

# Analysis of Health Care System Development in the Regions amidst the Economic Inclusiveness and Social Determinants of Health

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*Abstract:* - The article proposes a neural network-based Kohonen's self-organized maps cluster analysis of Ukraine's health care system at regional level. At analysis, economic patterns and social determinants of health are considered. The research aims to estimate regional security at the public health level. For that, behavioral and social patterns determine a regions' potential resistance to public health risks. The authors identify the strengths and weaknesses of each region and assess the effectiveness of health care as it is provided. Interestingly, the clustering algorithm fits multidimensional space design into spaces with a lower dimension. Additionally, similar vectors in the source space appear closely on the resulting map. The algorithm design, stages of evaluation, and input groups of indicators by components are described. The data set reflects the 22 regions of Ukraine. The rationing of indicators is calculated to make the data comparable. Data are checked for quality, sparsity, duplicates, and inconsistencies. Five clusters are generated based on development of patterns within regions as well as the information value of healthcare-related socio-economic indicators. The residents of regions that belong to the first cluster systematically assess their health. Demographically, these residents are more physically active compared with residents in clusters of other regions. Findings also indicate that residents in the first cluster monitor their nutrition. The second cluster is informative on residents' behavioral components. In the third cluster are grouped regions with financially secure residents. The fourth cluster includes leader regions. The fifth cluster includes outsider regions. The proposed model can easily fit to new data, to identify new patterns and to graphically represent new results. The model can also analyze computationally complex approach based on a complete set of multidirectional indicators relating to the country's medical system at a state of risk. Moreover, this cluster-based approach can identify areas that require increased attention by state public health agencies.

*Key-Words:* - Regional health care system, Inclusive health, Public health, Behavioral patterns of health, Social determinants of health, Kohonen's self-organized maps, Regions' Clustering, Healthy region.

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## 1 Introduction

Challenges to the regional healthcare security systems are being addressed. Health care protection and illness prevention have increased since 2020 in the context of the COVID-19 pandemic. Reformation of public health systems is a prerequisite for fighting against the dangerous virus, which has caused significant human and economic losses. The number of deaths from COVID-19 worldwide is about 4.5 million people. The number of failures is 4.4% of the world's gross domestic product (GDP). In Ukraine, these figures are 58.1 thousand people and 5% of the GDP, respectively, [10]. Several sources confirm a strong link between the population's health and the state of the economy. The study in [8] notes that in 12 countries from 1820 to 2010, there was a significant correlation between the level of health care system

development, mortality reduction, and GDP per capita growth. A World Bank study, [55], states that from 1780 to 1979, 30% of Britain's GDP growth was due to people's improved health and nutrition. The World Health Organization (WHO) estimates that human morbidity increases treatment costs (20% of costs), and the economy loses the working-age population (80% of costs). About 6% of Ukraine's GDP losses are due to premature mortality. One-third of deaths are due to cardiovascular disease, the crucial causes of which are low physical activity and poor nutrition, [8]. At the same time, the cost of health care is not the main factor in improving the population's health. For example, in many countries in the European region, economic growth associated with increased life expectancy from 1970 to 2003 was 29-38% of GDP.

This growth is much higher than health care spending.

It is significant to restructure the health care system of territorial units in the country while considering each region's problems, needs, and potential. The analysis of development indicators makes it possible to identify different approaches to the health care support of the internal population. In times of global stress on the health sector, local health management strategies must rely on an innovative interpretation of the causal links between the environment (social and physical) and public health. It becomes possible thanks to the study of the determinants of regional health by groups of parameters that derive from the territory's demographic, social, economic, and environmental parameters. This work aimed to identify different components of regional health: the current state of health, the level of disease prevention, aspects related to public information, provision of medical services, financial aspects of the latest reforms, and the behavioral component of life in each area. The development of effective measures to preserve and strengthen regional health is the output of such an analysis, which makes it possible to identify the strengths and weaknesses of the region and carefully assess the feasibility and capacity (financial, managerial, or time) to improve. This set of tools aims to overcome the negative trend of life quality deteriorating, in particular the health of the people. According to [12], people in Ukraine spend 39 billion UAH annually on pharmacy purchases (excluding reimbursement volumes).

