained through spatial analysis using ArcGIS 10.3 software.

Graph 1. Graphs showing the relationship between the average elevation of the territory and population morbidity in Baku and Absheron-Khizi (a), Mountainous Shirvan (b), Shirvan-Salyan (c), and the Nakhchivan Autonomous Republic (d)

The decrease in the morbidity rate with increasing elevation in the southeastern districts of the Greater Caucasus is explained by the

improvement in air quality due to the increase in precipitation with increasing elevation in this area, where natural and anthropogenic air pollution predominates. Similar relationships were also obtained when the morbidity rate was compared with the average annual amount of precipitation in the territory. In Shirvan-Salyan, the inverse relationship was stronger ($R^2=0.8098$, $p<0.005$), indicating that for every 1-meter increase in the average elevation of the territory, the morbidity rate decreases by 16 cases per 10000 population. This is associated with the greater exposure of the population living in low-lying areas of the lower reaches of the Kura River to the adverse effects of water. In addition, periodic river floods in the Kura intermontane depression pose a risk to population health. The study found that following the large-scale floods that occurred along the Kura River in 2010, the sharpest increase in morbidity indicators during 2010-2019 was again observed in the lowest-lying districts of the lowland, namely Neftchala (2.8-fold) and Salyan (2.7-fold).

In the Middle Aras region, the direct proportional relationship between the variables is associated with the population being exposed to the adverse effects of cold weather as elevation increases. Thus, the highest morbidity rate, at 1273.4 cases per 10000 population, was recorded in Shahbuz district, whose territory is located in the southern part of the Daralayaz Range and on the western slope of the Zangazur Range, with an average elevation of 1834.7 m. Here, the morbidity rate of the population from diseases such as chronic pharyngitis, nasopharyngitis, sinusitis, pneumonia, chronic and unspecified bronchitis, emphysema, allergic rhinitis, and others is 2-3 times higher than in the region as a whole^{21, 22}.

The second section of the chapter examines the impact of the interacting social sphere and economic conditions on human health. It was established that during 1999-2019, diseases of the circulatory system ranked first among the causes of mortality in Azerbaijan, and

²¹ Mammadova, A.R. The impact of relief and environmental conditions on the incidence of respiratory diseases (a study in the Middle Aras region) // "Socioeconomic development and geographical problems of regions" international scientific-practical conference, – Baku: – 18 – 19 March, – 2025, – pp. 367-373. (In Eng.)

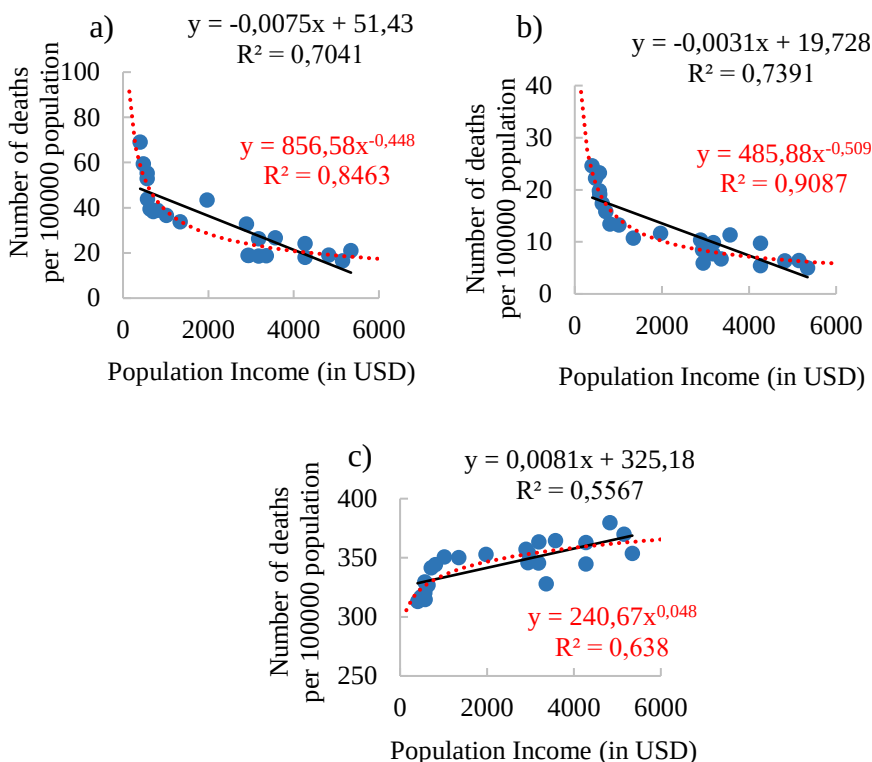
²² Mammadova, A.R. The impact of geographical conditions on population health in the Republic of Azerbaijan // JSC Institute of Geography and Water Security, Geography and Water Resources, Almaty, 2026. №1. – pp. 116-126. (In Eng.)

