Ministry of Education and Science of Ukraine

Sumy State University

Academic and Research Institute of Business, Economics and Management

Department of Economic Cybernetics

«Admitted to the defense»
Head of Department
___________ Vitaliia Koibichuk
(signature) (First and LAST NAME)
____ ___________ 2023 p.

QUALIFICATION WORK

to obtain an educational degree bachelor
(bachelor / master)

from the specialty 051 Economics ,
(code and name)
educational-professional programs «Business analytics»
(educational-professional / educational-scientific) (the name of the program)
on the topic: Modelling of Socio-economic Consequences of Exposure to Socially Dangerous Diseases.

Student of the group AB-91a.an KUROVSKA Yuliia
(group code) (full name)

The qualification work contains the results of own research. The use of ideas, results and texts of other authors are linked to the corresponding source

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Sumy – 2023

ABSTRACT

Modern society is facing unprecedented socio-economic challenges related to epidemic diseases that affect the healthcare system. In recent years, the following diseases have been particularly relevant: COVID-19, tuberculosis, hepatitis and AIDS/HIV. COVID-19, which has been spreading rapidly over the past two years and has several types of mutations with different levels of threat to human life, has had a huge impact on both human life and the global economy. All these diseases are widespread in the European Union and have serious consequences for public health and several socioeconomic indicators.

The healthcare system and the state of health of the population depend on many factors, the functionality of which depends on their interaction. Among these factors are the social and economic development of the country, accessibility and quality of medical care, education and awareness of the population in the field of health care and some measures approved by the state to prevent and prevent various types of diseases.

The relevance of this work is that due to demographic and political changes and the increasing burden of chronic diseases, the healthcare system needs constant adaptation and improvement.

The object of the study is the current state of health care in the European Union and its morbidity.

The subject of the study is the decisions and measures taken for the timely detection, prevention and control of dangerous and epidemiological human diseases.

The purpose of the study is to study the impact of socially dangerous diseases on the indicators of the socio-economic situation of society and to improve the medical approach to addressing the challenges of the public health system.

The research tasks are:

- a study of the concept of " socially dangerous disease", its place and role in the economic environment;

- conducting a bibliometric analysis of modern scientific research in the field of health care and economics;
- formulation of research hypotheses;
- description of input variables;
- development of a mathematical model and description of methods for studying socio-economic indicators of health care using packages of applied mathematical programs;
- development of recommendations based on the results of the calculations.

Keywords: healthcare system, HIV/AIDS, COVID-19, tuberculosis, hepatitis, socioeconomic impact, socially dangerous diseases, modelling, STATA.

Based on the results of the study, the article "Theoretical Research Aspects of the Key COVID-19 Trends and Transformation of Indicators in the Healthcare Sphere" was published in the professional journal Health Economics and Management Review (Volume 4, Issue 1, 2023) [1].

This contribution was undertaken as a part of the research projects granted by the Ministry of Education and Science of Ukraine: "Socio-economic recovery after COVID-19: modeling the implications for macroeconomic stability, national security and local community resilience" (registration number 0122U000778). The results of this study will play an important role in the timely detection of new cases of coronavirus and in preventing fatalities in the future.

The content of the qualification work is set out on 61 pages. The list of references consists of 41 titles located on pages 45-49. The work contains 7 tables, 12 figures, and appendices A, B, and C.

The year of the qualifying work is 2023.

The year of the work defence is 2023.

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

SUMY STATE UNIVERSITY

Academic and Research Institute of Business, Economics and Management

Department of Economic Cybernetics

APPROVED BY

Head of Department Candidate

of Economics, Associate Professor

____________ Koibichuk V. V.

“__” ____________ 2023.

TASKS FOR BACHELOR’S LEVEL DEGREE QUALIFICATION THESIS

(specialty 051 “Economics” (Study Programme “Business Analytics”))
Student of IV course, group’s code AB-91a.an.

KUROVSKA YULIIA VLADYSLAVIVNA
(student’s full name)

1. The theme of the work is “Modeling of Socio-economic Consequences of Exposure to Socially Dangerous Diseases” approved by the order of the university from “_15_” ___June___2023 year № 0674-VI.
2. The term of completed paper submission by the student is “16” June 2023 year.
3. The purpose of the qualification work is is to study the impact of socially dangerous diseases on the indicators of the socio-economic situation of society and to improve the medical approach to addressing the challenges of the public health system.
4. The object of research is the current state of health care in the European Union and its morbidity.
5. The subject of the research is the decisions and measures taken for the timely detection, prevention and control of dangerous and epidemiological human diseases.
6. The qualification paper is carried out on materials of pre-diploma practice
7. The indicative plan of qualification work, terms of submission of the chapters to the research advisor, and the content of tasks for the performance of the set purpose is as follows:

Chapter 1. Theoretical and methodological foundations for assessing the socio-

economic impact of the healthcare system
Section 1 discusses the theoretical and methodological aspects related to the healthcare system's impact on the European Union's socioeconomic indicators. A review of recent research and publications on the selected topics is made to confirm the relevance of the chosen topic. Also, analysis and review of the four studied deadly diseases and their statistical indicators were conducted to more accurately assess their impact on society's economic situation.

Chapter 2 covers all aspects related to the practical part of modelling the socioeconomic impact of the consequences of deadly diseases. The input panel database is developed, the most significant components are estimated using the principal components method, and panel regression is performed to determine the degree of influence of independent variables on dependent variables.

8. Supervision on work:

Chapter	Full name and position of the advisor	Date, signature	
		task issued by	task accepted by
1	Didenko I.V., Senior Lecturer at the Department	05.04.2023	05.04.2023
2	Didenko I.V., Senior Lecturer at the Department	17.04.2023	17.04.2023

9. Date of issue of the tasks: “03” 04 2023 year

Research Advisor (signature) __Didenko I.V.___ (full name)

The tasks have been received (signature) __Kurovska Y.V.__ (full name)

CONTENT

INTRODUCTION

In the modern world, socially dangerous diseases pose a serious challenge to society and the economy. Their spread and impact on socio-economic processes are becoming a subject of increasing interest to researchers and are becoming central to modelling. Socially dangerous diseases, such as epidemics, pandemics, and other mass diseases, can have a significant impact on public health, the healthcare system, economic development, labor markets, trade flows, financial markets, and other aspects of the socioeconomic sphere. Given the scale and consequences of such diseases, it is important to have tools that allow for predicting and assessing their socioeconomic impact.

One of the key aspects of studying the socio-economic impact of these diseases is their modelling. Modelling allows us to understand and predict the impact of these diseases on various aspects of social and economic life. Models of the socioeconomic impact of socially dangerous diseases include the analysis of the relationship between diseases and such factors as the overall economic situation, employment, public health, education, access to healthcare services, and many others.

In this study, we will review various methods of modelling the socioeconomic impact of socially dangerous diseases and their use to analyze the impact on society and the economy. Research in this area is important for understanding the challenges faced by modern societies and developing effective strategies to manage these challenges.

CHAPTER 1. THEORETICAL AND METHODOLOGICAL FOUNDATIONS FOR ASSESSING THE SOCIO-ECONOMIC IMPACT OF THE HEALTHCARE SYSTEM

1.1 The concept of "fatal disease": place and role in the economic environment

In the era of globalization, health issues play an important role in many aspects of life, including economic development. The term "fatal disease" refers to a disease that is incurable or difficult enough to treat that it can lead to the patient's death [1]. In this context, it is important to understand the place and role of these diseases in the economic environment. In the context of this study, we consider such common socially dangerous diseases as HIV/AIDS, hepatitis, tuberculosis, and COVID-19.

The graph below (Fig. 1.1) shows the most dangerous diseases for humanity in 2019:

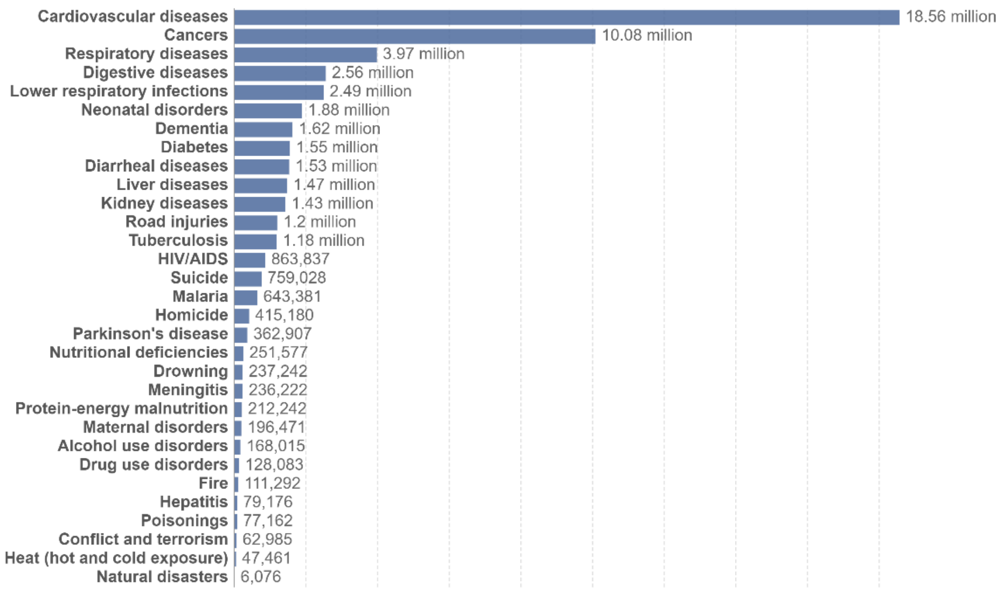


Fig. 1.1 – Number of deaths by cause, mln pers.

Source: IHME, Global Burden of Disease (2019) [1]

According to the data presented, tuberculosis ranks 13th, HIV/AIDS - 14th, and hepatitis 27th in terms of the number of deaths. Since the first cases of coronavirus were recorded only at the end of 2019, it was not included in this chart. Nevertheless, the problem of COVID-19 incidence is still relevant for the entire humanity, so the analysis of the virus behavior, ways of its spread, and methods of treatment and prevention should be analyzed and improved.

The first disease studied in this research is HIV/AIDS. Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) are serious chronic diseases that affect the human immune system and eventually weaken it, making the body vulnerable to various infections and diseases. The virus affects almost all vital organs, which often leads to the development of cancer. Since the immune system under the influence of the human immunodeficiency virus is completely unable to counteract external stimuli, it begins to destroy the patient's cells, mistaking them for other people. The main danger of HIV/AIDS is that in some cases, after infection, the disease does not produce any symptoms and the patient may not realize his or her diagnosis for years.

HIV is most often spread mainly through unprotected sexual contact, through the exchange of infected blood, or from mother to child during pregnancy, childbirth, or breastfeeding. The virus can be transmitted through the sharing of infected needles by sharing needles or syringes with an infected person. This is especially true for injecting drug users.

Ukraine has a leading position in terms of the number of HIV-infected people among all European Union countries. In January-October 2021, according to the Center for Public Health of the Ministry of Health of Ukraine, 12,626 cases of HIV infection were recorded in Ukraine. During this period, 3,496 AIDS cases and 1,584 AIDS-related deaths were registered in Ukraine. There were also 28 cases of HIV infection among foreigners living in Ukraine. The highest prevalence of HIV infection was found in Odesa, Dnipro, Mykolaiv regions, the city of Kyiv, Kyiv, Kherson, and Chernihiv regions [2]. As of January 4, 2023, 157,992 people living with HIV were under medical supervision in healthcare facilities, which corresponds to 385.2 people per 100,000 population. According to official registries, the highest

HIV prevalence rates per 100,000 people were recorded in Odesa (150.6), Dnipro (955.9), Mykolaiv (747.4), Kherson (442.9), Kyiv (458.4), Chernihiv (432.0) regions and the city of Kyiv (633.3) [3].

These data demonstrate the importance of taking measures to prevent and control the spread of HIV in Ukraine and ensure adequate medical care for people living with HIV, by developing vaccination programs, supporting social services and raising public awareness.

In the context of global prevalence, HIV/AIDS is most prevalent in countries with low living standards, socioeconomic inequality, limited access to healthcare, high unemployment and low levels of education. These countries face numerous challenges, including socioeconomic factors, limited access to education and health services, sexually transmitted infections, and cultural norms. According to official UNAIDS data, 38.4 million people worldwide were living with HIV as of 2021, 8.7 million people had access to antiretroviral therapy, and only 650,000 died from AIDS-related illnesses. Since the beginning of the coronavirus pandemic, 84.2 million new HIV cases and 40.1 million deaths from AIDS-related diseases have been detected [4].

The next disease to be studied is COVID-19, which was first detected in China in late 2019 and has since spread rapidly around the world. The pandemic was officially declared by the World Health Organization in March 2020. The coronavirus has forced millions of people to adapt to new life realities and has challenged the World Health Organization.

Symptoms of COVID-19 range from mild cold or flu symptoms to severe respiratory illness, but some people may be asymptomatic. The elderly and people who already had certain chronic illnesses or weak immune systems at the time of the virus detection are at the highest risk of morbidity and ongoing complications. The coronavirus can seriously damage the heart, lungs, brain, kidneys, blood vessels, and other vital organs and systems, leading to high mortality. Complications can occur after both severe and mild forms of COVID-19, so it is difficult to predict the behavior of the virus and its impact on the human body.

The development and introduction of COVID-19 vaccines have played an important role in the fight against the pandemic. Various vaccines have been developed and used around the world to protect the public and limit the spread of the virus. Prevalence and mortality depend on many factors, such as availability and access to testing and vaccination, adherence to isolation and minimum personal hygiene practices, etc. As the virus is airborne, protective and hygiene equipment and its proper use can have a significant impact on the spread of COVID-19.

While it is impossible to single out specific regions and countries that are most affected by COVID-19, countries with high population densities, complex socioeconomic structures, and limited access to healthcare have higher morbidity and mortality rates than countries with smaller demographics, stable healthcare systems, and more stringent quarantine measures. Globally, as of June 12, 2023, there were 767,984,989 confirmed cases of COVID-19, including 6,943,390 deaths reported by WHO. As of June 10, 2023, a total of 13,396,701,847 doses of vaccines have been administered [5].

Fig. 1.2 shows the percentage of the population of the United States, Europe, and the world who have received their primary dose of coronavirus vaccination from December 2020 to the present day. Achieving high vaccination rates in all countries is essential to successfully responding to the challenges posed by COVID-19, and international cooperation and vaccine distribution is an important step in this direction.

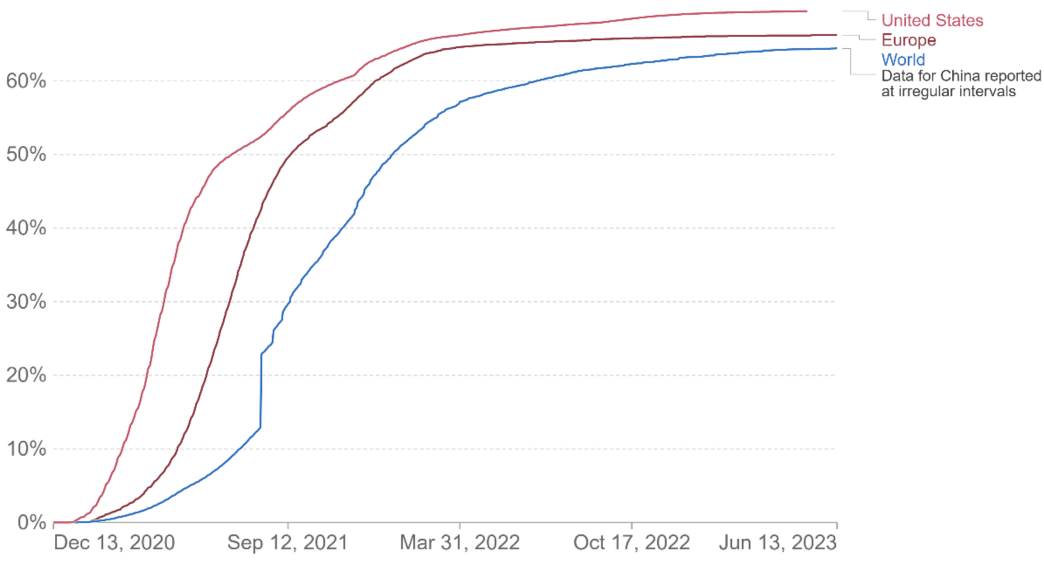


Fig. 1.2 – Share of people who completed the initial COVID-19 vaccination protocol during 2020-2023, percent.