The authors decided to generalize different indicators of the health system in Ukraine and define the level of health care in regions with their further typology.

## 2 Problem Formulation

### 2.1 Literature Review

The formation of a theoretical approach to defining goals and essence, a "fair evaluation" in the healthcare sector, [53], creates an opportunity to methodologically assess the state of a healthcare system of a particular region or of multiple regions with a clear understanding of the tasks while mitigating potential mistakes. Assessment of the relationships between stakeholders and their costs for healthcare are analyzed in [16].

Some systems generalize specific indices of regional development. They are presented in [7]. In [31], the authors proposed an algorithm for solving

the problem of development indicators at the enterprise level. It could help analyze health care system development, as it allows to take into account various impact aspects. Many scientists include assessing the health care system indicators to evaluate the territory's competitiveness or determine the interdependence between public health and other macroeconomic parameters, [4], [5], [7], [13], [23], [24], [25], [28], [29], [35], [49].

Measuring public healthcare delivery efficiency from a regional perspective by applying conditional nonparametric models is discussed in the following studies, [1], [15]. The researchers used data development analysis (DEA) and the free disposal hull (FGH) method to determine the impact of GDP level on regional healthcare delivery. In the article [3], DEA is described as a tool for analysis of health delivery with ranking, but it is discouraged due to lack of discrimination and comparability. The researchers proposed a DEA-based model, which is improved.

Applying cluster factor analysis, [51], allowed a cross-sector analysis of secondary data for mapping and scheduling based on ISR in health regions. Using the example of Brazil, researchers have identified the regions with the highest and lowest rates of health system development, depending on the level of socio-economic development. Correlation and regression analysis was performed in [46], [48] to estimate the relationship between healthcare and economic indicators.

The study of various aspects of the Covid-19 pandemic, including the implementation of clustering of regions based on Boxplots and Pearson correlations that determine relationships between outcomes, clusters, and contextual factors, [9]. Another method is spatial modeling of disease transmission [32] by using Global Ordinary Least Squares (OLS), Geographically Weighted Regression (GWR), and multiscale geographically weighted regression MGWR. The researchers studied the involvement degree in solving different problems of key stakeholders ([42], [48]) for assessing critical changes in health care under the influence of health threats ([43], [44]) and identification the socioecological-economic vulnerability parameters of regions for adjusting state and regional programs concerning the mobilization of economic and healthcare systems, [26].

The study of essence of inclusive development as a part of achieving sustainable development goals is in [14], [19]. Consideration of the role of stakeholders in this process of essence is in [6], [20], [29], [30], [38] that allowed to define the goals

of health care development as one of the critical areas ensuring the well-being of individual regions and the country.

## 2.2. Materials and Methods

The article generalizes the level of health care in the country's regions and provide the typology of the parts. This is performed by cluster analysis with the goal to identify issues that need urgent solutions as well as promising areas of development of the health care system. The information base of the study consists of open Internet sources, data from reports of international and national health organizations and organizations in related industries, statistical yearbooks and thematic collections, and sociological surveys.

The selected cluster technique is non-traditional Kohonen's self-organizing maps (Kohonen's network), a type of neural network algorithm. It is a method for fitting multidimensional space design into spaces with a lower dimension. Importantly, similar vectors in the source space appear closely on the resulting map.

The selected clustering method addresses various scientific problems. Here, it is used to stratify regions of Ukraine depending on the level of health care. The dividing multiplicity of the areas into clusters will help to identify internal patterns in groups and understand the informativeness of the socio-economic properties of these areas. As a result, this could enable the development of local and national level health care strategies. The Deductor Studio Academic 5.3 software is employed to create Kohonen's maps. This software has several advantages, such as accessibility to a wide range of users in the field of neural network computing, significant analytical power, and graphical and statistical capabilities with a user-friendly process of interactive research analysis.