the number of deaths from these diseases increased by 27.4% (7290 people). During these years, significant changes occurred in the structure of the causes of mortality in the Republic: the share of diseases of the circulatory system increased from 54% to 58%, neoplasms from 11% to 16%, and diseases of the endocrine system, nutritional disorders and metabolic disorders from 2.3% to 3.2%. In contrast, the share of certain infectious and parasitic diseases decreased from 3.9% to 1.2%, while that of diseases of the respiratory organs decreased from 9.4% to 3.3%.²³.

The analysis of the inverse linear relationship between per capita income and causes of mortality in the Republic showed that during 1997-2019, every USD 1000 increase in income reduced mortality from diseases of the respiratory organs by 7.5 cases per 100000 population ($R^2=0.7041$), while mortality from certain infectious and parasitic diseases decreased by 3.1 cases ($R^2=0.7391$). According to the hyperbolic models, every 1% increase in income resulted in a decrease of 0.45% ($R^2=0.8463$) and 0.51% ($R^2=0.9087$), respectively. This indicates that the effect is stronger at lower income levels. As income increases, the rate of decline becomes weaker. During this period, per capita income increased approximately eightfold, from USD 401.9 (AZN 320.5) to USD 3362.5 (AZN 5716.2), while mortality from these causes decreased fourfold. The increase in population income improves socio-economic conditions and, by reducing mortality, particularly among infants and children, increases life expectancy. This, in turn, gradually increases the share of diseases of the circulatory system among the causes of mortality, which are mainly characteristic of the older population (Graph 2).

Analysis of mortality by age groups showed that the share of deaths from diseases of the circulatory system increases with age. Thus, while this indicator was 1.7% among infants under 1 year of age in 2021, it reached 70.1% among the population aged over 65. Compared with 2015, as a result of improvements in socio-economic conditions and healthcare, mortality among children decreased approximately twofold among infants under 1 year of age (from 2252 to 1144), 1.7-fold among children aged 1-4 years (from 380 to 226), and 1.3-fold among children aged 4-15 years (from 401 to 319).

²³ Demographic Indicators of Azerbaijan / Statistical Yearbook. – Baku: SSC, – 2023. – 589 p. (In Aze.)



Source: Compiled by the author based on data from the State Statistical Committee^{24, 25}.

Graph 2. Graphs showing the relationships between per capita income and mortality caused by diseases of the respiratory organs (a), certain infectious and parasitic diseases (b), and diseases of the circulatory system (c) in Azerbaijan (1997-2019)

Although the absolute number of deaths from diseases of the circulatory system did not increase significantly in these age groups, their share increased as a result of the decline in deaths from other causes (Table 2).

²⁴ Population Income: [Electronic resource] / State Statistical Committee. – Baku, – 2023. URL: https://www.stat.gov.az/source/system_nat_accounts/az/032.xls (In Aze.)

²⁵ Causes of Death: [Electronic resource] / State Statistical Committee. – Baku, – 2023. URL: <https://www.stat.gov.az/source/demography/#> (In Aze.)