Source: Official data collated by Our World in Data [6].

As we can see from this graph, more than 64.42% of people worldwide, 66.23% of the European Union population, and 69.46% of the US population are fully vaccinated, which indicates a fairly high level of awareness of the health consequences of COVID-19. Vaccination is an important step in the fight against the pandemic and a means of gradually restoring normal social, economic and cultural life.

When talking about diseases that affect respiratory functions and lungs, it is impossible not to mention tuberculosis, which is one of the most common infectious diseases in the world. Like COVID-19, it is transmitted by airborne droplets through coughing, sneezing, or sharing household items with an infected person.

The category of people at increased risk of contracting Mycobacterium tuberculosis (TB) or developing the disease after infection includes:

- HIV-positive people;
- alcohol and drug addicts;
- homeless people;

- immigrants from regions with a high prevalence of tuberculosis;
- persons with immunodeficiency conditions, including those receiving immunosuppressive therapy;
- persons who have recently been in contact with patients shedding Mycobacterium tuberculosis (MTB), as confirmed by smear microscopy;
- persons with "minimal" changes in the lungs, which are detected by chest X-ray;
- persons taking tumor necrosis factor (TNF) inhibitors or other biological products with immunosuppressive effects;
- smokers or persons with a history of smoking (with a slight increase in the risk of disease);
- persons with a body mass index (BMI) ≤ 20 kg/m^2 [7].

TB mainly affects the lungs, but can also affect other organs of the body, including the kidneys, brain, and bones, depending on the severity and form. The early symptoms of pulmonary tuberculosis can vary and are often only detected by an X-ray during a routine checkup or a test for a completely different disease. Symptoms of this disease include a dry, long-lasting cough, headache, weakness, loss of appetite, night sweats, skin discoloration, fever, swollen lymph nodes, and fatigue. In severe cases, if the infection spreads beyond the lungs, different symptoms may appear, depending on the affected organ.

Diagnosis of pulmonary tuberculosis is an important part of a broader effort to reduce infection, morbidity, disability and death from this serious disease. Detection can be based on several symptoms that can point investigators in the right direction and allow for early treatment. While identifying patients with symptoms is an important goal, early detection is not enough, as early-stage pulmonary TB can be asymptomatic. One of the most common practices for diagnosing tuberculosis is the Mantoux test for children from the age of one, which determines the presence of mycobacteria in the body.

The graph below (Fig. 1.3) shows the percentage of one-year-olds who have received tuberculosis vaccination around the world as of 2021. As we can see, in most countries this percentage is close to 100. Low rates of TB vaccination can be observed in different countries for various reasons, such as weak healthcare infrastructure, lack of adequate access to the vaccine, difficult economic situation and underdevelopment, lack of education and awareness of the importance of vaccination, etc. All these factors have a significant impact on the spread of the virus, so current efforts by national and international TB organizations are aimed at raising awareness, improving access to vaccines, and strengthening health systems to achieve higher vaccination rates.

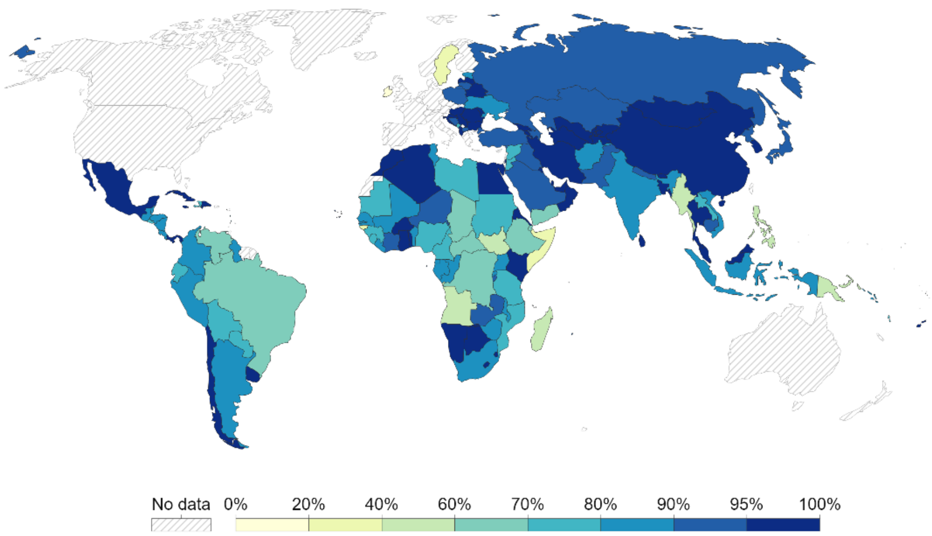


Fig.1.3 – Share of one-year-old vaccinated against tuberculosis in 2021, percent.

Source: WHO; UNICEF (2022) [8]

In 2020, about 9.9 million new cases of tuberculosis were reported worldwide, which is about 127 cases per 100,000 people. The highest number of new cases was reported in Southeast Asia (43%), Africa (25%) and the Western Pacific (18%). The global incidence of drug-susceptible tuberculosis and deaths from the disease are slowly declining. The overall percentage decrease between 2015 and 2019 was 9%

(142 to 130 new cases per 100,000 population), including a 2.3% decrease between 2018 and 2019. These trends are likely due in part to international TB control efforts that have provided access to TB and HIV treatment for more people. However, the global COVID-19 pandemic that broke out in 2020-2021 has affected other public health programs, including TB control. [9].

The next disease studied in this paper is hepatitis. In 2016, scientists from Imperial College London and the University of Washington conducted a large international study, which found that hepatitis mortality is comparable to tuberculosis, malaria, and HIV [10]. Hepatitis is an inflammatory liver disease caused by various viruses or other factors. There are several types and genotypes of hepatitis, including hepatitis A, B, C, D, and E, each with its characteristics and modes of transmission.

Hepatitis A: The infection enters the human body through the consumption of food or water contaminated with infected faeces, as well as through close contact with a patient. Once infected, a person becomes immune to hepatitis A for life. In many cases, the disease is almost or completely asymptomatic, especially in children and young people. Symptoms of hepatitis A include severe generalized weakness and increased fatigue and body temperature, loss of appetite, diarrhea, vomiting, darkening of the urine, and jaundice [11]. Hepatitis A can cause mild or severe illness but usually does not lead to chronic infection.

Hepatitis B: The virus is transmitted by contact with infected blood, sexual contact, mother-to-child transmission at birth, injecting drugs with contaminated needles, or through medical equipment. Sources of infection are patients with acute and chronic forms of hepatitis, as well as patients with asymptomatic disease. The primary signs of hepatitis B are similar to hepatitis A. Compared to hepatitis A, hepatitis B is more likely to be moderate to severe and has more severe liver dysfunction. It is characterized by a more frequent occurrence of cholestatic syndrome, exacerbations, prolonged course, relapses and the development of hepatic coma. About 10% of patients with acute hepatitis B progress to an active or persistent chronic form, which can eventually lead to cirrhosis [12].

Hepatitis C: Transmitted through contact with contaminated blood, i.e., the hepatitis C RNA virus, which can only parasitize the human body and non-sterile instruments. Hepatitis C is often asymptomatic, but chronic infection can lead to progressive fibrosis, cirrhosis, and liver cancer. The main symptom on objective examination is a moderate enlargement of the liver. Fatal bleeding is likely to occur due to dilated esophageal and gastric veins [13]. Currently, there is no vaccine against hepatitis C, so the prevention of infection is to reduce the risk of infection.

Hepatitis D: Occurs in the human body only in the presence of the hepatitis B virus and is often a complication of it. This type of hepatitis is characterized by acute development and massive liver damage. The source of hepatitis D is usually a virus carrier or a sick person. Infection occurs when the virus enters the bloodstream. Hepatitis D can be recognized by the following symptoms:

- general weakness and fatigue;
- fever;
- jaundice;
- palmar erythema and spider veins;
- ascites and edema [14].

Hepatitis E: Hepatitis E is most found in East and South Asia and African countries. The spread of the disease occurs in economically underdeveloped and middle-income countries with limited access to water, sanitation, hygiene, and health care services. In some cases, outbreaks of hepatitis E occur in areas of conflict and humanitarian emergencies, such as armed conflict zones or refugee camps. Symptoms of hepatitis E are similar to those of hepatitis A, and the transmission route of the hepatitis E virus is similar to that of hepatitis A. The virus is spread in the environment through the faeces of an infected person and enters the human body through digestion. The main way of transmitting hepatitis E is through contaminated drinking water. The infection is usually benign, and patients recover within 2-6 weeks. However, in some cases, acute liver failure can occur, and the disease can be severe, increasing the risk of death [15].

As you can see, hepatitis has a similar clinical picture but differs in its causes, form of infection, pathological changes in the body, and prognosis for the patient. Even though anyone can be at risk of hepatitis, it is enough to follow basic personal hygiene rules for prevention. Hepatitis vaccination is an effective means of preventing and controlling these infectious diseases. The most common practice of hepatitis prevention is the vaccination of newborns, which is carried out at 1 day of life, 2 and 6 months.

Figure 1.4 shows the global statistics of one-year-olds vaccinated against hepatitis B in 2021.

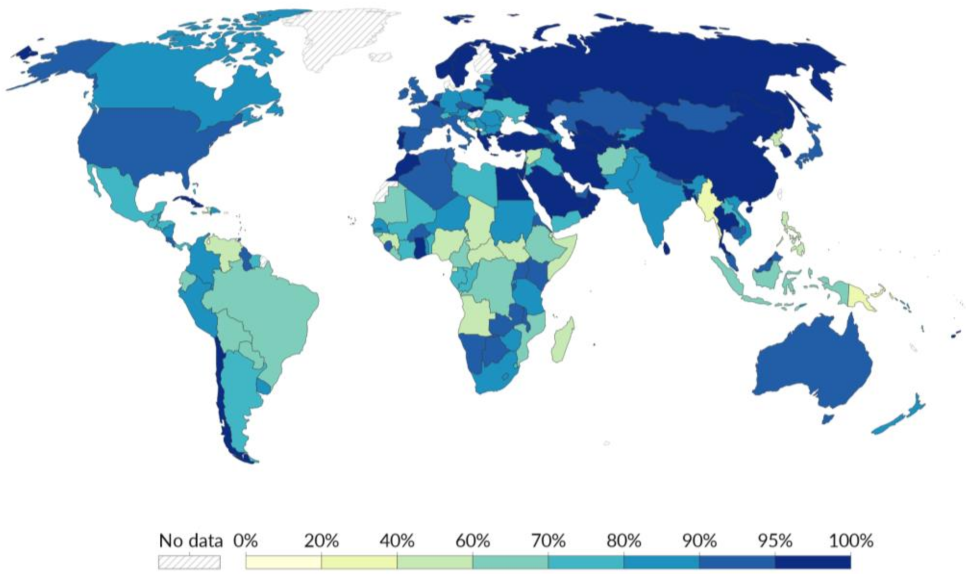


Fig.1.4 – Share of one-year-old vaccinated against hepatitis B in 2021, percent.

Source: WHO, UNICEFF (2022) [16]

As we can see, in most countries this indicator is close to 100%, which indicates high awareness and information of the population about the danger of the disease. Data on the number of childhood vaccinations against hepatitis B are not available in most Nordic countries, except Sweden, as this vaccine is not yet included in the general newborn vaccination program, although it is provided to high-risk groups. Vaccination is an important step in maintaining health and preventing the spread of hepatitis.

In November 2019, Ukraine joined the Global Strategy for the Elimination of Viral Hepatitis B and C and approved the State Strategy for Combating HIV/AIDS, Tuberculosis and Viral Hepatitis until 2030. According to government experts, 5% of Ukraine's population is infected with viral hepatitis C (3.6% have a chronic form), and 1.5% with viral hepatitis B. However, many patients are unaware of their condition and do not receive the necessary treatment. The total number of people infected with HCV is 1,342,418, and the total number of people infected with HBV is 559,341. However, as of January 1, 2021, only 92,591 people are under medical supervision for detected HCV antibodies (markers), and 18,433 people are under medical supervision for HBV markers. In 2020, 631,500 tests for HCV markers were performed, and 19,840 (3.1%) of them were positive for HCV antibodies. It should be noted that most people with HCV markers did not have a confirmed diagnosis and were not included in official statistics and medical surveillance. Of the 19,840 people with detectable HCV antibodies, only 3,474 had a confirmed diagnosis of chronic HCV. The situation with hepatitis B is similar [17].

The study and improvement of prevention and treatment of tuberculosis, hepatitis, HIV/AIDS and coronavirus are of great importance for humanity and its position in society. Since the mortality rate from these diseases remains quite high, it directly affects the socio-economic and demographic indicators of the state. This also shows that the healthcare system and organizations fighting these diseases should continue to research them to prevent new outbreaks and protect society from mass diseases. Scientific progress in the medical field will allow for the development of new and more effective vaccines, medicines, and prevention methods.

1.2 Bibliometric analysis of modern scientific research in the field of health care and economics

The economic and healthcare sectors are closely interconnected and have a significant impact on each other's performance. The healthcare sector is recognized as an important sector of the economy that contributes to public health and ensures the sustainability of socio-economic development. To confirm the trends outlined in this study, we analyzed publications from 2000 to 2022 using keywords such as "healthcare" and "economy". A total of 2,698 documents were found. Figure 1.5 shows the number of documents related to the topic of healthcare and economy.

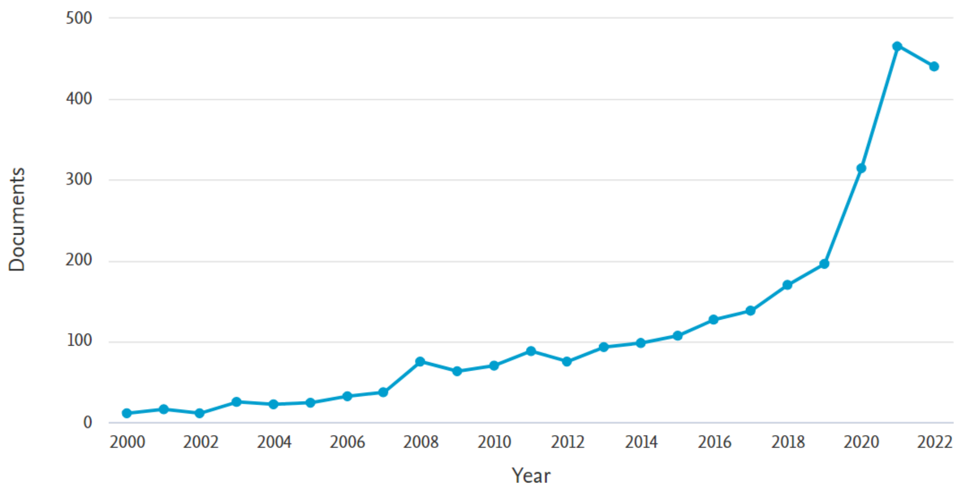


Fig 1.5 – Dynamics of publications by the keywords "healthcare" and "economy" according to the Scopus scientometric database in 2000-2022.

Source: Scopus

Based on the data presented in Figure 1.5, it can be noted that health and economic issues have shown a generally gradual increase throughout the analyzed period. Since 2017, we can observe an upward trend in the number of publications per year, from about 120 to 200. The highest number of publications on this topic was in 2021, namely 466.