## 3 Problem Solution

To conduct the study, the authors have selected input indicators that contain various aspects of health care in the regions: the current state of health, the level of preventive work, coordination of information work (information influence), support for health services, financial aspects considering reforms in the health care system, and the behavior of the population of the region. The following indicators are involved in certain groups (we indicate them together with the sources of information):

### 1. The current state of health:

- average life expectancy after 60 (retirement age), [39], [47];
- the mortality rate in the age group of 35-44 years (based on WHO classification of young people and number of employees, [27]);
- the number of deaths from illnesses of the circulatory system (incidences of cardiovascular disease are the leading cause of death in Ukraine at a four times higher rate compared with EU countries [36], [18]);
- the number of deaths from malignant neoplasms-cancer (Between 2015-2020, cancer followed cardiovascular diseases as the largest cause of death among Ukrainians [54]);
- self-assessment of health at the levels of "good" or better among the population (results of primary research are informative and representative sources of information in health care systems, [41]);

### 2. Level of preventive work:

- vaccination of neonates against tuberculosis, [18];
- percentage of people vaccinated against COVID-19, [52];
- AIDS incidence (timely detection of human immunodeficiency virus (HIV) infection does not always lead to AIDS. Prevention screening helps to early detect HIV and support people living with HIV), [18];

### 3. Provision of medical services:

- number of hospitals, [21], [34];
- ratio of doctors to people, [45];
- population per health worker, [45].

### 4. Financial component:

- payments under the contracts of the Medical Guarantees Program. Since 2020, there have been systemic changes in the medical sector of Ukraine. In particular, the National Health Service provided the new Medical Guarantees Program. According to this program, all medical service providers receive funds under the contract for specific medical services, [2], [50];
- percentage of declarations submitted to primary care physicians, [2].

### 5. Information influence:

- level of trust in Ukrainian television. According to results of all-Ukrainian polls, television remains in the first place among all media, from which the country's residents most often receive information about current events affairs in Ukraine and around the world, [22]. Thus, it is appropriate to use television to disseminate information on various aspects of disease control and prevention and the operations of the national health system. The effectiveness of this information

depends on the level of trust in media in different regions of the country, [33];

- number of Internet users. Currently, the Internet is the second source of information after television. People often search the Internet for information about social events in the health care sphere. The Internet can be used as an effective communication tool for dissemination of information. However, this is conditioned to the proportion of residents with stable access to the Internet in all regions and rural areas, [37];

- count of Ukrainian-language and Russian-language search queries of "disease prevention" according to Google Trends. There is a hypothesis that people's willingness to influence information can be checked by the activity of search queries on disease prevention, [57];

- knowledge about the symptoms of a stroke. In many media sources, the signs of the stroke are called indicative. It claims the success or ineffectiveness of information work among people of all ages, [17].

#### 6. Behavioral component:

- consumption of milk and dairy products. There is a hypothesis that the consumption of healthy foods, such as milk, and dairy products. First, this is considered a personal choice. Second, it is a crucial component of human health, disease prevention and disease control, [4];

- consumption of fruits for example, berries, and grapes, [4];

- consumption of fish and fish products, [4];

- consumption of sugar. This component gauges population health nutrition trends. Research finds show that consumption of sugar replaces the consumption of fruits such as a fresh fruits or dried fruits, [4];

- number of people engaged in physical activities such as sports (this indicates people's lifestyle and personal health care), [11];

- number of smokers, [40];

- population that is obese, [40].

The listed set of indicators differs in dimension and indicators' direction. For some indicators, a higher value is the best; for others – a lower value is the best. We use two formulas to bring all the indicators into a single dimension to facilitate our cluster analysis:

$$M = \frac{K_{max} - K_{ij}}{K_{max} - K_{min}}, \quad (1)$$

where  $K_{max}$ ,  $K_{min}$  – are the maximum and minimum values of indicators, respectively;  $K_{ij}$  – the

value of the  $i$ -th indicator of the  $j$ -th region for the analyzed case.