Table 2

**Sex and Age Structure of Deaths in the Republic of
Azerbaijan in 2015 and 2021**

<i>in 2015</i>									
Deaths by age groups	Male			Female			Total		
	Deaths from all causes, persons	Due to diseases of the circulatory system.		Deaths from all causes, persons	Due to diseases of the circulatory system		Deaths from all causes, persons	Due to diseases of the circulatory system	
		persons	%		persons	%		persons	%
under 1 year	1283	7	0.5	969	6	0.6	2252	13	0.6
1-4 years	204	5	2.5	176	4	2.3	380	9	2.4
5-14 years	233	5	2.1	168	12	7.1	401	17	4.2
15-49 years	4174	1107	26.5	2100	541	25.8	6274	1648	26.3
50-64 years	8749	4512	51.6	5341	2514	47.1	14090	7026	49.9
over 65 years	15057	10156	67.5	17065	12251	71.8	32122	22407	69.8
Total	29700	15792	53.2	25819	15328	59.4	55519	31120	56.1
<i>in 2021</i>									
under 1 year	644	12	1.9	500	8	1.6	1144	20	1.7
1-4 years	130	4	3.1	96	3	3.1	226	7	3.1
5-14 years	204	15	7.4	115	4	3.5	319	19	6.0
15-49 years	4371	1283	29.4	2422	617	25.5	6793	1900	28.0
50-64 yaş	11109	5468	49.2	7674	3322	43.3	18783	8790	46.8
Over 65 years	19797	13433	67.9	21795	15729	72.2	41592	29162	70.1
Total	36255	20215	55.8	32602	19683	60.4	68857	39898	57.9

Source: The data were calculated by A.R. Mammadova based on the table on the number and causes of deaths recorded by medical institutions obtained from the Ministry of Health of the Republic of Azerbaijan (Classification of the Main Causes of Death According to ICD-10. Total: (ICD-10 A00–T98), Diseases of the Circulatory System (ICD-10 I00–I99)).

In Azerbaijan, the age at death of the population is characterized by significant regional differences. Thus, the share of deaths from all causes occurring among people under 65 years of age was higher in the districts of Beylagan (60%), Aghsu (53%), Sabirabad (51%), Gabala (49.5%), and Jalilabad (48.3%), as well as in the city of Shirvan (48.4%) and Baku (48.1%). At the same time, approximately half of the population who died from diseases of the circulatory system in the city of Shirvan and in the districts of Gabala, Aghsu, Beylagan, and Sabirabad were also under 65 years of age. The analysis shows that in 2021, there was a certain geographical spatial dependence between the age structure of mortality by districts and the capacity of medical infrastructure. In districts with a higher capacity of outpatient and polyclinic facilities (capacity per 10,000 population), such as Zagatala (130.1) and Gakh (112.2), the level of premature mortality was low (20-27%). A moderate inverse correlation was identified between the variables ($r = -0.6$; $P < 0.05$; CI (0.1267-0.8505)). As the capacity of polyclinic facilities increases in the districts, premature deaths from all causes ($R^2 = 0.319$) and deaths caused by diseases of the circulatory system ($R^2 = 0.2151$) decrease, with a 32% and 22% dependence, respectively. This indicates that the accessibility of primary health care services and the timely implementation of preventive measures help prevent premature deaths at a young age²⁶.

The fourth chapter of the dissertation is entitled **“The Importance of Atmospheric Air Protection for Improving Human Health”**. The main objective of this chapter was to study the impact of atmospheric air pollution on population health, as well as the importance of its protection in improving human health..

In Azerbaijan, road transport and stationary sources play the main role in atmospheric pollution. In 2022, of the 930 thousand tons of harmful substances released into the atmosphere, 83% (772 thousand tons) were attributed to transport, while 158 thousand tons were released from stationary sources. The average amount of

²⁶ Mammadova, A.R. Sex, Age, and Regional Differences in Cardiovascular Diseases and Related Deaths in Azerbaijan // – Baku: Proceedings of the Azerbaijan Geographical Society, Geography and Natural Resources, – 2022. № 3 (18), – pp. 81-87. (In Aze.)

pollutants released into the atmosphere from stationary sources by region showed that, of the 174.1 thousand tons of pollutants generated during 2015-2020, 78% was generated in Baku city alone. At the same time, during this period, an average of 740 thousand cases of morbidity were registered annually across the country, of which 200 thousand cases were recorded in Baku and 117 thousand in the Absheron-Khizi economic region. It was established that diseases were observed very frequently in the Absheron-Khizi economic region (one in every five people). To assess the relationship between the occurrence of these diseases and residence in areas with a high level of anthropogenic atmospheric air pollution, relative risk indicators were calculated. As a result, a comparison of Baku city (135 thousand tons) and the Nakhchivan Autonomous Republic (10 thousand tons) showed that pollution increased the risk of morbidity by 2.5 times (CI 2.22-2.84; $p < 0.0001$)²⁷.