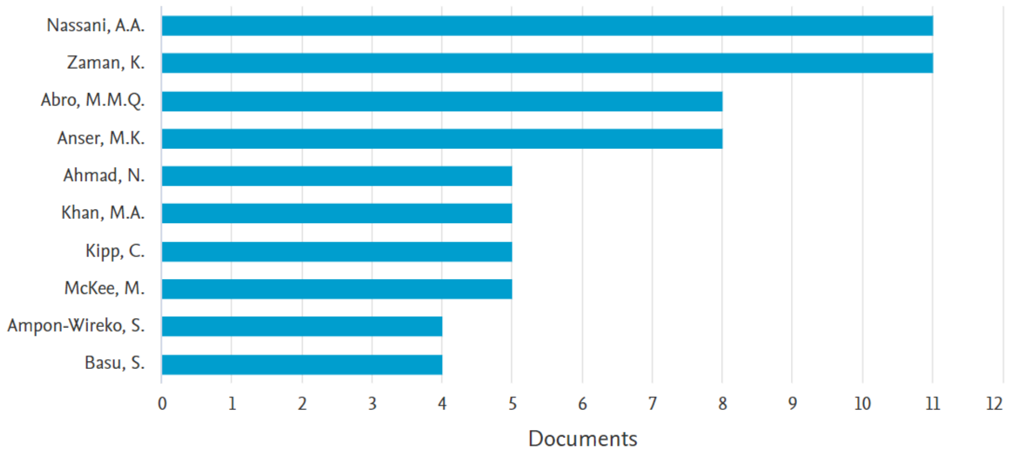


Fig 1.6 – Dynamics of the number of publications by authors on healthcare and economics in the Scopus database in the period 2000-2022

Source: Scopus

Figure 1.5 shows the researchers by the number of publications on the subject matter in the Scopus scientometric database. In particular, Nassani A. from King Saud University (Riyadh, Saudi Arabia) has 11 publications, most of which are in the areas of environmental science, medicine, economics, econometrics and finance. Together with Zaman K. and others, in his paper "Identifying the Potential Causes, Consequences, and Prevention of Communicable Diseases (Including COVID-19)" [18], the author argues that high population density, lack of primary handwashing facilities, use of chemicals in production, combustion of fossil fuels with emissions of harmful substances and high poverty significantly increase the spread of infectious diseases, while population distribution, low carbon concentration in the air, and use of renewable energy sources help to reduce the spread of diseases.

In this work, it is also quite appropriate to analyze the general list of keywords that appear in the selected scientific publications. Using the VOSviewer software, we created six clusters of keywords that are the most common in scientific papers for the period from 2000 to 2022 (Fig. 1.7). In this example, we will consider the three largest of them.

The largest cluster is red, which contains 285 keywords, including "economic aspect", "health services", "questionnaire", "medical education", etc. That is, this cluster can be described as the one that summarizes the impact of the health care system and its components on the economy.

The next largest cluster is the green cluster, consisting of 218 keywords. It includes such concepts as "clinical study", "hospitalization", and "health care cost", which summarizes this cluster as one that mediates the analysis of the domestic medical system and its activities.

The third largest cluster contains 190 words, including such concepts as "COVID-19", "prevention and control", and "epidemiology". This allows us to summarize the blue cluster as summarizing the analysis and impact of various types of diseases on global social indicators.

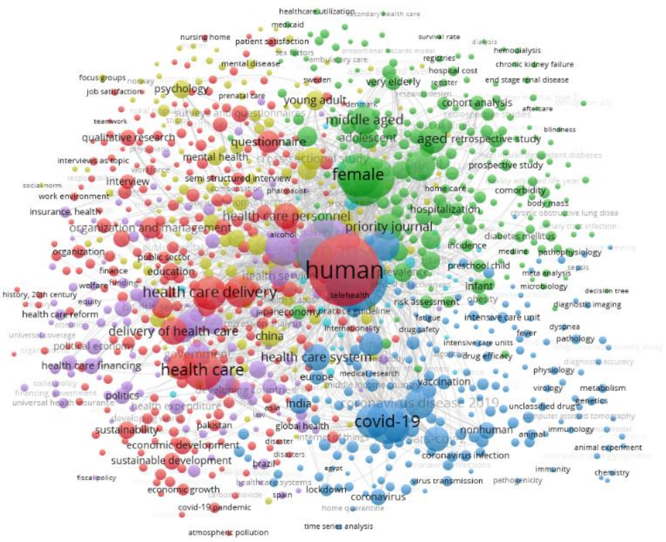


Fig. 1.7 – Bibliometric analysis of keywords that simultaneously occur in publications indexed in the Scopus scientometric database for the queries "healthcare" and "economy". VOSviewer

Source: Scopus, VOSviewer

Fig. 1.8 shows the development of scientific publications on the selected topic during the period from 2000 to 2022, which were published in the Scopus scientometric database.

Since 2018, the most commonly used concepts in scientific papers have been those related to the economy and its statistical indicators, which are indicated in purple and blue in the figure. From 2019 to 2020, scientists began to actively study the healthcare system, its accessibility, internal components, principles of operation and development. In 2021, active research on the coronavirus, its mutations, diagnosis, and prevention of the disease began.

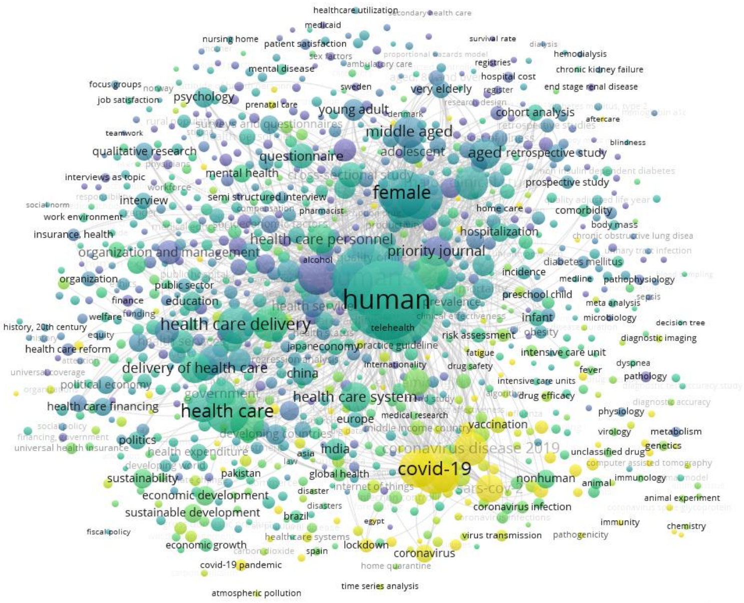


Fig 1.8 – Bibliometric analysis of keywords that simultaneously occur in publications indexed in the Scopus scientometric database for the queries "healthcare" and "economy". VOSviewer

Source: Scopus, VOSviewer

Thus, the bibliometric analysis of scientific publications confirmed both the relevance of this study and the impact of the healthcare system on the socio-economic indicators of countries in the global community.

1.3 Formulation of research hypotheses

To effectively combat the spread of deadly diseases, many measures must be taken to ensure that society is sufficiently aware of the dangers and has the necessary access to medical care.

The physical health of the population is of great social and economic importance for any country. Serious and socially dangerous diseases lead to shorter life expectancy, disability and demographic changes in general. This has consequences in the form of disability, which negatively affects the quality of life of the population and the socio-economic development of society. It is also worth noting that the diseases studied in this paper entail huge costs for health care, treatment and patient care. Research in this area will help to assess the economic burden of incurable diseases and develop effective strategies to address the problem of healthcare costs.

Research on deadly diseases and their impact on the economy will help to better understand the scale of the problem, identify key factors that affect the incidence and effective management of these diseases, and develop strategies and measures for their prevention, control and treatment. This can help optimize healthcare system costs, improve the quality of medical care, reduce the burden on the state's financial sector, and contribute to the improvement of society.

Thus, research on deadly diseases and their economic impact is important for developing effective prevention and control strategies, achieving sustainable economic growth and improving the quality of life.

Based on observations and analysis of research publications, the following two research hypotheses were identified:

1. Socially dangerous diseases have a negative statistically significant impact on socioeconomic indicators.
2. The COVID-19 pandemic has a weaker statistically significant impact on socioeconomic indicators.

CHAPTER 2. BUILDING A MATHEMATICAL MODEL OF THE INTERACTION BETWEEN THE HEALTH CARE SYSTEM AND THE LEVEL OF ECONOMIC DEVELOPMENT OF THE COUNTRY.

2.1 Description of input variables

A key stage of economic modelling is the selection of a data set for further analysis. In this paper, we use panel data because they have several advantages over univariate data in the context of this study.

First, panel data provide more information because they contain many observations. Such data are characterized by a large variation and less collinearity between the explanatory variables, which allows for more efficient parameter estimation. In addition, more informative data contribute to more reliable parameter estimates.

Secondly, panel data allow us to study the dynamics of changes in individual characteristics of the population units. They can be used to explain variations in the behavior of different units of the population and to determine the reasons that lead to different changes in the behavior of a unit of the population in different periods.

Thirdly, the use of panel data avoids the bias that can arise from data aggregation, as panel data are collected at the micro level and can be measured more accurately than similar variables collected at the macro level. When analyzing time series, panel data allow us to study the change in the characteristics of a certain representative unit of the population over time, while spatial data do not take into account the invisible individual characteristics of the population units [20].

For this study, socio-economic statistics from 34 European Union countries were selected as dependent variables, and morbidity, mortality, and other relevant data for the selected deadly diseases COVID-19, HIV/AIDS, tuberculosis, and hepatitis. The full table with calculations is blurred in Appendix B.

Table 2.1 summarizes the indicators described above.

Table 2.1 – Description of indicators

№	Variable	Indicator	Unit of measure
1	Birth_rate	Birth rate, crude (per 1,000 people)	Units
2	Age_dep	Age dependency ratio (% of working-age population)	%
3	Health_exp	Current health expenditure (% of GDP)	%
4	Death_rate	Death rate, crude (per 1,000 people)	Units
5	Life_exp	Life expectancy at birth, total (years)	Units
6	Tot_popul	Total population, mln	Units
7	GDP	GDP, bln	Units
8	Inf_rate	Inflation rate, %	%
9	Conf_cases	Confirmed cases of COVID-19, mln	Units
10	Conf_deaths	Confirmed deaths of COVID-19, ths	Units
11	Case_fatal	Case fatality rate of COVID-19, %	%
12	New_HIV	New HIV diagnoses, ths	Units
13	Death_HIV	Death rate from HIV/AIDS (per 1,000 people)	Units
14	Posit_HIV	Incidence of tuberculosis (per 100 000 population) (HIV-positive cases)	Units
15	Death_tuberc	Number of deaths due to tuberculosis	Units
16	Incid_tuberc	Incidence of tuberculosis (per 100 000 population per year)	Units
17	Cases_tuberc	Tuberculosis new and relapse cases, ths	Units
18	Prev_tuberc	Previously treated cases, excluding relapse, ths	Units
19	Incid_hepB	Incidence rate of hepatitis B (per 100 000 population)	Units
20	Death_hepB	Death rate (per 100 000 population)	Units
21	Immuniz_hepB	Immunization, HepB3 (% of one-year-old children)	%

Source: developed by the author based on [20 – 26].

Let's analyze the panel data set using descriptive statistics for all variables (Figure 2.1). According to the results, we can note that the distribution of variables is asymmetric and not close to the norm. This also indicates that our study involves different countries with different socioeconomic indicators. Some of the analyzed European Union countries have very high economic development, while others still need changes in their internal structures to reach this level of maturity.

Variable	Obs	Mean	Std. Dev.	Min	Max
year	238	2018	2.004215	2015	2021
id	238	17.5	9.831384	1	34
Birth_rate	238	9.961723	1.376729	6.8	14.9
Age_dep	238	52.8663	4.674776	41.94	63.12
Health_exp	233	8.582747	1.893617	4.9	13.2
Death_rate	238	11.15912	2.782216	6.3	22.34
Life_exp	238	79.08042	3.559258	68.8	83.97
Tot_popul	238	17.27367	22.17262	.330815	83.2
GDP	238	543.2417	868.2522	7.75	3600
Inf_rate	238	1.932059	3.709043	-1.74	48.7
Conf_cases	238	.877265	1.709966	.000197	13.44
Conf_deaths	238	18951.73	33992.94	0	176813
Case_fatal	238	2.612731	2.228575	0	17.11
New_HIV	231	1.334961	2.782281	.012	16.256
Death_HIV	204	1.159853	2.387257	0	13.3
Posit_HIV	238	1.182122	3.27906	0	20
Death_tuberc	238	254.6765	702.064	2	5000
Incid_tuberc	238	17.1521	21.45497	2.1	102
Cases_tuberc	235	2.338613	4.668121	0	30.151
Prev_tuberc	235	.1985021	.6562062	0	5.153
Incid_hepB	183	218.6126	110.3962	78.82	578.97
Death_hepB	194	.0515464	.0619098	0	.38
Immuniz_hepB	199	90.38191	10.09575	22	99

Fig. 2.1 – Descriptive statistics of socio-economic indicators

Source: own calculations with the help STATA

2.2 Development of the mathematical model and description of research methods

To analyze panel data and determine the degree of relationship between the factor variables and the dependent variable, a regression model of type (1) is used.

$$y_{it} = \alpha + X^{*}_{it}\beta + v_{it}, i = 1,...,N; t = 1,...,T \quad (1)$$

where i is the serial number of the research object;

t – research period;

α – a free term;

β – vector of coefficients of dimension $K \times 1$;

X^*_{it} – vector-row of the matrix K of explanatory variables;

v_{it} – regression error.

$$v_{it} = u_i + \varepsilon_{it}, \tag{2}$$

where u_i – where are the individual effects of observations;

ε_{it} – the model residuals.

When analyzing panel data, it is important to keep in mind that the individual effects of the observations are not part of the model but are simply random components of the regression model. Two main types of models can be used in panel data analysis: The fixed Effects model and Random Effects model.

A fixed effects model assumes that each factor variable is not random but is included in the model after a detailed study of the phenomenon. Each variable has its unique impact on the outcome variable. A fixed-effects model uses only those factors that are taken into account in the study.

A random effects model selects a certain set of indicators from a large set of variables that are used for further research. This model considers the possible random effects of those indicators that were excluded from consideration. This approach is used when the random effects are not correlated with the regressors.

To determine which type of model is best suited for a set of panel data, special criteria are used, such as the Wald test, the Breusch-Pagan test, and the Hausman test [28]. These tests help determine which type of model is best suited to analyze a given data set.

In addition to the difficulties associated with collecting the necessary input information and possible errors, it is sometimes difficult to choose a set of input variables that best describes the phenomenon under study. To solve the problem of redundancy of input information and select the most important factors of the study, a special tool is used - the principal component method.

The essence of this method is to identify groups of variables that have hidden relationships with each other and can explain the object under study from a certain functional position. Thus, the principal components method allows you to select and identify components and determine their level within specific units of the data set. Since this method allows you to identify hidden relationships between variables, the value of the components is purely hypothetical [28]. The relationship between the original variables and the extracted components is expressed as (3):

$$z_i = \sum_{1}^{m} a_{ij} G_j \quad (3)$$

where z_i – the standardized values of the i-th trait with unit variances;

m – the total number of studied features;

a_{ij} – the factor load of the j-th component on the i-th feature.

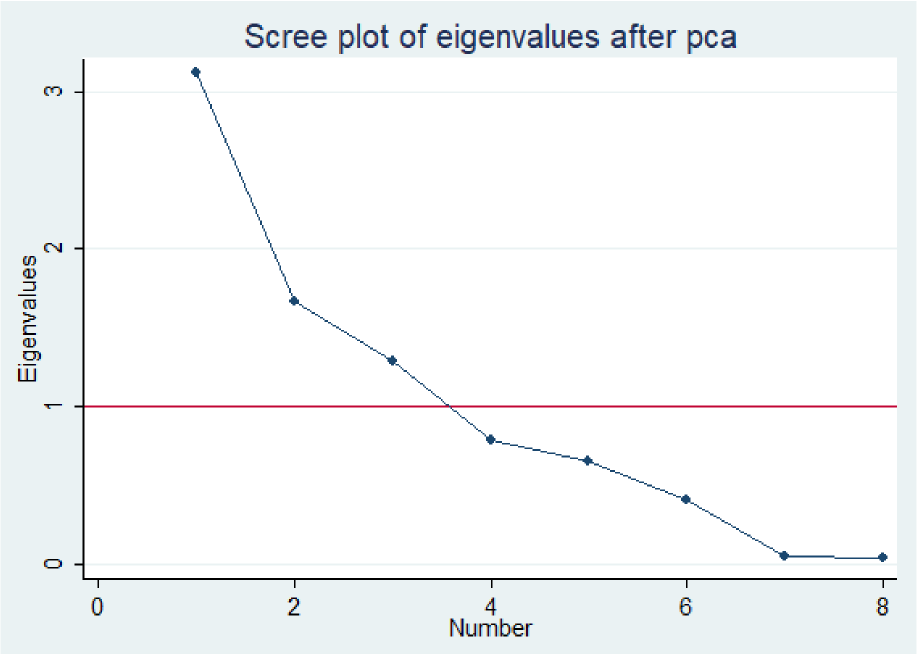
To select the most influential indicators using the principal components method, we use the statistical package STATA. The results are presented in Table 2.2.

