Public health system effectiveness: determinants and impacts

Vitaliia KOIBICHUK
Svitlana KOLOMIIETS
Serhii DROZD

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Reviewers:

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Prof. Nataliya Pedchenko
Prof. Maksym Korneev

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INTRODUCTION

The problem of human health is one of the most complex and relevant problems of modern science. Preservation of people's health and providing a high-quality, fulfilling life are essential goals for individual countries and the entire world community. Not only the level of well-being depends on the state of health of the population, but above all, the level of development of the country's economy and the ability of society to counteract global crises, which is very relevant in the current conditions of the consequences of the COVID-19 pandemic, conditions of constant changes.

Health as an economical category is currently one of the global problems of humanity. Health is one of the most important economic resources of society. Modern economic studies prove that investments in health bring not only a social but also a significant economic effect.

The health of an individual citizen and society is the most excellent value for any country and necessary for achieving sustainable socio-economic development.

The Member States of the United Nations had adopted a Development plan until 2030 to achieve the approved goals and objectives to solve many problems in various spheres - social, economic, humanitarian, energy, environmental, security, etc. The States have set themselves very ambitious tasks to achieve an adequate quality of life for all inhabitants of the planet Earth and to improve the state of the environment in the medium and long term.

The Member States of the United Nations joined the implementation of the Sustainable Development Goals by adopting the Global Goals to national realities and developing

relevant national strategic tasks, among which special attention is paid to forming public health programs.

One of the most effective ways of organizing the public health system and improving the population's health is to improve the determinants that define it. Since the modern world is in a state of turbulence when the socio-economic development of many states is characterized by constant changes and crises, the analysis of determinants of public health to ensure the effectiveness of the public health system remains highly relevant.

In the work, a review of normative documents in the context of the Sustainable Development Goals and the public health system, a bibliometric analysis of the array of publications of the Scopus database to identify vital socio-economic determinants affecting the indicator of human inequality was carried out. A regression model was built that describes the dependence of the coefficient of human inequality on the Gini coefficient, inequality in life expectancy, gross national income, and the index of life expectancy adjusted for inequality. A cluster analysis of the dividing of member countries of the Organization for Economic Cooperation and Development into groups was carried out to assess the effectiveness of the healthcare system in each group.

The monograph was performed within the framework of the research themes “The impact of COVID-19 on the transformation of the medical and social security system: economic, financial and budgetary, institutional and political determinants” (122U000781), “Socio-economic recovery after COVID-19: modelling the implications for macroeconomic stability, national security and local community resilience” (0122U000778) which are financed by the State budget of Ukraine.

1. PUBLIC HEALTH AND ITS DETERMINANTS: THEORETICAL FOUNDATIONS OF RESEARCH

Healthcare issues are essential to policies in many countries and supranational structures. Understanding the need for a global approach to public health and environmental protection is one of the important achievements of scientific thought of the 20th century. We are talking about the global health policy, which is formed by the key players of this policy - mainly international (supranational) organizations.

The World Health Organization (WHO), as a specialized agency of the United Nations (UN), pays significant attention to the public health system both through the development of standards, recommendations, and model legislation, as well as the adoption of charters, declarations, etc., and the publication of annual reports on the situation in this or that area of health care.

Generally accepted documents and principles regulate activities in the field of public health in the world.

1. Alma-Ata Declaration of the World Health Organization on primary health care. The Declaration was adopted at the international conference on primary health care on September 12, 1978, in Alma-Ata. The Declaration indicated the need for immediate action by all governments, all health workers, and the entire global community to protect and promote the health of all peoples of the world. It emphasized that achieving health is impossible without primary health care, which should be available to all.

2. Ottawa Charter for Health Promotion. The Charter was adopted in Ottawa on November 21, 1986. The Charter identified five main directions: promoting the implementation of health policy; creation of favorable natural and social

environments; development of the activity of communities and organizations; development of personal skills of a healthy lifestyle; reorientation of the priorities of the health care system.

3. World Health Organization Framework Convention on Tobacco Control. The Convention was adopted by the World Health Assembly on May 21, 2003, and entered into force on February 27, 2005. The WHO Framework Convention was developed in response to the globalization of the tobacco epidemic. The Convention is a milestone for promoting public health and provides new legal aspects for international cooperation in public health.

4. International Health Regulations were adopted in 2005. It is an agreement between 196 countries to work together for global health. Countries agreed to build the capacity to identify, assess and report public health events. International health regulations specify specific measures at ports, airports, and ground transport to limit the spread of health risks to neighboring countries and prevent unjustified travel and trade restrictions so that trade losses are minimized.

5. Rio Political Declaration on Social Determinants of Health. The Declaration was adopted during the World Conference on Social Determinants of Health on October 21, 2011. The Declaration articulates a global political commitment to implement social determinants of health to reduce health inequalities and achieve other global priorities.

6. Resolution of the UN General Assembly on preventing and controlling non-communicable diseases. The resolution was adopted on 20 September 2011 and provided an opportunity to review the current global health agenda. The resolution formulated a global plan for Prevention Non-Communicable Diseases: cardiovascular, oncological, endocrine, chronic respiratory, and related risk factors.

7. European policy in the interests of health and well-being "Health-2020". The World Health Organization European Regional Committee adopted the European Health 2020 framework policy in 2012. The Health 2020 policy presents a wealth of evidence, particularly about the social determinants of health. It emphasizes the need to engage politicians, professionals, and civil society representatives to promote health and reduce health inequalities.

8. European Action Plan for Strengthening Public Health Capacity and Services. The European Action Plan was adopted in September 2021. These documents are the main components of the new European policy in the interests of health and well-being "Health 2020". The aim is to ensure that public health services are strengthened to meet the European region's current and future public health challenges.

9. Health in all policies Helsinki Statement. The 8th Global Conference on Health Promotion was held in Helsinki, Finland, on 10–14 June 2013. Framework documents, strategies, and resolutions were adopted at the conference, formulating the goals for developing the public health system after 2015. As a result of the meeting, the Helsinki Declaration on health in all policies was adopted.

10. Action Plan for the Prevention and Control of Noncommunicable Diseases in the World Health Organization European Region for 2016–2025. The Action Plan for the Prevention and Control of Noncommunicable Diseases in the WHO European Region for 2016–2025 is a continuation and update of the Action Plan for the Implementation of the European Strategy for 2012–2016. This document focuses on priority action areas for the next ten years to achieve regional and global goals to reduce premature mortality, reduce disease

burden, improve quality of life and equalize healthy life expectancy worldwide.

11. European work program for 2020-2025 “Joint actions for stronger health”. The European work program for 2020-2025 defines priority tasks for the next five years. The goal was to guarantee the realization of people's right to universal access to quality medical care without fear of financial difficulties, adequate protection in emergencies in the field of health care, and the opportunity to live safely in a healthy society.

12. Sustainable Development Goals. Resolution of the UN General Assembly “Transforming our world: the 2030 agenda for sustainable development” adopted on September 25, 2015. The Resolution announces a new plan of action to put the world on a path of sustainable and sustainable development. The third Sustainable Development Goal, “Good Health and Well-being”, aims to ensure healthy lifestyles and promote well-being for all ages.

The current trend in the development of the medical field is the transition from the policy of treatment to the policy of strengthening and preserving health and preventing diseases. The public health system is important for the implementation of this policy.

Public health is the science and practice of preventing diseases, increasing life expectancy and strengthening health through organized efforts of society. Also, the public health system is a set of tools, procedures and measures implemented by state and non-state institutions to strengthen the health of the population, increase the duration of active and working age, and encourage a healthy lifestyle through the combined efforts of the entire society.

The focus of public health is improving health and quality of life through the prevention and treatment of diseases and other

physical and mental conditions. This is done through epidemiological surveillance of cases and health indicators and by promoting a healthy lifestyle. According to the definition of the World Health Organization, 10 main operational functions of public health are distinguished: 1) supervision and assessment of the state of health and well-being of the population; 2) monitoring and responding to health hazards and during health emergencies; 3) health protection, in particular ensuring the safety of the environment, work, food products, etc.; 4) strengthening of health through influence on social determinants and reduction of inequalities in terms of health indicators; 5) disease prevention, in particular, early detection of health disorders; 6) ensuring strategic management in the interests of health and well-being; 7) provision of the sphere of public health care with a sufficient number of qualified personnel; 8) creation of stable organizational structures and provision of their financing; 9) informational and explanatory activities, advocacy, communication and social mobilization in the interests of health; 10) promoting the development of research in the field of health care for the scientific justification of the relevant policy and practice.

Scientific research is essential for substantiating and improving policies and principles of public health service delivery. As stated in World Health Organization documents, scientific research in the field of health care is carried out in the following directions:

– scientific research to expand the knowledge base on which the process of policy-making based on factual data is oriented;

– development of new methods of scientific research, innovative technologies, and solutions in the field of health care;

- creating partnerships with scientific research centers and academic institutions to conduct timely research that allows you

to substantiate decision-making at all levels of the public health system.

Analysis of World Health Organization information resources showed that during the 20th-21st century, humanity had significantly improved health worldwide. In the conditions of the formation of the digital economy, knowledge and experience in health care are increasing. Countries have more resources for health care than ever before.

However, progress in the field of health care in different countries of the world is highly uneven. A child born in Sweden can live more than 80 years; if born in Brazil, less than 72 years; if born in India – less than 63 years; if taken in Lesotho – less than 50 years. In Ireland, a woman's risk of dying during pregnancy or childbirth is 1 in 47,600, and in Afghanistan, it is 1 in 8.

Life expectancy and health can vary dramatically between countries and within countries. Depending on where we live and grow up, however, significant health inequalities exist between countries and within countries.

The disparity in health supported by statistics cannot be explained by biology. Differences in health between and within countries result from socioeconomic policies shaping the environment in which people are born, grow up, live, and work. As noted in WHO documents, health disparities are unfair and associated with the uneven distribution of resources for the growth of the national economy. Addressing health disparities is a matter of social justice and human rights.

In September 2015, the United Nations General Assembly approved a new global strategy, “Transforming our world: the 2030 agenda for sustainable development”.

The member countries of the United Nations have adopted a development plan until 2030 with the aim of achieving a

common better future. According to the Sustainable Development Goals, the joint efforts of countries should be aimed at overcoming extreme poverty, fighting injustice and inequality, protecting the population and the planet Earth. The governments of countries, businesses, and civil society should be involved in the implementation of these tasks. 17 Sustainable Development Goals and 169 tasks for their implementation have been approved.

The approved goals and objectives are aimed at solving many problems in various spheres - social, economic, humanitarian, energy, environmental, security, etc. The countries of the world have set themselves very ambitious tasks to achieve an adequate quality of life for all inhabitants of the planet Earth, to improve the state of the environment in the medium and long term.

The Sustainable Development Goals Declaration was adopted in 2015 after the expiration of the Millennium Declaration, which defined the Millennium Development Goals as a general framework of values, principles and key drivers of development until 2015. The Millennium Development Goals covered only the social, humanitarian and environmental spheres. In the Global Sustainable Development Goals, the list of areas and tasks has been expanded.

The declaration "Goals of sustainable development" contains the main provisions (Transforming our world: the 2030 Agenda for Sustainable Development, 2015):

Goal 1. Overcoming poverty in all its forms and everywhere.

Goal 2. Overcoming hunger, achieving food security, improving nutrition and promoting the sustainable development of agriculture.

Goal 3. Ensure healthy lifestyles and promote well-being for all at all ages.

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Goal 5. Ensuring gender equality, expanding rights and opportunities for all women and girls.

Goal 6. Ensuring the availability and rational use of water resources and sanitation for all.

Goal 7. Ensuring access to affordable, reliable, sustainable and modern sources of energy for all.

Goal 8. Promote progressive, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Goal 9. Creation of sustainable infrastructure, promotion of comprehensive and sustainable industrialization and innovation.

Goal 10. Reduction of inequality within and between countries.

Goal 11. Ensuring openness, safety, vitality and ecological sustainability of cities and settlements.

Goal 12. Ensuring the transition to rational models of consumption and production.

Goal 13. Taking urgent measures to combat climate change and its consequences.

Goal 14. Conservation and rational use of oceans, seas and marine resources in the interests of sustainable development.

Goal 15. Protection and restoration of terrestrial ecosystems and promotion of their rational use, rational forest use, combating desertification, halting and reversing the process of land degradation and halting the process of biodiversity loss.

Goal 16. Promote the building of a peaceful and open society and the interests of sustainable development, ensuring access to justice for all and the creation of effective, accountable and participatory institutions at all levels.

Goal 17. Strengthen the means of implementation and activation of work within the framework of the Global Partnership in the interests of sustainable development.

The goals of sustainable development are a general call to all countries of the world, aimed at overcoming poverty, establishing and maintaining social justice, the existence of equal opportunities for all without exception, strengthening state institutions, ensuring peace and prosperity for people around the world.

Issues of sustainable development are relevant for many countries. Implementation of the goals of sustainable development contributes to the achievement of global progress in the development of the whole world.

However, global efforts will not be possible without the active participation of civil society. People should know their rights and the responsibilities of their governments. Health is not only a desire for well-being but a human right.

The right to health is recognized in numerous international and regional treaties, starting with the Universal Declaration of Human Rights (Article 25), in particular in the International Covenant on Socio-Economic Rights (Article 12), the Convention on the Rights of the Child (Articles 6, 24), in the Convention on the Elimination of All Forms of Discrimination Against Women (Articles 10, 11, 12, 14), in the European Social Charter.

The right to health is the right for all without discrimination to use various services, institutions, and things and to have adequate living conditions to be as healthy as possible. The right to health includes health care services and the conditions that determine our health, including access to safe drinking water, adequate sanitation and housing, adequate nutrition, healthy working conditions, and environmental conditions, as well as

access to health-related education and information (United Nations Document E/C.12/2000/4, 2000).

The European Union pays considerable attention to health issues. These concerns are preventing diseases and providing EU citizens access to medical services outside the country of permanent residence.

Public health policy, organization of the public health system, financing, and management of public health is a national obligation that individual member states of the European Union undertake.

Proper health is the main problem of EU citizens. The European Union works to improve health protection by implementing its policies and measures by Article 168 of the Treaty on the Functioning of the European Union.

Article 168 of the Treaty outlines the objectives of European Union health policy and its underlying legal framework, with a particular emphasis on coordination and cooperation to prevent those significant threats to health that cause disease (Treaty on the Functioning of the European Union).

The European Union health measures aim to improve public health, prevent disease and health threats (including lifestyle-related), and promote research.

The European Union provides more detailed regulation of the following nine main areas of activity:

1. Public health strategies in the EU.
2. Measures to guarantee health safety.
3. Health care systems.
4. Risk assessment.
5. Prevention of diseases.
6. Substances that disrupt the work of the endocrine system.
7. Health and safety at work.
8. Health promotion.

9. Pharmaceutical products.

According to the EU Treaties, a member of the European Union can become “any European state that respects the values specified in Article 2 and is committed to their promotion”.

The values include: “respect for human dignity, freedom, democracy, equality, the rule of law and respect for human rights, including the rights of minorities”.

To become a member, a candidate state must have stable institutions that guarantee democracy, the rule of law, human rights, respect and protection of minority rights, a functioning market economy, and the ability to cope with competitive pressures and market forces in the Union. Membership assumes that the candidate takes the obligations arising from the fact, particularly recognizing the objectives of its political, economic, and monetary unions.

Having signed the Association Agreement between Ukraine and the European Union, Ukraine undertook to implement measures to protect human health as a prerequisite for sustainable development and economic growth. As a member of the United Nations (UN), Ukraine joined the implementation of the Sustainable Development Goals through the adaptation of the Sustainable Development Goals to national realities, the development of relevant national strategic tasks, among which special attention is paid to the formation of public health programs.

Ukraine also joined the global process of ensuring sustainable development. In order to establish the strategic framework of the national development of Ukraine for the period until 2030, an inclusive process of adaptation of the Sustainable Development Goals was launched. During 2016-2017, each global goal was reviewed in Ukraine, taking into account national specifics.

Based on a wide range of informational, statistical and analytical materials, a national system of Sustainable Development Goals (86 development tasks and 172 indicators for monitoring implementation) was developed. The national system of Sustainable Development Goals is reflected in the National Report "Sustainable Development Goals: Ukraine", which was presented by the government on September 15, 2017 (Goals of sustainable development: Ukraine, 2017).

In 2019, the Cabinet of Ministers of Ukraine approved a list of indicators, in the context of which data collection is carried out to monitor the implementation of the Sustainable Development Goals and the publication of data and coordination of work on the development of metadata for indicators.

By order of the Cabinet of Ministers of Ukraine, 183 indicators have been defined, the managers of the relevant information and the terms of its delivery have been determined. The State Statistics Service of Ukraine is the coordinator of data collection for monitoring the implementation of the Sustainable Development Goals and the development of metadata based on national indicators.

In July 2020, at the High-Level Political Forum on Sustainable Development under the auspices of the UN Economic and Social Council, Ukraine presented to the world community the first Voluntary National Review of the Status of Achievement of the Sustainable Development Goals (Goals of sustainable development of Ukraine. Voluntary National Review, 2020). This review is a summary of public opinion and expert assessments.

In 2021, permanent monitoring of indicators for achieving the Sustainable Development Goals was introduced. Monitoring of indicators of achievement of the Sustainable Development Goals in Ukraine is carried out on an annual basis. Data analysis

allows identifying current problems, determining the priority of solving the tasks of economic and social policy.

Achieving the Sustainable Development Goals requires the involvement of a wide range of stakeholders at different levels of government, as well as significant financial resources.

According to the information of the Government portal, in 2021, UNDP, WHO, UNICEF, together with the UN Economic Commission for Europe, as part of the Joint Program for the Promotion of Strategic Planning and Financing of Sustainable Development in Ukraine, together with the Government of Ukraine, started work on improving state financing for the implementation of the Goals sustainable development in Ukraine.

The cooperation at the national and sub-national levels, the Joint Program allowed conducting research and assessing the state of financing of the Sustainable Development Goals in Ukraine. On the basis of the study, recommendations for improving financing using existing and potential financial instruments were determined, directions for the use of resources that could be attracted were agreed with long-term development priorities and the achievement of the Sustainable Development Goals in Ukraine.

The Sustainable Development Goals are closely related to each other. Success in achieving one of the goals necessarily contributes to the success of achieving other goals. All Goals are aimed at improving the lives of people in different countries of the world. One of the main conditions for ensuring the quality of life of the population of any country is the health of the population.

Preserving the health of citizens, ensuring a high-quality, fulfilling life is an extremely important task both for individual countries and for the entire world community. The health of an

individual citizen and society as a whole is the greatest value for the country and a necessary condition for achieving sustainable socio-economic development of the country.

Not only the level of well-being depends on the state of health of the population, but above all, the level of development of the country's economy, the ability of society to counteract global crises.

The implementation of the action plan aimed at achieving strategic goal No. 3 of sustainable development requires significant attention from many countries of the world, especially in the conditions of military conflicts, military aggressions, as well as the global crisis - the COVID-19 pandemic.

The strategic goal No. 3 “Strong health and well-being” is to reduce mortality, stop epidemics, ensure equal access to health care services for all, access to essential medicines and vaccines for all.

According to World Health Organization (Goal 3), progress has been made in reducing child mortality, improving maternal health, and fighting HIV/AIDS, malaria, and other diseases. Since 1990, there has been a more than 50 percent decline in preventable child deaths worldwide. The global maternal mortality rate also dropped by 45%. From 2000 to 2013, the number of new HIV/AIDS infections decreased by 30%. Over 6.2 million lives have been saved from malaria.

Despite this progress, more than 6 million children die before their fifth birthday each year. Preventable diseases such as measles and tuberculosis kill 16,000 children every day. Hundreds of women die every day during pregnancy or from complications during childbirth. In many rural areas, only 56% of births are attended by qualified professionals. AIDS is the

leading cause of death among adolescents in sub-Saharan Africa, a region devastated by the HIV epidemic.

According to World Health Organization, these deaths can be prevented through prevention and treatment, education, immunization campaigns, and targeted sexual and reproductive health programs. The Sustainable Development Goals make a bold commitment to end the epidemics of AIDS, tuberculosis, malaria and other infectious diseases by 2030. The goal is to ensure universal health coverage and access to safe and affordable medicines and vaccines. Supporting scientific research and vaccine development is an integral part of this process.

Tasks to achieve the goal:

3.1 By 2030, reduce the global maternal mortality ratio to less than 70 cases per 100,000 live births.

3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to no more than 12 per 1,000 live births and under-5 mortality to no more than 25 cases per 1000 live births.

3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other infectious diseases.

3.4 By 2030, reduce premature mortality from non-communicable diseases by a third through prevention and treatment, and support mental health and well-being.

3.5 Improve the prevention and treatment of addiction to psychoactive substances, including drug and alcohol abuse.

3.6 By 2020, halve the number of deaths and injuries from road traffic accidents worldwide.

3.7 By 2030, ensure universal access to sexual and reproductive health services, including family planning services,

information and education, and the inclusion of reproductive health issues in national strategies and programs.

3.8 Ensure universal health coverage, including financial risk protection, access to quality essential health services and safe, effective, quality and affordable essential medicines and vaccines for all.

3.9 By 2030, significantly reduce the number of deaths and illnesses as a result of exposure to hazardous chemicals, pollution and poisoning of air, water and soil.

3.a Activate, if necessary, the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries.

3.b Promote research and development of vaccines and drugs for the treatment of infectious and non-infectious diseases that primarily affect developing countries, ensure the availability of low-cost essential drugs and vaccines in accordance with the Doha Declaration "Agreement and Public Health", where the right of developing countries to fully use the provisions of the Agreement on Trade-Related Aspects of Intellectual Property Rights to exercise flexibility for public health purposes and, in particular, to ensure access to medicines for all, is confirmed.

3.c Substantially increase health financing and the recruitment, development, training and retention of health personnel in developing countries, especially in least developed countries and small island developing States.

3.d Build the capacity of all countries, especially developing countries, in early warning, risk reduction and management of national and global health risks.

Progress in achieving the Sustainable Development Goals is measured by global and national indicators. Ukraine measures progress in this direction by 183 indicators. 22 of which fully correspond to the global ones, 72 are global analogs, the

remaining 89 indicators were added to the system of indicators of the Sustainable Development Goals due to the consideration of the national specificities of Ukraine.

The analysis of the Sustainable Development Goals, in particular, strategic goal No. 3, shows that the worldview paradigm of the Goals is based, first of all, on a fundamental change in social relations, awareness by representatives of all segments of the population of responsibility for their own lives and for the life of the entire society, awareness of the danger of the ecological crisis and its consequences for the life of an individual and the entire planet Earth.

But in addition to personal responsibility, joint actions of countries' governments, businesses, relevant institutions, public organizations, etc., are of great importance for the implementation of the Sustainable Development Goals.