This formula is used to evaluate indicators whose growth is positive: average life expectancy; self-assessment of health at the levels not lower than "good" among the population of the region; vaccination coverage against tuberculosis; the percentage of people vaccinated against COVID-19; the number of hospitals; the ratio of doctors; payments under the contracts of the Medical Guarantee Program; the percentage of declarations submitted to primary care physicians; level of trust in Ukrainian television; the number of Internet users; count of Ukrainian-language search queries "disease prevention", count of Russian-language search queries "disease prevention"; knowledge about the symptoms of a stroke; consumption of milk and dairy products; consumption of fruits; consumption of fish and fish products; number of people engaged in physical activities.

$$M = \frac{K_{ij} - K_{min}}{K_{max} - K_{min}}, \quad (2)$$

This formula is used to evaluate indicators whose growth has a negative effect. All other indicators not listed above belong to this group.

Table 1 presents the initial values of indicators for the six components of the primary integrated assessment of the health care system in the regions of Ukraine. Table 2 shows the results of data generalization of the rest of the indicators on the information influence and behavioral components. Tables 3-4 present the values of equal indicators after their rationing. The authors didn't consider the Luhansk and Donetsk regions due to missing or incomplete indicators. After preliminary data preparation, an analysis of the level of health care in the regions of Ukraine was performed using Kohonen's self-organized maps.

Table 1. Indicators for integrated assessment of the health care system of the regions of Ukraine (first part)

Region	Average life expectancy at the age of 60, years	The mortality rate of the selected age category, per 100 thousand people of the selected age	The number of deaths from diseases of the circulatory system, per 100 thousand people	The number of deaths from malignant neoplasms, per 100 thousand population	Self-assessment of health at the level not lower than "good", % of respondents	Coverage of vaccination against infectious diseases, %	Percentage of people vaccinated against COVID-19, %	Incidence of ARI, persons per 100 thousand population	The number of hospitalizations, units per 100 thousand population	Ratio of doctors per 10 thousand population	Population per average health worker, persons	Payments under the contracts of the Medical Services Program, UAH billion	The percentage of declarations submitted to primary care physicians, %
Vinnitsia	18,29	760,3	1204,2	191	57	78	14,8	7,9	3,9	45,8	103	1,59	85,1
Volyn	17,84	804,7	917,2	157,5	46	68	12,6	6,9	4,5	35,5	100	0,74	86,2
Dnipropetrovsk	17,66	884,1	1184,8	252	42	87	15,8	28,6	4,5	38,5	115	2,3	83,4
Donetsk	n.d.	n.d.	585,5	117,4	27	91	4,8	13,2	1,9	27,6	n.d.	1,18	35,7
Zhytomyr	17,43	1012,8	1275,1	188,4	28	75	15,3	8,1	1,7	33,8	97	0,9	86,7
Zakarpattia	16,8	374,6	790,7	158,9	25	92	11,4	1,5	1,8	32,1	121	0,76	84,9
Zaporizhzhia	17,9	882,2	1102,8	269,1	34	86	12,6	10,5	4,7	42,2	111	1,23	82,8
Ivano-Frankivsk	18,17	596,9	984,8	181,2	57	90	11,7	3,1	5,7	52,6	95	1	86
Kyiv	16,66	504	1199,8	224,8	40	77	20,2	13,3	4,1	31,7	119	0,95	92,3
Kirovohrad	17,68	863,6	1128	211,1	40	89	13,9	7	5,5	30,6	105	0,88	80,3
Luhansk	n.d.	n.d.	486,8	79,4	49	90	3,9	2,4	1,7	27,6	n.d.	0,42	23,6
Lviv	18,12	846,4	873,4	176,2	42	89	14,8	4,7	5	47,9	99	1	87,4
Mykolaiv	17,99	817,2	1097,8	181,4	43	79	14,2	15,3	4,2	27	132	0,71	77,8
Odesa	18,13	746,9	938,3	209,1	50	86	11,6	11,5	1,7	38,6	120	1,4	76,5
Poltava	17,58	761,1	1248	230,4	42	92	20	8,2	5	43,2	106	0,93	84,8
Rivne	17,67	727,9	954,2	184,2	37	93	11,3	3,7	4,4	38,3	98	0,82	87,5
Sumy	17,89	774,4	1106,6	200,7	50	95	17,1	4,4	1,2	33,1	96	0,85	85,9
Ternopil	18,1	481,9	1107,7	178,7	37	92	13,9	1,8	6,1	47,2	97	0,71	85,3
Kharkiv	17,71	783,5	1141,8	234,9	38	78	14,6	3,9	4,7	42,1	113	1,8	82,4
Kherson	17,52	921,9	999,5	265,3	47	88	15	10,3	3,9	27	118	0,66	82,1
Khmelnytskyi	18,07	825,8	1007,5	200,4	48	95	15,6	3,9	4,6	37,6	100	0,99	88,2
Cherkasy	18,27	777,6	1213,5	208,9	52	94	16,7	10,2	4,6	32,3	103	0,91	84,2
Chernivtsi	17,79	498,1	988,4	179	41	97	12,4	2,9	6	53,4	101	0,69	84,7
Chernihiv	17,68	912,7	1406,3	206	27	77	16,2	11,3	5,1	34	96	0,79	86,1