Table 2.2 – Eigenvalues and the proportion of total variance accounted for by the selected components

Main components	Eigenvalues	% of total dispersion	Cumulative % of total dispersion
Comp 1	3.11646	0.3896	0.3896
Comp 2	1.67153	0.2089	0.5985
Comp 3	1.28266	0.1603	0.7588
Comp 4	0.782588	0.0978	0.8567
Comp 5	0,651429	0,0814	0,9381
Comp 6	0,407246	0,0509	0,9890
Comp 7	0,052816	0,0066	0.9956
Comp 8	0,035272	0,0044	1.0000

Source: own calculations with the help STATA

As you can see, four factors were programmatically extracted from the eight factors specified earlier. The eigenvalues of the extracted components are a measure of the variance explained by each factor. In the first column, we see that the first three variables have eigenvalues greater than one, which means that these first three components will be enough for our study. The third column of Table 2.2 shows the



percentage of the total variance explained by each component. Note that the first component explains 38% of the total variance of the variables. The second component explains 20.89% of the total variance, the third component explains 16.03%, and the fourth component explains 9.78%. Based on the results of the table, we can conclude that three factors are sufficient for this case, as they explain more than 85% of the total variance. This result satisfies the conditions for further use of the extracted components. To confirm this result, we present a graph of Kettel's rocky scree criterion (Fig. 2.2).

Fig. 2.2 – Graph of the rocky scree criterion

Source: own calculations with the help STATA

As we can see from the graph, the sharp decline in eigenvalues falls on the first three factors, after which the graph falls more smoothly. This confirms the optimal decision to select three components for our study.

Now let's move on to determining the factor loadings for each variable within each component (Table 2.2).

Table 2.2 – Factor burdens of the selected principal components

Variable	Comp1	Comp2	Comp3
Birth_rate	-0.0201	-0.3891	0.6079
Age_dep	0.2970	0.1324	-0.4309
Health_exp	0.4520	0.1324	0.0324
Death_rate	-0.3371	0.5310	-0.2300
Life_exp	0.4777	-0.3028	-0.1503
Tot_pop	0.3503	0.5001	0.2812
GDP	0.4563	0.3342	0.2417
Inf_rate	-0,1853	0.3090	0.4802

Source: own calculations with the help STATA

The results for components 4-8 are presented in Appendix B.

Let's analyze the results. As we can see, given the high factor loadings, the following variables should remain in further study: birth rate (Comp3), total population (Comp2) and inflation rate (Comp3). Even though the factor loading of the Death rate (0.5310) in this case is higher than that of the Birth rate, it is more appropriate to use the second indicator for the study. Since from a demographic point of view, they describe the same phenomenon, but in a negative and positive context, it is not appropriate to study these variables simultaneously.

When choosing the optimal type of model that best fits our statistical data, we use the Hausman test. The Hausman test allows us to test the hypothesis that there is no correlation between individual effects and regressors. This test determines which model - a random effects model or a fixed effects model - best fits the experimental data. The Hausman test can be used to choose between these two models, considering the presence or absence of correlation between individual effects and regressors [29].

In our case, we use this tool for all three components selected above. The results of the Hausman tests for COVID-19 (Table 2.3), HIV/AIDS (Table 2.4), tuberculosis (Table 2.5), and hepatitis (Table 2.6) are presented below.

Table 2.3 – Hausman test results for COVID-19

	Coefficients		
	(b) fixed	(B) random	(b-B) difference
Conf_cases	0.0259951	0.0307621	-0.004767
Conf_deaths	-0.0000112	-0.0000114	1.81e-07
Case_fatal	0.0285158	0.0289149	-0.000399
\Prob>chi2=0.6271			

Source: own calculations with the help STATA

Table 2.4 – Hausman test results for HIV/AIDS

	Coefficients		
	(b) fixed	(B) random	(b-B) difference
New_HIV	0.1800945	-0.093888	0.2739825
Death_HIV	0.638543	-0.0594514	0.6979944
Posit_HIV	0.2614628	0.2570832	0.0043796
\Prob>chi2=0.0000			

Source: own calculations with the help STATA

Table 2.5 – Hausman test results for tuberculosis

	Coefficients		
	(b) fixed	(B) random	(b-B) difference
Death_tuberc	0.0007645	-0.0006249	0.0013895
Incid_tuberc	0.0616211	0.0501758	0.0114453
Cases_tuberc	-0.0351454	-0.1025901	0.0674447

Prev_tuberc	0.4700384	1.051357	-0.5813182
\Prob>chi2=0.0000			

Source: own calculations with the help STATA

Table 2.6 – Hausman test results for hepatitis

	Coefficients		
	(b) fixed	(B) random	(b-B) difference
Incid_hepB	0.002494	0.0011954	0.0012986
Death_hepB	25.38245	-3.201538	28.58399
Immuniz_hepB	-0.0253569	-0.0262814	0.0009245
\Prob>chi2=0.0000			

Source: own calculations with the help STATA

According to the test results, we build a fixed-effects regression model for HIV/AIDS, tuberculosis, and hepatitis indicators, since their Prob > chi2 is less than 0,05. For COVID-19 data, we will build a random effects regression model.

We first build a random effects model of the COVID-19 panel data. In a random effects model, the individual effect is a stochastic variable that is uncorrelated with the explanatory variables. Random effects models allow controlling for unobserved heterogeneity that remains constant over time and is uncorrelated with the independent variables [30].

Figs. 2.3 demonstrate the results of modelling for the Birth_rate with random effects. The first indicator we focus on is Prob>chi2. This is an F-test that checks whether all coefficients in the model that are different from zero are significant. In our case, they are not zero, which means that the model is adequate. Since our model is a random effects model, inter-entity errors do not show any correlation with the regressors. The statistically significant indicators for this model were confirmed deaths of COVID-19 and the constant, which means that in 95% of cases, they will have the greatest impact on the result.

```
. xtreg Birth_rate Conf_cases Conf_deaths Case_fatal, re

Random-effects GLS regression                   Number of obs      =       238
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.2187                         Obs per group: min =         7
       between = 0.0231                                        avg =       7.0
       overall = 0.0495                                        max =         7

                                                Wald chi2(3)       =     57.16
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
  Birth_rate |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  Conf_cases |   .0307621    .056537     0.54   0.586    -.0800484    .1415726
 Conf_deaths |  -.0000114   3.23e-06    -3.53   0.000    -.0000177   -5.08e-06
  Case_fatal |   .0289149    .021278     1.36   0.174    -.0127893     .070619
       _cons |   10.07531   .2344999    42.97   0.000     9.615699    10.53492
-------------+----------------------------------------------------------------
     sigma_u |   1.281865
     sigma_e |  .49125644
         rho |  .87193871   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Fig. 2.3 – Regression random effects model of COVID-19 panel data for the Birth_rate variable

Source: own calculations with the help STATA

```
. xtreg Birth_rate  Incid_hepB Death_hepB Immuniz_hepB, re

Random-effects GLS regression                   Number of obs      =       145
Group variable: id                              Number of groups   =        29

R-sq:  within  = 0.1109                         Obs per group: min =         2
       between = 0.1006                                        avg =       5.0
       overall = 0.1016                                        max =         6

                                                Wald chi2(3)       =     16.90
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0007

------------------------------------------------------------------------------
  Birth_rate |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  Incid_hepB |   .0011954   .0014871     0.80   0.421    -.0017192      .00411
  Death_hepB |  -3.201538   3.272199    -0.98   0.328     -9.61493    3.211854
Immuniz_hepB |  -.0262814    .006959    -3.78   0.000    -.0399208    -.012642
       _cons |   12.36152   .8076807    15.30   0.000      10.7785    13.94455
-------------+----------------------------------------------------------------
     sigma_u |  1.2153243
     sigma_e |  .41392385
         rho |  .89605766   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Fig. 2.4 – Regression random effects model of hepatitis panel data for the Birth_rate variable

Source: own calculations with the help STATA

```
. xtreg Birth_rate New_HIV Death_HIV Posit_HIV, re

Random-effects GLS regression                   Number of obs      =       200
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.0930                         Obs per group: min =         4
       between = 0.0394                                        avg =       5.9
       overall = 0.0425                                        max =         6

                                                Wald chi2(3)       =     14.82
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0020

------------------------------------------------------------------------------
  Birth_rate |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     New_HIV |   -.093888   .0748434    -1.25   0.210    -.2405784    .0528024
   Death_HIV |  -.0594514   .1553563    -0.38   0.702    -.3639442    .2450414
   Posit_HIV |   .2570832   .0979228     2.63   0.009      .065158    .4490084
       _cons |   9.913339    .247183    40.11   0.000     9.428869    10.39781
-------------+----------------------------------------------------------------
     sigma_u |  1.1653245
     sigma_e |  .45849487
         rho |  .86594968   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Fig. 2.5 – Regression random effects model of HIV/AIDS panel data for the Birth_rate variable

Source: own calculations with the help STATA

```
. xtreg Birth_rate Death_tuberc Incid_tuberc Cases_tuberc Prev_tuberc, re

Random-effects GLS regression                   Number of obs      =       235
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.3671                         Obs per group: min =         4
       between = 0.0680                                        avg =       6.9
       overall = 0.0835                                        max =         7

                                                Wald chi2(4)       =    101.44
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
  Birth_rate |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Death_tuberc |  -.0006249   .0003145    -1.99   0.047    -.0012414   -8.47e-06
Incid_tuberc |   .0501758   .0077398     6.48   0.000      .035006    .0653456
Cases_tuberc |  -.1025901   .0594517    -1.73   0.084    -.2191133     .013933
 Prev_tuberc |   1.051357   .2341438     4.49   0.000     .5924433     1.51027
       _cons |   9.301365   .2434388    38.21   0.000     8.824234    9.778496
-------------+----------------------------------------------------------------
     sigma_u |  1.1770441
     sigma_e |  .42142891
         rho |  .88637343   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Fig. 2.6 – Regression model random effects of tuberculosis panel data for the Birth_rate variable

Source: own calculations with the help STATA

It is also worth paying attention to the intraclass correlation (rho), which indicates how much of the variance in the original data is explained by the differences between the objects. In this example, it is 87%.

A similar analysis is performed for other disease indicators for the Birth_rate component. It was found that each of the constructed divisions is adequate since the number Prob>chi2 is less than 0.05. Statistically significant indicators among HIV/AIDS incidence rates with values not exceeding 0.05 are the incidence of tuberculosis among HIV-positive cases and the constant; for tuberculosis - the incidence of tuberculosis, previously treated cases and the constant; for hepatitis - the percentage of one-year-old children who received vaccinations and the constant. The intraclass correlation for these models is 86%, 88%, and 89%, respectively (Fig. 2.4-2.6).

Now let's move on to building fixed-effects regression models. A fixed-effects model is a statistical model in which the model parameters are constant or unchanged values [31]. As in the case of the Birth_rate component, we will consider the impact of coronavirus statistics on the Tot_popul component (Fig. 2.7).

```
. xtreg   Tot_popul Conf_cases Conf_deaths Case_fatal,fe

Fixed-effects (within) regression               Number of obs      =       238
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.2622                         Obs per group: min =         7
       between = 0.0058                                        avg =       7.0
       overall = 0.0006                                        max =         7

                                                F(3,201)           =     23.81
corr(u_i, Xb)  = -0.0311                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   Tot_popul |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  Conf_cases |   .1505371   .0258598     5.82   0.000     .0995458    .2015285
 Conf_deaths |  -5.95e-06   1.49e-06    -3.99   0.000    -8.89e-06   -3.00e-06
  Case_fatal |  -.0222718   .0099019    -2.25   0.026    -.0417968   -.0027469
       _cons |   17.31248   .0387003   447.35   0.000     17.23617    17.38879
-------------+----------------------------------------------------------------
     sigma_u |  22.461563
     sigma_e |  .22382473
         rho |  .99990071   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(33, 201) = 27520.09             Prob > F = 0.0000
```

Fig. 2.7 – Regression fixed effects model of COVID-19 panel data for the Tot_popul variable

Source: own calculations with the help STATA

The principle of analysis is similar to random effects models. The adequacy of the model is indicated by the Prob>F value, which should be less than 0.05; in our case, the model is adequate. The regressor coefficients show how much Y changes when X increases by one. As you can see, all variables became statistically significant for the model, except for Case_fatal, which means the percentage of COVID-19 case fatality rate. Unlike the random effects model, this model correlates with the errors u_i and the regressors, which is equal to -0.0311. The intraclass correlation (rho) characterizes 99% of the variation between objects and the variance of the original data. We also pay attention to the t-value, which tests the hypothesis that each coefficient is different from 0. To reject this hypothesis, the t-value must be greater than 1.96 (for a 95% confidence level). In our case, the variable of confirmed coronavirus cases has a significant impact on the dependent variable

We use the same principle to analyze all other models, the results of which are presented in Appendix C. For the Tot_popul component of the HIV/AIDS model, the variables of new HIV diagnoses and the constant are statistically significant; in the model with tuberculosis data, the most significant indicators are the constant and previously treated cases, excluding relapse; for the hepatitis variables, only the constant was significant. Based on the t-value, we can note that similar variables have a significant impact on the Tot_popul component. All models are adequate, with a high intraclass correlation (Fig. 2.8-2.10).

The third component variable Inf_rate is characterized by the following results of the fixed-effects model: the statistically significant variables for COVID-19 data are the constant; for HIV/AIDS, all values except the mortality rate have the greatest impact on the result; for tuberculosis, these variables are those characterizing the number of deaths and the constant; for hepatitis data, all the variables studied, except the one characterizing prevalence, are significant. The built models are are of high quality and can be used for further research (Fig. 2.11-2.14).

```
. xtreg   Tot_popul New_HIV Death_HIV Posit_HIV,fe

Fixed-effects (within) regression               Number of obs      =       200
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.2116                         Obs per group: min =         4
       between = 0.5610                                        avg =       5.9
       overall = 0.5435                                        max =         6

                                                F(3,163)           =     14.58
corr(u_i, Xb)  = -0.7492                        Prob > F           =    0.0000

------------------------------------------------------------------------------
   Tot_popul |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     New_HIV |  -.2735627   .0436893    -6.26   0.000    -.3598327   -.1872927
   Death_HIV |   .0426516   .0867248     0.49   0.624    -.1285974    .2139006
   Posit_HIV |   .0405779   .0474154     0.86   0.393    -.0530498    .1342056
       _cons |   17.79881   .0980001   181.62   0.000      17.6053    17.99232
-------------+----------------------------------------------------------------
     sigma_u |  22.893675
     sigma_e |  .20924258
         rho |  .99991647   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(33, 163) = 22094.07             Prob > F = 0.0000
```

Fig. 2.8 – Regression fixed effects model of HIV/AIDS panel data for the Tot_popul variable

Source: own calculations with the help STATA

```
. xtreg   Tot_popul  Death_tuberc Incid_tuberc Cases_tuberc Prev_tuberc,fe

Fixed-effects (within) regression               Number of obs      =       235
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.0970                         Obs per group: min =         4
       between = 0.0292                                        avg =       6.9
       overall = 0.0218                                        max =         7

                                                F(4,197)           =      5.29
corr(u_i, Xb)  = -0.1550                        Prob > F           =    0.0005

------------------------------------------------------------------------------
   Tot_popul |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Death_tuberc |   -.000197   .0002416    -0.82   0.416    -.0006735    .0002794
Incid_tuberc |   .0063875   .0053858     1.19   0.237    -.0042337    .0170087
Cases_tuberc |  -.0196942    .041217    -0.48   0.633    -.1009774     .061589
 Prev_tuberc |   .3805347    .164269     2.32   0.022     .0565832    .7044861
       _cons |   17.38193   .0906191   191.81   0.000     17.20322    17.56064
-------------+----------------------------------------------------------------
     sigma_u |  22.483758
     sigma_e |  .25010475
         rho |  .99987628   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(33, 197) = 20881.01             Prob > F = 0.0000
```

Fig. 2.9 – Regression fixed effects model of tuberculosis panel data for the Tot_popul variable