In the dissertation, the impact of air pollution on the health of the population of Baku was analysed by administrative districts of the city. It was established that in 2020, 121.9 thousand tons of gaseous substances were released from stationary sources, of which 14 thousand tons were nitrogen oxides, 11.4 thousand tons were carbon oxides, and 941.1 tons were sulfur anhydride. In Sabail district, which ranked first in terms of emissions of carbon and nitrogen oxides, the highest morbidity rate (1856.6 per 10000 population) was observed. In Yasamal and Nasimi districts, where pollution levels were the lowest, the indicators were two times lower than the city average. As a result, a strong and positive correlation was identified between the morbidity rate in the districts and emissions of carbon oxides ($r = +0.80$; $P < 0.005$) and nitrogen oxides ($r = +0.76$; $P < 0.005$) into the atmosphere. Regression analysis showed that an increase of 1,000 tons in pollutant emissions increases the morbidity rate by 215 and 121 cases per 10000 population, respectively. The variation in pollutants explains 65% and 59% of the variation in morbidity, respectively. At the same time, the

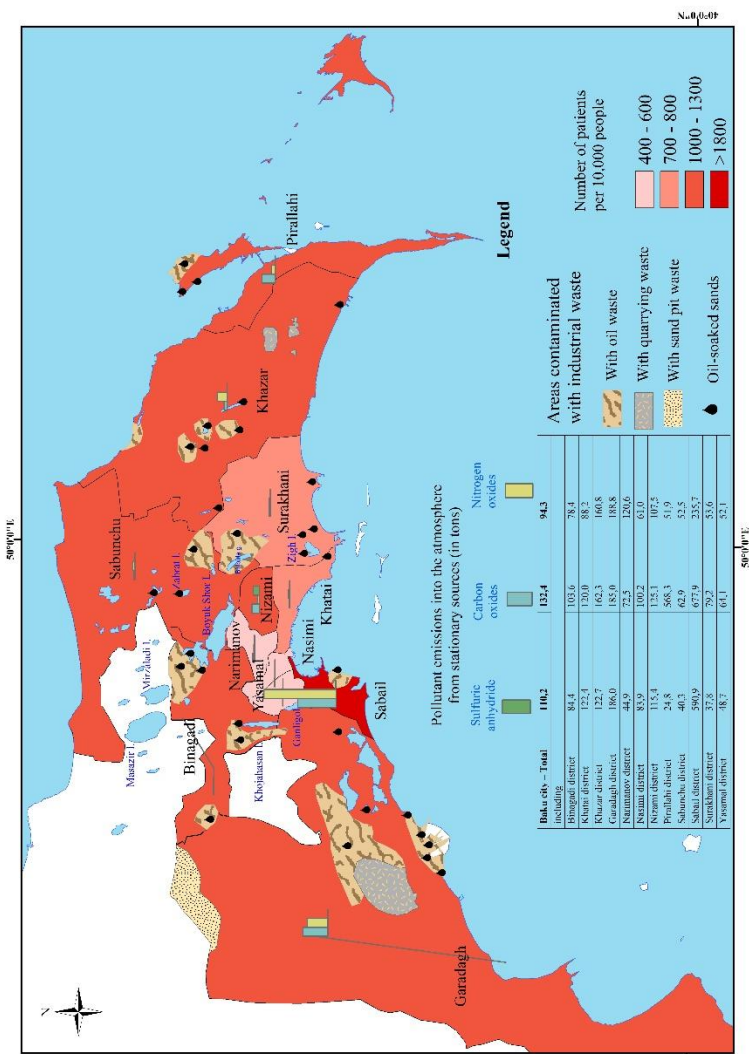
²⁷ Mammadova, A.R. Study of the Role of Atmospheric Pollution in the Geographical Distribution of Respiratory Diseases in Baku City // – Baku: Proceedings of the Azerbaijan Geographical Society, Geography and Natural Resources, – 2024. № 2 (22), – pp. 72-80. (In Aze.)