Table 2. Indicators for integrated assessment of the health care system of the regions of Ukraine (second part)

Region	Level of trust in Ukrainian television, as %	The number of internet subscribers per 1000 population	Popularity of Ukrainian-language and Russian-language search queries "disease prevention", in points	Knowledge about the symptoms of a stroke, % of respondents	Consumption of milk and dairy products per 1 person per year, kg	Consumption of fruits, berries, and greens per 1 person per year, kg	Consumption of fish and fish products per 1 person per year, kg	Sugar consumption, per 1 person per year, kg	The number of people engaged in physical culture and sports, per 1 thousand people	Number of smokers per 1,000 people	Population aged 18 years with obesity, %
Vinnitsia	90,5	0,07	80	58	198,9	82,5	15,4	30,6	202,2	155,5	25,2
Volyn	95	0,06	72	33	206,9	48,3	12,5	31,6	141,7	146,1	26,5
Dnipropetrovsk	63	0,08	54	54	197,5	68,1	1,5	28,5	184,5	238	16,4
Donetsk	57	0,04	76	70	170,4	45,6	12,9	26,5	53	225,7	35,6
Zhytomyr	90,5	0,08	47	31	209	54,6	15	26,8	80,3	166	28,2
Zakarpattia	95	0,06	53	64	230,8	55,8	8	29,4	149,2	190,4	17,9
Zaporizhzhia	78	0,09	57	75	173,4	53,8	13,6	28,8	137,8	221,4	16,8
Ivano-Frankivsk	95	0,3	88	11	276,7	54,7	9	32,5	72,1	113,1	24,4
Kyiv	90,5	0,09	36	49	211,2	81,4	16,8	24	114,1	108,9	19,4
Kirovohrad	90,5	0,07	58	70	213,8	53,5	13,3	32,7	60,8	199,1	28,9
Luhansk	57	0,02	100	50	147,4	45,3	9	29	22,8	81	16,4
Lviv	95	0,1	62	60	215,3	58,5	9,4	30,4	114,5	150,9	12,8
Mykolaiv	78	0,15	45	70	204,3	62,1	13,4	29,4	117,1	137,3	14
Odesa	78	0,47	53	72	185,8	84,3	16	27	280,9	167,2	16
Poltava	83	0,11	45	41	201,1	54,7	12	28,5	87,5	229,2	20,9
Rivne	95	0,05	79	74	191,7	44,8	10,5	28,3	84	160,8	12,5
Sumy	63	0,08	84	15	182,4	45,8	9,5	31	148,9	121,6	14,9
Ternopil	95	0,1	100	21	245,1	35,7	9,6	26,1	41,5	162,8	16,5
Kharkiv	63	0,07	54	54	203,9	55,6	9,2	25	111,3	176,7	14,8
Kherson	78	0,09	73	60	183,9	52,1	14	31,6	213,8	184,3	22,1
Khmelnytskyi	95	0,06	80	49	208,2	64,4	10,5	30	81,2	142,1	17,2
Cherkasy	90,5	0,06	49	21	216,6	62,7	13,9	35	93,1	185,5	19
Chernivtsi	95	0,08	73	47	226,5	70,1	10,5	31,2	118,1	165,2	18
Chernihiv	63	0,08	50	64	210,3	52,9	12,7	39,5	66,3	185,6	24,6