Source: own calculations with the help STATA

```
. xtreg   Tot_popul  Incid_hepB Death_hepB Immuniz_hepB,fe

Fixed-effects (within) regression               Number of obs      =       145
Group variable: id                              Number of groups   =        29

R-sq:  within  = 0.0296                         Obs per group: min =         2
       between = 0.0026                                        avg =       5.0
       overall = 0.0020                                        max =         6

                                                F(3,113)           =      1.15
corr(u_i, Xb)  = 0.0349                         Prob > F           =    0.3326

------------------------------------------------------------------------------
   Tot_popul |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  Incid_hepB |  -.0007809   .0008435    -0.93   0.357    -.0024521    .0008902
  Death_hepB |  -2.618676   3.001658    -0.87   0.385    -8.565502    3.328149
Immuniz_hepB |  -.0052495   .0031208    -1.68   0.095    -.0114323    .0009333
       _cons |    19.6122   .4457118    44.00   0.000     18.72916    20.49524
-------------+----------------------------------------------------------------
     sigma_u |  23.681497
     sigma_e |  .18681269
         rho |  .99993777   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(28, 113) = 74298.07             Prob > F = 0.0000
```

Fig. 2.10 – Regression fixed effects model of hepatitis panel data for the Tot_popul variable

Source: own calculations with the help STATA

```
. xtreg  Inf_rate Conf_cases Conf_deaths Case_fatal,fe

Fixed-effects (within) regression               Number of obs      =       238
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.0091                         Obs per group: min =         7
       between = 0.0012                                        avg =       7.0
       overall = 0.0037                                        max =         7

                                                F(3,201)           =      0.62
corr(u_i, Xb)  = -0.0771                        Prob > F           =    0.6060

------------------------------------------------------------------------------
    Inf_rate |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  Conf_cases |   .1163851   .3363921     0.35   0.730    -.5469252    .7796954
 Conf_deaths |   -.000011   .0000194    -0.57   0.572    -.0000493    .0000273
  Case_fatal |  -.1469589   .1288067    -1.14   0.255    -.4009447    .1070269
       _cons |   2.422243   .5034249     4.81   0.000     1.429572    3.414915
-------------+----------------------------------------------------------------
     sigma_u |  2.5934149
     sigma_e |  2.9115762
         rho |  .44239734   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(33, 201) =     5.43             Prob > F = 0.0000
```

Fig. 2.11 – Regression fixed effects model of COVID-19 panel data for the Inf_rate variable

Source: own calculations with the help STATA

```
. xtreg  Inf_rate New_HIV Death_HIV Posit_HIV,fe

Fixed-effects (within) regression               Number of obs      =       200
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.3030                         Obs per group: min =         4
       between = 0.0085                                        avg =       5.9
       overall = 0.0012                                        max =         6

                                                F(3,163)           =     23.62
corr(u_i, Xb)  = -0.8885                        Prob > F           =    0.0000

------------------------------------------------------------------------------
    Inf_rate |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     New_HIV |  -3.498743   .5403881    -6.47   0.000    -4.565807   -2.431679
   Death_HIV |   .3220369   1.072689     0.30   0.764    -1.796122    2.440196
   Posit_HIV |   2.024654   .5864762     3.45   0.001     .8665835    3.182724
       _cons |   3.620162   1.212151     2.99   0.003     1.226618    6.013706
-------------+----------------------------------------------------------------
     sigma_u |  6.9555614
     sigma_e |  2.5880974
         rho |  .87838632   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(33, 163) =     2.31             Prob > F = 0.0003
```

Fig. 2.12 – Regression fixed effects model of HIV/AIDS panel data for the Inf_rate variable

Source: own calculations with the help STATA

```
. xtreg  Inf_rate Death_tuberc Incid_tuberc Cases_tuberc Prev_tuberc,fe

Fixed-effects (within) regression               Number of obs      =       235
Group variable: id                              Number of groups   =        34

R-sq:  within  = 0.5059                         Obs per group: min =         4
       between = 0.7706                                        avg =       6.9
       overall = 0.4585                                        max =         7

                                                F(4,197)           =     50.43
corr(u_i, Xb)  = -0.9804                        Prob > F           =    0.0000

------------------------------------------------------------------------------
    Inf_rate |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Death_tuberc |   .0172316   .0020037     8.60   0.000     .0132802    .0211831
Incid_tuberc |  -.0681149   .0446663    -1.52   0.129    -.1562004    .0199705
Cases_tuberc |  -.0129609   .3418283    -0.04   0.970    -.6870733    .6611514
 Prev_tuberc |    1.75137   1.362345     1.29   0.200    -.9352818    4.438021
       _cons |   -1.65221   .7515385    -2.20   0.029    -3.134303   -.1701166
-------------+----------------------------------------------------------------
     sigma_u |  10.104946
     sigma_e |  2.0742128
         rho |  .95956897   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(33, 197) =     3.31             Prob > F = 0.0000
```

Fig. 2.13 – Regression fixed effects model of tuberculosis panel data for the Inf_rate variable

Source: own calculations with the help STATA

```
. xtreg Inf_rate Incid_hepB Death_hepB Immuniz_hepB,fe

Fixed-effects (within) regression               Number of obs      =       145
Group variable: id                              Number of groups   =        29

R-sq:  within  = 0.2794                         Obs per group: min =         2
       between = 0.1842                                        avg =       5.0
       overall = 0.1513                                        max =         6

                                                F(3,113)           =     14.60
corr(u_i, Xb)  = -0.8795                        Prob > F           =    0.0000

------------------------------------------------------------------------------
    Inf_rate |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  Incid_hepB |   .0036688    .012955     0.28   0.778    -.0219973     .029335
  Death_hepB |   94.35074   46.10086     2.05   0.043     3.016616    185.6849
Immuniz_hepB |  -.2787066     .04793    -5.81   0.000    -.3736646   -.1837487
       _cons |   20.67161   6.845449     3.02   0.003     7.109541    34.23368
-------------+----------------------------------------------------------------
     sigma_u |  7.1417007
     sigma_e |  2.8691564
         rho |  .86102935   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(28, 113) =     3.29             Prob > F = 0.0000
```

Fig. 2.14 – Regression fixed effects model of hepatitis panel data for the Inf_rate variable

Source: own calculations with the help STATA

2.3 Development of recommendations based on the results of the calculations

The analysis by the method of average components is carried out and regression models with fixed and random effects are built for 34 countries according to statistical indicators of diseases and their consequences and the impact on the socio-economic indicators of these countries. The indicators were divided into 4 groups, of which the fertility rate, inflation rate, and total population were selected for analysis.

According to the results of the built models, it was found that such indicators of deadly diseases as confirmed cases and mortality from coronavirus, new HIV/AIDS cases including those with tuberculosis, previously treated cases and mortality from tuberculosis, and the percentage of children vaccinated against hepatitis are the most statistically significant on a global scale. All other indicators have a smaller impact on the overall model. The model coefficients indicate that new cases, relapse cases and deaths from tuberculosis, hepatitis and COVID-19 have the most negative impact on economic indicators. The impact of other disease indicators should be considered in the context of the variable under study.

Given these results of paragraphs 2.1 and 2.2, the following measures are proposed to improve the existing health care system, such as:

- conducting educational campaigns and information activities aimed at raising awareness about the transmission, prevention and treatment of these diseases;
- ensuring effective cooperation between medical institutions, health authorities, civil society organizations and other stakeholders to implement TB and hepatitis control programs and share best practices;
- ensuring adequate access to vaccines for vulnerable populations and people at higher risk of infection;
- systematic screening and monitoring to detect and diagnose diseases at an early stage;

– developing and implementing effective disease control strategies, including isolation of patients, strengthening hygiene measures, vaccination of contact persons, personal hygiene and dissemination of preventive measures;

– continuous research, development and analysis of vaccines to develop the best and most effective vaccines.

Thus, to address the negative consequences of deadly diseases, it is necessary to adopt a comprehensive approach at the state level, using modern data analysis methodologies and engaging foreign experts.

CONCLUSIONS

In today's realities, the concept of a socially dangerous disease has a huge impact on both human life and well-being and society. The scale of socially dangerous diseases can be large, which creates a financial burden on the healthcare system and the country's economy. In this regard, it is important to understand the place and role of socially dangerous diseases in the economic environment and develop strategies to minimize them.

In this paper, the concept of a deadly disease in the economic space was studied to identify the socio-economic consequences of the impact of such socially dangerous diseases as COVID-19, HIV/AIDS, tuberculosis and hepatitis.

Given the objectives, the first section of this study examines the concept of a socially dangerous disease and its impact on the economy. It was found that a socially dangerous disease refers to a disease that is characterized by incurable or highly difficult to treat and can lead to the patient's death. The statistics and indicators of the studied diseases confirm the opinion that, given the high mortality rate associated with these diseases, they directly affect the socioeconomic and demographic indicators of the country. A bibliometric analysis of modern scientific research in the field of healthcare and economics was conducted, during which the 3 largest clusters of keywords were identified. According to the results of this description, the queries "healthcare" and "economy" are used to describe the concepts of the domestic medical system, it's functioning, internal components, impact on the country's economy, as well as the impact of various types of diseases on global social indicators. The hypotheses of this study were formed regarding the statistically significant impact of socially dangerous diseases on the socio-economic indicators of the European Union countries.

In the second section of this study, an array of panel data of input variables was formed for further analysis, study and modelling. It includes socio-economic statistics of 34 European countries as dependent variables, as well as data on morbidity, mortality and other relevant indicators for COVID-19, HIV/AIDS, tuberculosis and hepatitis. The data were analyzed using the principal components method to select the appropriate type of regression model for panel data - with fixed and random effects. The three main economic indicators for the study were identified, for which the appropriate number of regression models were built on the statistical indicators of the studied diseases.

Based on the results of the built models, it was found that some indicators of deadly diseases, including confirmed cases and mortality from coronavirus, new HIV/AIDS infections including tuberculosis patients, previously treated cases and mortality from tuberculosis, and the percentage of children vaccinated against hepatitis, have the most significant statistical impact at the global level. Based on these results, several recommendation measures have been formulated to improve the existing healthcare system.

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APPENDIX A

SUMMARY

Kurovska Yuliia Vladyslavivna «Modeling of Socio-economic Consequences of Exposure to Socially Dangerous Diseases» Bachelor's thesis. Sumy State University, Sumy, 2023.

The main goal of the work is to study the impact of fatal diseases on the indicators of the socio-economic situation of society and to improve the medical approach to addressing the challenges of the public health system.

By the aim of the study, regression models of panel data with fixed and random effects were built. Given the tasks set, the first section of this study considered the concept of a fatal disease and its impact on the economy; formed the research methodology, the array of input data, modelled the socio-economic consequences of the impact of socially dangerous diseases, summarized the results of this study and proposed several recommendation measures to improve the existing health care system.

Keywords: healthcare system, HIV/AIDS, COVID-19, tuberculosis, hepatitis, socioeconomic impact, socially dangerous diseases, modelling, STATA.

АННОТАЦІЯ

Куровська Юлія Владиславівна «Моделювання соціально-економічних наслідків впливу суспільно-небезпечних захворювань» - Кваліфікаційна робота бакалавра. Сумський державний університет, Суми, 2023.

Основна мета роботи полягає у вивченні впливу смертельних захворювань на показники соціально-економічного стану суспільства та удосконаленні медичного підходу до вирішення проблем системи громадського здоров'я.

Відповідно до поставленої мети роботи, біло побудовано регресійні моделі панельних даних з фіксованими та випадковиви ефектами. З огляду на поставлені завдання, у першому розділі даного дослідження було розглянуто поняття смертельного захворювання та його впливу на економіку; сформовано методологію дослідження, масив вхідних даних, було проведене моделювання соціально-економічних наслідків впливу суспільно-небезпечних захворювань, сформовано результати даного дослідження та запропоновано ряд рекомендаційних заходів з метою покращення існуючої системи охорони здоров'я.

Ключові слова: система охорони здоров'я, ВІЛ/СНІД, COVID-19, туберкульоз, гепатити, соціально-економічні наслідки, соціально небезпечні хвороби, моделювання, STATA.

APPENDIX B

A	B	C	D	E	F	G	H	I	J
		Birth_rate	Age_dep	Health_exp	Death_rate	Life_exp	Tot_popul	GDP	Inf_rate
Country	Year	Birth rate, crude (per 1,000 people)	Age dependency ratio (% of working-age population)	Current health expenditure (% of GDP)	Death rate, crude (per 1,000 people)	Life expectancy at birth, total (years)	Total population, mln	GDP, bln	Inflation rate, %
Albania	2015	11,72	46,41	4,90	7,95	78,64	2,881	11,39	3,5
Albania	2016	11,29	46,55	4,92	8,04	78,86	2,876	11,86	-0,37
Albania	2017	10,87	46,72	5,01	8,15	79,05	2,873	13,02	2,06
Albania	2018	10,52	46,91	5,23	8,31	79,18	2,866	15,16	2,03
Albania	2019	10,34	47,28		8,48	79,28	2,854	15,4	1,41
Albania	2020	10,29	47,70	5,30	10,79	76,99	2,838	15,13	1,62
Albania	2021	11,31	48,18		11,32	78,73	2,812	18,26	2,04
Austria	2015	9,80	48,70	10,37	9,60	81,19	8,643	381,97	0,9
Austria	2016	10,00	48,93	10,35	9,20	81,64	8,737	389,57	0,89
Austria	2017	10,00	49,29	10,38	9,50	81,64	8,798	398,37	2,08
Austria	2018	9,70	49,66	10,32	9,50	81,69	8,841	408,03	2
Austria	2019	9,60	50,05	10,43	9,40	81,90	8,88	414,22	1,53
Austria	2020	9,40	50,50	11,47	10,30	81,19	8,917	387,49	1,38
Austria	2021	9,94	51,12	12,20	10,06	81,60	8,956	405,15	2,77
Belgium	2015	10,80	54,31	10,43	9,80	80,99	11,27	462,34	0,56
Belgium	2016	10,80	54,69	10,77	9,50	81,44	11,33	468,19	1,97
Belgium	2017	10,50	55,10	10,78	9,60	81,49	11,38	475,77	2,13
Belgium	2018	10,40	55,55	10,76	9,70	81,60	11,43	484,31	2,05
Belgium	2019	10,20	55,97	10,66	9,50	82,00	11,49	495,16	1,44
Belgium	2020	9,90	56,25	11,06	11,00	80,80	11,54	468,61	0,74
Belgium	2021	10,70	56,51	11,20	9,52	81,70	11,59	497,35	2,44
Bosnia and	2015	8,84	43,62	9,35	12,01	76,18	3,524	16,21	-0,06
Bosnia and	2016	8,95	44,29	9,25	11,61	76,81	3,481	16,72	0,18
Bosnia and	2017	9,02	45,17	8,94	11,84	76,94	3,44	17,25	1,43
Bosnia and	2018	9,07	46,26	8,89	12,06	77,09	3,4	17,9	1,74
Bosnia and	2019	8,82	47,43	9,05	12,27	77,24	3,361	18,4	1,63
Bosnia and	2020	8,61	48,52	9,84	14,09	76,23	3,318	17,83	0,48
Bosnia and	2021	7,75	49,39	9,00	15,71	77,63	3,27	19,18	2,55
Bulgaria	2015	9,20	52,95	7,41	15,30	74,61	7,178	50,78	-0,1
Bulgaria	2016	9,10	53,78	7,48	15,10	74,81	7,128	52,33	-0,8
Bulgaria	2017	9,00	54,58	7,52	15,50	74,81	7,076	53,77	2,06
Bulgaria	2018	8,90	55,44	7,34	15,40	74,96	7,025	55,21	2,81
Bulgaria	2019	8,80	56,28	7,13	15,50	75,11	6,976	57,44	3,1
Bulgaria	2020	8,50	56,95	8,52	18,00	73,61	6,934	55,17	1,67
Bulgaria	2021	8,78	57,27	8,10	22,34	75,23	6,878	59,38	3,3
Croatia	2015	8,90	51,11	6,79	12,90	77,28	4,204	50,24	-0,46
Croatia	2016	9,00	51,78	6,83	12,30	78,02	4,174	52,03	-1,13
Croatia	2017	8,90	52,60	6,76	13,00	77,83	4,125	53,81	1,13