The need for joint actions of various state and non-state institutions, civil society and individual citizens is of great importance for the implementation of the goals of sustainable development of the humanitarian direction No. 2, 3, 4, 5.

The Global Indicator System of the Sustainable Health and Well-Being Goal contains 28 indicators. As a result of the adaptation of these indicators, a system of national indicators of 16 indicators was formed in Ukraine.

The national system presents 6 indicators from the global system: maternal mortality, mortality of children under five years of age, the number of new HIV and tuberculosis patients, mortality in road accidents, and the level of immunization of the population.

The global mortality rate from cardiovascular diseases, cancer, diabetes or chronic respiratory diseases in Ukraine is presented in 4 indicators - mortality from cerebrovascular (non-

infectious) diseases, mortality from breast and cervical cancer. Indicators regarding tobacco use are partly comparable.

Ukraine has introduced monitoring for 4 indicators that are not represented in the global system: the probability of dying at the age of 20-64 for women and men, the number of people injured as a result of road accidents, and the share of population costs in the total health care costs.

Ukraine does not monitor 19 indicators from the global system of CSD. This includes, in particular, the proportion of births attended by qualified staff, neonatal mortality (newborns under 28 days), hepatitis B disease, suicide mortality, etc.

The Strong Health and Well-Being Global Goal is cross-cutting, so progress towards it contributes to other goals, and achievement of other goals contributes to Global Goal #3. The third goal has 17 sub-goals and is closely related to the other goals:

Goal No. 5. “Ensuring gender equality, expanding the rights and opportunities of all women and girls”,

Goal No. 6. “Ensuring the availability and rational use of water resources and sanitation for all”,

Goal No. 8. “Promoting progressive, inclusive and sustainable economic growth, full and productive employment and decent work for all”.

Goal No. 10. “Reducing inequality within and between countries”.

Goal No. 11. “Ensuring the openness, safety, viability and ecological sustainability of cities and settlements”.

Goal No. 13. “Take urgent measures to combat climate change and its consequences”.

Goal No. 17. “Strengthening the means of implementation and activation of work within the framework of global partnership in the interests of sustainable development”.

Implementation of the Strategic Goal “Strong health and well-being” involves the formation of appropriate public health programs.

The international community considers the problem of the development of public health systems as one of the important global problems. The problem of public health as a social phenomenon has a long history. One of the official documents in which the term “public health” was used for the first time is the “Protection of Public Health” statute, which was adopted in England in the 19th century.

According to WHO definition, health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

The World Health Organization, based on Donald Acheson's 1988 definition, defines public health as “the art and science of disease prevention, prolongation of life, and promotion (enhancement) of health through the organized efforts of society.

Considering the term “public health”, World Health Organization draws attention to the fact that public health is a set of activities

– general policy in the field of health care and resource allocation;

– management policies in the health care system;

– measures aimed at protecting the health of the population, preventing diseases, injuries, disabilities, and death;

– promotion of a healthy lifestyle;

– preserving a healthy environment and living conditions for current and future generations, etc.

The focus of public health care is on the entire spectrum of health and well-being, not on eradicating only certain diseases. Many interventions, such as health promotion campaigns, target

different populations. Public health services also include individual services provided to each individual, such as vaccination, behavioral or health counseling (Public health services. World Health Organization).

The world experience accumulated over the last half century shows that one of the most effective ways of organizing the public health system and improving the health of the population is to improve the determinants that determine it. The modern world is in a state of turbulence, when the socio-economic development of many states is characterized by constant changes and crises, the analysis of determinants of public health to ensure the effectiveness of the public health system. remains very relevant.

Considerable attention is paid to the problem of public health research and the improvement of the public health system from the standpoint of achieving the Sustainable Development Goals, in particular, strategic goal No. 3 – "Strong health and well-being". Achieving the strategic goal of "Strong health and well-being" is impossible without taking into account the impact of the environment on individual health and the health of the country's population as a whole.

The Scientific works of researchers S. Dudnyk, N. Levchuk, E. Libanova. devoted to the study of socio-economic aspects of public health, the organization of the public health system in Ukraine.

The influence of public health on economic growth is studied in the work of T.O. Pidvysitska, in the works of I.V. Zhalinska. Causal relationships between the health of the population and the determinants that determine it are considered in the works of foreign scientists, including J. Spijker, M. Marmot and R. Wilkinson, D. Raphael, R.R. Patil, D. Bradshaw, D. Kindig, and

in studies by the Commission on Social Determinants of the World Health Organization.

A thorough analysis of the influence of socio-economic determinants on inequality in the health of the population for the purpose of scientific substantiation of the principles and directions of the state policy on preserving and strengthening the health of the population was carried out in the work (Shushpanov D.G., 2019). The work has developed a conceptual basis for the study of socio-economic determinants of inequality in the health of the population with the determination of their structure, degree and directions of influence on health.

In this paper (Hrybovskyi Y.L., 2019), a conceptual model for monitoring indicators of the state of health of the rural population, taking into account medical and social determinants at the regional level, was scientifically substantiated and developed.

The World Health Organization pays considerable attention to the study of public health, the determinant of public health (WHO, Operational manual "Development and financing of regional and local public health programs", 2020).

Issues of complex analysis of socio-economic determinants of population health are also considered in works (Shushpanov D. G., 2017; Kraysovatyi A.I. & Desyatniuk O. M., 2016; Grynchutskyi V.I. 2015).

Monitoring of the achievement of the Sustainable Development Goals, in particular Goal No 3, is devoted to the Monitoring Reports "Sustainable Development Goals. Ukraine 2020", "Goals of sustainable development. Ukraine 2021".

There cannot be unambiguous patterns for the study of determinants of health, since the structure of determinants and mechanisms of action differ both between countries and within them. Considering that the modern world is in a state of

turbulence, when the socio-economic development of many states is characterized by constant changes and crises, the analysis of determinants of public health remains very relevant from the point of view of increasing the efficiency of the public health system.

According to the definition of the World Health Organization, public health is the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society.

Analysis of scientific literature shows that the term «public health» is used in both broad and narrow sense. The translation of the term «public health» allows us to interpret public health directly as public health and as public health care. Most often, the term «public health» is considered as the health of the population, determined by the complex action of social, behavioral and biological factors.

In scientific works on the problems of researching the health of the world population, six levels of health of the world community are distinguished:

1) the health of an individual;
2) health of a separate group of people;
3) health of the organization;
4) community health;
5) health of the country;
6) the health of the world population.

All these levels are interdependent and mutually determined.

Quite often, the term “public health” in the scientific literature is understood as a socio-cultural phenomenon that involves systematic and complex activities aimed at improving the health and quality of life of the entire population.

As stated in (Operational manual “Development and financing of regional and local public health programs”, 2020),

the public health system is considered as the basis of preventive medicine, which provides the main measures in the field of health care aimed at preserving the health of the population and reducing the costs of medical care.

The operational manual «Development and financing of regional and local public health programs» (Operational manual "Development and financing of regional and local public health programs", 2020) emphasizes that the mission of public health is to maximize the health and well-being of people and communities at the national and global levels.

The issue of ensuring public health is not new for Ukraine, but it is quite relevant from the point of view of achieving the Sustainable Development Goals. In the direction of achieving the goal of «Strong health and well-being», Ukraine has taken certain steps, in particular, the Concept of the Development of the Public Health System has been approved and the Law of Ukraine «On the Public Health System» has been adopted.

The concept of the development of the public health system, which was approved by the order of the Cabinet of Ministers of Ukraine dated November 30, 2016 under No. 1002, reveals the main directions, principles, tasks, mechanisms and deadlines for the development of the public health system in Ukraine.

Even in Russia's military aggression against Ukraine, Ukraine did not stop adapting the legislative framework in the field of public health the legislative framework of the European Union.

In September 2022, the Verkhovna Rada of Ukraine regulated the mechanisms for creating a public health system through the adoption of the Law of Ukraine «The Public Health System».

The Law of Ukraine «The Public Health System» defines the legal, organizational, economic and social principles of the

functioning of the public health system in Ukraine (Law The Public Health System). The purpose of the functioning of the public health system in Ukraine is to strengthen the health of the population, prevent diseases, improve the quality and increase the life expectancy of the population.

The law regulates social relations in the field of public health and sanitary-epidemic well-being, defines the rights and obligations of state bodies and local self-government bodies, legal entities and individuals in the field of public health.

The Law of Ukraine "On the Public Health System" contains nine sections:

Section I. General provisions.

Section II. State policy and regulation of the public health system.

Chapter III. Epidemiological surveillance and preparedness for response.

Chapter IV. Protection of public health.

Chapter V. Preservation of health and prevention of diseases.

Section VI. State regulation and control in the field of health protection and sanitary-epidemiological well-being of the population.

Section VII. Personnel, scientific and financial support of the public health system.

Chapter VIII. Liability for violation of the requirements of sanitary legislation.

Chapter IX. Final and transitional provisions.

Article 1. "Definition of Terms" contains the main definitions, including:

– public health – the field of knowledge and organized activity of the subjects of the public health system regarding health promotion, disease prevention, quality improvement and life expectancy increase;

– determinants of health - a set of individual, social, economic and environmental factors that determine the state of

health of individuals, contingents or population groups, in particular:

– individual determinants of health – genetic (hereditary) and behavioral characteristics of a specific person;

– social determinants of health - level of availability of food products, housing, work, education, medical care;

– services in the field of public health – services provided within the scope of the implementation of operational functions of public health;

– economic determinants of health - the state and level of economic relations that directly affect the environment of human life;

– one health - a cross-sectoral approach to the development and implementation of programs, the implementation of public policies, legislation and scientific research, in which several sectors, such as medicine, occupational medicine, veterinary medicine, food safety and environmental protection, interact in order to ensuring the protection of health and sanitary-epidemic well-being of the population and achieving better results in the field of public health;

– public health information fund - a state information resource containing data on the state of health, sanitary and epidemic well-being of the population and indicators of the living environment and is filled in according to the procedure established by the Cabinet of Ministers of Ukraine from information systems and databases located in property or disposal of the central executive body, which ensures the formation of state policy in the field of health care, other state bodies, or from other specified sources;

– response to dangerous factors and emergency situations in the field of public health - a complex of organizational, medical and sanitary, anti-epidemic and administrative measures in the center of detection of a dangerous factor and/or emergency situation and beyond, aimed at eliminating dangerous factors

and reducing harmful effects on the health of the population of environmental factors that pose a threat to the health, life or working capacity of a person or the health of future generations;

– the living environment of a person (hereinafter - the living environment) - a set of objects, phenomena and environmental factors (natural and artificially created) that directly surround a person, influence and determine the conditions of his living, nutrition, work, recreation, education, upbringing, etc. ;

– public health system is a set of tools and measures carried out by the subjects of the public health system and aimed at protecting and strengthening the health of the population, preventing diseases, improving the quality and increasing the length of life, ensuring the sanitary and epidemic well-being of the population;

– harmful effect on human health - the influence of factors of the living environment, which creates a threat to the health, life or working capacity of a person or the health of future generations.

Research on the determinants of population health is relevant to expand the knowledge base on which the policy-making process is oriented based on factual data. In this regard, it is necessary to unify the definitions of such concepts as “health”, “public health”, “population health”, and “determinants of health”.

There are different approaches to the definition of “public health” and the purpose of the determinants of public health in the scientific literature. So, there are two interpretations of the term “public health”:

– public health, considered as a set of the health of all members of society;

– public health is considered the science and practice of preventing diseases, increasing life expectancy, and strengthening health through organized efforts

The problem of the unity of the terminology used in social medicine, public health, organization, and economics of health care has acquired particular importance in recent years.

In the sources of scientific information on health care, there are different interpretations of the same terms, which leads to terminological confusion and complicates the work of scientists and practitioners in the field of public health.

Glossary of basic concepts and terms used in European policy: Health-2020 contains terms used in reports prepared by the working groups of the European Bureau of the World Health Organization, in scientific publications, and normative legal acts of Ukraine (Table 1).

Table 1. Basic terms used in the field of health care

Term	Interpretation
Health for all	A strategic goal consists of achieving for all people in the world such a level of health that would allow them to lead a socially and economically productive life.
Public health	The population's health is determined by the complex influence of social, economic, behavioral, ecological, and biological factors, which are assessed by demographic indicators, physical development characteristics, morbidity, and disability.
Public health protection	The science and practice of disease prevention, life extension, and health promotion through the organized actions of society.
Determinants of health	A set of individual, social, economic, and environmental factors determine individuals' health status or population groups.
Health	A complete physical, mental and social well-being, not just the absence of disease or physical defects.
Public health services	Services related to the implementation of the main operational functions of public health. These services may be provided by the health system or other sectors (outside the system) whose activities ensure health.

continued Table 1

Term	Interpretation
Health inequality	This term refers to differences in health outcomes between individuals or groups, such as life expectancy, mortality, or morbidity. Inequalities in health are differences, fluctuations, and imbalances in dynamic indicators of the state of health of individual citizens and population groups. Some of these differences depend on biological or other uncontrollable factors, such as age; other differences, on the contrary, can be eliminated.
Health resource	In a broad sense, a health resource can be defined as any factor (or resource) that increases the ability of an individual, a local community, or a broader population to protect, strengthen and maintain their health and well-being. Such resources may function at the individual, group, community, and population levels as protective factors for coping with life stress and enabling factors for achieving one's maximum health potential.
Public health resources, public health potential	Resources (physical, financial, personnel, and others) are necessary to implement the main operational functions of public health.
Health care system	The totality of all public and private organizations, institutions, structures, and resources, the purpose of which is to improve, preserve or restore people's health. Healthcare systems include the provision of both individual and community services and influencing the policies and activities of other sectors so that the social, environmental, and economic determinants of health are given the necessary attention.
Social gradient of health	Gradual improvement of health indicators as the socioeconomic situation improves. Parameters such as income, work type, or education level serve as a reference scale. Similarly, the social gradient of health can be defined as a gradual (gradual) or linear decrease in health indicators as the social situation worsens.

continued Table 1

Term	Interpretation
Social determinants of health	Social determinants of health are the conditions in which people are born, grow, live, work, and age, including the health care system. These circumstances are formed depending on the distribution of money, power, and resources at the global, national, and local levels, which, in turn, are influenced by the implemented policy measures. The social determinants of health underlie most health inequities, i.e., discriminatory and discriminatory differences in health outcomes within and between countries.
Justice about health, social justice about health	Social justice is the absence of unjust differences between groups of people (which can be prevented or eliminated) united by social, economic, demographic, or geographical characteristics. "Social equity in health" assumes that, ideally, everyone should have a decent opportunity to achieve their full health potential. More practically, no one should be disadvantaged in achieving this potential.

Source: built by the authors based on (Terms in the public health system. Terminological dictionary. The first part).

It is the differences in the translation and interpretation of some concepts of the health care system that cause the difference in the definitions of the concepts of «public health» as the health of the population and «public health» as the science and practice of disease prevention and health promotion population through the organized efforts of society.

The complex interaction of social, behavioral, biological, and other determinants generally determines public health.

The analysis of scientific publications, WHO documents, state-level legislative acts confirms the existence of differences in the interpretation of the concept of «determinants of health».

In the WHO glossary, determinants of health are considered as a complex of individual, social, economic, and environmental factors that affect both the health status of individuals and population groups. You can be healthy only if you understand the influence of these factors and are able to control them.

The health of people of all age groups is affected by a number of factors, some of which depend on the person, and some of which do not. One model that describes the relationship between these factors is Dahlgren and Whitehead's "Policy Rainbow" model. Factors are divided into immutable - age, gender and genetic factors, potentially changeable - personal lifestyle, physical and social environment, and factors over which an individual has no influence: environment, broad socio-economic, cultural and ecological conditions.

In 2005, World Health Organization established the Commission on Social Determinants of Health to develop recommendations to promote equity in health care.

Social determinants are the conditions in which people are born, grow, live and age, as well as the areas that influence these conditions, including the state of economic development, social norms, public policies and political systems of a country.

Social determinants relate to working conditions; processes of exclusion of certain groups of people from participation in public life; gender equality issues, exploring what actions can be taken to reduce gender inequities in health care; early development of children, which is crucial for the formation of health and development throughout life; globalization affecting health and production.

The issue of systematization and structuring of health determinants is important. There are different approaches to the classification of health determinants.

One of the modern models is the three-level model of health determinants, which is a three-level division of health determinants:

1) *contextual* – global and socio-political determinants that create prerequisites for the formation of structural level determinants;

2) *structural*, related to inequality among different population groups: territorial, demographic, social, ethnic, etc.

3) *proximal level* – determinants of the individual characteristics of each person, their health behavior may depend on the determinants of the contextual and structural levels (Shushpanov D.G., 2019, p. 89).

The same approach can be applied to the classification of determinants of public health.

As noted in (Shushpanov D.G., 2019), this approach makes it possible to comprehensively investigate the determinants of health at all levels of their formation, and in the context of framework studies, it will help to focus attention on a more detailed study of the mechanism by which determinants of one or another level determine health.

Contextual level covers determinants, which include global and socio-political processes that affect population health, usually indirectly, through determinants of lower levels.

The global level covers the determinants of health that are most distant from the individual and have an impact on him. Global determinants – governance structures, economic globalization, international trade, international migration, global social interactions (migration, conflicts, social capital and communication networks), global climate change, etc. These

determinants can have positive or negative effects on public health.

Structural level covers determinants of health that affect the health of the population directly, but do not determine its individual characteristics. Determinants of population health at the structural level can be grouped into the following groups: social, economic, cultural, medical, and environmental. This division has a certain aspect of convention, because a number of determinants can be attributed simultaneously to several groups.

Pervasive (individual level) covers determinants of health that affect health directly and determine individual characteristics. At this level, the determinants should also be grouped into social, economic, cultural and environmental groups.

There are differences in the health of individuals within population groups, subject to the same influence of social determinants of the structural level, related to the individual lifestyle (behavior) at the proximal level.

To the social, economic, cultural and ecological determinants, which are exogenous to a person, determinants of endogenous origin are added at the proximal level: biological and psychological. Biological caused by genetics, heredity. Psychological ones are also somewhat hereditary, although they can change over time.

The health of people of all age groups is affected by several factors, some of which depend on the person and others do not.

One model that describes the relationship between these determinants is the «rainbow of factors», the Dahlgren-Whitehead rainbow (The Dahlgren-Whitehead rainbow, 1991). Factors are divided into immutable – age, gender, and genetic factors; potentially changeable – personal lifestyle, physical and social environment; and factors over which an individual has no

influence – environment, overall socio-economic, cultural, and ecological conditions.

According to Dahlgren-Whitehead's model, socioeconomic, cultural, and environmental determinants are politics and economics, safe ecosystems and sustainable relationships between people and nature, societal values and rules, artistic integrity, and identity.

Living and working conditions are education, working conditions, access to medical services and quality, minimum social protection system, water supply, agriculture, food production, and employment opportunities. Education is one of the critical determinants of health. Formal and informal education, teaching in the family, community in society, and value orientations of culture have a significant impact on both individual health and the population's health as a whole.

A social support network is a solidarity, social support of family, friends, local community, strong families, and freedom from fear, both in family and society.

Personal lifestyle – attitude to health, environmental adaptation, skills of achieving well-being, personality traits.

Age, gender, features of the body, and ethnic features are a set of external and internal features of the body that are inherited from parents, independent of human will.

Building a model of determinants of public health in the conditions of the modern development of society is an urgent and essential task since the conceptual model of determinants of public health is the basis for determining the causes and problems in the field of health care, as well as the foundation for building policies and development promotion programs public health systems.

The analysis of the considered models of health determinants shows that the change in health determinants included in the

model is due to the historical development of states, the influence of modern processes of globalization, digitalization, etc.Also, it is essential to consider the impact of the digitalization process on individual health, population health, and the public health system. This is of great importance in the digital economy's formation conditions. Right now, most EU countries' healthcare sector is undergoing several vital reforms to fulfill the primary mission - improving citizens' quality of life in the conditions of the digital economy. The main bet is on the transition to electronic health care, which consists of supporting health care's mission with the help of information and communication technologies. Implementing electronic health care will allow providing the correct information at the right time and place at all stages and processes of citizens' health care. For example, in Slovakia, the «ezdravia» implementation program is implemented through several projects. The implemented National Electronic Medical Services project is financed from EU structural funds in the form of the Operational Program for Informatization of Society (OPIS). The Electronic Medical Servicesproject includes the creation of the National Health Portal and filling it with basic information, the creation and launch of applications for trial operation: the Citizen's Electronic Health Record, eRecipe / eMedication, eAllocations. Information systems of medical service providers must be integrated with the national medical solution.

Another project is the National Electronic Medical Services project - the expansion of the functionality and scope of services financed from EU structural funds in the form of the Operational Program for Informatization of Society (OPIS). Its purpose is the consolidation of drug and knowledge databases, the ability to manage and update drug data and the knowledge database, the expansion of security mechanisms for the protection of personal

data of a particular category of extended functionality, and the scope of electronic health care services, new functionalities of electronic health care services (Lessons from public health reforms in Slovakia).

The research showed that considerable attention is paid to developing the public health system. Modern public health is comprehensive in its purpose as it addresses interventions that address both community-wide and individual health needs. Public health aims to maximize the health and well-being of people and communities at the national and global levels. Effective socio-economic development of the country is impossible without the proper level of health of the population.

The world experience accumulated over the last half century shows that one of the most effective ways of organizing the public health system and improving the health of the population is to improve the determinants that determine it. The modern world is in a state of turbulence, when the socio-economic development of many states is characterized by constant changes and crises, the analysis of determinants of public health to ensure the effectiveness of the public health system. remains very relevant.

2. DETERMINING THE IMPACT OF SOCIO-ECONOMIC FACTORS AND THE HEALTH DETERMINANT ON THE HUMAN INEQUALITY INDICATOR FOR ENHANCED ECONOMIC GROWTH

Nowadays, humankind has one of its oldest unresolved problems – human inequality – a possible reason for the sharp differentiation prevailing within the contemporary world, resulting in some people living beyond poverty and without any opportunity to change their status. At the same time, some people are constantly getting well-off, on the other hand. Inequality is caused by systems such as the labour market, education and its accessibility, health and life expectancy, and the environment. The strongest negative effects of human inequalities may be noticed in people's health, life expectancy, economic and social well-being and social mobility.

Most people worldwide understand the concept of being healthy in the sense of being physically fit for a particular moment. The physical part occupies one of the top positions among the health components: social, medical, economic and spiritual.

Most of all, the key to health is to be acutely aware of yourself and actively engage in the many aspects of life that may be under your control. It is much more than just physical health and psychological well-being.