morbidity rate is high (10-12%) in districts with low population density, such as Garadagh (118 persons/km²), Khazar (455 persons/km²), and Pirallahi (687 persons/km²), as well as in districts such as Khazar, Sabunchu, and Binagadi, where the population is increasing at a high rate. An inverse relationship was identified between population density and the morbidity rate ($r=-0.6$; $P<0.005$)²⁸ (Figure 2).

In this chapter of the dissertation, the positive effects of atmospheric air protection on population health were analysed. It was established that after Azerbaijan gained independence, during the period 1990-2022, the amount of pollutants released into the atmosphere from stationary sources in the country decreased approximately 13-fold, from 2108 thousand tons to 158.5 thousand tons. On 27 March 2001, the Law “On the Protection of Atmospheric Air”, which established the legal framework for the protection of atmospheric air, was signed. Compared with 2000, the specific load of pollutants released into the country’s atmospheric air from stationary sources in the Republic was 5951.5 kg/km², while this figure decreased approximately threefold, to 1829.1 kg/km², in 2022. The application of technologies that comply with established standards has resulted in lower emissions from industrial enterprises into the environment. It was established that atmospheric air protection played a significant role in the 4.6-fold decrease observed during 1990-2022 in the number of people who died from respiratory diseases, which were the second leading cause of death among the population of Azerbaijan in 1990 and accounted for 34% (2010 people) of deaths, of whom infants under one year of age constituted the largest share.

The results show that there is a strong and positive correlation between the amount of pollutants released into the atmospheric air from stationary sources and the mortality rate per 100000 population ($r=0.83098$, $P<0.0001$). The regression equation shows that a decrease of 1000 tons in pollutant emissions reduces the mortality rate by 42 cases per 100000 population.

²⁸ Rzayeva, S.I. Assessment of the Impact of Environmental Quality on Population Settlement and Health in Baku City / S.I. Rzayeva, A.R. Mammadova, Z.A. Mirzayeva [et al.] // Regional Geosystems, Belgorod State University, – Belgorod: – 2025. № 49 (2), – pp. 375-388. (In Russ.)

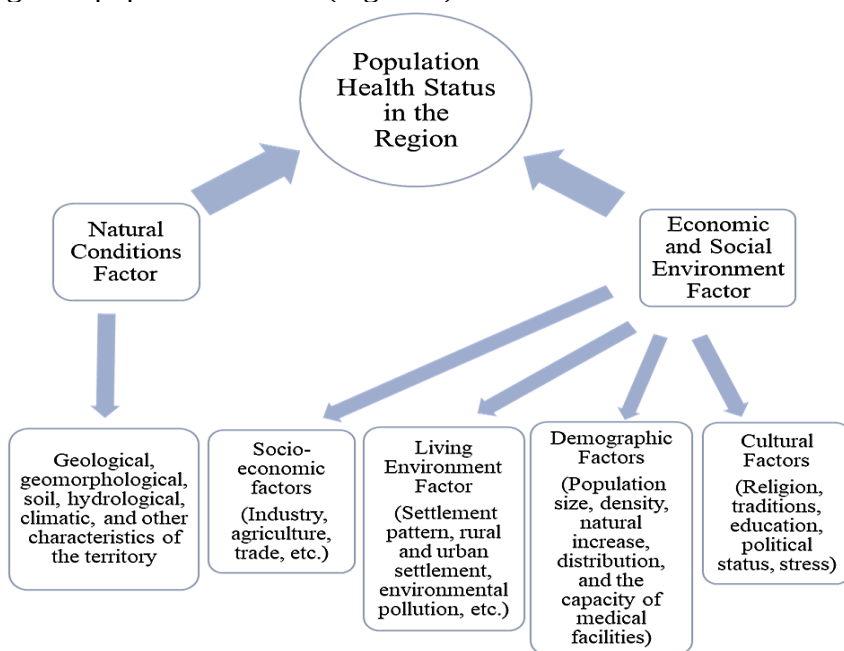


Source: Prepared by A.R. Mammadova using ArcGIS software based on data from the State Statistical Committee and the National Atlas of the Republic of Azerbaijan.