Fig. B.1 – The input data, economic indicators

Croatia	2018	9,00	53,57	6,78	12,90	78,07	4,088	55,31	1,5
Croatia	2019	8,90	54,66	6,98	12,70	78,42	4,065	57,21	0,77
Croatia	2020	8,90	55,68	7,00	14,10	77,72	4,048	52,3	0,15
Croatia	2021	8,56	56,52	7,60	15,32	75,23	3,899	59,13	2,55
Czechia	2015	10,50	50,06	7,20	10,50	78,58	10,55	188,03	0,31
Czechia	2016	10,70	51,50	7,11	10,20	79,03	10,57	192,8	0,68
Czechia	2017	10,80	52,91	7,14	10,50	78,98	10,59	202,77	2,45
Czechia	2018	10,70	54,24	7,52	10,60	79,03	10,63	209,3	2,15
Czechia	2019	10,50	55,48	7,83	10,50	79,23	10,67	215,64	2,85
Czechia	2020	10,30	56,56	9,24	12,10	78,23	10,7	203,77	3,16
Czechia	2021	10,00	57,37	9,80	12,76	77,20	10,51	211	3,84
Denmark	2015	10,20	55,45	10,23	9,20	80,70	5,683	302,67	0,45
Denmark	2016	10,80	55,75	10,14	9,20	80,85	5,728	312,5	0,25
Denmark	2017	10,60	56,08	10,04	9,20	81,10	5,765	321,32	1,15
Denmark	2018	10,60	56,41	10,07	9,50	80,95	5,794	327,71	0,81
Denmark	2019	10,50	56,72	9,96	9,30	81,45	5,814	332,6	0,76
Denmark	2020	10,40	57,02	10,53	9,40	81,55	5,831	325,97	0,42
Denmark	2021	10,96	57,32	10,80	10,00	80,50	5,857	341,8	1,85
Estonia	2015	10,10	57,64	6,35	11,60	77,59	1,315	22,89	-0,49
Estonia	2016	9,60	58,66	6,43	11,70	77,64	1,316	23,61	0,15
Estonia	2017	9,10	59,60	6,59	11,80	78,09	1,317	24,98	3,42
Estonia	2018	8,60	60,47	6,69	11,90	78,24	1,322	25,93	3,44
Estonia	2019	8,30	61,13	6,73	11,60	78,65	1,327	26,9	2,28
Estonia	2020	8,40	61,69	7,75	11,90	78,35	1,33	26,75	-0,44
Estonia	2021	9,03	62,13	7,50	14,00	78,89	1,331	28,89	4,65
Finland	2015	10,10	57,64	9,65	9,60	81,48	5,48	234,53	-0,21
Finland	2016	9,60	58,66	9,38	9,80	81,43	5,495	241,13	0,36
Finland	2017	9,10	59,60	9,13	9,80	81,63	5,508	248,83	0,75
Finland	2018	8,60	60,47	9,04	9,90	81,73	5,516	251,66	1,08
Finland	2019	8,30	61,13	9,15	9,80	81,98	5,522	254,74	1,02
Finland	2020	8,40	61,69	9,61	10,00	82,13	5,53	249,13	0,29
Finland	2021	8,89	62,13	9,20	10,36	82,14	5,541	256,53	2,19
France	2015	12,00	59,47	11,45	8,90	82,32	66,55	2440	0,04
France	2016	11,80	60,26	11,47	8,90	82,57	66,72	2470	0,18
France	2017	11,50	60,99	11,33	9,10	82,58	66,92	2520	1,03
France	2018	11,30	61,67	11,19	9,10	82,68	67,16	2570	1,85
France	2019	11,20	62,28	11,06	9,10	82,83	67,39	2620	1,11
France	2020	10,90	62,76	12,16	9,90	82,18	67,57	2410	0,48
France	2021	11,00	63,12	12,40	9,91	82,86	67,75	2580	1,64
Germany	2015	9,00	51,87	11,18	11,30	80,64	81,69	3360	0,51
Germany	2016	9,60	52,45	11,24	11,10	80,99	82,35	3430	0,49
Germany	2017	9,50	53,14	11,33	11,30	80,99	82,66	3520	1,51
Germany	2018	9,50	53,90	11,45	11,50	80,89	82,91	3560	1,73
Germany	2019	9,40	54,73	11,70	11,30	81,29	83,09	3600	1,45
Germany	2020	9,30	55,56	12,82	11,90	80,94	83,16	3460	0,51

Fig. B.2 – The input data, economic indicators, continuation of the table

Germany	2021	9,39	56,36	13,20	12,49	80,80	83,2	3550	3,14
Greece	2015	8,50	54,69	8,07	11,20	81,04	10,82	195,68	-1,74
Greece	2016	8,60	55,22	8,32	11,00	81,39	10,78	194,73	-0,83
Greece	2017	8,20	55,74	8,10	11,60	81,29	10,75	196,86	1,12
Greece	2018	8,10	56,18	7,96	11,20	81,79	10,73	200,14	0,63
Greece	2019	7,80	56,62	7,84	11,70	81,64	10,72	203,91	0,25
Greece	2020	7,90	57,13	7,70	12,20	81,09	10,7	185,55	-1,25
Greece	2021	7,30	57,65	6,70	12,99	82,47	10,64	201,2	1,22
Hungary	2015	9,40	48,32	6,86	13,40	75,57	9,843	125,17	-0,06
Hungary	2016	9,70	49,21	7,00	13,00	76,06	9,814	127,93	0,39
Hungary	2017	9,70	50,01	6,76	13,50	75,82	9,788	133,39	2,35
Hungary	2018	9,60	50,80	6,55	13,40	76,07	9,776	140,55	2,85
Hungary	2019	9,50	51,89	6,35	13,30	76,32	9,771	147,37	3,34
Hungary	2020	9,60	53,08	7,25	14,50	75,62	9,75	140,67	3,33
Hungary	2021	9,36	53,78	7,30	15,90	74,50	9,71	150,69	5,11
Iceland	2015	12,50	51,20	8,07	6,60	82,47	0,330815	17,52	1,63
Iceland	2016	12,00	51,06	8,10	6,90	82,20	0,335439	18,62	1,7
Iceland	2017	11,90	50,53	8,31	6,50	82,66	0,3434	19,4	1,76
Iceland	2018	12,00	49,90	8,44	6,40	82,86	0,352721	20,35	2,68
Iceland	2019	12,30	49,62	8,64	6,30	83,16	0,360563	20,84	3,01
Iceland	2020	12,30	49,88	9,56	6,30	83,07	0,366463	19,42	2,85
Iceland	2021	11,77	50,50	8,69	6,79	83,22	0,37252	20,27	4,44
Ireland	2015	13,90	52,62	7,32	6,40	81,45	4,702	291,78	-0,29
Ireland	2016	13,40	52,87	7,42	6,40	81,65	4,755	297,63	0,01
Ireland	2017	12,90	53,02	7,06	6,30	82,16	4,807	324,43	0,34
Ireland	2018	12,50	53,11	6,86	6,40	82,20	4,867	352,1	0,49
Ireland	2019	12,00	53,14	6,68	6,30	82,70	4,934	371,26	0,94
Ireland	2020	11,20	53,19	7,10	6,40	82,20	4,985	394,22	-0,33
Ireland	2021	12,01	53,24	6,70	7,06	82,00	5,033	447,78	2,36
Italy	2015	8,00	55,62	8,86	10,70	82,54	60,73	1840	0,04
Italy	2016	7,80	55,93	8,73	10,10	83,24	60,63	1860	-0,09
Italy	2017	7,60	56,14	8,68	10,70	82,95	60,54	1890	1,23
Italy	2018	7,30	56,29	8,68	10,50	83,35	60,42	1910	1,14
Italy	2019	7,00	56,55	8,67	10,60	83,50	59,73	1920	0,61
Italy	2020	6,80	56,81	9,63	12,60	82,34	59,44	1740	-0,14
Italy	2021	7,28	57,07	9,50	11,49	83,71	59,11	1860	1,87
Latvia	2015	11,10	53,69	5,65	14,40	74,48	1,978	27,26	0,17
Latvia	2016	11,20	54,82	6,14	14,60	74,58	1,96	27,91	0,14
Latvia	2017	10,70	55,98	5,97	14,80	74,63	1,942	28,83	2,93
Latvia	2018	10,00	56,92	6,19	15,00	74,78	1,927	29,98	2,53
Latvia	2019	9,80	57,89	6,58	14,50	75,39	1,914	30,75	2,81
Latvia	2020	9,20	58,86	7,45	15,20	75,39	1,9	30,08	0,22
Latvia	2021	10,19	59,34	6,20	19,23	75,46	1,884	31,3	3,28
Litjuania	2015	10,80	51,10	6,49	14,40	74,32	2,905	41,44	-0,88
Litjuania	2016	10,70	51,86	6,64	14,30	74,67	2,868	42,48	0,91

Fig. B.3 – The input data, economic indicators, continuation of the table

Litjuania	2017	10,10	52,69	6,48	14,20	75,48	2,828	44,3	3,72
Litjuania	2018	10,00	53,44	6,53	14,10	75,68	2,802	46,07	2,7
Litjuania	2019	9,80	54,21	7,01	13,70	76,28	2,794	48,02	2,33
Litjuania	2020	9,00	55,02	7,54	15,60	74,93	2,795	48,19	1,2
Litjuania	2021	10,04	55,70	7,90	18,25	76,11	2,801	51,07	4,68
Moldova	2015	14,90	41,96	8,56	14,13	69,24	2,836	7,75	9,68
Moldova	2016	14,76	43,67	7,54	13,54	69,92	2,803	8,09	6,36
Moldova	2017	13,81	45,29	7,01	13,09	70,52	2,755	8,47	6,57
Moldova	2018	13,44	46,74	6,59	13,34	70,49	2,707	8,83	3,05
Moldova	2019	12,89	48,10	6,38	13,09	70,94	2,664	9,16	4,84
Moldova	2020	12,48	49,26	6,60	14,45	70,16	2,635	8,48	3,77
Moldova	2021	11,20	50,18		16,86	68,80	2,615	9,66	5,11
Netherland	2015	10,10	52,64	10,32	8,70	81,51	16,94	765,57	0,6
Netherland	2016	10,10	52,93	10,29	8,70	81,56	17,03	782,35	0,32
Netherland	2017	9,90	53,28	10,11	8,80	81,76	17,13	805,13	1,38
Netherland	2018	9,80	53,63	10,03	8,90	81,81	17,23	824,13	1,7
Netherland	2019	9,80	54,01	10,13	8,80	82,11	17,34	840,25	2,63
Netherland	2020	9,70	54,43	11,14	9,70	81,41	17,44	807,6	1,27
Netherland	2021	10,12	54,93	11,20	9,61	81,71	17,53	846,87	2,68
th Macedo	2015	11,10	42,53	6,34	9,90	75,40	2,07	10,06	-0,3
th Macedo	2016	11,10	42,78	6,38	9,85	75,40	2,072	10,35	-0,24
th Macedo	2017	10,50	43,03	6,59	9,80	75,95	2,075	10,46	1,35
th Macedo	2018	10,30	43,35	6,55	9,50	76,65	2,076	10,76	1,46
th Macedo	2019	9,60	43,84	7,25	9,80	76,60	2,077	11,19	0,77
th Macedo	2020	9,20	44,31	6,60	12,40	75,69	2,073	10,5	1,2
th Macedo	2021	9,50	44,58		13,88	76,00	2,065	10,92	3,23
Norway	2015	11,30	52,11	10,13	7,80	82,30	5,189	385,8	2,17
Norway	2016	11,30	52,42	10,59	7,80	82,41	5,235	389,94	3,55
Norway	2017	10,70	52,82	10,32	7,70	82,61	5,277	398,99	1,88
Norway	2018	10,40	53,20	10,02	7,70	82,76	5,312	403,46	2,76
Norway	2019	10,20	53,45	10,52	7,60	82,96	5,348	406,47	2,17
Norway	2020	9,80	53,71	11,42	7,50	83,21	5,379	403,55	1,29
Norway	2021	10,20	54,00	10,10	7,76	83,20	5,408	419,21	3,48
Poland	2015	9,70	43,91	6,39	10,40	77,45	37,99	477,11	-0,87
Poland	2016	10,10	45,14	6,53	10,20	77,85	37,97	491,2	-0,66
Poland	2017	10,60	46,57	6,56	10,60	77,75	37,97	516,45	2,08
Poland	2018	10,20	48,06	6,33	10,90	77,60	37,97	547,15	1,81
Poland	2019	9,90	49,53	6,45	10,80	77,90	37,97	571,5	2,23
Poland	2020	9,40	50,88	6,49	12,60	76,60	37,9	559,96	3,37
Poland	2021	9,44	51,99	6,60	13,12	76,55	37,75	598,3	5,06
Portugal	2015	8,30	53,35	9,32	10,50	81,12	10,36	199,39	0,49
Portugal	2016	8,40	53,87	9,39	10,70	81,12	10,33	203,42	0,61
Portugal	2017	8,40	54,49	9,31	10,70	81,42	10,3	210,55	1,37
Portugal	2018	8,50	54,98	9,41	11,00	81,32	10,28	216,55	0,99
Portugal	2019	8,40	55,40	9,53	10,90	81,68	10,29	222,36	0,34

Fig. B.4 – The input data, economic indicators, continuation of the table

Portugal	2020	8,20	55,74	10,55	12,00	80,98	10,3	203,91	-0,01
Portugal	2021	7,73	56,02	11,00	12,02	81,00	10,33	215,08	1,27
Romania	2015	10,20	48,26	4,95	13,20	74,91	19,82	177,88	-0,59
Romania	2016	10,40	49,17	5,00	13,10	75,21	19,7	182,97	-1,54
Romania	2017	10,80	50,21	5,15	13,40	75,31	19,59	197,96	1,34
Romania	2018	10,40	51,29	5,56	13,60	75,36	19,47	209,9	4,63
Romania	2019	10,30	52,29	5,74	13,40	75,61	19,37	217,99	3,83
Romania	2020	9,20	53,15	6,27	15,40	74,35	19,27	209,97	2,63
Romania	2021	9,45	58,73	5,50	16,25	74,20	19,12	220,68	5,05
Serbia	2015	9,30	50,55	8,81	14,60	75,29	7,095	39,66	1,39
Serbia	2016	9,20	51,20	8,46	14,30	75,69	7,058	40,98	1,12
Serbia	2017	9,20	51,67	8,22	14,80	75,54	7,021	41,84	3,13
Serbia	2018	9,20	52,25	8,58	14,60	75,89	6,983	43,72	1,96
Serbia	2019	9,30	52,92	8,67	14,60	75,94	6,945	45,62	1,85
Serbia	2020	8,90	58,55	8,70	16,90	74,28	6,899	45,2	1,58
Serbia	2021	9,21	53,82	8,50	18,94	73,20	6,834	48,62	4,09
ovak Repub	2015	10,30	41,94	6,79	9,90	76,56	5,424	88,9	-0,33
ovak Repub	2016	10,60	43,12	7,11	9,60	77,17	5,431	90,63	-0,52
ovak Repub	2017	10,70	44,51	6,77	9,90	77,17	5,439	93,29	1,31
ovak Repub	2018	10,60	45,92	6,71	10,00	77,27	5,447	97,05	2,51
ovak Repub	2019	10,50	47,28	6,96	9,80	77,67	5,454	99,5	2,66
ovak Repub	2020	10,40	48,51	7,23	10,80	76,87	5,459	96,14	1,94
ovak Repub	2021	10,08	49,50	7,00	13,31	77,72	5,447	99,04	3,15
Slovenia	2015	10,00	48,73	8,50	9,60	80,78	2,064	43,11	-0,53
Slovenia	2016	9,90	49,89	8,46	9,50	81,18	2,065	44,48	-0,06
Slovenia	2017	9,80	51,08	8,19	9,90	81,03	2,066	46,63	1,43
Slovenia	2018	9,40	52,34	8,28	9,90	81,38	2,074	48,7	1,74
Slovenia	2019	9,30	53,56	8,52	9,90	81,53	2,088	50,38	1,63
Slovenia	2020	8,90	54,57	8,30	11,40	80,53	2,102	48,21	-0,05
Slovenia	2021	9,15	55,50	8,10	10,84	80,70	2,108	52,16	1,92
Spain	2015	9,00	50,93	9,18	9,10	82,83	46,44	1200	-0,5
Spain	2016	8,80	51,33	8,95	8,80	83,33	46,48	1230	-0,2
Spain	2017	8,40	51,69	8,96	9,10	83,28	46,59	1270	1,96
Spain	2018	7,90	51,87	8,99	9,10	83,43	46,8	1300	1,68
Spain	2019	7,60	51,82	9,18	8,80	83,83	47,13	1320	0,7
Spain	2020	7,10	51,67	9,45	10,40	82,33	47,37	1170	-0,32
Spain	2021	8,03	51,54		9,59	83,06	47,41	1240	3,09
Sweden	2015	11,70	58,59	10,80	9,30	82,20	9,799	505,1	-0,05
Sweden	2016	11,80	59,27	10,85	9,20	82,31	9,923	515,56	0,98
Sweden	2017	11,50	59,82	10,79	9,10	82,41	10,06	528,8	1,79
Sweden	2018	11,40	60,23	10,94	9,10	82,56	10,18	539,11	1,95
Sweden	2019	11,10	60,54	10,87	8,60	83,11	10,28	549,82	1,78
Sweden	2020	10,90	60,71	10,90	9,50	82,41	10,35	537,89	0,5
Sweden	2021	11,00	60,82	11,30	8,85	83,03	10,42	565,19	2,16
Switzerland	2015	10,50	48,65	11,01	8,20	82,90	8,282	694,12	-1,14