Overall, the basic idea of staying healthy is to find a balance between all the components making up our lives. It is not a new idea, but one gaining popularity dramatically over the last decade, especially in the western world, and having a significant impact, especially on adults and elderly people.

Health status is a general indicator for diseases (acute and chronic), disorders, injuries or trauma. Health status can also

cover other circumstances, such as pregnancy, ageing, stress, congenital abnormality or genetic predisposition (Fundamentals of Ukrainian legislation on health care).

These definitions will help us but not enough because the concept of health belongs to the philosophical category of concepts in the scientific sense. Simultaneously, the concept of health is an essential medical category of studying normal and abnormal processes in the human body, and finding methods to prevent and treat human diseases and promote health is the objective of medicine.

Health is an important economic category, and the social development of the population depends on the level of health. It is for the development and improvement of living standards that such a thing as health care is needed.

An economy always works to produce some material product, and the social sphere is always a person-centred one – all components of the social sphere work for a human being. The most important area is health care, which is a mechanism for restoring the workforce, which, in turn, is necessary for the economy functioning. For health care, medical services as a type of such intangible goods were created; they are an integral part of the reproduction of the labour force. Effective functioning of the economic system is impossible without these intangible goods.

Creating a socio-economic environment for a sustainable high level of public health is an important goal for all humankind. It is necessary to define the conceptual aspects of the structural and functional content of health indicators to achieve this goal. By clearly defining the conceptual aspects of health indicators, it is possible to create a qualitative modeled system with each indicator having its own weight and containing

potential reserves for improving health and, as a result, the growth of the country's economy.

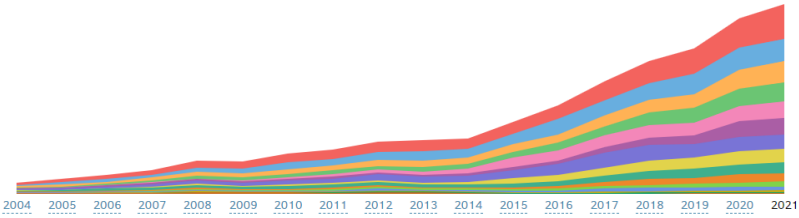
Health as an economical category is a multidimensional entity that includes specific dimensions such as physical indicators, mental indicators, social indicators, economic relations, philosophical, cultural, socio-economic, environmental, educational, nutritional, social, therapeutic and preventive indicators. If the system of indicators is being made operative, a specific dimension of health as an economical category will appear.

Health aspects are multidimensional: the WHO definition identifies three specific dimensions, but there are many more dimensions. The physical dimension is the ideal functioning of the body: assessment of physical health, self-assessment of general health, investigation of symptoms of poor health and risk factors, request for medication, request for daily activity levels, request for the use of health services, standardised questionnaires for cardiovascular disease, standardised questionnaires for respiratory disease, clinical examination, assessment of diet and nutrition and biochemical laboratory tests.

Mental dimension of health aspects: the attributes of a mentally healthy person include the freedom from internal conflicts, not internal battling with yourself, reasonable social adjustment: the ability to get along well with others, accepting criticism, finding identity in oneself, having a solid sense of self-worth, knowing oneself, your needs, problems and goals, having good self-control, finding a balance between rationality and emotions, facing problems and trying to solve them reasonably, i.e. coping with it.

Improved health provides more capable, efficient worker who thereby increases per capita income to the economic mechanism.

This effect will appear along with a rapid increase in health care expenditures. The dynamics of public spending of Ukraine in the field of education, pension fund, health care, public order and security, interest payments on public debt, transportation, social security, protection, administration of government bodies, economic activity by various types, culture and sports, municipal services, agricultural activity, environmental protection and energy in the period from 2004 to 2021 is shown in Figure 1.



	Progress as of 30/09/2021	Local Budgets	State Budget	Consolidated Budget
Education	66%	255,692 MM UAH	68,554 MM UAH	324,246 MM UAH
Pensions	74%	10,886 MM UAH	200,631 MM UAH	211,517 MM UAH
Healthcare	64%	30,472 MM UAH	170,033 MM UAH	200,505 MM UAH
Public Order and Safety	65%	1,802 MM UAH	174,683 MM UAH	176,485 MM UAH
Interest on the National Debt	70%	2,290 MM UAH	159,386 MM UAH	161,676 MM UAH
Transportation	66%	60,743 MM UAH	92,731 MM UAH	153,474 MM UAH
Social Welfare	76%	17,962 MM UAH	118,207 MM UAH	136,169 MM UAH
Defense	65%		122,166 MM UAH	122,166 MM UAH
Administration of Government Bodies	62%	45,997 MM UAH	57,861 MM UAH	103,858 MM UAH
Other Economic Activity	41%	58,722 MM UAH	21,779 MM UAH	80,501 MM UAH
Culture and Sport	60%	27,314 MM UAH	18,921 MM UAH	46,235 MM UAH
Municipal Services	58%	33,521 MM UAH	365 MM UAH	33,885 MM UAH
Agricultural subsidies	47%	716 MM UAH	17,963 MM UAH	18,679 MM UAH
Environmental Protection	36%	3,266 MM UAH	9,299 MM UAH	12,565 MM UAH
Energy Subsidies	90%	10 MM UAH	4,741 MM UAH	4,751 MM UAH
Total		549,391 MM UAH	1,237,321 MM UAH	1,786,712 MM UAH
Intergovernmental Transfers		12,368 MM UAH	173,813 MM UAH	

Figure 1. Dynamics of public expenditures of Ukraine in 2021 (The price of state: budget for Ukraine)

Source: developed by the authors

In particular, the dynamics of state contributions to the health sector from 2007 to 2021 are shown in Figure 2. As can be seen from the data (Figure 2), the dynamics of state contributions from the consolidated budget increased steadily until 2021. Comparing the data for 2021 and 2020 indicated that progress in 2021 to be accounted for 64%. Of course, such rapid growth is also related to the impact of the global COVID-19 pandemic. Before 2020, healthcare funding from local budgets was almost five times greater than the national budget. While in 2020, the expenditure from local budgets to the health sector amounted to UAH 51.323 million, the state budget expenditure amounted to UAH 128.067 million, which is 2.5 times more than contributions from local budgets. In 2021, contributions from the state budget were 5.6 times higher than expenditures from local budgets (Figure 2).

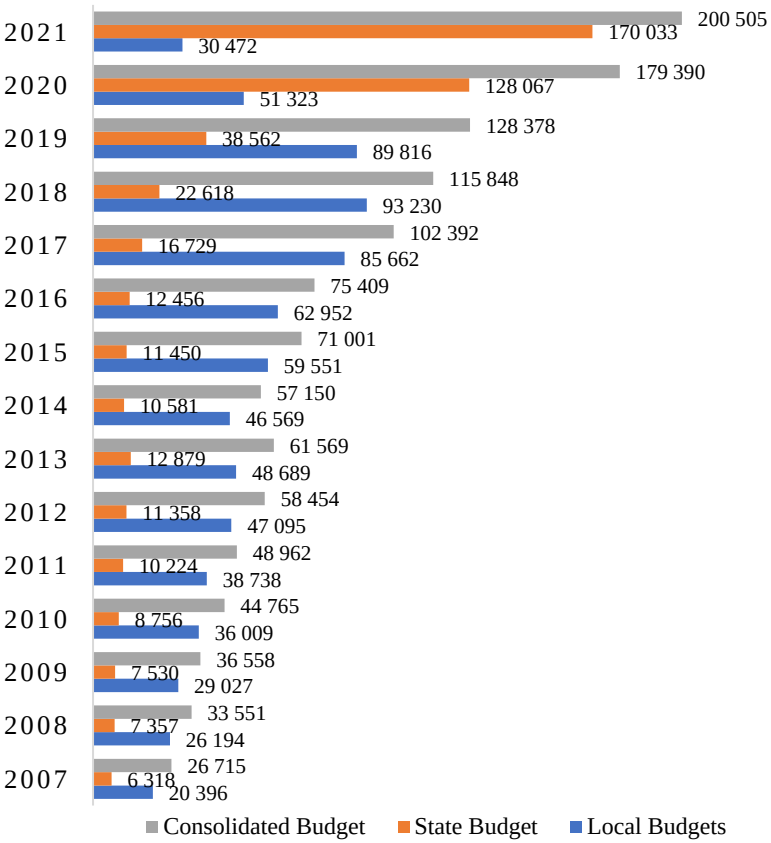


Figure 2. Dynamics of public expenditure in the health sector in Ukraine, million UAH.

Source: developed by the authors

Inequality in human life is widespread. People who are beyond the border of inequality become hostages to the state. Inequalities make people's lives insecure, they lose confidence in society and the state. Also, people's inequality is hostage to progress (economic, informational, technological). However, on

the other hand, not every inequality has negative features and has a destructive effect on the development of each individual and the state as a whole. For example, the socio-economic status of parents significantly affects the quality of children's health and education. Thus, the relevant goal is an in-depth and comprehensive analysis of the indicators that determine human inequality as a factor of the economic category, as well as the analysis of indicators that are stimulators (reduce the value of the human inequality ratio) and disincentives (increase the value of the human inequality ratio), determining the extent of their impact.

Numerous domestic and foreign publications of scientists confirm the relevance of the issue. The search engine of the Scopus scientometric database TITLE-ABS-KEY ("inequality" AND "human" AND "Gini coefficient") has retrieved a list of 935 papers from 1982 to 2022.

The bibliometric analysis of the array of received publications using VOSviewer software made it possible to identify the key determinants of human inequality, to form clusters with the most frequently used keywords. Thus, when processing this array and establishing a minimum number of links of 5 units, only 56 words out of 1379 keywords have 5 links each (Figure 3).

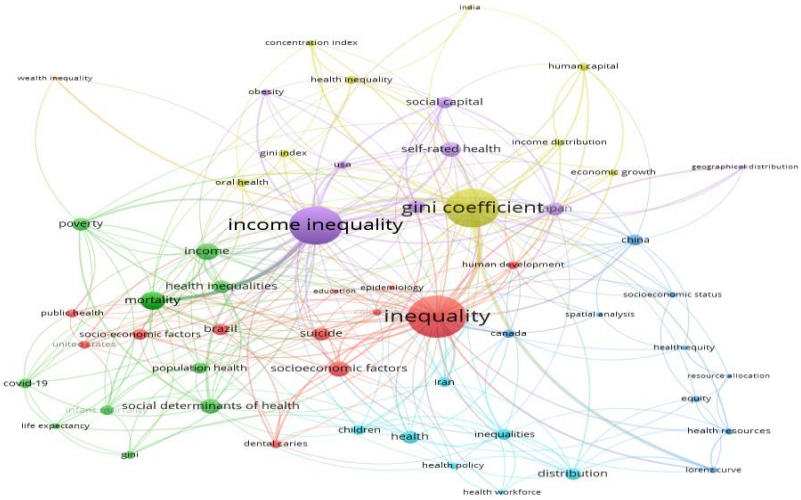


Figure 3. Map of relationships between keywords in the context of the study "human inequality and the Gini coefficient"

Source: developed by the authors based on the results of the Scopus database using VOSviewer software tools

Figure 4 presents a list of the most used keywords and the number of relationships shared by scholars worldwide. The list of most commonly used keywords: income inequality, the Gini coefficient, inequality, mortality, income, poverty, self-rated health, social determinants of health, Lorenz curve, socio-economic factors, multilevel analysis, Japan, social capital, health inequality, China, distribution, health, human capital, income distribution, inequality.

Selected	Keyword	Occurrences	Total link strength
☑	income inequality	113	151
☑	gini coefficient	114	130
☑	inequality	89	115
☑	mortality	17	32
☑	income	18	31
☑	poverty	16	28
☑	self-rated health	13	28
☑	social determinants of health	19	28
☑	lorenz curve	18	27
☑	socioeconomic factors	22	27
☑	multilevel analysis	12	26
☑	japan	11	25
☑	social capital	12	25
☑	health inequalities	18	24
☑	china	16	21
☑	distribution	9	18
☑	health	10	18
☑	human capital	9	16
☑	income distribution	11	16
☑	inequalities	13	16

Figure 4. List of top keywords related to "human inequality and Gini coefficient"

Source: developed by the authors based on the results of the Scopus database using VOSviewer software tools

When examining the studies of domestic scholars I. A. Markina, O. V. Kalinichenko, V. S. Lesyuk (Markina et al., 2019), S. V. Moroz (Moroz 2020), V. V. Opalko (Opalko 2018), N. V. Koval (Koval 2016), S. V. Voloshina, A. V. Skubilina, A. N. Chebotarenko (Voloshina et al., 2017), O. M. Lyashenko, L. V. Duma, N. V. Bazhanova (Lyashenko et al., 2020) on the topic of inequality and factors influencing it It should be emphasized that the authors consider issues in different manifestations of human inequality and at varying levels of global influence. At the international level, inequality is addressed by the following authors in their works: M. Simonovich, A. Pierce, H. Thomson, G. McCartney, S. V. Katikireddy (Simonovich et al., 2022), N. Sudo (Sudo 2020), A. Siegel, J. F. Schug, M. A. Rieger (Siegel et al., 2022), J. Nenow, A. Nenow, K. M. Campbell, J. Toomin (2022). They provide an overview of inequality in the context of the country's location, taking into

account income, the level of economic development of the country and the impact of the pandemic.

Moreover, a bibliometric analysis carried out by means of the Bibliometrix web resource (Aria et. al, 2017), the R programming language and the R Studio environment made it possible to identify groups of the most influential journals by industry, the number of articles published in them by world scientists on the topic of studying the impact of socio-economic factors and health determinants on the indicator of human inequality, as well as to identify the most significant countries by the total number of citations of the analysed publications of the authors in the context of the research topic.

Bibliometrix is a web resource that allows for a comprehensive analysis of scientific publications and can import data and convert them into R programming language codes; display descriptive analysis of publication datasets; selections from the global collaborative citation network; collaborate on publications; and conduct network analysis of publications. Publications are imported using the Biblioshiny R library in the form of matrices (Aria et al., 2017), which may contain information needed for citation (authors, author identifiers, document title, year, Scopus EID (unique academic work identifier assigned in Scopus bibliographic database), source title, volume, issue, pages, number of citations, source and type of document, publication stage, DOI, open access), bibliographic information (organisations, serial identifiers, publisher, editors, language of original paper, correspondence address, abbreviated source name), author and index brief description and keywords, funding information (number, acronym, sponsor, information about funding), and information such as firm and producer name, account numbers, conference information, references in the article. It is also possible to download and collect data in various formats (bibtext, xlsx, csv) from databases such as Web of Science, Scopus, Dimensions (a

database of research grants linking grants to impact publications and patents), Lens (an online resource for searching patents and scientific literature), PubMed (contains biomedical research), Cochrane Library.

Table 2 presents the top 25 most relevant journals by the number of articles published in them in the context of the study of the impact of socio-economic factors and health determinants on the indicator of human inequality to increase economic growth.

Table 2. The most relevant sources

Sources	Articles
SOCIAL SCIENCE AND MEDICINE	27
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	22
BMC PUBLIC HEALTH	13
PLOS ONE	12
EUROPEAN JOURNAL OF PUBLIC HEALTH	7
HEALTH POLICY	7
JOURNAL OF EPIDEMIOLOGY AND COMMUNITY HEALTH	7
REVISTA PANAMERICANA DE SALUD PUBLICA/PAN AMERICAN JOURNAL OF PUBLIC HEALTH	7
AMERICAN JOURNAL OF PUBLIC HEALTH	6
COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY	6
HEALTH PROMOTION INTERNATIONAL	6
SOZIAL- UND PRÄVENTIVMEDIZIN SPM	6
WORLD HEALTH STATISTICS QUARTERLY	6
AGING AND MENTAL HEALTH	5
BMC HEALTH SERVICES RESEARCH	5
BMJ OPEN	5
HEALTH AND QUALITY OF LIFE OUTCOMES	5
JOURNAL OF PUBLIC HEALTH	5
CANADIAN JOURNAL OF PUBLIC HEALTH	4
COMMUNITY DENTAL HEALTH	4
GESUNDHEITSWESEN	4
HEALTH ECONOMICS	4
INTERNATIONAL JOURNAL OF HEALTH SERVICES	4
INTERNATIONAL JOURNAL OF PUBLIC HEALTH	4
JOURNAL OF CHRONIC DISEASES	4

Source: developed by the authors using the Bibliomenix package (Aria et. al, 2017)

To find the most relevant scientific information in the context of the research topic "impact of socio-economic factors and determinants of health on the human inequality indicator" and to be able to publish our own research, it is advisable to use Bradford's Law of Scattering (Marcia et. al, 2015), the results for the top 25 journals are presented in Table 3.

Table 3. Source clustering through Bradford's Law

Sourse	Rank	Frequency	Cummulativve Frequancy	Zone
SOCIAL SCIENCE AND MEDICINE	1	27	27	Zone 1
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	2	22	49	Zone 1
BMC PUBLIC HEALTH	3	13	62	Zone 1
PLOS ONE	4	12	74	Zone 1
EUROPEAN JOURNAL OF PUBLIC HEALTH	5	7	81	Zone 1
HEALTH POLICY	6	7	88	Zone 1
JOURNAL OF EPIDEMIOLOGY AND COMMUNITY HEALTH	7	7	95	Zone 1
REVISTA PANAMERICANA DE SALUD PUBLICA/PAN AMERICAN JOURNAL OF PUBLIC HEALTH	8	7	102	Zone 1
AMERICAN JOURNAL OF PUBLIC HEALTH	9	6	108	Zone 1
COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY	10	6	114	Zone 1
HEALTH PROMOTION INTERNATIONAL	11	6	120	Zone 1
SOZIAL- UND PRÄVENTIVMEDIZIN SPM	12	6	126	Zone 1
WORLD HEALTH STATISTICS QUARTERLY	13	6	132	Zone 1
AGING AND MENTAL HEALTH	14	5	137	Zone 1
BMC HEALTH SERVICES RESEARCH	15	5	142	Zone 1
BMJ OPEN	16	5	147	Zone 1
HEALTH AND QUALITY OF LIFE OUTCOMES	17	5	152	Zone 1
JOURNAL OF PUBLIC HEALTH	18	5	157	Zone 1
CANADIAN JOURNAL OF PUBLIC HEALTH	19	4	161	Zone 1
COMMUNITY DENTAL HEALTH	20	4	165	Zone 1
GESUNDHEITSWESEN	21	4	169	Zone 1
HEALTH ECONOMICS	22	4	173	Zone 1

continued Table 3

Sourse	Rank	Frequency	Cummulativve Frequancy	Zone
INTERNATIONAL JOURNAL OF HEALTH SERVICES	23	4	177	Zone 1
INTERNATIONAL JOURNAL OF PUBLIC HEALTH	24	4	181	Zone 1
JOURNAL OF CHRONIC DISEASES	25	4	185	Zone 1

Source: developed by the authors using the Bibliomenix package (Aria et. al, 2017)

The essence of Bradford's law, according to one of its varieties of formulations and applications (Alvarado, 2016; Marcia et al., 2015; Debnath et al., 2021; Desai et al., 2018) is that if journals in a given industry are divided into three zones (clusters) in such a way that each zone contains one-third of all articles by a number of publications in them, then the number of journals in each cluster will be proportionally determined by the formula (1):

$$1: n: n2, \quad (1)$$

where n – is the number of journals in the cluster.

Using this logic (1) and the Bradford multiplier b_m we can determine the optimal number of journals, which the researcher should analyse in the scope of his activity. That is, if, for example, a researcher is aware of the activities of five major journals in their field of study that together have published 12 articles, objects for researcher's interest, then the researcher needs to review at twice as many journals to find the next 12 articles, so the Bradford multiplier b_m =10/5=2. Hence, the researcher needs to look through bm times as many journals to find the next new 12 articles. After analysing 5, 10, 20, …, 60, … journals the researcher realises that they do not need any further analysis, they have found the top relevant journals for

their field of study. Various researchers have their primary base of core journals and have different Bradford multipliers, and define their core areas for publication.

The list of the top 30 countries by the total number of citations of authors' publications is presented in Figure 5.

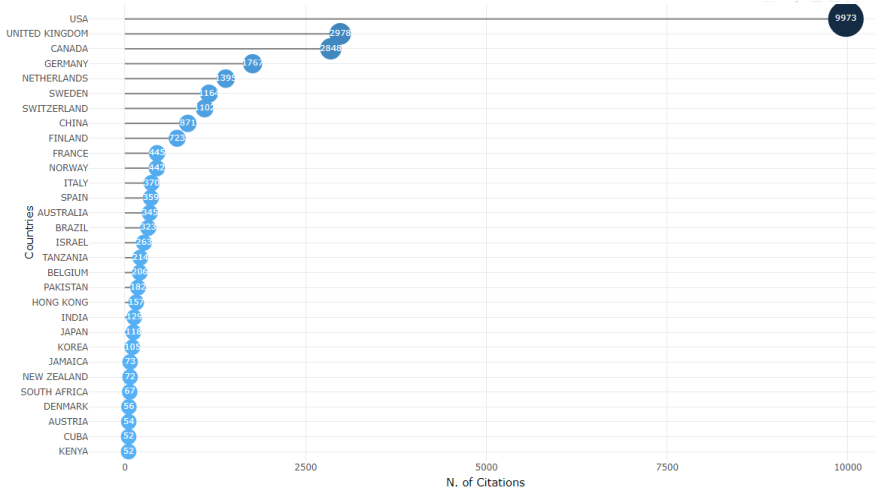


Figure 5. Most Cited Countries

Source: built by the authors using the Bibliomenix package (Aria et. al, 2017)

The top-25 affiliations of the authors by the number of publications are shown in Table 4.

Table 4. Most Relevant Affiliations

Affiliation	Articles
Notreported	39
University of California	28
Peking University	26
University of Helsinki	22
University of Toronto	21
London School of Hygiene and Tropical Medicine	18
Division of Adolescent and School Health	15
Universidade Federal de Pelotas	15

continued Table 4

University College London	14
University of British Columbia	14
University of Maryland	14
Cornell University	13
Universidad de Granada	13
University of washington	13
Centers for Disease Control and Prevention	12
University of Florida	12
Erasmus University	11
Ghent University	11
Harvard School of Public Health	11
Université de Montréal	11
University Medical Center	11
University of Bergen	11
Arizona state University	10
Beijing normal university	10
University of Georgia	10

Source: formed by the authors using the Bibliomenix package (Aria et. al, 2017)

It is advisable to use the tools of Multiple Correspondence Analysis to identify keywords of authors by basic categories.