Figure 2. The impact of atmospheric pollution on population morbidity from respiratory diseases in Baku city (2020)

The variation in pollutants explains 70% of the variation in mortality indicators ($R^2=0.6906$). The reduction in the differences previously observed in the share of deaths between the urban and rural populations of the country highlights, along with environmental improvement, the influence of such factors as improved provision of medical services to the population in residential areas, improvement of housing and working conditions, migration of the population from rural areas to cities, and others²⁹.

Based on the research conducted on the impact of natural-geographical and socio-economic conditions on human health in Azerbaijan, we have proposed a geographical development model of regional population health (Figure 3).



Note: Prepared by A.R. Mammadova.

Figure 3. Geographical Development Model of Regional Population Health

²⁹ Mammadova, A.R. Dynamics of Deaths Caused by Respiratory Diseases in Urban and Rural Settlements in Azerbaijan // II International Scientific-Practical Conference “Modern Problems of Geography: Integration of Science and Education”, dedicated to the 100th anniversary of the National Leader Heydar Aliyev, – Baku: – 22 – 23 November, – 2023, – pp. 61-69. (In Aze.)

According to the conceptual model, taking natural conditions, economic and social factors into account should be one of the important steps towards improving population health. We are confident that increasing research aimed at identifying and preventing the factors contributing to the occurrence of diseases, as well as taking appropriate measures, will produce positive results. It is not easy for individuals to combat separately the many factors in the environment that cause or are known to facilitate the development of diseases. Preventive measures aimed at preventing diseases should seek to reduce current or future risks and should be among the priority directions in protecting and improving human health.

CONCLUSION

1. The results of the study of the impact of natural-geographical conditions on population morbidity from respiratory diseases show that factors such as the geographical location of the territory, elevation above sea level, relative humidity of the air, amount of precipitation, hydrological regime, and natural and anthropogenic pollution of the atmosphere cause significant regional differences in the geographical distribution of diseases. It was established that among the natural regions of the Republic, the highest incidence of these diseases was observed in the Greater Caucasus region, at 11.3% (1134.6 per 10000 population), while the lowest was recorded in the Middle Aras region, at 5.7% (567.1 per 10000 population).

2. In the Baku and Absheron-Khizi, Mountainous Shirvan, and Shirvan-Salyan economic regions of the Greater Caucasus and Kura intermontane depression natural regions, respectively, the morbidity rate from respiratory diseases decreases as the average elevation of the territory above sea level increases, whereas in the Middle Aras natural region, it increases conversely. According to the obtained coefficients of determination, there is a 71%, 65%, 81%, and 34% dependence between the variables, respectively. In the Shirvan-Salyan economic region, for every 1-meter increase in the average elevation of administrative districts, the morbidity rate decreases by

16 cases per 10000 population ($R^2=0.8098$, $p<0.0001$) [15; 19].

3. There is a clear and statistically significant relationship between living in areas with high relative humidity in the atmospheric air (75-80%) and the development of respiratory diseases. With 95% confidence, it can be stated that, due to high average annual relative humidity of the air, the risk of morbidity among the population increases 1.5-fold compared with dry areas (CI 1.3807-1.7210, $p<0.0001$).

4. During 1997-2019, every USD 1000 increase in income reduced mortality from respiratory diseases by 7.5 cases per 100000 population ($R^2=0.70$), while mortality from certain infectious and parasitic diseases decreased by 3.1 cases ($R^2=0.74$). Every 1% increase in income resulted in a corresponding decrease of 0.45% ($R^2=0.85$) and 0.51% ($R^2=0.91$), respectively. The effect is stronger at lower income levels [17].