Fig. B.5 – The input data, economic indicators, continuation of the table

Switzerland	2015	10,50	48,65	11,01	8,20	82,90	8,282	694,12	-1,14
Switzerland	2016	10,50	49,02	11,30	7,80	83,60	8,373	708,48	-0,43
Switzerland	2017	10,30	49,50	11,48	7,90	83,55	8,452	718,13	0,53
Switzerland	2018	10,30	50,05	11,38	7,90	83,75	8,514	738,67	0,94
Switzerland	2019	10,00	50,59	11,29	7,90	83,90	8,575	747,11	0,36
Switzerland	2020	9,90	51,02	11,38	8,80	83,10	8,638	729,36	-0,73
Switzerland	2021	10,30	51,59	11,90	8,03	83,97	8,703	760,15	0,58
Ukraine	2015	10,70	44,74	7,78	14,90	71,19	45,15	91,03	48,7
Ukraine	2016	10,30	45,70	7,55	14,70	71,48	45	93,25	13,91
Ukraine	2017	9,40	46,58	7,48	14,50	71,78	44,83	95,45	14,44
Ukraine	2018	8,70	47,22	7,52	14,80	71,58	44,62	98,78	10,95
Ukraine	2019	8,10	47,76	7,10	14,70	71,83	44,39	101,94	7,89
Ukraine	2020	7,80	48,19	7,60	15,90	71,19	44,13	98,12	2,73
Ukraine	2021	7,30	48,42	7,80	16,80	72,23	43,79	101,45	9,36
UK	2015	11,90	55,09	9,90	9,20	80,96	65,12	2930	0,37
UK	2016	11,80	55,70	9,87	9,10	81,16	65,61	3000	1,01
UK	2017	11,40	56,30	9,81	9,20	81,26	66,05	3070	2,56
UK	2018	11,00	56,81	9,90	9,20	81,26	66,46	3120	2,29
UK	2019	10,70	57,24	10,15	9,00	81,20	66,84	3170	1,74
UK	2020	10,20	57,51	12,00	10,40	80,90	67,08	2820	0,99
UK	2021	10,40	57,67	11,90	9,72	80,70	67,33	3040	2,52

Fig. B.6 – The input data, economic indicators, continuation of the table

K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Conf_cases	Conf_deaths	Case_fatal	New_HIV	Death_HIV	Posit_HIV	Death_tuberc	Incid_tuberc	Cases_tuberc	Prev_tuberc	Incid_hepB	Death_hepB	Immuniz_hepB	
Confirmed cases, mln	Confirmed deaths, ths	Case fatality rate of Covid-19, %	New HIV diagnoses, ths	Death rate from HIV/AIDS (per 1,000 people)	Incidence of tuberculosis (per 100 000 population) (HIV-positive cases)	Number of deaths due to tuberculosis	Incidence of tuberculosis (per 100 000 population per year)	Tuberculosis new and relapse cases, ths	Previously treated cases, excluding relapse, ths	Incidence rate of hepatitis B (per 100 000 population)	Death rate (per 100 000 population)	Immunization, HepB3 (% of one-year-old children)	ID
0,000197	0,01	5,08	0,096	0,06	0,16	8	17	0,415	0	227,12	0,03	99	1
0,009279	0,275	2,96	0,127	0,06	0,16	8	17	0,415	0	228,01	0,03	98	1
0,02004	0,493	2,46	0,094	0,06	0,2	8	20	0,503	0	228,53	0,03	99	1
0,105229	1756	1,67	0,102	0,06	0,17	8	18	0,44	0	219,79	0,03	99	1
0,132513	2456	1,85	0,101	0,06	0,36	8	16	0,412	0	199,2	0,03	99	1
0,168782	2668	1,58	0,096	0,09	0,15	9	16	0,24	0		0	98	1
0,208899	3212	1,54	0,104		0,07	13	17	0,269	0			98	1
0,005556	0,078	1,4	0,332	0,43	0,16	65	7,5	0,564	0,019	167,58	0,03	93	2
0,023908	0,813	3,4	0,297	0,33	0,17	39	8,1	0,619	0,015	161,04	0,03	87	2
0,093171	1294	1,39	0,31	0,36	0,16	36	7,3	0,562	0,008	154,66	0,03	90	2
0,448597	10309	2,3	0,208	0,35	0,13	49	6,1	0,47	0,012	152,12	0,03	85	2
0,640729	12939	2,02	0,245	0,34	0,13	41	6	0,464	0,01	149,13	0,03	85	2
0,732483	13378	1,83	0,166	0,32	0,1	41	4,9	0,382	0,006	144,28	0,02	85	2
1,26	16683	1,32	0,175		0,11	41	5	0,387	0,009			85	2
0,012875	0,894	6,94	0,995	0,44	0,32	61	9,5	0,928	0,06	160,38	0,04	98	3
0,085279	10007	11,73	0,929	0,44	0,35	32	10	0,986	0,061	156,14	0,04	97	3
0,414136	11498	2,78	0,922	0,43	0,34	33	9,3	0,916	0,056	151,62	0,04	97	3
0,766011	22329	2,92	0,911	0,42	0,34	33	9,2	0,913	0,068	149,21	0,04	97	3
1,08	25319	2,35	0,94	0,41	0,33	33	8,9	0,895	0,073	147,61	0,04	97	3
1,23	25742	2,08	0,749	0,26	0,28	33	7,7	0,778	0,052	139,14	0,02	97	3
2,1	28356	1,35	0,781		0,3	33	8,1	0,817	0,058	145,6		97	3
0,000352	0,009	2,56	0,015	0,04	0,07	130	40	1,092	0,003	237,18	0,11	82	4
0,019793	0,598	3,02	0,024	0,04	0,06	120	33	0,907	0	234,92	0,11	78	4
0,046639	1182	2,53	0,015	0,04	0,06	110	29	0,766	0,002	232,08	0,11	77	4
0,13169	5088	3,86	0,024	0,04	0,05	100	25	0,666	0,003	227,07	0,11	80	4
0,205004	9645	4,71	0,03	0,04	0,06	95	27	0,58	0	218,23	0,1	80	4
0,233775	10574	4,52		0	0,05	94	26	0,357	0		0	80	4
0,290471	13428	4,62			0,05	92	25	0,362	0,001			80	4
0,000346	0,008	2,31	0,227	0,63	0,025	120	28	1,619	0,041	578,97	0,14	92	5
0,01619	0,613	3,79	0,202	0,62	0	120	27	1,525	0,078	549,04	0,14	91	5
0,04815	1225	2,54	0,241	0,6	0,06	98	25	1,408	0,055	518,29	0,13	92	5
0,246706	10128	4,12	0,311	0,58	0	98	23	1,29	0,068	512,68	0,13	85	5
0,421751	18049	4,28	0,258	0,57	0,02	98	21	1,288	0,056	510,36	0,13	93	5
0,500112	20812	4,16	0,199	0,31	0,02	97	19	0,887	0,043			91	5
0,744298	30890	4,15	0,238		0,02	96	17	0,673	0,014			89	5
0,00079	0,006	0,84	0,117	0,22	0,11	46	13	0,484	0,002	325,33	0,03	94	6
0,010123	0,184	1,82	0,109	0,15	0,11	58	12	0,449	0,011	321,04	0,03	92	6
0,043775	0,511	1,17	0,106	0,15	0,09	61	10	0,364	0,007	317,12	0,03	92	6

Fig. B.7 – Input data, statistical indicators of morbidity

0,242617	5503	2,27	0,094	0,15	0,09	60	10	0,364	0,008	309,69	0,03	93	6
0,359736	8205	2,28	0,102	0,15	0,08	36	8,3	0,297	0,006	295,2	0,03	93	6
0,40308	8628	2,14	0,075	0,14	0,05	36	5	0,177	0,006		0,04	91	6
0,709678	12493	1,76	0,077		0,04	36	4	0,154	0,003			90	6
0,003026	0,023	0,81	0,266	0,13	0,03	57	5,6	0,508	0,01	213,07	0,03	97	7
0,24507	0,426	1,74	0,286	0,18	0,04	43	5,6	0,511	0,005	206,49	0,03	96	7
0,311013	3193	1,03	0,254	0,16	0,04	38	5,4	0,499	0,006	198,74	0,03	94	7
1,25	20666	1,67	0,208	0,15	0,03	39	4,7	0,435	0,009	194,51	0,03	96	7
1,69	30485	1,81	0,222	0,15	0,04	23	5	0,458	0,006	190,97	0,03	97	7
1,71	30579	1,79	0,251	0,07	0,03	23	3,9	0,36	0,007		0,02	96	7
2,52	36331	1,44	0,233		0,03	23	3,9	0,352	0,005			94	7
0,002395	0,072	3,01	0,277	0,42	0,16	17	6,5	0,32	0,037	208,31	0,03		8
0,016891	0,63	3,73	0,244	0,38	0,15	23	5,9	0,292	0,038	206,44	0,04		8
0,044034	0,722	1,64	0,242	0,37	0,13	14	5,1	0,253	0,022	204,55	0,04		8
0,210732	2353	1,12	0,219	0,36	0,14	10	5,4	0,27	0,021	204,15	0,04		8
0,295837	2534	0,86	0,19	0,34	0,11	10	5,2	0,26	0,021	204,18	0,04		8
0,360869	2654	0,73	0,161	0,24	0,1	10	4,1	0,207	0,014	117	0,01		8
0,783702	3256	0,41	0,137		0,08	10	3,8	0,191	0,017	124			8
0,000695	0,003	0,43	0,27	3,17	2,1	22	18	0,206	0,011	140,65	0,03	91	9
0,00238	0,064	2,69	0,229	2,94	1,9	28	16	0,188	0,004	136,47	0,03	93	9
0,004772	0,073	1,53	0,219	2,79	1,2	23	15	0,171	0,004	132,15	0,03	92	9
0,065674	0,589	0,9	0,19	2,67	1,1	13	13	0,145	0,002	127,59	0,03	93	9
0,131259	1269	0,97	0,178	2,56	1,5	16	13	0,147	0,003	120,44	0,03	91	9
0,156562	1357	0,87	0,147	2,77	1	16	10	0,12	0,004		0,03	90	9
0,241806	1932	0,8	0,125		1,1	16	9,3	0,107	0,004			84	9
0,001473	0,031	2,1	0,174	0,09	0,07	33	5,6	0,267	0,004	202,5	0,03		10
0,008185	0,314	3,84	0,18	0,09	0,06	26	4,7	0,225	0,011	203,91	0,03		10
0,015991	0,349	2,18	0,158	0,09	0,07	35	4,9	0,234	0,003	205,22	0,03		10
0,057952	0,783	1,35	0,153	0,09	0,07	30	4,8	0,229	0,001	202,98	0,03		10
0,096005	0,985	1,03	0,148	0,08	0,07	30	4,7	0,224	0,001	197,98	0,03		10
0,141688	1115	0,79	0,134	0,08	0,05	30	3,6	0,174	0	160	0,01		10
0,263856	1932	0,65	0,163		0,05	30	3,5	0,17	0				10
0,039636	2602	6,57	5,318	0,61	0,51	470	8,5	4,494	0,294	433,31	0,03	88	11
0,291678	30467	10,45	5,439	0,61	0,59	440	8,8	4,675	0,283	432,05	0,03	90	11
1,51	35719	2,37	5,377	0,6	0,51	430	9,1	4,839	0,292	430,84	0,03	90	11
3,6	85846	2,39	5,1	0,59	0,56	430	9	4,779	0,313	421,42	0,03	91	11
5,66	110108	1,95	5,109	0,57	0,56	440	9,1	4,869	0,247	404,87	0,03	91	11
6,79	114393	1,68	3,549	0,45	0,42	440	8,3	4,398	0,208		0,03	91	11
9,48	120962	1,28	3,513		0,41	440	7,7	4,042	0,232			91	11
0,063894	2035	3,19	3,646	0,47	0,19	320	7,6	5,671	0,194	114,36	0,04	87	12
0,24353	9531	3,91	3,391	0,44	0,2	300	7,7	5,737	0,178	112,37	0,04	88	12
0,513237	12669	2,47	3,17	0,42	0,19	300	7,1	5,353	0,133	110,38	0,04	88	12
2,44	77390	3,17	2,88	0,41	0,19	310	7	5,265	0,164	109,35	0,04	88	12
3,73	92828	2,49	3,12	0,39	0,16	270	6,1	4,628	0,163	108,51	0,04	88	12
4,23	95649	2,26	2,466	0,3	0,14	270	5,3	4,01	0,117	102	0,03	88	12

Fig. B.8 – Input data, statistical indicators of morbidity, continuation of the table

7,17	118458	1,65	2,234		0,13	270	5	3,792	0,104			87	12
0,001156	0,038	3,29	0,781	0,38	0,15	45	4,7	0,438	0,044	501,65	0,36	96	13
0,010134	0,262	2,58	0,652	0,25	0,15	48	4,4	0,407	0,036	494,11	0,34	96	13
0,03551	0,615	1,73	0,645	0,23	0,16	58	4,7	0,434	0,033	487,6	0,37	96	13
0,189831	6468	3,41	0,723	0,21	0,16	52	4,4	0,406	0,026	483,85	0,38	96	13
0,421829	12695	3,01	0,663	0,2	0,17	44	4,7	0,434	0,025	480,86	0,38	96	13
0,653535	14795	2,26	0,618	0,38	0,15	44	4,2	0,38	0,016			96	13
1,13	20708	1,77	0,526		0,15	43	4,1	0,195	0,011			96	13
0,000447	0,015	3,36	0,271	0,25	0,09	100	10	0,858	0,048	379,03	0,03		14
0,005961	0,614	10,3	0,228	0,24	0,08	64	8,6	0,737	0,049	377,93	0,03		14
0,071413	1699	2,38	0,223	0,28	0,08	63	7,6	0,65	0,035	376,68	0,03		14
0,428599	14974	3,49	0,229	0,29	0,07	84	7,1	0,602	0,038	375,35	0,03		14
0,808128	29992	3,71	0,238	0,28	0,07	62	6,2	0,528	0,024	373,38	0,03		14
0,822705	30190	3,67	0,201	0,14	0,05	62	4,5	0,384	0,022		0,03	93	14
1,25	39186	3,12	0,223		0,04	62	3,7	0,314	0,021				14
0,001086	0,002	0,18	0,012	0,31	0,05	2	2,4	0,007	0	152,2	0,02		15
0,002018	0,01	0,5	0,028	0,31	0,04	2	2,1	0,006	0	149,56	0,02		15
0,004507	0,012	0,27	0,024	0,25	0,09	2	4,4	0,013	0	147,02	0,03		15
0,005352	0,03	0,56	0,038	0,24	0,06	2	2,6	0,008	0,001	146,92	0,03		15
0,005793	0,031	0,54	0,028	0,24	0,09	2	4,1	0,013	0	148,15	0,03		15
0,010724	0,033	0,31	0,034	0,09	0,08	2	3,8	0,012	0		0		15
0,0026733	0,036	0,13	0,2		0,06	2	2,9	0	0				15
0,002415	0,058	2,4	0,487	0,18	0,23	17	7,3	0,295	0,017	149,93	0,03	95	16
0,028719	1740	6,06	0,502	0,18	0,24	17	7,1	0,293	0,025	144,63	0,03	95	16
0,060512	1888	3,12	0,488	0,17	0,25	18	7,3	0,301	0,017	140,07	0,03	95	16
0,219329	4567	2,08	0,523	0,17	0,25	18	7	0,294	0,02	137,61	0,03	94	16
0,272667	5039	1,85	0,533	0,16	0,21	18	5,8	0,247	0,019	134,54	0,03	93	16
0,391754	5324	1,36	0,435	0,15	0,19	18	5,3	0,229	0,011			94	16
0,736003	6008	0,81	0,403		0,17	18	4,8	0,21	0,007			93	16
0,097689	10779	11,03	3,615	0,81	0,33	340	6,6	3,476	0,293	134,94	0,14	93	17
0,268617	35477	13,21	3,711	0,82	0,36	310	7,2	3,778	0,254	125,51	0,13	93	17
0,616994	38122	6,18	3,599	0,81	0,38	310	7,3	3,828	0,116	116,5	0,14	94	17
2,91	97507	3,35	3,017	0,79	0,37	300	7,3	3,777	0,135	114,7	0,14	95	17
4,26	127542	3	2,492	0,77	0,31	300	6,1	3,185	0,161	113,69	0,14	95	17
4,67	130870	2,8	1,393	0,6	0,21	300	4,2	2,163	0,124	172		94	17
5,85	137247	2,29	1,77		0,26	300	4,9	2,378	0,102			94	17
0,000376	0	0	0,404	6,45	6,6	99	40	0,697	0,024	94,1	0,05	94	18
0,001396	0,034	2,44	0,373	6,11	4,1	80	37	0,641	0,019	88,35	0,06	98	18
0,005679	0,069	1,22	0,378	5,91	3,5	75	32	0,543	0,009	81,98	0,06	98	18
0,086186	1618	1,88	0,333	5,72	2,1	65	28			79,85	0,06	96	18
0,137429	2513	1,83	0,302	5,55	2	65	24			78,82	0,06	99	18
0,158291	2717	1,72	0,257	3,65	1,9	64	20				0,01	99	18
0,275517	4570	1,65	0,212		1,2	63	16	0,255	0,006			94	18
0,000279	0,004	1,43	0,157	1,95	2,1	190	54	1,395	0,112	137,48	0,04	94	19
0,002864	0,069	2,41	0,214	2,27	1,7	180	53	1,347	0,095	134,99	0,04	95	19