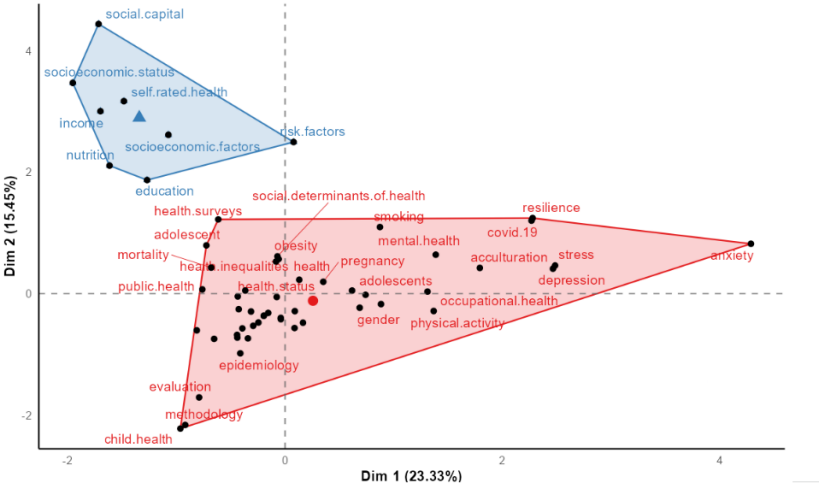


Figure 6. Conceptual structure of keywords obtained using the MCA (Multiple Correspondence Analysis) method.

Source: built by the authors using the Bibliomenix package (Aria et. al, 2017)

Multiple Correspondence Analysis (Abdesselam, 2020; Akassou et al., 2015; Avalio et al., 2013) identified two main categories regarding the number of authors' keywords in publications analysing the impact of socio-economic factors and the determinant of health on the human inequality indicator.

Consequently, the next stage of research is to develop a regression model of the impact of the indicators "human inequality ratio", "Gini coefficient", "inequality in life expectancy", "gross national income", "inequality-adjusted life expectancy index" on the "human inequality level" indicator.

In the current global situation, an in-depth analysis of indicators characterising the dynamics and trends of changes in society and the economy is a relevant and important issue. One such indicator is inequality, namely the coefficient of human inequality. An objective analysis is possible with the use of analytical economic and mathematical methods, methods of multivariate statistical analysis (descriptive, correlative, factor, regression), the results of which provide a comprehensive view of the content of this issue – the impact and significance of indicators on the level of human inequality.

The information base used the official Human Development Index (HDI) reports of the United Nations Development Programme (UNDP) 2022 for the year 2019 for 138 countries. Taking into account the bibliometric analysis conducted and the substantive nature of the determinants influencing the level of human development and human inequality, the following indicators were selected: human inequality ratio, Gini coefficient, inequality in life expectancy, gross national income, inequality-adjusted life expectancy index.

Human inequality is a state of society where the income inequality between the rich and the poor is so significant that it

threatens the realisation of human rights and directly impacts health and the quality of education. There is also a horizontal and a vertical dimension of inequality, where the horizontal will manifest itself in cultural differences and the vertical one – in establishing relationships at interpersonal levels or relationships between households.

The human inequality coefficient was introduced in 2014 as an experimental indicator. It is a simple average of inequalities in health, education and income. The average is calculated from an unweighted arithmetic mean of the estimated inequalities in these dimensions (United Nations Development Programme 2022).

The Gini coefficient is a statistical measure of the degree of inequality of a given country (region)'s society on a particular research attribute and can take values between 0 and 1 (Blesh et al., 2022). A 0 indicates perfect equality and a 1 indicates perfect inequality. Most commonly used to measure economic inequality, the Gini coefficient is a measure of household income inequality in a country or region: the more its value deviates from zero and approaches one, the more income is concentrated in the hands of certain strata.

The health dimension is measured by life expectancy at birth, the average number of years of schooling for adults aged 25 and over and the expected years of studying for school-age children. The living standard is measured by gross national income per capita.

Life expectancy is a statistical measure of the average time an organism is expected to live based on its year of birth, current age and other demographic, as well as gender factors.

The United Nations estimates global life expectancy at 72.6 as of 2019. The global average was higher than any country in 1950. The UN estimates that the healthiest country with the best

health in 1950 was Norway, with a life expectancy of 72.3 years (Our world in data 2021).

Gross National Income (GNI) is the total amount of money earned by people and businesses in a country. It is used to measure and track the nation's wealth yearly. This number includes the gross domestic product (GDP) of a country and the income received from foreign sources.

Therefore, the following indicators are chosen for the calculation: human inequality ratio (K1), Gini coefficient (K2), inequality in life expectancy (K3), gross national income (K4), inequality-adjusted life expectancy index (K5).

Since the input array of indicators is measured in different scales and contains both relative and absolute indicators (coefficients and indices), the calculations should be standardised to ensure they are accurate and adequate and the further modelling to be valid, i.e. the normalisation procedure should be carried out. In this case, the quality of standardisation's results depends on the type of normalisation function and the possibility of its application, taking into account the substantive nature of indicators (indicators-stimulators or indicators-disincentives) and their descriptive characteristics ("box-and-whiskers" plots, measures of central tendency, measures of variability) (Figure 7.).

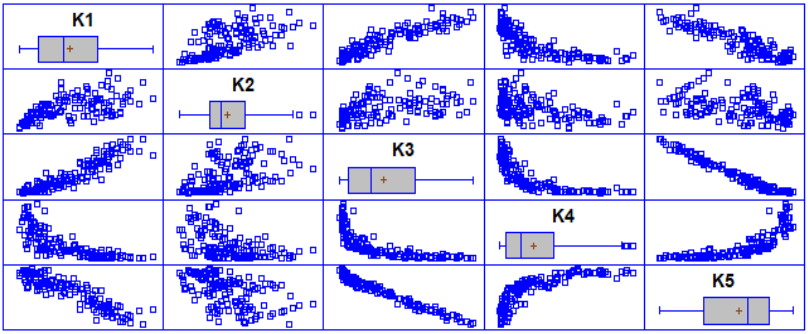


Figure 7. “Box-and-whiskers” for indicators under study

Source: calculated by the authors using Statgraphics Centurion software tools

A scatter plot (“box-and-whiskers”) is a convenient way of visually representing clusters of numerical data through quartiles (Dumbgen et al., 2007). A box plot contains lines extending vertically out of the box (called whiskers) and indicates the amount of variability, the degree of dispersion (variance) beyond the upper and lower quartiles. Outliers are plotted as single points in line with the whiskers. Scatter plots can be placed either horizontally or vertically.

Scatter plots are commonly used in descriptive statistics and make it possible for one or more data sets to be quickly examined graphically. Although it may seem primitive compared to a histogram or density plot, it has the advantage of saving space, which is particularly useful when comparing distributions between a large number of clusters or datasets (Severino, 2022).

The calculation of descriptive statistics is necessary to characterise a “typical sample” representative. But the numbers often have little to say about the sample and the “typical representative”. A visual representation of the results is useful to better understand the findings. Such a chart in a convenient form

shows the median, mean, lower and upper quartiles, minimum and maximum sample values and outliers. The distances between different parts of the “box” allow us to determine the degree of scattering (dispersion) and asymmetry of the data, as well as to identify outliers. It is possible to compare the distribution of one variable with another visually by placing several such “boxes” on the same graph.

The first step in constructing this plot is determining the box’s boundaries. They are the first and third quartiles (25th and 75th percentiles, respectively). The line inside the box is the median (50th percentile). The ends of the “whiskers” are the boundaries of a statistically significant sample (without outliers). But the whisker ends can represent several possible alternative values, including the minimum and maximum value of the sample data, the standard deviation, the ninth and ninety-first percentiles, and the second and ninety-eighth percentiles. Unusual percentiles of 2%, 9%, 91%, 98% are sometimes used on shaded whisker areas and whisker ends to show descriptive statistics for seven numerical characteristics.

Any data that does not fall into the space between the “whiskers” should be plotted as isolated points, small circles or asterisks. However, sometimes, this is not done. Some whisker boxes include additional symbols to show the average of the data. Sometimes the “box” may be presented without “whiskers” at all.

Since there is no consensus on exactly how to construct a “box with whiskers”, when one sees such a graph, one should look for information in the accompanying program text as to what parameters the parameters used to construct it. If the data have a normal distribution, the locations of the statistical parameters on the graph will be equidistantly distributed (PsyMag, 2022).

Thus, in Figure 7, the “whiskers” are the lines that extend from the rectangle, indicating variability outside the upper and lower quartiles.

Table 5. Numerical characteristics of the distribution of human inequality indicators

Numerical characteristics/Indicators	*K1*	*K2*	*K3*	*K4*	*K5*
Count	138	138	138	138	138
Average	19,2978	38,195	15,009	18859,600	0,697
Median	17,750	36,400	11,400	12238,000	0,743
Geometric mean	16,473	37,389	10,977	10543,700	0,669
Harmonic mean	13,784	36,615	7,852	5268,660	0,639
5% Trimmed mean	18,970	37,847	14,404	17260,800	0,703
5% Winsorized mean	19,178	38,102	14,918	18483,000	0,699
Variance	102,222	64,639	120,755	3,40E+08	0,034
Standard deviation	10,111	8,040	10,989	18443,900	0,184
Coefficient of variation, %	52,392	21,050	73,217	97,796	26,455
Gini coefficient	0,286	0,104	0,395	0,506	0,137
Standard error	0,861	0,684	0,935	1570,050	0,016
Geometric standard deviation	1,806	1,229	2,308	3,294	1,346
5% Winsorized sigma	10,692	8,261	11,806	19140,900	0,197
Mean absolute deviation	0,516	0,169	0,727	1,005	0,251
MAD	8,600	5,100	7,800	9260,000	0,161
Sbi	10,530	8,073	11,598	16849,300	0,194
Minimum	4,400	24,200	2,400	754,000	0,307
Maximum	44,200	63,000	40,900	72712,000	0,965
Range	39,800	38,800	38,500	71958,000	0,658
Lower quartile	10,000	32,800	5,000	3954,000	0,524
Upper quartile	27,800	43,300	24,200	29558,000	0,844
Interquartile range	17,800	10,500	19,200	25604,000	0,320
1/6 sextile	7,900	30,500	3,700	2633,000	0,480
5/6 sextile	30,800	45,800	28,700	38881,000	0,907
Intersextile range	22,900	15,300	25,000	36248,000	0,427
Skewness	0,327	0,625	0,652	1,157	-0,399
Stnd. skewness	1,567	2,996	3,127	5,550	-1,912
Kurtosis	-1,078	0,058	-0,856	0,388	-1,060
Stnd. kurtosis	-2,585	0,140	-2,053	0,931	-2,541
Sum	2663,100	5270,90	2071,200	2602620,000	96,191
Sum of squares	65396,40	210177,000	47629,500	9,57E+10	71,707

Source: calculated by the authors using Statgraphics Centurion software tools

Numerical characteristics of descriptive statistics for the initial indicators of the study – the coefficient of human inequality (K1), Gini coefficient (K2), inequality in life expectancy (K3), gross national income (K4), inequality-adjusted life expectancy index (K5) - are presented in Table 5. The numerical characteristics to determine the mean measures, measures of variability and distribution laws for the studied indicators are as follows a total number of countries - objects of research, indicators of which have been selected for the study, mean values of input variables, a median indicator for variables, geometric mean and harmonic mean, 5% reduced mean, 5% Winsorized mean, dispersion indicator of the output variable, standard deviation, coefficient of variation, Gini coefficient, standard error, geometric standard deviation, 5% Winsorized sigma, mean absolute deviation, Sbi, minimum and maximum values of variables, range, lower quartile and upper quartile and interquartile range, 1/6 sextile and 5/6 sextile, intersextile range, skewness index, standard skewness index, kurtosis, standard kurtosis, a sum of variables, a sum of squares.

Covariance is a systematic relationship between a pair of random variables, wherein a change in one variable is reciprocally affected by an equivalent change in the other variable.

Covariance can take any value from -∞ до + ∞, where a negative value indicates an inverse relationship, while a positive value is a direct relationship. This indicator defines a linear relationship between variables. Therefore, if the value equals zero, it indicates no relationship. In addition, if all observations of any variable are the same, the covariance is equal to zero.

Table 6. Covariance of variables K1, K2, K3, K4, K5.

	K1	*K2*	*K3*	*K4*	*K5*
K1	102,222	47,8396	102,62	-141664,	-1,68677
K2	47,8396	64,6392	40,8346	-66620,0	-0,709729
K3	102,62	40,8346	120,755	-151819,	-1,99177
K4	-141664,	-66620,0	-151819,	3,40177E8	2728,99
K5	-1,68677	-0,709729	-1,99177	2728,99	0,0340044

Source: calculated by the authors using Statgraphics Centurion software tools

Table 6 shows the covariances between each pair of variables. Covariances measure how much variables vary together and are used to calculate Pearson's correlations.

Pearson's correlation coefficient measures the density of the linear correlation between quantitative scalar features of variables. The value of the correlation coefficient may vary from −1 to +1. Values −1 and +1 correspond to a clear linear functional dependence, which in the first case is decreasing and increasing in the second. The closer the correlation coefficient is to −1 or +1, the more reasonable the assumption of a linear relationship is. Approaching the value of the correlation coefficient to zero indicates the absence of a linear relationship but is not proof that a statistical relationship is absent.

Table 7. Pairwise Pearson's correlation coefficients

	K1	*K2*	*K3*	*K4*	*K5*
K1		0,5885	0,9237	-0,7597	-0,9047
K2	0,5885		0,4622	-0,4493	-0,4787
K3	0,9237	0,4622		-0,7491	-0,9829
K4	-0,7597	-0,4493	-0,7491		0,8024
K5	-0,9047	-0,4787	-0,9829	0,8024	

Source: calculated by the authors using Statgraphics Centurion software tools

A high level of the linear relationship is observed between variables whose relationship equals an absolute value between 0.7 and 1. For the selected survey indicators (Table 7), a high

level of correlation is observed between the human inequality coefficient (K1) and inequality in life expectancy (K3), its value being 0.9237, as well as between the human inequality coefficient (K1) and gross national income (K4) (inverse-proportional relationship at 0.7597); between the human inequality coefficient (K1) and the inequality-adjusted life expectancy index (K5) (inverse-proportional relationship at 0.9047); between inequality in life expectancy (K3) and gross national income (K4) (correlation coefficient high -0.7491); between inequality in life expectancy (K3) and the inequality-adjusted life expectancy index (K5) (inverse correlation at 0.9829); between gross national income (K4) and the inequality-adjusted life expectancy index (K5) for this pair, the Pearson's correlation coefficient is 0.8024.

A pair of variables with Pearson's correlation coefficients between (-0.69; -0.4) and (0.4; 0.69) has a moderate linear relationship density. Consequently, moderate relationship density is observed between the human inequality coefficient (K1) and Gini coefficient (K2) (correlation coefficient value is 0.5885), between Gini coefficient (K2) and inequality in life expectancy (K3) with correlation coefficient value. 0.4622, between the Gini coefficient (K2) and Gross National Income (K4) (inverse correlation at 0.4493) and between the Gini coefficient (K2) and inequality-adjusted life expectancy index (K5) (inverse correlation at 0.4787).

Further research to obtain qualitative and adequate results is only possible after data normalization, as the input data are measured in different units. At the same time, the quality of the results depends on the quality of the normalization carried out. Thus, a large number of researchers around the world, in particular (Acuna-Soto et al., 2021; Celen et al., 2014; Chen et al., 2003; Sun et al., 2020), suggest that normalization should be

performed taking into account weighting factors, stimulant indicators (whose increase has a positive effect on the indicator under study) and disincentives, without necessarily the lowest value of the stimulator or disincentive indicator being the best value of it. It depends directly on the content of the indicator itself, on its essence. Weighting coefficients of normalization functions can be used as follows: 1) weights defining measures of central tendency of the indicator (median, mode, mean), measures of variability (dispersion, minimum, maximum value of the variable, range, skewness and kurtosis coefficients); 2) weighted indicators; 3) weights generated by expert judgement. In order to carry out the normalisation of the original data, it has been proposed to use a modified logistic function (2) that takes into account the weights of the indicators:

$$y_{ij} = \frac{1}{1 + e^{-3\frac{x_{ij} - p_i}{q_i - p_i}}} \qquad (2)$$

where y_{ij} is a the normalised value of the i-country j-indicator, q_i is the value of the indicator x_{ij}, at which the conversion function acquires a value of at least 0,95; p_i is the value of the indicator x_{ij}, at which the conversion function acquires a value of 0,5 (Us et al., 2018).

Consequently, as a result of the normalisation procedure, given the substantive nature, the minimum value (q_i) is used as a weight measure of variability for the Gini coefficient (K2), and the maximum values (q_i) for the human inequality ratio (K1), inequality in life expectancy (K3), gross national income (K4); inequality-adjusted life expectancy index (K5). The median values (p_i) are used as measures of central tendency (they are not sensitive to outliers) (Table 8).

Table 8. Values of parameters (q_i) and (p_i) for output data standardisation

	Indicator				
Parameter	K1	K2	K3	K4	K5
q	44,2	24,2	40,9	72 711,7	0,965
p	19,3	36,4	11,4	12 238,1	0,7

Source: built by authors

A fragment of normalized data according to formula (1) for a sample of 138 countries worldwide is presented in Table 9. A complete list of input and normalized data is presented in Appendix A, Tables A.1, A.2.

Table 9. Fragment of normalised indicators

Country/Indicator	K1	K2	K3	K4	K5
Norway	0,166804	0,205226	0,199179	0,934235	0,9312
Ireland	0,18895	0,342431	0,206675	0,940373	0,926022
Switzerland	0,180463	0,339713	0,208581	0,943489	0,946888
Iceland	0,161492	0,201308	0,188321	0,880337	0,945819
Germany	0,202052	0,318358	0,214377	0,883996	0,907684
Sweden	0,176403	0,243009	0,197337	0,879308	0,938135
Australia	0,201815	0,38723	0,212432	0,835907	0,939888
Netherlands	0,182997	0,236397	0,201033	0,896981	0,928451
…	…	…	…	…	…
Finland	0,155726	0,213229	0,199179	0,839141	0,923888
Uruguay	0,308177	0,545382	0,304984	0,516763	0,82054
Bulgaria	0,276664	0,56628	0,26265	0,561867	0,795261
Panama	0,524017	0,791004	0,413718	0,644734	0,792135
Georgia	0,281279	0,445941	0,304984	0,438604	0,76188
Costa Rica	0,447037	0,765999	0,285698	0,494803	0,86154
Serbia	0,295962	0,439973	0,236623	0,476788	0,819323
Mauritius	0,334617	0,457923	0,343018	0,588291	0,766476
Seychelles	0,378455	0,73899	0,348259	0,610187	0,742671
Albania	0,266211	0,353406	0,288068	0,432708	0,836199
Iran	0,275911	0,578121	0,337815	0,411626	0,791776
Sri Lanka	0,339653	0,548379	0,283339	0,415148	0,815252
Burundi	0,776743	0,512245	0,826816	0,267248	0,45738
South Sudan	0,882761	0,727158	0,920957	0,281097	0,371512
Chad	0,899142	0,649632	0,952574	0,276082	0,311321
Central African Republic	0,934021	0,898219	0,948206	0,269865	0,306688
Niger	0,727385	0,384364	0,863104	0,272152	0,450957

Source: built by authors

Before developing a regression model of the dependence of the human inequality coefficient (K1) on the indicators of the Gini coefficient (K2), inequality in life expectancy (K3), gross national income (K4), inequality-adjusted life expectancy index (K5), it is advisable to determine the density and direction of the relationships between them based on the values of Pearson's Spearman rank-order correlation coefficients, where their ranks are used to assess the strength of the linear relationship between variables, rather than the numerical values of these variables (Al Salem, Aqeel Asaad et al., 2021; Xiao 2019):

$$\rho = 1 - \frac{6}{n(n-1)(n+1)} \sum_{i=1}^{n} (R_i - S_i)^2, \qquad (3)$$

where n is the volume of observations, R_i is the rank of observation of x_i in the series of variable x, S_i is the rank of observation of y_i in the series of variable y, $\rho \epsilon [-1; 1]$.

The practical calculations have been carried out in the Statgraphics Centurion software using the procedure Describe/Multiple Variable Analysis. The results of the calculations are presented in Table 10.

Table 10. Spearman's rank-order correlations

Indicator	K1	K2	K3	K4	K5
K1		0,5885	0,9237	-0,7597	-0,9047
K2	0,5885		0,4622	-0,4493	-0,4787
K3	0,9237	0,4622		-0,7491	-0,9829
K4	-0,7597	-0,4493	-0,7491		0,8024
K5	-0,9047	-0,4787	-0,9829	0,8024	

Source: calculated by the authors using Statgraphics Centurion software tools

The data in Table 10 reflect Spearman's rank-order correlations between each variable pair. These correlation

coefficients range from -1 to +1 and measure the strength of the relationships between variables. In contrast to the more common Pearson's correlations, Spearman's coefficients are calculated based on the ranks of the data values rather than the values themselves. Consequently, they are less sensitive to outliers than Pearson's coefficients. A significance level (P-value) below 0.05 was obtained for each pairwise correlation between variables, indicating statistically significant non-zero correlations at the 95.0% confidence level.

A very high density of correlation is observed between three pairs of attributes (Table. 10): between the result indicator of human inequality coefficient (K1) and inequality index of life expectancy (K3) and is 0.9237; between the indicators human inequality coefficient (K1) and inequality-adjusted life expectancy index (K5) (0.9047); between the indicators inequality in life expectancy (K3) and inequality-adjusted life expectancy index (K5) (0.9829). The correlation is directly proportional for the first pair and inversely proportional for the second and third pairs of indicators. For all other pairs of indicators, the correlation density is characterised by an average level (the value of the rank correlation coefficient lies in the range from 0.45 to 0,55) or moderate (the value of the rank correlation coefficient lies in the range from 0.6 to 0.8). The direction of the correlation is determined by the «+» (direct-proportional) or «–» inverse-proportional one (Table 10).

The expediency of using all factor attributes is proposed to be checked using the rigid cut-off of the factors containing multicollinearity when developing a regression model.

Consequently, the next stage of the study was to develop a regression model describing the dependence of the outcome indicator (human inequality ratio) on influential attributes (the

Gini coefficient, inequality in life expectancy, gross national income, inequality-adjusted life expectancy index).

A statistically significant regression model was developed in the Statgraphics Centurion software within multiple regression analysis:

$$K1 = -0{,}137446 - 0{,}119656 \cdot K2 + 1{,}22138 \cdot K3 - 0{,}195314 \cdot K4 + 0{,}240431 \cdot K5 \quad (4)$$

where K1 is the dependent variable, the human inequality coefficient; K2 is the Gini coefficient, K3 is inequality in life expectancy, K4 is gross national income, K5 is an inequality-adjusted life expectancy index.