5. The main causes of mortality among the population in the country are characterized by significant regional differences in their age structure. In the districts of Beylagan (60%), Aghsu (53%), Sabirabad (51%), Gabala (49.5%), and Jalilabad (48.3%), as well as in the city of Shirvan (48.4%) and Baku (48.1%), the share of the population under 65 years of age among deaths from all causes is high. In these areas, approximately half of the population who died from diseases of the circulatory system were also under 65 years of age. It was established that as the capacity of outpatient and polyclinic facilities increases in the districts, the share of premature deaths decreases inversely (in 2021) [6; 8; 9; 11].

6. During 2015-2020, an average of 740 thousand people with respiratory diseases were registered annually in the Republic, of whom approximately 200 thousand were in Baku city and 117 thousand in the Absheron-Khizi economic region, which are major industrial centres. Living in areas with high levels of pollutants released into the atmospheric air increases the risk of morbidity by 2.5 times (CI 2.2226-2.8396, $p<0.0001$) [14].

7. In the administrative districts of Baku city, there is a positive, linear, and statistically significant correlation between the incidence of respiratory diseases and carbon oxides ($r=0.80471$,

$P < 0.005$, CI 0.4180-0.9416) and nitrogen oxides ($r = 0.76599$, $P < 0.005$, CI 0.3514-0.932) released into the atmosphere from stationary sources. According to the regression analysis, an increase of 1000 tons in pollutants increases the morbidity rate by 215 and 121 cases per 10000 population, respectively [14; 15; 18].

SUGGESTIONS

1. Development of differentiated intervention plans based on regional risk for the prevention of morbidity among the population:

- Preparation of programs covering measures such as air quality monitoring in residential areas and public facilities in coastal settlements (particularly in the Lankaran region), strengthening state control over humidity and mould risks, monitoring the application of ventilation systems and moisture-resistant materials in new buildings, and providing financial support for the purchase of dehumidifiers and antifungal agents.

- In the Kura intermontane depression natural region (particularly in the Shirvan-Salyan economic region), regular monitoring of groundwater, renovation of collector-drainage systems, prevention of waterlogging, regular disinfection and ventilation measures in residential buildings in the Neftchala and Salyan districts, strengthening of insulation systems, and implementation of awareness-raising measures among the population on protection against mould spores.

- In the Middle Aras natural region, particularly in the Shahbuz administrative district, the implementation of climate-adapted health policies is recommended, including measures such as heating and ventilation support during the winter months, mobile medical services in mountain villages, preventive vaccination adapted to cold weather conditions, and additional pharmaceutical assistance.

2. In industrial centres, priority should be given to technologies that neutralize technogenic gases generated during production processes, the use of gas and dust-collecting devices should be expanded, and the use of electric vehicles should be encouraged to reduce carbon emissions from road transport. To address the problem,

alongside preventing anthropogenic atmospheric pollution, it is also necessary to take measures aimed at ensuring the socio-economic development of regions and preventing population migration to Baku city by addressing employment issues.

3. Large-scale programs should be implemented to prevent the “rejuvenation” of mortality from diseases of the circulatory system among the young population through promoting increased physical activity, reducing tobacco and alcohol consumption, increasing the share of fruit in the diet, and other related measures. Particularly in high-risk areas (the city of Shirvan and the districts of Beylagan, Aghsu, Sabirabad, Gabala, and Jalilabad), increasing preventive medical examinations, improving access to medical services, and establishing cardiology centres may reduce premature mortality.

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The defense will be held on 30 October 2026, at 14⁰⁰ at the meeting of the BFD 1.23 One time dissertation council established on the basis of the Dissertation council FD 1.23 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at the Institute of Geography, Public Legal Entity, Ministry of Science and Education of the Republic of Azerbaijan.

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The dissertation is accessible at the library of the Institute of Geography of the Ministry of Science and Education of the Republic of Azerbaijan.

Electronic versions of the abstract is available on the official website of the . Institute of Geography of the Ministry of Science and Education of the Republic of Azerbaijan.

The abstract was sent to the required addresses on 23 September 2026.

Signed for print: 19.09.2026

Paper format: A5

Volume: 41 147

Number of hard copies: 20