Fig. B.9 – Input data, statistical indicators of morbidity, continuation of the table

0,014788	0,144	0,97	0,263	2,01	1,8	160	50	1,268	0,119	131,51	0,03	94	19
0,199162	3258	1,64	0,16	1,94	1,4	120	43	1,063	0,79	124,49	0,03	93	19
0,279153	4384	1,57	0,151	1,88	1,1	120	41	1,006	0,52	112,77	0,03	92	19
0,332552	4998	1,5	0,102	0,74	0,85	120	28	0,688	0,38		0,01	91	19
0,52235	7397	1,41	0,11		0,65	120	26	0,628	0,18			90	19
0,000263	0,002	0,76	0,818	3,85	8,9	250	102	3,608	0,603	411,06	0,03	88	20
0,0367	0,997	2,72	0,832	3,48	8,8	220	101	3,571	0,563	402,71	0,03	90	20
0,074233	1756	2,37	0,835	3,77	7,9	170	95	3,358	0,5	394,31	0,02	89	20
0,184856	4183	2,26	0,905	3,73	7,4	170	86	3,022	0,443	390,96	0,02	94	20
0,256669	6739	2,63	0,922	3,66	8,4	160	80	2,809	0,446	388,9	0,02	94	20
0,292839	7328	2,5	0,68	3,9	9,6	160	78	1,767	0,139		0	87	20
0,375358	10269	2,73	0,792		9	180	84	2,067	0,181			87	20
0,097689	0,756	7,04	1,052	0,27	0,17	37	5,7	0,85	0,017	205,91	0,03	94	21
0,070044	6218	8,88	0,959	0,3	0,2	30	5,9	0,877	0,012	202,67	0,03	93	21
0,329296	7257	2,2	0,913	0,25	0,22	24	5,2	0,776	0,011	198,49	0,03	92	21
1,08	15537	1,43	0,776	0,24	0,21	28	5,3	0,791	0,015	194,41	0,03	92	21
1,68	17742	1,05	0,682	0,24	0,17	21	4,9	0,746	0,013	188,94	0,03	92	21
2	18166	0,91	0,458	0,14	0,13	21	4,1	0,614	0,009	92	0,01	93	21
3,1	20885	0,67	0,396		0,13	21	4,4	0,671	0,009			93	21
0,000285	0,007	2,46	0,025	0,12	0	21	17	0,282	0,002	285,16	0,07	92	22
0,01434	0,603	4,21	0,03	0,11	0	25	16	0,263	0,004	281,24	0,07	94	22
0,030487	0,982	3,22	0,044	0,1	0	13	13	0,216	0,003	277,92	0,07	91	22
0,102786	3137	3,05	0,045	0,1	0,06	25	13	0,217	0	275,37	0,06	92	22
0,155684	5484	3,52		0,1	0,08	9	12	0,199	0	271,79	0,06	92	22
0,191408	6676	3,49		0,02	0,06	9	12	0,143	0,005	469	0,03	84	22
0,224507	7964	3,54			0,07	9	11	0,143	0,003			79	22
0,004635	0,022	0,47	0,221	0,21	0,13	12	6,3	0,286	0,032	115,66	0,04	96	23
0,010816	0,264	2,44	0,22	0,24	0,24	18	6,1	0,278	0,021	105,33	0,04	96	23
0,020182	0,282	1,4	0,213	0,24	0,11	18	5,2	0,237	0,024	95,51	0,04	96	23
0,071728	0,622	0,87	0,191	0,23	0,16	18	4,1	0,189	0,02	93,94	0,04	96	23
0,131418	0,795	0,6	0,172	0,23	0,15	18	3,3	0,153	0,012	93,63	0,04	96	23
0,189353	0,897	0,47	0,137	0,15	0,06	18	3,1	0,144	0,016			97	23
0,390716	1394	0,35	0,102		0,14	19	2,9	0,14	0,17			96	23
0,001862	0,022	1,18	1,278	0,39	0,18	580	19	6,237	0,193	132,24	0,03	96	24
0,06687	2033	3,04	1,317	0,31	0,19	600	18	6,143	0,301	123,69	0,03	95	24
0,342834	5149	1,61	1,421	0,32	0,18	560	17	5,535	0,252	117,29	0,03	93	24
1,71	43839	2,56	1,21	0,31	0,18	570	16	5,196	0,291	116,11	0,03	91	24
2,88	75043	2,6	1,551	0,3	0,17	510	15	4,983	0,338	116,24	0,03	91	24
2,91	75665	2,6	0,937	0,27	0,11	510	9,4	3,15	0,238		0,04	90	24
4,11	97058	2,36	1,096		0,12	510	10	3,446	0,258			90	24
0,004998	0,127	2,54	1,525	3,87	3,3	220	23	2,087	0,037	189,13	0,03	98	25
0,059121	1824	3,08	1,535	3,86	2,8	210	20	1,794	0,042	182,39	0,03	98	25
0,132918	2439	1,89	1,379	3,82	2,2	200	20	1,76	0,04	175,76	0,03	98	25
0,774892	16268	2,1	1,182	3,74	1,8	240	21	1,856	0,049	170,21	0,03	98	25
0,866126	17084	1,97	0,92	3,66	2	240	19	1,72	0,051	163,77	0,03	98	25

Fig. B.10 – Input data, statistical indicators of morbidity, continuation of the table

1,07	17959	1,68		2,21	1,6	240	16	1,402	0,043			99	25
1,36	18937	1,4			1,4	240	16	1,463	0,041			99	25
0,00176	0,043	2,44	0,898	0,78	2,1	1100	82	14,225	0,97	290,25	0,03	90	26
0,086785	3578	4,12	0,796	0,92	1,9	990	74	12,79	0,827	285,66	0,03	90	26
0,235586	6764	2,95	0,82	0,82	1,5	950	72	12,31	0,694	280,36	0,03	92	26
0,799164	20287	2,54	0,76	0,8	1,6	930	68	11,586	0,619	277,58	0,03	93	26
1,08	33605	3,11	0,762	0,77	1,2	930	65	11,083	0,55	274,94	0,03	90	26
1,22	36865	3,02	0,491	1,22	1,4	930	43	7,193	0,505		0,01	87	26
1,81	58714	3,25	0,56		0,96	1700	45	7,591	0,388			86	26
0,000741	0,013	1,75	0,183	0,92	0,07	75	21	1,649	0,009	204,85	0,05	94	27
0,031365	0,711	2,27	0,179	0,83	0,06	86	19	1,472	0,016	197,94	0,05	91	27
0,045137	0,809	1,86	0,186	0,71	0,06	80	19	1,45	0,016	191,45	0,05	93	27
0,45645	4429	0,97	0,188	0,59	0,05	79	17	1,33	0,028	189,43	0,05	91	27
0,716458	7043	0,98	0,223	0,51	0,05	54	14	1,106	0,073	186,92	0,05	94	27
0,93444	8187	0,88	0,126	0,27	0,04	46	14	0,439	0,002		0,04	87	27
1,3	12688	0,98	0,181		0,05	120	15	0,445	0,002			87	27
0,000336	0,001	0	0,086	0,07	0,02	35	6,5	0,308	0,009	266,63	0,03	96	28
0,003917	0,033	0,84	0,088	0,07	0,02	25	5,9	0,281	0,015	266,82	0,03	96	28
0,057664	0,212	0,39	0,072	0,07	0	27	4,8	0,228	0,021	266,36	0,03	96	28
0,308083	7189	2,33	0,102	0,07	0,03	25	5,8	0,273	0,008	255,24	0,03	96	28
0,391642	12510	3,19	0,104	0,07	0,12	14	4,5	0,214	0	233,52	0,03	97	28
0,412507	12637	3,06	0,103	0,03	0,01	14	3,2	0,153	0,005		0,02	97	28
0,841733	16635	1,98	0,113		0,09	14	2,8	0,134	0,003			97	28
0,000757	0,013	1,72	0,052	0,15	0	11	7,1	0,129	0,001	298,13	0,03		29
0,002884	0,132	4,58	0,062	0,11	0,07	7	6,5	0,118	0	297,27	0,03		29
0,034315	0,363	1,12	0,041	0,1	0,06	7	6,1	0,112	0	296,52	0,03		29
0,190179	4160	2,19	0,037	0,1	0,05	6	5,4	0,098	0,001	287,64	0,03		29
0,257423	4761	1,85	0,034	0,09	0,07	14	5,3	0,098	0,003	270,18	0,03		29
0,293479	4926	1,68	0,027	0	0	14	4,1	0,075	0,002		0,01		29
0,464121	6120	1,32	0,032		0	14	4,3	0,079	0,001			86	29
0,103314	7766	7,52	4,274	1,05	0,64	250	10	4,026	0,165	210,94	0,03	97	30
0,486409	31004	6,37	4,339	1,15	0,77	260	12	4,734	0,143	197,59	0,03	97	30
1,25	39057	3,19	4,256	1,14	0,73	250	11	4,379	0,191	183,74	0,03	94	30
3,15	75134	2,38	3,967	1,12	0,76	250	11	4,5	0,148	180,77	0,03	96	30
3,83	82823	2,16	3,817	1,09	0,68	230	9,9	4,071	0,079	180,89	0,03	95	30
4,98	88544	1,78	2,769	0,81	0,49	230	7,2	2,949	0,095	202		94	30
6,51	91688	1,41	2,785		0,56	230	8,2	3,37	0,138			92	30
0,003944	0,239	6,06	0,447	0,21	0,18	25	9,1	0,782	0,039	113,69	0,03	53	31
0,084238	5789	6,87	0,429	0,21	0,17	26	8,1	0,702	0,024	112,68	0,03	67	31
0,129046	5973	4,78	0,434	0,19	0,12	23	5,6	0,488	0,032	111,73	0,03	76	31
0,664854	12996	1,96	0,481	0,18	0,12	22	5,4	0,477	0,014	109,32	0,03	92	31
1,09	14631	1,34	0,449	0,17	0,12	22	5,4	0,478	0,001	104,86	0,03	97	31
1,15	14877	1,29	0,36	0,1	0,08	23	3,5	0,316	0,012			97	31
1,33	15345	1,16	0,352		0,08	23	3,8	0,344	0,013			98	31
0,016602	0,38	2,29	0,536	0,29	0,35	17	7,4	0,531	0,033	193,93	0,04		32

Fig. B.11 – Input data, statistical indicators of morbidity, continuation of the table

0,016602	0,38	2,29	0,536	0,29	0,35	17	7,4	0,531	0,033	193,93	0,04		32
0,042241	1770	4,19	0,529	0,35	0,37	25	7,9	0,573	0,036	193,34	0,04		32
0,171125	2216	1,37	0,447	0,35	0,34	17	7,2	0,529	0,026	192,75	0,04	69	32
0,554627	9628	1,74	0,424	0,34	0,3	17	6,4	0,473	0,043	191,15	0,04	69	32
0,70011	10383	1,48	0,42	0,34	0,25	17	5,4	0,402	0,033	188,57	0,04	69	32
0,837533	10703	1,28	0,291	0,22	0,21	17	4,7	0,351	0,036			72	32
1,33	11921	0,89	0,315		0,22	17	4,7	0,355	0,009			73	32
0,00048	0,011	2,29	13	13,07	20	5000	91	30,151	5,153	275,13	0,18	22	33
0,121215	2557	2,11	14,233	13,17	18	4500	87	29,052	5,036	250,37	0,17	26	33
0,387481	7041	1,86	15,612	13,3	19	4000	84	27,229	4,355	224,68	0,17	52	33
1,35	25982	1,93	15,659	12,98	18	4000	80	26,512	3,866	213,13	0,17	67	33
2,24	52340	2,34	16,256	12,63	18	3700	77	25,379	3,16	204,73	0,16	76	33
2,42	56274	2,32	15,593	11,51	16	3600	74	17,533	1,988			81	33
3,67	95899	2,62	15,36		14	3600	71	18,307	1,486			77	33
0,026554	3005	11,32	6,218	0,35	0,33	350	10	5,854	0,386	173,93	0,03		34
0,337739	57794	17,11	5,365	0,34	0,33	310	9,9	5,793	0,382	168,29	0,03		34
1,03	63131	6,26	4,791	0,32	0,26	260	8,9	5,248	0,319	162,65	0,03		34
4,25	147643	3,48	4,684	0,31	0,23	260	8,1	4,775	0,3	163,33	0,03		34
4,89	154483	3,16	4,408	0,3	0,28	230	8,1	4,803	0,329	165,62	0,03	93	34
7,96	163768	2,06	2,961	0,23	0,24	230	7	4,185	0,273	155	0,02	93	34
13,44	176813	1,31	2,955		0,22	230	6,3	4,795	0	169		93	34

Fig. B.12 – Input data, statistical indicators of morbidity, continuation of the table

APPENDIX C

Principal components (eigenvectors)

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Comp8	Unexplained
Birth_rate	-0.0201	-0.3891	0.6079	0.1996	0.5967	0.1183	0.1459	0.2179	0
Age_dep	0.2970	0.1324	-0.4309	0.5974	0.4653	-0.2912	-0.2184	-0.0508	0
Health_exp	0.4520	0.0134	0.0324	0.3057	-0.2411	0.7819	-0.1716	0.0456	0
Death_rate	-0.3371	0.5310	-0.2300	0.0857	0.2368	0.3367	0.5406	0.2872	0
Life_exp	0.4777	-0.3028	-0.1503	0.0667	-0.2788	-0.2617	0.6182	0.3531	0
Tot_popul	0.3503	0.5001	0.2812	-0.2852	0.0533	-0.1968	-0.3127	0.5722	0
GDP	0.4563	0.3342	0.2417	-0.2249	0.2121	-0.0127	0.3479	-0.6364	0
Inf_rate	-0.1853	0.3090	0.4802	0.6050	-0.4333	-0.2629	0.0914	-0.0912	0

Fig. C.1 – Factor burdens of the selected principal components