Regression analysis is a commonly used tool in statistics. It allows for an investigation of the relationships between different quantitative variables and is applied by mathematical equations. In other words, this analysis is a process or model that analyses the relationships between a dependent variable and one or more independent variables. Thus, in this study, a mathematical relationship is revealed. Through regression processes, it is possible to understand how the dependent variable is affected by changes in other factors.

The application to regression analysis is one of the main applications of regression analysis for forecasting with various scenarios by considering the degree of influence (called correlation in statistics) on the dependent variable.

That is, the purpose of the analysis is to construct a function to estimate the future value of the variable under study. From another point of view, regression makes it possible to calculate the conditional (mean) expectation. For this purpose, the values of independent variables are taken as given. It should be noted that when only one independent variable is taken into account,

we are talking about a simple linear regression. On the other hand, if more factors are included, it is a multivariate linear regression (Economypedia, 2022).

So, model (4) tested for multicollinearity has shown its absence. The test has been implemented using the Multiple Regression/Backward Stepwise Selection procedure. The results confirming the statistical significance of the model (4) are presented in tables 11, 12.

Table 11. Statistical peculiarities of model parameters (4)

Parameter	Assessment	Standard error	T-statistics	Significance level
Constant	-0,137446	0,110715	-1,24144	0,2166
K2	-0,119656	0,0263823	-4,53545	0,0000
K3	1,22138	0,132173	9,24074	0,0000
K4	-0,195314	0,0841533	-2,32093	0,0218
K5	0,240431	0,0961305	2,50109	0,0136

Source: calculated by the authors using Statgraphics Centurion software tools

Table 12 shows the variance analysis results and confirms the statistical significance of model (4) by Fisher's criterion and the p-value. The purpose of the analysis of variance (ANOVA – Analysis of Variation) is to test the significance of the difference between the means of the different clusters by comparing the variance of these clusters.

In general, analysis of variance can be divided into several types: univariate (one dependent variable) and multivariate (several dependent variables); single-factor (one grouping variable) and multifactor (several grouping variables) with possible interaction between factors; with simple measures (dependent variable is measured only once) and repeated measures (dependent variable is measured several times) (Statsoft 2022).

Table 12. Dispersion analysis (ANOVA)

Source	Sum of squares	Number of degrees of freedom	Mean square	F-statistics	Level of significance (P-value)
Model	7,99456	4	1,99864	307,99	0,0000
Residuals	0,863087	133	0,00648938		
Total	8,85765	137			

Source: calculated by the authors using Statgraphics Centurion software tools

The R^2 statistics (coefficient of determination allows to estimate how well the theoretical model fits the actual data) for model (4) and explains 90.256% of the variability in K1 and has a solid level of relationship. The adjusted R^2 statistics (standardised value), at 89.963%, also indicate a solid correlation between the data values used in the analysis, indicating the statistical significance of the econometric linear multiple regression model (4). The assessment's standard error shows that the residuals' standard deviation equals 0.0806. The mean absolute error is 0.0566. The Durbin-Watson statistics equal 1.92405 (P-value = 0.3286), this value belongs to the interval between 0.584 and 2.464 and corresponds to the uncertainty zone. However, further investigation according to the Johann von Neumann's criterion indicates its absence, $DW \approx 2$ – the autocorrelation is absent (Bartels, 2007).

Thus, the econometric model (4) describes a statistically significant relationship of the variables and determines the pattern of behaviour, degree of influence and direction of the relationship between independent variables K2, K3, K4, K5 and dependent variable K1, which determines the human inequality ratio. The relationship between indicators K1 and K3 (inequality in life expectancy), between K1 and K5 (inequality-adjusted life expectancy index) is directly proportional, and between K1 and K2 (the Gini index), K1 and K4 (gross national income) are inversely proportional. Thus, for instance, by decreasing the

coefficient K2 by 1% and keeping K3, K4 and K5 constant at their average level, the value of the human inequality coefficient will increase by 0.119656, which is 11.96%. Considering the content of indicator K4, it should be noted that the higher the gross national income, the lower the value of the human inequality coefficient. The developed regression model substantiates that with an increase in gross national income for the countries studied by 1% (assuming that the values of indicators K2, K3 and K5 remain constant at their average level), the gap between the values of the human inequality ratios will decrease by 0.1953, that is, by 19.53%.

Thus, the study's results allowed us to create a statistically qualitative feature space characterising human capital as one of the key determinants of health category formation and its impact on economic development. The feature space is defined by an outcome indicator (human inequality ratio) and four influential factors (the Gini coefficient, inequality in life expectancy, gross national income, inequality-adjusted life expectancy index) to develop a regression model. The statistical significance of the created feature space is substantiated by descriptive analysis tools, namely the coefficient of variation (for all features, its value is more than 5%) and Spearman's rank-order correlation. In order to adequately model and bring the original data set into a unified measurement scale, the standardisation procedure has been implemented using a modified logistic function that considers the weights of the indicators, their degree of variability and central tendency.

Statistical significance of the econometric model built, characterising the dependence of the result indicator (human inequality coefficient) on influential factor indicators (the Gini coefficient, inequality in life expectancy, gross national income, inequality-adjusted life expectancy index) is justified by

Fisher's, Durbin-Watson test criteria, determination coefficient value and significance level (p-value). All factor attributes are included in the model, as there is no multicollinearity between them, which is justified by the rigorous screening of statistically insignificant indicators using the Backward Stepwise Selection procedure by means of the Statgraphics Centurion software.

The results may be used by public economic development agencies to develop comprehensive measures to reduce disparities in inequality, increase the value of the human development index and, consequently, promote the economic development for each country under study, taking into account the peculiarities of the political and economic environment.

3. CLUSTER ANALYSIS OF THE COUNTRIES' DIVISION INTO GROUPS AND EFFECTIVENESS EVALUATION OF THE HEALTH CARE SYSTEM

For most people on the planet, the concept of being healthy is based on understanding the physical state at a given moment in time. The physical part occupies one of the most critical positions in the rich list of components of health: social, medical, economic, and spiritual.

Above all, the key to health is to be acutely aware of yourself and actively engage in the many aspects of life you can control. It is much more than just physical health and psychological well-being.

In general, the main idea of health is the balance of all the elements that make up our life. It is not a new idea, but its practice has grown dramatically over the past decade, especially in the Western world.

Its impact is significant, especially on adults and the elderly. Creating a socio-economic climate to form a sustainable high level of public health is an important task for all humanity. To achieve this goal, it is necessary to define the conceptual aspects of health indicators' structural and functional content. Having a clear definition of the conceptual aspects of health indicators, it is possible to create a high-quality simulated system in which each indicator has its weight and contains potential reserves for improving the level of health and, as a result, the growth of the country's economy.

After all, improving the state of health gives the economic mechanism a more capable, efficient worker, thereby increasing the income per capita. This effect will appear with a rapid increase in health care costs.

Therefore, many scientists deal with health issues and their components, and each has done work to expand public knowledge on this issue. In particular, when reviewing research in the field of health aspects among domestic scientists, the results of scientists should be noted: Kruk Y. B. - examines the legal side of health care and determines the compliance of Ukrainian health standards with international standards (Kruk, 2012). O. Ya. Rybalka, N. O. Gurinenko, S. V. Ivanivskyi, V. G. Pasynok - analyze the main directions of health culture formation (Rybalka. et al., 2017). Such scientists as Salata I.V. and Horachuk V.V. review the level of training of medical process personnel, and identify insufficient qualifications and uneven distribution of personnel resources (Salata et al., 2021). Surmyak Y.R. and Kudryk L.G. conduct work on the study of the problem of forming a culture of personal health as a component of national security and considered the psychological aspect in the formation of a culture of health (Surmyak et al., 2012). Sergin S. M., Sokolosky S. I., Shipko A. F. researched determining the impact of mental health on professional life (Sergin et al., 2009). A. S. Svintsitsky considers health a state security factor (Svintsitsky 2013). O. A. Fedko deals with the definition of the state of health in the modern value system of Ukrainian society (Fedko, 2009). At the international level, the authors Prince M., Patel V., Saxena S., Maj M., Maselko J., Phillips M., Rahman A. consider the mental aspect of health and substantiate that many diseases are related to nervous-mental disorders (Prince et al., 2007). Svalastog A.L., Donev D., Kristoffersen N.J., and Hajovich S. assessed the impact of digital society on health (Svalastog et al., 2017). Stoewen D.L. describes the dimensions of health in his scientific work (Stoewen, 2017). Felman A. defined types of health and factors of external and internal influence on health components

(Felman, 2020). Huber M., Nottnerus A., Green L., and Horst H. review the details of health, summarise the definition's limitations, and describe proposals for its future development (Huber et al., 2011).

The life and health of the population serves as a guarantee for the prosperity of the country's economy, it is a force that achieves favorable conditions for competing on the world stage.

According to the World Health Organization (WHO), health is a state of complete physical, mental and social well-being, characterized not only by the absence of diseases or physical defects. Health is a multifaceted category that includes many physical, social, medical, economic, and spiritual indicators (Constitution of WHO 2006).

Such an indicator as health is complex and consists of the following typical medical and statistical indicators: medical and demographic indicators of statistics such as population size, gender, population composition, social groups, and so on; morbidity indicators are formed from the number of people's appeals to medical institutions, reports from medical examinations; indicators of disability are formed from the absolute number of disabled people who are registered in the bodies of social protection of the population; indicators of physical development of the population are characterized by average height, weight, as well as somatometric and stomatoscopic measurements; indicators of natural population movement such as birth rate, mortality, natural population growth, average life expectancy (Ahlamov, 2011).

These complex indicators make it possible to reveal the general comprehensive indicator of health in more detail and systematically determine the data necessary for modeling any possible models that are related by category to the name of health.

Quantitative indicators include the following parameters: anthropometric (height, weight, chest volume, geometric shape of organs and tissues); physical (pulse rate, blood pressure, body temperature); biochemical (the content of chemical elements in the body, erythrocytes, leukocytes, hormones and others); biological (composition of intestinal flora, presence of viral and infectious diseases, etc.).

In the medical field, there is such a concept as “Norm” when the quantitative parameters of human health are within a specific range of acceptable values.

Qualitative indicators consist of a set of quantitative parameters that compare with the average indicators of a population of this age and sex. Qualitative indicators are often subjective and can be presented in different forms; they carry additional information to the same quantitative indicators. The data will be more complete and informative; there is only one problem, they cannot be presented without a context that the general audience will not understand.

The number of factors that affect a person goes to infinity; health is affected by factors at the micro and macro levels; the main difference in the time required for drastic changes in health can take a day or ten years. Disease agents and transmission routes are numerous, and unhealthy environmental conditions are common, affecting most illnesses and injuries. Non-communicable diseases, including coronary heart disease, chronic respiratory diseases and cancer, are the most common consequences of global environmental change (WHO 2021).

In terms of the physical aspect of health, it is a composite category consisting of self-assessment of the general state of health. The following indicators determine self-assessment of the state of health: symptoms of poor health, risk factors for poor health, a person's request for medication, determination of the

level of activity for the day, use of medical services (quantitative characteristics according to the relevant request), clinical examination; food and diet assessment.

The mental aspect of the health category is determined by a set of qualitative indicators that characterize a person from the point of view: free from internal conflicts, well adapted to the social environment (can get along well with others, accepts criticism, is not easily upset), seeks identity, has a strong sense of self-worth, knows himself, his needs, problems and goals, has good self-control, balances rationality and emotionality, faces difficulties and tries to solve them intelligently.

The spiritual aspect includes honesty, ethical principles, belief in the concept, and the purpose of life.

Emphasis should also be placed on the impact of the professional aspect on the level and state of health. Its most significant effect occurs when people suddenly lose their jobs or face the need for retirement. For some, this dimension may be a source of income, but for others, it may be a source of self-esteem and life success. Also, a factor that characterizes dissatisfaction with professional conditions, when work seems aimless or when a person lacks a specific vocation in life, which forms a feeling of aimlessness and uncertainty, harms health.

Achieving goals and self-realization at work is a source of satisfaction, increased self-esteem and, as a result, improved health.

The economic aspect regarding the impact on health should include qualitative and quantitative indicators: managing one's own resources, making informed financial decisions, setting realistic goals, preparing for short-term and long-term needs or emergency situations. Each person’s financial values, needs and circumstances are unique. Worrying about money is one of the main causes of stress and illness. People can reduce this stress

by making more efficient use of personal resources and planning for the future.

The ecological dimension of health is characterized by the state of the environment and the sphere of the natural environment (air quality, food and quality, water sources, the impact of chemicals on the environment, garbage pollution, etc.). Over the last few years, with an increasing number of consumers thinking about the environmental impact of beauty, food and lifestyle products, there has been an incredible push in the environmental policies of well-known brands to provide the general public with more environmentally friendly products (Martins 2022). And as more research emerges about how certain substances affect our integumentary, respiratory, endocrine, and reproductive systems, people are becoming more aware of what they consume. Of course, the nutritional aspect directly impacts the level of health; the balanced consumption of nutrients provides a solution to daily energy needs.

Understanding the state of the environment means a deeper understanding of what people consume and use in their daily lives.

A detailed analysis of the impact of physical, environmental, and mental aspects that led to diseases and mortality in 2020 for the population of Ukraine is shown in Figure 8.

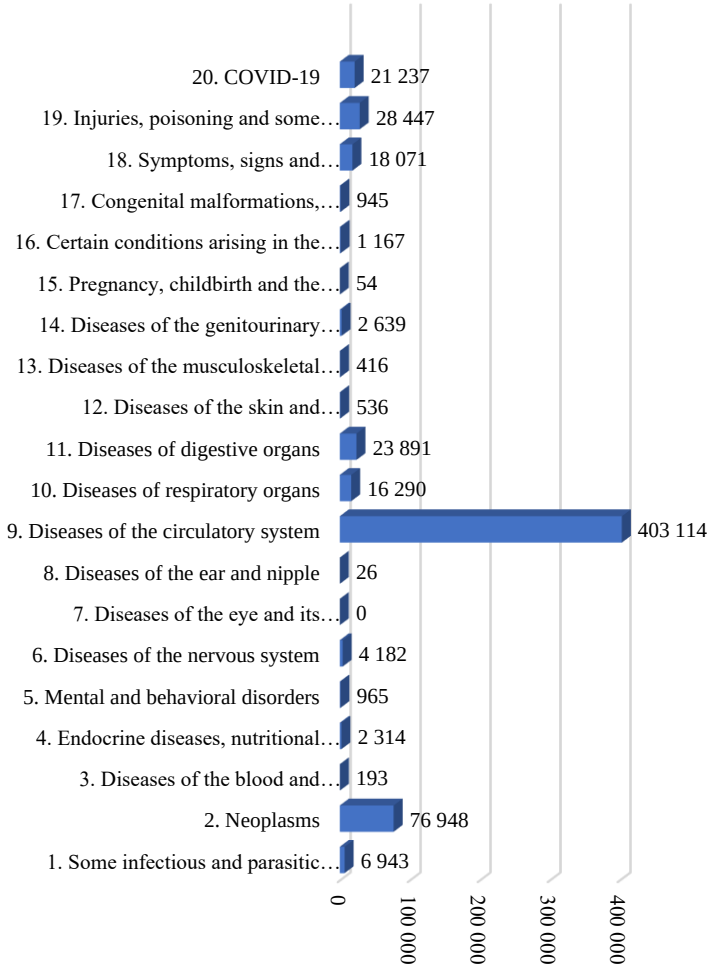


Figure 8. Mortality rates of the population of Ukraine for 2020

Source: compiled by the authors based on the results of the database of the Ukrainian Center for Social Data (Mortality in Ukraine 2022)

From the distribution of mortality (Figure 8), it can be seen that the first five places in the list are occupied by classes of diseases such as diseases of the circulatory system - 403,114 people, neoplasms - 76,948 people, external causes of mortality and injuries, poisoning and some other consequences of the action of external factors – 28,447 people, diseases of the digestive organs – 23,891 people, the COVID-19 pandemic – 21,237 people.

According to the data, we have several extensive statistical clusters; the indicators are likely to be changed with the help of early recommendations for diagnosing the state of health and implementing all possible actions to improve the state of health. Each such step can save or prolong a person's life, thereby increasing the stimulation of the economic sector

A detailed analysis of the distribution of the largest number of deaths by five categories (Figure 8) of the population of Ukraine in 2020 in terms of sex-age structure is shown in Figure 9 (Mortality in Ukraine 2022).

The diagram (Figure 9) shows different age groups, types of settlement and sex of deceased people from diseases of the circulatory system, neoplasms, external causes, injuries, poisonings, diseases of the digestive organs, the COVID-19 pandemic and allows to identify groups of people who need to be actively engaged in care about your health. For example, men between 50 and 70 need to increase the number of medical examinations for the timely detection of possible diseases and their prevention in the future.

The work provides a detailed description of aspects of health, such as: physical, mental, social, professional, economic, ecological, spiritual, and nutritional. These are the main aspects that can be distinguished among the multifaceted factors of determining the level of health depending on the changes taking

place in the world and having a colossal effect on the change in the level of health. An analysis of the number and causes of death of Ukrainian citizens for 2020 was also conducted.

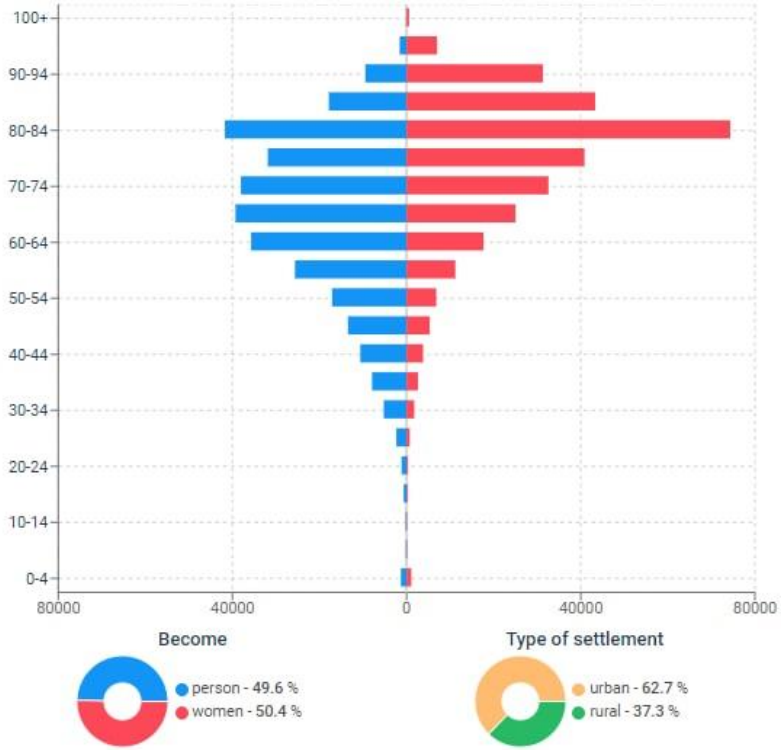


Figure 9. Gender and age structure of the deceased in 2020

Source: interactive map of the Ukrainian Social Data Center (Mortality in Ukraine 2022)

Each dimension of health deserves detailed attention because systematically ignoring one of them will, over time, negatively affect the others and, ultimately, health, well-being and quality of life. Every person who falls out of the normal state of health

creates economic pressure on human capital and reduces the state's economic growth. Economic growth and human capital have a strong relationship that affects an individual's quality of life and productivity over the economic cycle.

Findings regarding the meaningful essence of health indicators provide ample opportunities for healthcare system workers and employees of the medical field to identify reserves for improving the state of the healthcare system in each country of the world.

The work of many international and domestic scientists, such as Leonov S., Vasilyeva T., Buryak A., (Leonov et al., 2013), Lisek O., Hugo P., Seidel- Morgenstern A. (Lisec et al., 2001). The work of M. P. Denysenko and V. D. Dolot describes the category of health in terms of the economic relations of a person and the state apparatus of health care (Denysenko et al., 2017). The complexity and multifaceted nature of health care based on quantitative and qualitative indicators of the medical, socio-spiritual and political spheres are considered by scientists Kolomiiets Yu., Petrushenko Yu. (Kolomiiets et al., 2017) and Greta Keliuotit-Stanyuleniene, Kamile Daunaraviciute (Keliuotytė-Staniulėnienė et al., 2021).

To carry out the policy of reforming the health care system, it is necessary to analyse relatively effective strategies. To determine the efficiency of the health care system, it is required to use the frontier analysis method to assess the efficiency of the socio-economic objects.

The input information base of the study used indicators for 2019 regarding the life expectancy of the population, the use of health care, and health care costs in the section of the countries that are part of the Organization for Economic Cooperation and Development (Table 13). The Organization for Economic Co-operation and Development is an intergovernmental economic

organization, with 37 member countries founded in 1961 to stimulate economic progress and world trade. It is a forum of countries that describe themselves as committed to democracy and market economies, providing a platform for comparing policy experiences, finding answers to common problems, identifying best practices and coordinating its members' domestic and international policies (OECD 2013).

Table 13. Summary statistical base of the study for 2019

Countries	Health Care Expenditure	Life Expectancy	Health Care Use
Australia	9,155	82,8	7,3
Austria	10,318	81,8	6,6
Belgium	10,764	81,7	7,3
Canada	10,806	82	6,6
Chile	9,159	80,4	2,9
Colombia	7,625	76,5	2,6
Costa Rica	7,296	80,4	2,3
Czech Republic	7,525	79,1	8,2
Denmark	10,071	81	4
Estonia	6,686	78,4	5,5
Finland	9,036	81,8	4,4
France	11,198	82,8	5,9
Germany	11,45	81	9,8
Greece	7,959	81,9	3,2
Hungary	6,546	76,2	10,7
Iceland	8,43	82,9	5,9
Ireland	6,86	82,3	5,8
Israel	7,532	82,9	8,2
Italy	8,675	83,4	10,4
Japan	10,926	84,3	12,5
Korea	7,52	82,7	17,2
Latvia	6,534	74,9	6,1
Lithuania	6,191	75,8	9,5
Luxembourg	5,286	82,4	5,5
Mexico	5,379	75	2,3

continued Table 13

Countries	Health Care Expenditure	Life Expectancy	Health Care Use
Netherlands	10,032	81,9	8,8
New Zealand	9,024	81,8	3,8
Norway	10,024	82,8	4,4
Poland	6,328	77,7	7,7
Portugal	9,413	81,4	4,1
Slovak Republic	6,705	77,4	11,1
Slovenia	8,279	81,5	6,7
Spain	8,99	83,5	7,3
Sweden	10,941	82,6	2,6
Switzerland	11,151	83,8	4,3

Source: constructed by the authors based on (OECD 2013)

These indicators are the basis for determining countries' effectiveness in health care using the Frontier Analyst Application software tool. To carry out the analysis, we will divide the groups of countries into three equal parts. Such a distribution will give a more accurate picture and highlight more countries with high indicators (Frontier Analyst, 2022). Healthcare spending is selected as an input, and life expectancy and healthcare utilization indicators are output values.