Software-wise, the following options were considered to construct the Kohonen's self-organized maps:

- 1) for all variables, the initial purpose "Inbox" is set. For the variable "Region," the goal is "Information";
- 2) extension 16:12 was chosen as a parameter of the map. It was enough to identify a set of regions' clusters;
- 3) the number of epochs is equal to 500, and the level of error for recognition is less than 0.05;
- 4) to determine the initial weights of neurons, the method "From eigenvectors" was chosen. This method allows to initialize the initial weights of neurons with the values of a subset of the hyperplane through which two eigenvectors of the covariance matrix of input sample values pass, [56];
- 5) as a function of the neighborhood, step one is chosen.

Table 3. Normalized values of health assessment indicators in the regions of Ukraine (first part)

Region	Average life expectancy at the age of 60, years	The mortality rate of the selected age category, per 100 thousand people of the selected age	The number of deaths from diseases of the circulatory system, per 100 thousand people	The number of deaths from malignant neoplasms, per 100 thousand population	Self-assessment of health at the level not lower than "good", % of respondents	Coverage of vaccination against infectious diseases, %	Percentage of people vaccinated against COVID-19, %	Incidence of ARI, persons per 100 thousand population	The number of hospitalizations, units per 100 thousand population	Ratio of doctors per 10 thousand population	Population per average health worker, person	Payments under the contracts of the Medical Services Program, UAH billion	The percentage of declarations submitted to primary care physicians, %
Vinnitsia	0	0,524	0,641	0,266	0,53	0,695	0,626	0,213	0,917	0,295	0,216	0,746	0,419
Volyn	0,276	0,808	0,227	0	0,318	1	0,884	0,18	0,907	0,678	0,135	0,363	0,345
Dnipropetrovsk	0,587	0,758	0,82	0,668	0,32	0,345	0,5	0,903	0,807	0,64	0,541	0	0,534
Zhytomyr	0,518	1	0,688	0,277	0,96	0,828	0,927	0,22	1	0,71	0,064	0,864	0,311
Zakarpattia	0,914	0,375	0	0,913	1	0,372	1	0	0,958	0,807	0,703	0,951	0,432
Zaporizhzhia	0,238	0,754	0,485	1	0,84	0,379	0,884	0,3	0,383	0,424	0,432	0,991	0,574
Ivano-Frankivsk	0,074	0,217	0,269	0,035	0,52	0,242	0,986	0,053	0,187	0,08	0	0,803	0,358
Kyiv	1	0,833	0,634	0,803	0,6	0,68	0	0,383	0,832	0,822	0,649	0,833	0
Kirovohrad	0,374	0,907	0,519	0,48	0,4	0,274	0,716	0,189	0,25	0,864	0,27	1	0,743
Luhansk	0,088	0,120	0,128	0,168	0,32	0,276	0,824	0,107	0,498	0,398	0,108	0,302	0,284
Lviv	0,184	0,652	0,476	0,322	0,32	0,621	0,882	0,457	0,792	1	1	0,882	0,912
Odesa	0,098	0,499	0,218	0,463	0,32	0,379	0,977	1	1	0,523	0,676	0,556	1
Poltava	0,406	0,526	0,705	0,655	0,32	0,172	0,923	0,233	0,458	0,386	0,27	0,856	0,432
Rivne	0,38	0,463	0,263	0,68	0,52	0,138	0,988	0,073	0,708	0,648	0,027	0,907	0,357
Sumy	0,245	0,551	0,827	0,656	0	0,649	0,782	0,097	0,575	0,693	0,077	0,895	0,365
Ternopil	0,117	0	0,491	0,31	0,52	0,272	0,716	0,01	0	0,235	0,094	0,394	0,429
Kharkiv	0,356	0,568	0,544	0,514	0,48	0,855	0,836	0,08	0,583	0,428	0,541	0,339	0,602
Kherson	0,472	0,829	0,325	0,428	0,23	0,31	0,591	0,388	0,917	1	0,632	1	0,625
Khmelnytskyi	0,115	0,648	0,336	0,384	0,68	0,849	0,523	0,147	0,625	0,599	0,135	0,807	0,21
Cherkasy	0,012	0,557	0,955	0,461	0,72	0,209	0,998	0,29	0,629	0,799	0,218	0,858	0,48
Chernivtsi	0,307	0,532	0,322	0,139	0,26	0	0,886	0,047	0,942	0	0,163	0,894	0,448
Chernihiv	0,568	0,812	1	0,426	0,52	0,69	0,435	0,527	0,417	0,735	0,027	0,352	0,351