The first stage in the process of determining efficiency is finding the correlation coefficient between the input parameter and the output parameters of the model, i.e. finding the measure of the density of the connection of one parameter with another (5):

$$Correl(X,Y) = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2 \sum(y-\bar{y})^2}}, \quad (5)$$

where $\bar{x}, \bar{y}$ – mean values of samples of array x and array y.

If the correlated relationship is 0, then changing the input parameter does not change the value of the output.

The first 12 countries include Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, and France.

The value of the correlation coefficient between the indicators of health care costs and life expectancy is 0.77 and 0.34 - between the indicators of health care costs and the use of health care.

Similar calculations were made regarding the correlation coefficient values between the specified indicators of the health care system efficiency in the second and third groups of countries. Thus, the following are included in the second group of studied countries: Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, and Luxembourg.

Correl correlation coefficients are 0.45 between health care costs and life expectancy and 0.29 between health care costs and health care utilization.

For the third group of research countries, which includes Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, and Switzerland, we have the following values: *Correl* = 0.92 and *Correl* = -0.26 – density the relationship between indicators of health care costs and life expectancy, between indicators of health care costs and the use of health care, respectively.

At the second modelling stage, frontier diagrams (Figures 10-12) are developed, corresponding to two-dimensional unit efficiency graphs. Visualization makes it possible to visually detect how different the location of the countries participating in the study is compared to each other, as well as draw a “border” along the best element in the sample.

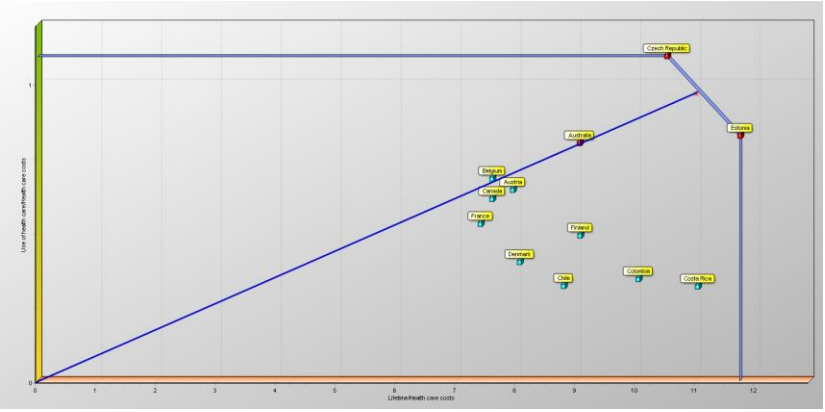


Figure 10. Frontier diagram of group 1
Source: made by the authors in the Frontier Analyst Application software.

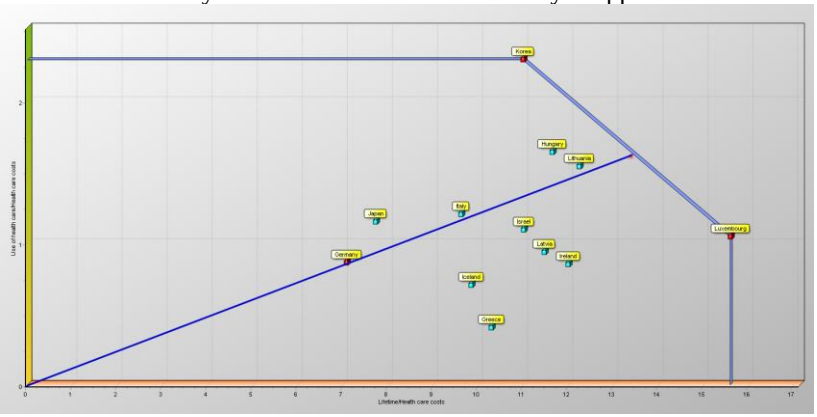


Figure 11. Frontier diagram of group 2
Source: made by the authors in the Frontier Analyst Application software.

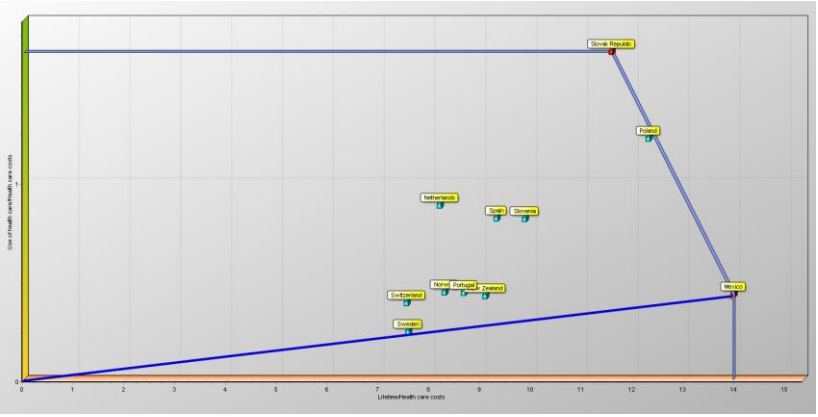


Figure 12. Frontier diagram of group 3
Source: Built by the authors in the Frontier Analyst Application software

Figure 10, with a set of 12 countries, shows that the Czech Republic and Estonia form a border strip of marginal efficiency, and the rest of the countries are distributed according to the efficiency of the used resources to meet the global development strategy. In figure 11, the Marginal efficiency is formed in the section of the second group of countries of the study by the countries of Luxembourg and Korea (figure 11). The border strip for the third group of countries of the study falls on the Slovak Republic and Mexico (Figure 12).

In the third stage, in order to determine the level of satisfaction of the population of Ukraine with the health care reform and the quality of the services received when referring to doctors as a factor characterizing the degree of use of health care, a comparative analysis of indicators was conducted (Zakon Ukrainy 2018): A1.1 – satisfaction with medical care provided by district therapists / family doctors; A1.2 – satisfaction with medical care provided by pediatricians; A1.3 – satisfaction with medical care provided by dentists; A1.4 – satisfaction with

medical care provided by narrow specialists in the polyclinic; A1.5 – satisfaction with medical care provided by emergency medical care; A1.6 – satisfaction with medical care provided in a hospital; A1.7 – satisfaction with medical care provided in maternity hospitals (Figure 11). The data collected by the Kyiv International Institute of Sociology during June-August 2019 for the sociological research "Health Index. Ukraine" (Health Index. Ukraine. (2022).

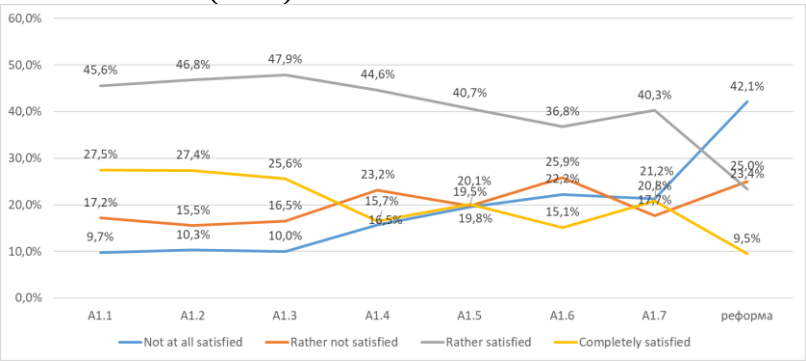


Figure 13. Diagram of satisfaction with the work of medical personnel in various areas and with the reform

Source: built by the authors in the Excel software

Figure 13 shows that the average value of the "Not at all satisfied" level for the population is 15.5%. The level of "Rather not satisfied" for the surveyed respondents is, on average, 19.4%. The average value of the "Rather satisfied" level is 43.2%. 21.8% of respondents are delighted with the quality of medical care. However, the attitude towards the reform differs to a large extent, namely: 42.1% of respondents gave the answer "not satisfied", "rather not satisfied" – 25.0%, "rather satisfied" – 23.4%, and "completely satisfied" – 9 .5%.

Findings indicate the need for the management of the health care system of Ukraine to conduct a thorough study of the features of the implementation and use of the health care reform at the national, regional and local levels and to conduct a detailed analysis of the features of the health care systems of the so-called "reference" countries to improve indicators of the degree of satisfaction of the population and, accordingly, an increase in the level of the economy as a whole.

The work carried out a frontier analysis of the countries that are part of the Organization for Economic Cooperation and Development to determine benchmark countries in terms of the quality of the healthcare system. During the Frontier Analyst Application program analysis, countries were divided into three subgroups for qualitative research and selecting countries with high-performance indicators of the health care system. Within each group, two countries that formed the efficiency frontier are highlighted. The frontier analysis made it possible to visualize how much and which country lags behind the standard among a limited list of countries. In addition, the work substantiates the urgent need to improve the health care reform of Ukraine based on a comparative analysis of its quality and the degree of satisfaction of the population with the received medical services.

A large number of scientists conduct research using methods of cluster analysis. Several important works should be noted when reviewing studies on cluster analysis of domestic scientists. O. V. Yalovenko and V. S. Fetisov conducted work on revealing the concept and highlighting the advantages of cluster analysis (Yalovenko et al., 2020). O. M. Zhigailo and V. V. Borys analyzed and implemented cluster analysis methods using intelligent data analysis and created the author's classification (Zhigailo et al., 2018). Such researchers as A. G. Tyurin and I. O. Zuev analyzed cluster analysis methods and

identified the advantages and disadvantages of each technique (Tyurin et al., 2014). Serga E. N. describes a new universal iterative data clustering method (Serga 2014). S. V. Dronov and A. Yu. Shelar gave a detailed explanation of latent data clustering methods (Dronov et al., 2018). Mons O. A., Yanov Yu. O., Bezpaly I. O. modified the approach to clustering data with an unknown number of clusters in advance (Amons et al., 2008). Among foreign scientists, we single out the following scientists and their works. Elgamifar E. and Vidal R. study an algorithm called sparse subspace clustering (Elgamifar et al., 2003). Merwe D., Engelbrecht A. proposed two new approaches for using cluster data in the K-means method for initial swarm seeding (Merwe et al., 2004). Sandeep R., Sanjay J., Rajesh K. reviewed the particle swarm method's plan and algorithm and identified the technique’s advantages (Sandeep et al., 2011).

The information base for the cluster analysis used official reports on the level of human development (Human Development Index (HDI)) of the United Nations (UN) program for 2019 for 137 countries (United Nations Development Program 2022).

In order to conduct cluster analysis, the following indicators were used: human inequality coefficient (K1), Gini coefficient (K2), inequality in life expectancy (K3), life expectancy at birth (K4), gross national income (K5), index life expectancy adjusted for inequality (K6), total population (K7), urban population (K8), education index (K9), the population aged 15 to 64 (K10). The initial input data is presented in Table A.1, where the value of the HDI indicator corresponds to the country's rank according to the distribution of the Human Development Index (Statisticssolutions 2020).

Unlike classification tasks, cluster analysis does not require a priori assumptions about the data set, does not impose

restrictions on the display of the objects under study, and allows the analysis of indicators of various types of data (interval data, frequencies, binary data). At the same time, it is necessary to remember that the variables must be measured in comparable scales.

Cluster analysis allows you to reduce the dimensionality of the data and make them visual. Cluster analysis can be applied to aggregates of time series; here, periods of similarity of some indicators can be distinguished, and groups of time series with similar dynamics can be determined. Cluster analysis was developed in parallel in several directions, such as biology, psychology, etc. Therefore most methods have two or more names. It significantly complicates the work when using cluster analysis.

Cluster analysis does not require a priori assumptions about the data set, does not impose restrictions on the display of the studied objects, and allows the analysis of indicators of various types of data (interval data, frequencies, binary data). At the same time, it is necessary to remember that the variables must be measured in comparable scales.

Tasks of cluster analysis can be combined into the following groups: 1. Development of a typology or classification. 2. Study of applicable conceptual schemes for grouping objects. 3. Presentation of hypotheses based on data research. 4. Testing hypotheses or studies to determine whether the types (groups) identified in one way or another are present in the available data. As a rule, several of the specified problems are solved simultaneously with the practical use of cluster analysis.

A cluster has the following mathematical characteristics: center, radius, standard deviation, cluster size. The cluster center is the geometric mean of the points in the space of variables. The radius of the cluster is the maximum distance of points from the

center of the cluster. Clusters can be overlapping. This situation occurs when overlapping clusters are detected. In this case, it is impossible to uniquely assign the object to one of the two clusters using mathematical procedures. Such objects are disputed, a disputed object is an object that can be assigned to several clusters in terms of similarity. Cluster size can be defined either by the radius of the cluster or by the root mean square deviation of the objects for that cluster. An object belongs to a cluster if the distance from the object to the center of the cluster is less than the radius of the cluster. If this condition is met for two or more clusters, the object is disputed. Ambiguity can be resolved by an expert or analyst.

The work of cluster analysis is based on two assumptions. The first assumption is that the considered features of the object in principle allow the desired division of the set of objects into clusters. The second assumption is the correct choice of the scale or unit of measurement of features, the choice of scale in cluster analysis is of great importance.

The input data in Table A.1 contain indicators measured in different scales, there are both relative indicators (coefficients and indices) and absolute indicators, therefore, for the correctness of further research and high quality and adequacy of calculations, they need to be standardized. The standardization procedure is implemented by the Statgraphics Centurion software toolkit.

The Sturges formula was used to determine the optimal number of clusters:

$$k = 1 + [3.322lgN] \quad (6)$$

where *k* is the number of clusters, where N is the volume of the total number of countries (equal to 137). According to the

results of the calculation, k = 8, which determines the optimal number of countries to be divided into clusters.

In addition, the optimal number of clusters was confirmed by the agglomeration protocol (Figure 14). The absence of characteristic jerks between the points of the graph makes it possible to assert that the selected number of clusters for the data set is correct. The agglomeration distance graph shows a normal distribution of gaps (Figure 14).

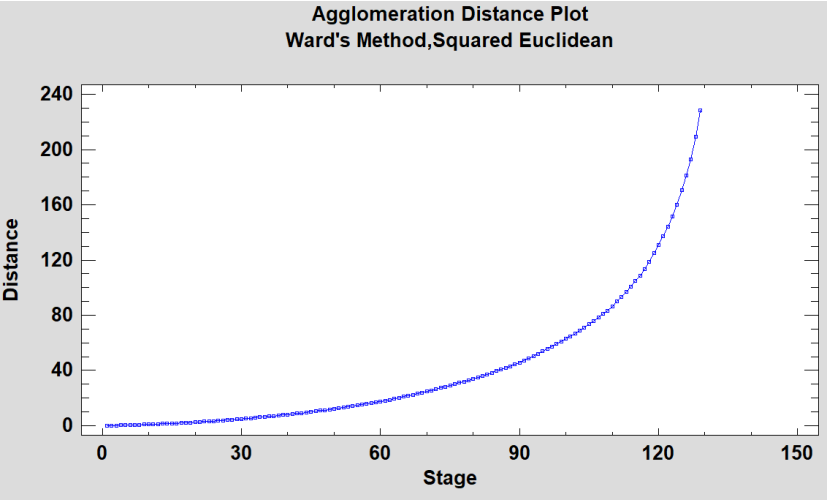


Figure 14. Intervals of agglomeration

Source: built by the authors using the Statgraphics Centurion software toolkit

Ward's method was chosen as the cluster construction method. Ward's method (Ward-Method) – first, in both clusters, the average values of individual variables are calculated for all available observations. Then, the squared Euclidean distances from the individual observations of each cluster to this cluster mean are calculated. These distances are summed up. Then those

clusters that give the smallest increase in the total amount of distances are united into one cluster. This method was used because, unlike other methods of cluster analysis (method of single connection, method of complete connection, centroid method, method of medians), it uses methods of dispersion analysis. As the distance between clusters, the increment of the sum of the squares of the distances of the objects to the center of the cluster obtained as a result of their union (7) is used. Figure 15 presents the final version of the distribution of clusters by 137 countries.

$$V_k = \sum_{i}^{n_k} \sum_{j}^{p} (x_{ij} - \overline{x_{jk}})^2 \qquad (7)$$

where k – cluster number, i – object number, j – feature number, p – number of features characterizing each object, nk – number of objects in the k-th cluster.

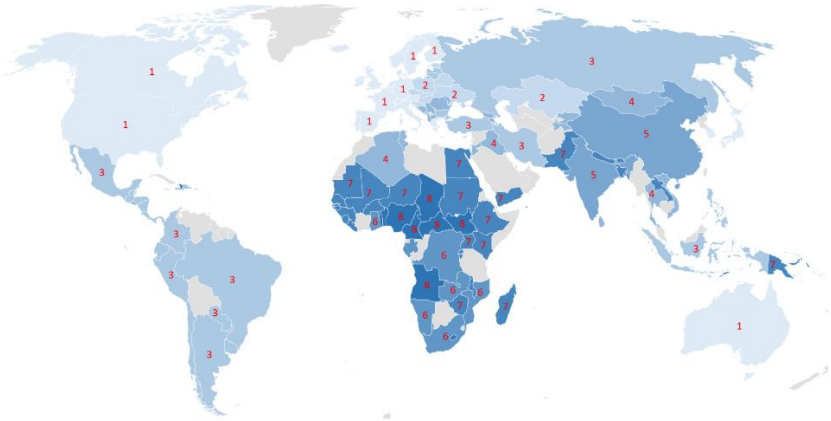


Figure 15. Cluster distribution on the geographic map
Source: made by the authors using Microsoft Excel software tools

Quantitative and percentage distribution of countries is presented in Table 14.

Table 14. Numerical characteristics of the cluster distribution

Cluster	*Quantity*	*Percentage*
1	25	18,25
2	11	8,03
3	25	18,25
4	22	16,06
5	2	1,46
6	10	7,30
7	28	20,44
8	14	10,22

Source: calculated by the authors using Statgraphics Centurion software tools.

Thus, the first cluster included European countries and countries with developed economies, namely: Norway, Ireland, Switzerland, Iceland, Germany, Sweden, Australia, the Netherlands, Denmark, Finland, the United Kingdom, Belgium, Canada, the United States, Austria, Israel, Japan, Korea (Republic), Luxembourg, Spain, France, Malta, Italy, Greece, Portugal.

The second cluster includes the following European countries: Slovenia, the Czech Republic, Estonia, Cyprus, Poland, Slovakia, Hungary, Croatia, Kazakhstan, Belarus, and Ukraine.

The third cluster includes countries from different parts of the world: Lithuania, Latvia, Chile, Argentina, Montenegro, the Russian Federation, Turkey, Uruguay, Bulgaria, Panama, Costa Rica, Seychelles, Iran, Mexico, Peru, Colombia, Brazil, Ecuador, the Dominican Republic, Paraguay, Indonesia, Philippines, Guatemala, Nicaragua, Honduras.

The fourth cluster also included countries from different parts of the world: Romania, Georgia, Serbia, Mauritius, Albania, Sri Lanka, Bosnia and Herzegovina, Thailand, Armenia, North Macedonia, Saint Lucia, Moldova, Algeria, Maldives, Tunisia,

Mongolia, Jordan, Vietnam, Kyrgyzstan, Iraq, El Salvador, Tajikistan.

The fifth cluster includes the two countries with the largest population in the world: China and India.

The sixth cluster includes the following African countries: Bolivia, South Africa, Gabon, Namibia, Sao Tome and Principe, Eswatini, Ghana, Zambia, Congo, and Mozambique.

The seventh cluster includes the following African countries: Egypt, Bhutan, Bangladesh, the Lao People's Democratic Republic, East Timor, Nepal, Kenya, Zimbabwe, Pakistan, Papua New Guinea, Mauritania, Uganda, Rwanda, Tanzania, Madagascar, Senegal, Sudan, Gambia, Ethiopia, Malawi, Liberia, Guinea, Yemen, Burkina Faso, Sierra Leone, Mali, Burundi, Niger.

The eighth cluster includes African countries: Angola, Cameroon, Comoros Islands, Benin, Nigeria, Ivory Coast, Lesotho, Goa, Haiti, Congo, Guinea-Bissau, South Sudan, Chad, the Central African Republic.

This distribution of countries by data clusters took place not only with the help of geographical distribution by region but also in terms of the influence of each indicator on the creation of a cluster. Thus, the first and second clusters included the countries of Europe, which were divided into two groups according to the level of economic development. The third and fourth clusters include countries from different parts of the world; in these clusters, it is quite difficult to determine which indicators influence their formation. Only two countries, China and India, entered the fifth cluster, and the indicator of the total population had the most significant impact on the creation of the cluster. African countries and some Asian countries were included in clusters six, seven eight. Their distribution is determined by economic factors, as well as population factors of the countries.

Discriminant analysis tools are added to check the quality of the performed clustering. Discriminant analysis is a method used to analyze research data when the criterion or dependent variable is categorical and the predictor or independent variable is the interval. Discriminant analysis is an essential tool when solving classification problems. Unlike other methods, discriminant analysis allows the researcher to predict to which class a new object belongs. It contains statistical methods for classifying multidimensional objects where the researcher has so-called training samples (classification with training). Despite many limitations when performing this method, it is advisable to use discriminant analysis in combination with other multivariate statistical analysis methods.

Like cluster analysis, discriminant analysis belongs to the methods of multivariate classification. The main difference between the methods is that in the course of discriminant analysis, new clusters are not formed. Still, a rule is formulated according to which new population units are assigned to one of the already existing classes; discriminant analysis allows dividing a sizeable heterogeneous population into homogeneous groups and assigning a certain object (phenomenon, process, observation) to a specific class. The main tasks of discriminant analysis: interpreting the differences between existing types, classifying new objects and assigning them to one of the classes (Klebanova, 2020).

The purpose of discriminant analysis is to develop discriminant functions, which are nothing more than a linear combination of the independent variables that perfectly distinguish between the categories of the dependent variable. It allows the researcher to test whether there are significant differences between groups in predictor variables (Statisticssolutions 2020).

The main problems of discriminant analysis are a set of discriminant variables. The number of observation objects should exceed the number of variables at least twice. Various criteria for the sequential selection of variables allow for obtaining the best resolution of sets. For example, you can use the step-by-step discriminant analysis algorithm.

Discriminant variables must be linearly independent. The effect of multicollinearity between features significantly worsens the results' quality, making it impractical to use the method. Before starting the research, the analyst should check the sample for a linear relationship between the factor characteristics.

The distribution law of a multivariate quantity must be normal. Suppose the sets used as training samples are close to each other. In that case, the probability of misclassifying new objects increases, especially when a thing far away from the centres of both sets is classified. A situation arises in which object recognition is complex. One of the possible solutions is to review the set of features.

When conducting a multiple discriminant analysis in the Statgraphics Centurion software, a regression model F1 was developed, which describes the contribution of each indicator to the formation of cluster 1, and has the form:

$$\begin{aligned} F1 = {} & -0{,}180166 \cdot K9 - 0{,}0471193 \cdot K2 + 1{,}29466 \\ & \cdot K10 - 0{,}664787 \cdot K7 + 0{,}0394757 \\ & \cdot K8 + 0{,}219873 \cdot K5 + 2{,}55374 \cdot K6 \\ & - 0{,}41317 \cdot K1 + 1{,}06147 \cdot K3 \\ & - 1{,}13345 \cdot K4 \end{aligned} \qquad (8)$$

where K1 is the coefficient of human inequality, K2 is the Gini coefficient, K3 is inequality in life expectancy, K4 is life expectancy at birth, K5 is gross national income, K6 is the index

of life expectancy adjusted for inequality, K7 is the total population , K8 – urban population, K9 – education index, K10 – population aged 15 to 64 years.

The weight of each indicator is displayed by the absolute value of the coefficient; the larger the value, the greater the contribution of this indicator to the formation of cluster 1 (Table 15).

Table 15. Standardized coefficients of discriminant functions

Indicator	F1	F2	F3	F4	F5	F6	F7
Index of Education	-0,180	0,022	0,503	0,186	-0,895	-0,010	0,543
Gini coefficient	-0,047	-0,099	0,412	0,875	0,200	0,046	0,250
Population aged 15-64	1,295	3,525	0,013	0,407	-0,507	-1,407	3,292
Total population	-0,665	-2,829	0,061	-0,421	0,509	1,464	-3,486
Urban population	0,039	-0,183	0,281	0,478	0,115	-0,052	-0,808
Gross national income (GNI)	0,220	-0,237	0,491	-0,307	0,696	-0,612	0,045
Index of expected duration	2,554	-0,855	2,864	-2,523	-4,844	4,328	-0,390
Coefficient of human inequality	-0,413	0,234	0,363	-0,326	-0,127	0,347	-0,144
Inequality is expected	1,061	-0,273	2,137	-1,285	-2,027	2,110	0,674
Life expectancy	-1,138	0,286	-1,564	1,478	3,466	-1,817	0,932

Source: calculated by the authors using Statgraphics Centurion software tools

Table 15 shows the functions' coefficients used to determine each indicator's impact on cluster formation.

From the relative value of the coefficients in the model (8), it is possible to determine how independent variables are used to distinguish clusters (Table 16).

Table 16. Value of the discriminant function

Discriminant function	Eigenvalue	Relative percentage	Canonical correlation	Lambda Wilks statistic	Chi-square	Degree of freedom	P-value
1	13,959	42,72	0,966	0,0002	1068,6	70	0
2	12,98	39,72	0,9635	0,0033	725,03	54	0
3	2,9069	8,9	0,8625	0,0463	390,05	40	0
4	2,1649	6,63	0,8270	0,1811	216,98	28	0
5	0,5147	1,58	0,5829	0,5732	70,66	18	0
6	0,1434	0,44	0,3542	0,8683	17,93	10	0,06
7	0,0071	0,02	0,0841	0,9929	0,90	4	0,92

Source: calculated by the authors using Statgraphics Centurion software tools

So, 137 countries divided into 8 clusters were used to develop the model. 10 predictor variables were used to form clusters. In five out of seven discriminant functions, the value of the level of significance (P-value) is below 0.05%, which indicates statistically significant functions at the confidence level of 95.0%. Wilks Lambda values are measured between 0 and 1; if the value goes towards zero, the values are better than each other. Five functions demonstrate a sufficient level of discrimination in the data used.

Various cluster analysis methods give a more detailed picture of the distribution. Each such analysis shows an essentially unique result. Therefore, to comprehensively analyze and interpret the division of countries into groups and evaluate the effectiveness of the health care system in each group, it is proposed to apply neuromodulating methods using machine learning and Kohonen self-organizing maps.

Self-organizing maps (SOM, Self Organizing Maps), developed by T. Kohonen (Kohonen, 1982), is a powerful tool that uses two paradigms of data analysis - clustering and projection, with visualization of multidimensional data on a plane (Kohonen, 2007).

The algorithm of functioning of self-organizing cards is one of the options for clustering multidimensional vectors - a design algorithm with the preservation of topological similarity. That is, if the indicators were significantly distant from each other in the original space, they would be substantially distant from each other on the map.

The advantage of self-organizing Kohonen cards is that the teaching method is used without a teacher; that is, the learning result depends only on the structure of the input data.

The formula for updating a neuron with the weight vector $W_v(s)$, formula 9, is used for training.

$$W_v(s+1) = W_v(s) + \theta(u, v, s) \cdot \alpha(s) \cdot (D(t) - W_v(s)) \qquad (9)$$

where s – step index, t – index in the training sample, u – the index of the best matching node for the input vector $D(t)$, $\alpha(s)$ – learning rate, which is monotonically decreasing; $\theta(u, v, s)$ – a neighborhood function that gives the distance between neuron u and neuron v at stage s. (Kohonen, 2007)

To construct Kohonen maps, the data set is divided into test and training samples in the 5% to 95% ratio. During the construction of the map, it is possible to change the dimension of the map to the desired size.

Available settings that are used to build maps. It is the construction method from eigenvectors, learning speed, learning radius, and distribution into clusters. The results of constructing the Kohonen map show the training set in the form of the maximum error and average error and the input data recognition indicator, the test set with the maximum error and average error indicators, the data recognition indicator, the number of training epochs and the time spent on training.

A separate Kohonen map was constructed for each variable. Figures 16-18 represent a visual representation of a multidimensional array of data in two-dimensional space. Each figure represents a separate indicator, namely: human inequality coefficient (K1), Gini coefficient (K2), inequality in life expectancy (K3), life expectancy at birth (K4), gross national income (K5), life expectancy index adjusted for inequality (K6), total population (K7), urban population (K8), education index (K9), the population aged 15 to 64 (K10) (Figures 16-18).

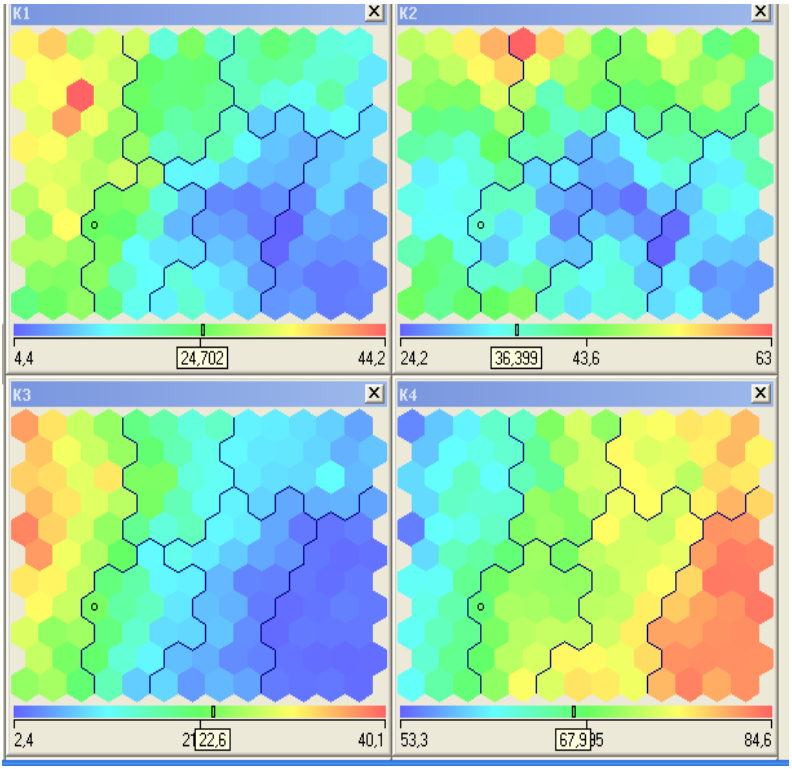


Figure 16. human inequality (K1), Gini coefficient (K2), inequality in life expectancy (K3), life expectancy at birth (K4)

Source: made by the authors with Deductor Studio software.

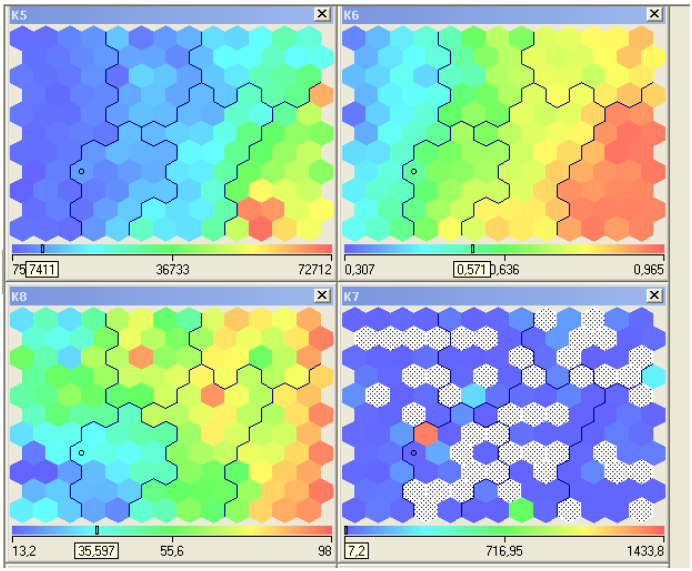


Figure 17. Gross national income (K5), inequality-adjusted life expectancy index (K6), total population (K7), urban population (K8)

Source: made by the authors with Deductor Studio software.

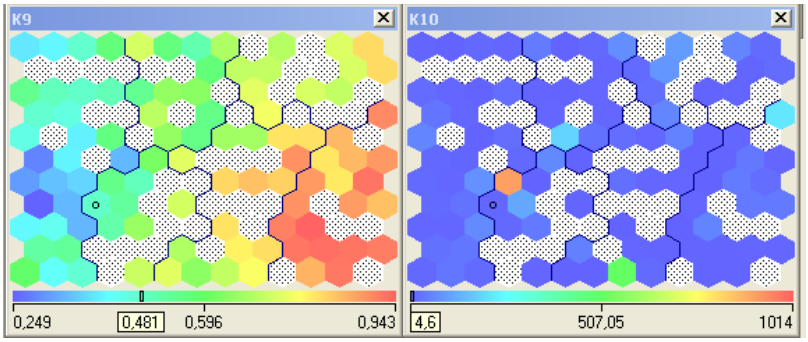


Figure 18. Education index (K9), population aged 15 to 64 (K10)

Source: built by the authors with Deductor Studio software

Determination of the optimal number of clusters was carried out by automatic search (Figure 19).

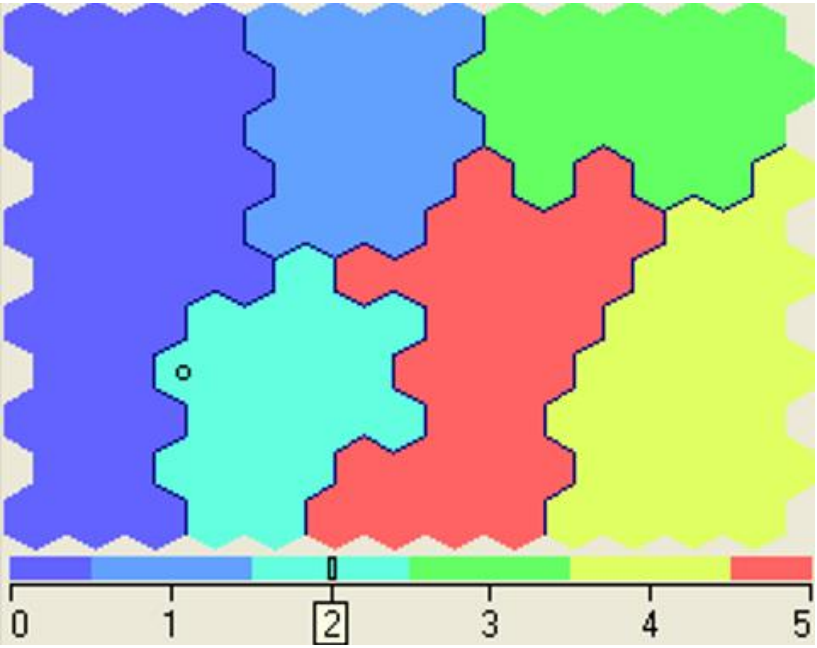


Figure 19. Cluster distribution
Source: built by the authors with Deductor Studio software

Kohonen maps make it possible to see a multi-dimensional array of data in a low-dimensional space while preserving the topological properties of the input data.

Table 17 shows the distribution of the influence of variables on the formation of clusters created by constructing Kohonen's self-organized cat.

Table 17. Influence of variables on the formation of clusters

Variable / Cluster	4	3	2	1	0	general
	99 (72,3%)	20 (14,6%)	12 (8,8%)	4 (2,9%)	2 (1,5%)	
K10	99,50%	6,60%	76,10%	97,40%	100,00%	100,00%
K7	99,60%	2,50%	81,20%	98,00%	100,00%	100,00%
K4	43,10%	72,60%	33,90%	22,00%	13,60%	30,70%
K9	31,10%	68,10%	24,30%	3,00%	30,80%	20,00%
K3	32,40%	57,30%	36,50%	3,10%	12,40%	13,50%
K2	4,80%	29,70%	17,60%	63,50%	1,10%	10,00%
K5	15,70%	41,30%	3,50%	37,80%	43,60%	8,80%
K1	15,90%	45,60%	18,00%	26,80%	14,90%	4,70%

Source: made by the authors with Deductor Studio software.

Therefore, the conducted comprehensive research allowed the distribution of the countries in this way. Cluster 4 includes ninety-nine countries of the world: Norway, Ireland, Switzerland, Iceland, Sweden, Australia, Netherlands, Denmark, Finland, Belgium, Austria, Israel, Slovenia, Luxembourg, Czechia, Malta, Estonia, Greece, Cyprus, Lithuania, Latvia, Portugal, Slovakia, Hungary, Chile, Croatia, Montenegro, Romania, Kazakhstan, Belarus, Uruguay, Bulgaria, Panama, Georgia, Costa Rica, Serbia, Mauritius, Seychelles, Albania, Sri Lanka, Bosnia and Herzegovina, Armenia, North Macedonia, Ecuador, Saint Lucia, Dominican Republic, Moldova, Maldives, Tunisia, Mongolia, Jordan, Paraguay, Bolivia,Gabon, Kyrgyzstan, El Salvador, Tajikistan, Guatemala, Nicaragua, Bhutan, Namibia, Honduras, Sao Tome and Principe, Lao People's Democratic Republic, Eswatini, Ghana, Timor-Leste, Nepal, Zambia, Angola, Congo, Zimbabwe, Cameroon, Papua New Guinea, Comoros, Mauritania, Benin, Rwanda, Côte d'Ivoire, Madagascar, Lesotho, Togo, Senegal, Haiti, Gambia, Malawi, Guinea-Bissau, Liberia, Guinea, Yemen, Mozambique, Burkina Faso, Sierra Leone, Mali, Burundi, South Sudan, Chad, Central African Republic, Niger.

Cluster 3 consists of twenty countries: United Kingdom, Canada, Korea (Republic), Spain, France, Italy, Poland, Argentina, Ukraine, Peru, Thailand, Colombia, Algeria, South Africa, Iraq, Kenya, Uganda, Tanzania (United Republic), Sudan, Congo (Democratic Republic)

The second cluster includes twelve countries: Germany, Japan, Russian Federation, Turkey, Iran (Islamic Republic), Mexico, Philippines, Egypt, Viet Nam, Bangladesh, Nigeria, Ethiopia.

Cluster 1 consists of 4 countries: United States, Brazil, Indonesia, Pakistan.

China and India form cluster 0.

Comparing two cluster analyses using the Uward method and Kohonen's self-organizing maps (SOM, Self Organizing Maps) clearly shows the difference in the results in the number of obtained clusters and their components. Each method claims reliability, and each analysis is statistically significant.

To calculate the cluster analysis, the following indicators were used: human inequality coefficient (K1), Gini coefficient (K2), inequality in life expectancy (K3), life expectancy at birth (K4), gross national income (K5), life expectancy index with adjusted for inequality (K6), total population (K7), urban population (K8), education index (K9), the population aged 15-64 (K10). Their values have different measurement values; they were standardized using the Statgraphics Centurion software toolkit.

The number of clusters argued using the Sturges formula is the number of eight data clusters. Lists of countries included in each cluster have been created.

The defined regression formula of the function from the discriminant analysis is used to determine the influence of each indicator on the created data cluster. The significance of the

discriminant functions is substantiated by Lambda Wilks indicators, and the P-value significance level is calculated using the Statgraphics Centurion toolkit.

The results of the cluster distribution can be used in state development to find optimal static values to which state development should be directed. To make the transition of underdeveloped states to more developed groups. The obtained data will serve for further in-depth data analysis and for finding new patterns in developing the world's countries.

CONCLUSIONS

The world experience accumulated over the last half-century shows that one of the most effective ways of organizing the public health system and improving the health of the population is to improve the determinants that determine it.

The nature of the effect of determinants on the health of the population can change both in space and in time, therefore there is a need for a systematic study and analysis of the determinants of the population's health. Such research is especially relevant in the context of the COVID-19 pandemic.

The monograph contains results in four areas: analysis of regulatory documents on the Sustainable Development Goals and World Health Organization documents on public health; analysis of existing approaches to the classification of determinants of public health; bibliometric analysis of the array of publications of the Scopus database with the aim of identifying the key determinants of health and the influence of socio-economic factors of health on the indicator of human inequality; cluster analysis of the distribution of countries into groups using agglomerative methods and methods of artificial intelligence for a thorough analysis of the quality of the health care system in each group; evaluation of the effectiveness of the health care system using methods of multi-criteria optimization and data envelopment analysis.

Among the main results of the work are:

– development using the Statgraphics Centurion software of a statistically significant regression model describing the dependence of the outcome indicator (the coefficient of human inequality) on the influencing indicators (the Gini coefficient, inequality in life expectancy, gross national income, the index of life expectancy adjusted for inequality);

– carrying out a frontier analysis of the countries that are Members of the Organization for Economic Cooperation and Development, in order to determine benchmark countries in terms of the quality of the health care system. During the analysis in the Frontier Analyst Application, countries were divided into three subgroups for qualitative analysis and selection of countries with high-performance indicators of the health care system and identification of potential targets for improving the quality of the health care system within each group;

– conducting a cluster analysis using the agglomerative method (Ward's method) and the mapping method for 137 countries of the world on the basis of reports on the level of human development (Human Development Index (HDI)) of the United Nations (UN) program, namely, such indicators as the coefficient of human inequality, Gini coefficient, inequality in life expectancy, life expectancy at birth, gross national income, index of life expectancy adjusted for inequality, total population, urban population, education index, the population aged 15 to 64;

– methods of multiple discriminant analysis using Statgraphics Centurion software substantiate the quality of the performed clustering and the contribution of each indicator to the formation of clusters;

– using machine learning methods and the Deductor Studio software, the distribution of 137 countries of the world was carried out according to ten significant indicators that determine or affect the level of health (coefficient of human inequality, Gini coefficient, inequality in life expectancy, life expectancy at birth, gross national income, inequality-adjusted life expectancy index, total population, urban population, education index, the population aged 15 to 64) into 4 clusters using Kohonen Self Organizing Maps;

– the results of two different cluster analysis methods (Ward's agglomerative method and neuromodeling using Kohonen Self Organizing Maps) were compared. Each of the proposed methods claims to be reliable, and each analysis is statistically significant and can be used for a detailed study of the features of the healthcare systems of the studied country and the identification of potential reserves for improving its quality.

The proposed methodology comprehensively combines a review of normative and legislative documents on the definition of health, factors of the health care system of the countries of the world, and a powerful mathematical toolkit for assessing the quality of health care systems, considering the impact and consequences of the COVID-19 pandemic. It is aimed at increasing the socio-economic development of any country.

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APPENDIX A

Table A.1. Input data

Country	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10
Norway	6	27	3	82,4	66494	0,931	5,4	82,6	0,93	3,5
Ireland	7,2	32,8	3,4	82,3	68371	0,926	4,9	63,4	0,922	3,2
Switzerland	6,8	32,7	3,5	83,8	69394	0,947	8,6	73,8	0,9	5,7
Iceland	5,6	26,8	2,4	83	54682	0,946	0,3	93,9	0,926	0,2
Germany	7,9	31,9	3,8	81,3	55314	0,908	83,5	77,4	0,943	54
Sweden	6,5	28,8	2,9	82,8	54508	0,938	10	87,7	0,918	6,2
Australia	7,9	34,4	3,7	83,4	48085	0,94	25,2	86,1	0,924	16,3
Netherlands	6,9	28,5	3,1	82,3	57707	0,928	17,1	91,9	0,914	11
Denmark	6	28,7	3,6	80,9	58662	0,903	5,8	88	0,92	3,7
Finland	5,3	27,4	3	81,9	48511	0,924	5,5	85,4	0,927	3,4
United Kingdom	7,9	34,8	4,1	81,3	46071	0,905	67,5	83,7	0,928	43,1
Belgium	7,7	27,4	3,6	81,6	52085	0,914	11,5	98	0,902	7,4
Canada	8,4	33,8	4,6	82,4	48527	0,916	37,4	81,5	0,894	24,9
United States	12,1	41,4	6,3	78,9	63826	0,848	329,1	82,5	0,9	215
Austria	6,9	29,7	3,7	81,5	56197	0,912	9	58,5	0,865	6
Israel	10,9	39	3,3	83	40187	0,937	8,5	92,5	0,883	5,1
Japan	8,1	32,9	2,9	84,6	42932	0,965	126,9	91,7	0,851	75,4
Slovenia	4,6	24,2	2,9	81,3	38080	0,916	2,1	54,8	0,91	1,3
Korea (Republic of)	10,7	31,6	3	83	43044	0,941	51,2	81,4	0,865	37
Luxembourg	9,6	34,9	3,4	82,3	72712	0,925	0,6	91,2	0,806	0,4
Spain	13,1	34,7	3	83,6	40975	0,949	46,7	80,6	0,831	30,7
France	8,9	31,6	3,8	82,7	47173	0,927	65,1	80,7	0,817	40,3
Czechia	4,4	24,9	3	79,4	38109	0,886	10,7	73,9	0,89	6,9
Malta	7,9	29,2	4,6	82,5	39555	0,918	0,4	94,7	0,825	0,3
Estonia	6,9	30,4	3,6	78,8	36019	0,871	1,3	69,1	0,882	0,8
Italy	11,8	35,9	3,1	83,5	42776	0,947	60,5	70,7	0,793	38,6
Greece	10,8	34,4	3,5	82,2	30155	0,924	10,5	79,4	0,849	6,7
Cyprus	9,1	31,4	3,6	81	38207	0,904	1,2	66,8	0,827	0,8
Lithuania	10	37,3	5,5	75,9	35799	0,813	2,8	67,9	0,898	1,8
Poland	7,6	29,7	4,3	78,7	31623	0,865	37,9	60	0,869	25,3
Latvia	9,2	35,6	5,4	75,3	30282	0,805	1,9	68,2	0,883	1,2
Portugal	11,8	33,8	3,5	82,1	33967	0,921	10,2	65,8	0,768	6,6
Slovakia	6,1	25,2	5	77,5	32113	0,841	5,5	53,7	0,826	3,7
Hungary	7,3	30,6	4,2	76,9	31329	0,838	9,7	71,6	0,821	6,4
Chile	15,9	44,4	6,3	80,2	23261	0,868	19	87,6	0,81	13
Croatia	7,9	30,4	4,3	78,5	28070	0,861	4,1	57,2	0,805	2,7
Argentina	13,2	41,4	8,6	76,7	21190	0,797	44,8	92	0,855	28,7
Montenegro	9,4	39	3,6	76,9	21399	0,844	0,6	67,2	0,803	0,4
Romania	11,4	36	6,3	76,1	29497	0,808	19,4	54,1	0,765	12,7
Kazakhstan	7,1	27,5	7,7	73,6	22857	0,761	18,6	57,5	0,83	11,8
Russian Federation	10	37,5	7,1	72,6	26157	0,751	145,9	74,6	0,823	97,4

continued Table A.1

Belarus	6,3	25,2	4,4	74,8	18546	0,806	9,5	79	0,838	6,4
Turkey	16,5	41,9	9	77,7	27701	0,808	83,4	75,6	0,731	55,9
Uruguay	12,6	39,7	7,9	77,9	20064	0,821	3,5	95,4	0,765	2,2
Bulgaria	11,3	40,4	6,1	75,1	23325	0,795	7	75,3	0,779	4,5
Panama	20,1	49,2	12	78,5	29558	0,792	4,2	68,1	0,7	2,8
Georgia	11,5	36,4	7,9	73,8	14429	0,762	4	59	0,862	2,6
Costa Rica	17,5	48	7,1	80,3	18486	0,862	5	80,1	0,726	3,5
Serbia	12,1	36,2	4,9	76	17192	0,819	8,8	56,3	0,783	5,8
Mauritius	13,6	36,8	9,4	75	25266	0,766	1,3	40,8	0,736	0,9
Seychelles	15,2	46,8	9,6	73,4	26903	0,743	0,1	57,1	0,726	0,1
Albania	10,9	33,2	7,2	78,6	13998	0,836	2,9	61,2	0,746	2
Iran	11,3	40,8	9,2	76,7	12447	0,792	82,9	75,4	0,756	57,2
Sri Lanka	13,8	39,8	7	77	12707	0,815	21,3	18,6	0,746	13,9
Bosnia and Herzegovina	14,2	33	5,4	77,4	14872	0,835	3,3	48,6	0,711	2,2
Mexico	20,8	45,4	10,5	75,1	19160	0,758	127,6	80,4	0,703	84,7
Ukraine	6,5	26,1	7,4	72,1	13216	0,742	44	69,5	0,799	29,6
Peru	18,8	42,8	10,8	76,7	12252	0,779	32,5	78,1	0,74	21,6
Thailand	16,7	36,4	7,9	77,2	17781	0,81	69,6	50,7	0,682	49,3
Armenia	9,7	34,4	8,7	75,1	13894	0,774	3	63,2	0,74	2
North Macedonia	11,8	34,2	7,9	75,8	15865	0,791	2,1	58,2	0,704	1,4
Colombia	21,6	50,4	10,7	77,3	14257	0,787	50,3	81,1	0,682	34,5
Brazil	24,4	53,9	10,9	75,9	14263	0,766	211,1	86,8	0,694	147
China	15,7	38,5	7,9	76,9	16057	0,806	1434	60,3	0,657	1014
Ecuador	18,4	45,4	11,5	77	11044	0,776	17,4	64	0,702	11,3
Saint Lucia	16,9	51,2	10,6	76,2	14616	0,773	0,2	18,8	0,672	0,1
Dominican Republic	21,1	43,7	17	74,1	17591	0,691	10,7	56	0,711	7
Moldova	10,3	25,7	9,6	71,9	13664	0,722	4	42,7	0,711	2,9
Algeria	19,7	27,6	14,1	76,9	11174	0,752	43,1	73,2	0,672	27,1
Maldives	20,4	31,3	6	78,9	17417	0,852	0,5	40,2	0,573	0,4
Tunisia	18,9	32,8	9	76,7	10414	0,794	11,7	69,3	0,661	7,9
Mongolia	14	32,7	13,1	69,9	10839	0,667	3,2	68,5	0,736	2,1
Jordan	14,6	33,7	10,6	74,5	9858	0,75	10,1	91,2	0,667	6,3
Paraguay	22,8	46,2	13,8	74,3	12224	0,719	7	61,9	0,638	4,5
Bolivia	23,7	42,2	22,5	71,5	8554	0,614	11,5	69,8	0,695	7,1
Indonesia	17,7	39	13,9	71,7	11459	0,685	270,6	56	0,65	183
Philippines	17,8	44,4	15,3	71,2	9778	0,668	108,1	47,1	0,678	69,4
South Africa	31,2	63	19,2	64,1	12129	0,549	58,6	66,9	0,724	38,4
Egypt	28,7	31,5	11,6	72	11466	0,707	100,4	42,7	0,618	61,1
Viet Nam	16,5	35,7	12,9	75,4	7433	0,742	96,5	36,6	0,63	66,8
Gabon	22,5	38	22,8	66,5	13930	0,552	2,2	89,7	0,65	1,3
Kyrgyzstan	9,5	27,7	11,3	71,5	4864	0,702	6,4	36,6	0,73	4
Iraq	19,4	29,5	15,9	70,6	10801	0,655	39,3	70,7	0,557	23
El Salvador	21,1	38,6	12,5	73,3	8359	0,718	6,5	72,7	0,555	4,2

continued Table A.1

Tajikistan	12,4	34	16,7	71,1	3954	0,655	9,3	27,3	0,682	5,6
Guatemala	26,9	48,3	14,6	74,3	8494	0,713	17,6	51,4	0,519	10,8
Nicaragua	23,2	46,2	13,1	74,5	5284	0,728	6,5	58,8	0,573	4,2
Bhutan	26,3	37,4	17,1	71,8	10746	0,66	0,8	41,6	0,496	0,5
Namibia	33,6	59,1	22,1	63,7	9357	0,524	2,5	51	0,584	1,5
India	25,7	37,8	19,7	69,7	6681	0,613	1366	34,5	0,555	916
Honduras	24,8	52,1	13,3	75,3	5308	0,737	9,7	57,7	0,499	6,2
Bangladesh	23,7	32,4	17,3	72,6	4976	0,669	163	37,4	0,529	110
Sao Tome and Principe	16,7	56,3	17	70,4	3952	0,643	0,2	73,6	0,567	0,1
Lao People's Democratic Republic	24,7	36,4	22,6	67,9	7413	0,571	7,2	35,6	0,481	4,6
Eswatini (Kingdom of)	29	54,6	25,1	60,2	7919	0,463	1,1	24	0,557	0,7
Ghana	27,8	43,5	24,2	64,1	5269	0,514	30,4	56,7	0,563	18,1
Timor-Leste	26,7	28,7	21,7	69,5	4440	0,596	1,3	30,9	0,51	0,8
Nepal	24,9	32,8	17,5	70,8	3457	0,645	28,6	20,2	0,521	18,5
Kenya	26,2	40,8	22,5	66,7	4244	0,557	52,6	27,5	0,534	30,7
Zambia	30,6	57,1	26,5	63,9	3326	0,496	17,9	44,1	0,557	9,5
Angola	31,7	51,3	32	61,2	6104	0,43	31,8	66,2	0,5	16,3
Congo	24,9	48,9	22,8	64,6	2879	0,529	5,4	67,4	0,543	3
Zimbabwe	22,5	44,3	24,2	61,5	2666	0,484	14,6	32,2	0,587	8
Cameroon	33,4	46,6	33,5	59,3	3581	0,402	25,9	57	0,547	14,2
Pakistan	30,2	33,5	29,9	67,3	5005	0,51	216,6	36,9	0,402	131
Papua New Guinea	29,6	41,9	24,1	64,5	4301	0,52	8,8	13,2	0,439	5,4
Comoros	44,2	45,3	28,9	64,3	3099	0,485	0,9	29,2	0,482	0,5
Mauritania	31,8	32,6	30	64,9	5135	0,484	4,5	54,5	0,396	2,6
Benin	36,9	47,8	34,9	61,8	3254	0,418	11,8	47,9	0,478	6,4
Uganda	26,7	42,8	27,2	63,4	2123	0,486	44,3	24,4	0,523	22,8
Rwanda	28,4	43,7	19,5	69	2155	0,607	12,6	17,3	0,458	7,2
Nigeria	35,2	43	37,1	54,7	4910	0,336	201	51,2	0,499	108
C?te d'Ivoire	35,3	41,5	33,3	57,8	5069	0,388	25,7	51,2	0,453	14,3
Tanzania	24,9	40,5	25,3	65,5	2600	0,522	58	34,5	0,429	31,1
Madagascar	26	42,6	21,1	67	1596	0,571	27	37,9	0,486	15,3
Lesotho	27,4	44,9	33,1	54,3	3151	0,353	2,1	28,6	0,532	1,3
Togo	31,7	43,1	30,5	61	1602	0,439	8,1	42,2	0,517	4,5
Senegal	31,2	40,3	21,2	67,9	3309	0,581	16,3	47,7	0,345	8,8
Haiti	40	41,1	32,2	64	1709	0,459	11,3	56,2	0,456	7
Sudan	34,3	34,2	27,4	65,3	3829	0,506	42,8	34,9	0,345	24,1
Gambia	31,2	35,9	28,5	62,1	2168	0,463	2,3	61,9	0,406	1,3
Ethiopia	27,3	35	24,9	66,6	2207	0,538	112,1	21,2	0,341	62,9
Malawi	28,6	44,7	25,1	64,3	1035	0,51	18,6	17,2	0,47	10
Congo	30,2	42,1	36,1	60,7	1063	0,4	86,8	45	0,496	44,2
Guinea-Bissau	37,4	50,7	32,3	58,3	1996	0,399	1,9	43,8	0,414	1,1

continued Table A.1

Liberia	31,8	35,3	29,8	64,1	1258	0,476	4,9	51,6	0,426	2,8
Guinea	33,1	33,7	31,3	61,6	2405	0,44	12,8	36,5	0,354	6,8
Yemen	30,9	36,7	24,7	66,1	1594	0,534	29,2	37,3	0,35	16,9
Mozambique	30,7	54	29,8	60,9	1250	0,441	30,4	36,5	0,395	16
Burkina Faso	29,5	35,3	32	61,6	2133	0,435	20,3	30	0,312	10,8
Sierra Leone	34,5	35,7	39	54,7	1668	0,326	7,8	42,5	0,406	4,4
Mali	32,4	33	36,7	59,3	2269	0,383	19,7	43,1	0,286	9,9
Burundi	29,6	38,6	28,5	61,6	754	0,457	11,5	13,4	0,417	6
South Sudan	36	46,3	36,2	57,9	2003	0,372	11,1	19,9	0,307	6,1
Chad	37,4	43,3	40,9	54,2	1555	0,311	15,9	23,3	0,288	8,1
Central African Republic	41,3	56,2	40,1	53,3	993	0,307	4,7	41,8	0,353	2,5
Niger	27,4	34,3	30,9	62,4	1201	0,451	23,3	16,5	0,249	11,1

Source: made by the authors

Table A.2. Normalised indicators

Країна/Показник	K1	K2	K3	K4	K5
Norway	0,1668	0,2052	0,1992	0,9342	0,9312
Ireland	0,1890	0,3424	0,2067	0,9404	0,9260
Switzerland	0,1805	0,3397	0,2086	0,9435	0,9469
Iceland	0,1615	0,2013	0,1883	0,8803	0,9458
Germany	0,2021	0,3184	0,2144	0,8840	0,9077
Sweden	0,1764	0,2430	0,1973	0,8793	0,9381
Australia	0,2018	0,3872	0,2124	0,8359	0,9399
Netherlands	0,1830	0,2364	0,2010	0,8970	0,9285
Denmark	0,1668	0,2408	0,2105	0,9018	0,9032
Finland	0,1557	0,2132	0,1992	0,8391	0,9239
United Kingdom	0,2028	0,3988	0,2203	0,8199	0,9047
Belgium	0,1984	0,2132	0,2105	0,8642	0,9140
Canada	0,2126	0,3702	0,2304	0,8393	0,9163
United States	0,2947	0,5957	0,2672	0,9245	0,8485
Austria	0,1833	0,2636	0,2124	0,8889	0,9117
Israel	0,2659	0,5243	0,2048	0,7664	0,9368
Japan	0,2052	0,3452	0,1973	0,7927	0,9655
Slovenia	0,1446	0,1554	0,1973	0,7447	0,9160
Korea	0,2615	0,3105	0,1992	0,7937	0,9406
Luxembourg	0,2360	0,4017	0,2067	0,9526	0,9251
Spain	0,3216	0,3959	0,1992	0,7742	0,9487
France	0,2225	0,3105	0,2144	0,8288	0,9274
Czechia	0,1425	0,1669	0,1992	0,7450	0,8861
Malta	0,2025	0,2520	0,2304	0,7600	0,9177
Estonia	0,1829	0,2803	0,2105	0,7223	0,8713
Italy	0,2887	0,4311	0,2010	0,7912	0,9468
Greece	0,2638	0,3872	0,2086	0,6523	0,9240

continued Table A.2

Cyprus	0,2261	0,3054	0,2105	0,7461	0,9044
Lithuania	0,2454	0,4730	0,2494	0,7198	0,8131
Poland	0,1955	0,2636	0,2243	0,6706	0,8647
Latvia	0,2277	0,4222	0,2472	0,6539	0,8047
Portugal	0,2881	0,3702	0,2086	0,6988	0,9212
Slovakia	0,1687	0,1720	0,2387	0,6766	0,8410
Hungary	0,1896	0,2853	0,2223	0,6670	0,8383
Chile	0,4002	0,6793	0,2672	0,5610	0,8675
Croatia	0,2015	0,2803	0,2243	0,6255	0,8612
Argentina	0,3250	0,5957	0,3224	0,5324	0,7969
Montenegro	0,2335	0,5243	0,2105	0,5353	0,8436
Romania	0,2795	0,4340	0,2672	0,6440	0,8080
Kazakhstan	0,1861	0,2153	0,3001	0,5555	0,7611
Russian Federation	0,2461	0,4790	0,2857	0,6003	0,7515
Belarus	0,1725	0,1720	0,2263	0,4956	0,8058
Turkey	0,4173	0,6102	0,3327	0,6207	0,8077
Uruguay	0,3082	0,5454	0,3050	0,5168	0,8205
Bulgaria	0,2767	0,5663	0,2627	0,5619	0,7953
Panama	0,5240	0,7910	0,4137	0,6447	0,7921
Georgia	0,2813	0,4459	0,3050	0,4386	0,7619
Costa Rica	0,4470	0,7660	0,2857	0,4948	0,8615
Serbia	0,2960	0,4400	0,2366	0,4768	0,8193
Mauritius	0,3346	0,4579	0,3430	0,5883	0,7665
Seychelles	0,3785	0,7390	0,3483	0,6102	0,7427
Albania	0,2662	0,3534	0,2881	0,4327	0,8362
Iran	0,2759	0,5781	0,3378	0,4116	0,7918
Sri Lanka	0,3397	0,5484	0,2833	0,4151	0,8153
Bosnia and Herzegovina	0,3509	0,3479	0,2472	0,4447	0,8354
Mexico	0,5440	0,7050	0,3723	0,5042	0,7580
Ukraine	0,1760	0,1880	0,2928	0,4220	0,7418
Peru	0,4844	0,6357	0,3804	0,4090	0,7786
Thailand	0,4213	0,4459	0,3050	0,4850	0,8098
Armenia	0,2383	0,3872	0,3250	0,4313	0,7738
North Macedonia	0,2883	0,3815	0,3050	0,4584	0,7906
Colombia	0,5692	0,8140	0,3777	0,4362	0,7871
Brazil	0,6478	0,8698	0,3832	0,4363	0,7660
China	0,3922	0,5092	0,3050	0,4611	0,8064
Ecuador	0,4739	0,7050	0,3997	0,3928	0,7762
Saint Lucia	0,4272	0,8282	0,3750	0,4412	0,7730
Dominican Republic	0,5531	0,6606	0,5574	0,4823	0,6906
Moldova	0,2525	0,1808	0,3483	0,4281	0,7218
Algeria	0,5131	0,2173	0,4737	0,3946	0,7517
Maldives	0,5326	0,3028	0,2604	0,4799	0,8521
Tunisia	0,4869	0,3424	0,3327	0,3845	0,7938
Mongolia	0,3448	0,3397	0,4449	0,3901	0,6667

continued Table A.2

Jordan	0,3630	0,3673	0,3750	0,3772	0,7500
Paraguay	0,6033	0,7248	0,4650	0,4086	0,7194
Bolivia	0,6310	0,6188	0,7043	0,3603	0,6142
Indonesia	0,4528	0,5243	0,4679	0,3984	0,6851
Philippines	0,4559	0,6793	0,5084	0,3761	0,6676
South Africa	0,8071	0,9526	0,6191	0,4074	0,5486
Palestine,	0,3293	0,3673	0,4137	0,3333	0,7318
Egypt	0,7574	0,3080	0,4025	0,3985	0,7071
Viet Nam	0,4177	0,4251	0,4392	0,3460	0,7424
Gabon	0,5954	0,4941	0,7115	0,4318	0,5519
Kyrgyzstan	0,2347	0,2194	0,3942	0,3144	0,7021
Iraq	0,5039	0,2589	0,5258	0,3896	0,6547
El Salvador	0,5552	0,5122	0,4278	0,3578	0,7178
Tajikistan	0,3035	0,3758	0,5488	0,3036	0,6549
Guatemala	0,7153	0,7724	0,4882	0,3595	0,7134
Nicaragua	0,6145	0,7248	0,4449	0,3195	0,7285
Bhutan	0,6986	0,4760	0,5603	0,3889	0,6604
Namibia	0,8483	0,9261	0,6946	0,3707	0,5238
India	0,6848	0,4881	0,6326	0,3366	0,6135
Honduras	0,6607	0,8431	0,4507	0,3198	0,7372
Bangladesh	0,6304	0,3316	0,5660	0,3157	0,6691
Sao Tome and Principe	0,4233	0,8993	0,5574	0,3035	0,6434
Lao People's Democratic Republic	0,6583	0,4459	0,7067	0,3458	0,5706
Eswatini	0,7639	0,8791	0,7630	0,3522	0,4631
Ghana	0,7364	0,6551	0,7436	0,3193	0,5139
Timor-Leste	0,7102	0,2408	0,6847	0,3093	0,5963
Nepal	0,6628	0,3424	0,5717	0,2977	0,6445
Kenya	0,6961	0,5781	0,7043	0,3070	0,5568
Zambia	0,7962	0,9077	0,7911	0,2962	0,4963
Angola	0,8176	0,8299	0,8775	0,3295	0,4305
Congo	0,6628	0,7849	0,7115	0,2911	0,5294
Zimbabwe	0,5961	0,6766	0,7436	0,2886	0,4838
Cameroon	0,8457	0,7343	0,8950	0,2992	0,4020
Pakistan	0,7886	0,3617	0,8488	0,3161	0,5098
Papua New Guinea	0,7750	0,6102	0,7414	0,3077	0,5196
Comoros	0,9526	0,7025	0,8334	0,2936	0,4848
Mauritania	0,8188	0,3370	0,8503	0,3177	0,4839
Benin	0,8928	0,7616	0,9093	0,2954	0,4183
Uganda	0,7090	0,6357	0,8042	0,2824	0,4857
Rwanda	0,7499	0,6606	0,6272	0,2828	0,6071
Nigeria	0,8718	0,6413	0,9282	0,3149	0,3357
Côte d'Ivoire	0,8735	0,5986	0,8928	0,3169	0,3877
Tanzania	0,6628	0,5692	0,7672	0,2879	0,5224
Madagascar	0,6918	0,6301	0,6695	0,2765	0,5710
Lesotho	0,7269	0,6923	0,8905	0,2942	0,3533

continued Table A.2

Togo	0,8169	0,6441	0,8575	0,2766	0,4388
Senegal	0,8069	0,5633	0,6720	0,2960	0,5812
Haiti	0,9238	0,5869	0,8799	0,2778	0,4590
Sudan	0,8593	0,3815	0,8078	0,3021	0,5061
Gambia	0,8080	0,4311	0,8268	0,2830	0,4626
Ethiopia	0,7230	0,4046	0,7588	0,2834	0,5384
Malawi	0,7551	0,6871	0,7630	0,2703	0,5100
Congo	0,7877	0,6159	0,9201	0,2706	0,3999
Guinea-Bissau	0,8984	0,8194	0,8812	0,2810	0,3991
Liberia	0,8188	0,4134	0,8473	0,2728	0,4763
Guinea	0,8407	0,3673	0,8685	0,2856	0,4397
Yemen	0,8015	0,4549	0,7545	0,2765	0,5344
Mozambique	0,7976	0,8712	0,8473	0,2727	0,4412
Burkina Faso	0,7739	0,4134	0,8775	0,2826	0,4350
Sierra Leone	0,8629	0,4251	0,9416	0,2773	0,3256
Mali	0,8288	0,3479	0,9251	0,2841	0,3828
Burundi	0,7767	0,5122	0,8268	0,2672	0,4574
South Sudan	0,8828	0,7272	0,9210	0,2811	0,3715
Chad	0,8991	0,6496	0,9526	0,2761	0,3113
Central African Republic	0,9340	0,8982	0,9482	0,2699	0,3067
Niger	0,7274	0,3844	0,8631	0,2722	0,4510

Source: formed by the authors

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Authors

© As. Prof. Ph.D. Vitaliia Koibichuk
Sumy State University, Ukraine

As. Prof. Ph.D. Svitlana Kolomiiets
Sumy State University, Ukraine

Ph.D. Student Serhii Drozd

Reviewers

D.Sc., Prof. Aleksandra Kuzior
Head of the Department of Applied Social Sciences, Faculty of Organization and Management of the Silesian University of Technology

D.Sc., Prof., Nataliya Pedchenko
First Vice-Rector of the Poltava University of Economic and Trade

D.Sc., Prof., Maksym Korneev
Dean of the Faculty of Innovative Technologies
University Of Customs And Finance

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