Table 4. Normalized values of health assessment indicators in the regions of Ukraine (second part)

Region	Level of trust in Ukrainian television, in %	The number of internet subscribers per 1000 population	Feasibility of Ukrainian-language and Russian-language search engines "Yandex" and "Google"	Knowledge about the symptoms of a stroke, % of respondents	Consumption of milk and dairy products, per 1 person per year, kg	Consumption of fruits, berries, and grapes per 1 person per year, kg	Consumption of fish and fish products per 1 person per year, kg	Sugar consumption, per 1 person per year, kg	The number of people engaged in physical culture and sports, per 1 thousand people	Number of smokers per 1000 people	Population aged 25 years with obesity, %
Vinnitsya	0,141	0,952	0,635	0,266	0,739	0,489	0,229	0,426	0,339	0,997	0,223
Volyn	0	0,976	0,458	0,696	0,893	0,877	0,489	0,49	0,562	0,321	0,331
Dnipropetrovsk	1	0,928	0,719	0,328	0,752	0,363	0,432	0,29	0,403	0,908	0,322
Zhytomyr	0,141	0,928	0,626	0,688	0,648	0,732	0,305	0,181	0,698	0,480	0,471
Zakarpattia	0	0,976	0,794	0,484	0,441	0,699	1	0,949	0,55	0,680	0,446
Zaporizhzhia	0,531	0,905	0,672	0	1	0,794	0,354	0,31	0,598	0,936	0,355
Ivano-Frankivsk	0	0,405	0,388	1	0	0,73	0,888	0,548	0,673	0,214	0,157
Kyiv	0,141	0,905	1	0,406	0,822	0	0	0	0,688	0	0,57
Kirovohrad	0,141	0,952	0,656	0,076	0,597	0,762	0,75	0,561	0,929	0,796	0,529
Lviv	0	0,881	0,394	0,234	0,385	0,626	0,841	0,413	0,653	0,36	0,823
Mykolaiv	0,531	0,762	0,959	0,784	0,588	0,527	0,386	0,888	0,684	0,739	0,124
Odesa	0,531	0	0,794	0,047	0,883	0,467	0,091	0,194	0	0,493	0,388
Poltava	1	0,807	0,859	0,531	0,734	0,73	0,546	0,29	0,808	1	0,684
Rivne	0	1	0,328	0,016	0,807	1	0,738	0,277	0,823	0,441	0
Sumy	1	0,928	0,565	0,938	0,898	0,973	0,83	0,492	0,553	0,11	0,388
Ternopil	0	0,881	0	0,844	0,5	0,757	0,828	0,129	1	0,457	0,331
Kharkiv	1	0,952	0,719	0,328	0,891	0,705	0,864	0,095	0,708	0,571	0,19
Kherson	0,531	0,905	0,422	0,284	0,881	0,21	0,318	0,49	0,285	0,633	0,793
Khmelnytskyi	0	0,976	0,315	0,406	0,651	0,801	0,718	0,387	0,814	0,388	0,388
Cherkasy	0,141	0,976	0,797	0,884	0,571	0,511	0,33	0,71	0,784	0,643	0,537
Chernivtsi	0	0,928	0,422	0,436	0,476	0,306	0,718	0,405	0,888	0,477	0,455
Chernihiv	1	0,928	0,781	0,172	0,829	0,779	0,468	1	0,898	0,945	1

It is possible to generate five clusters. The results are presented in Figure 1.

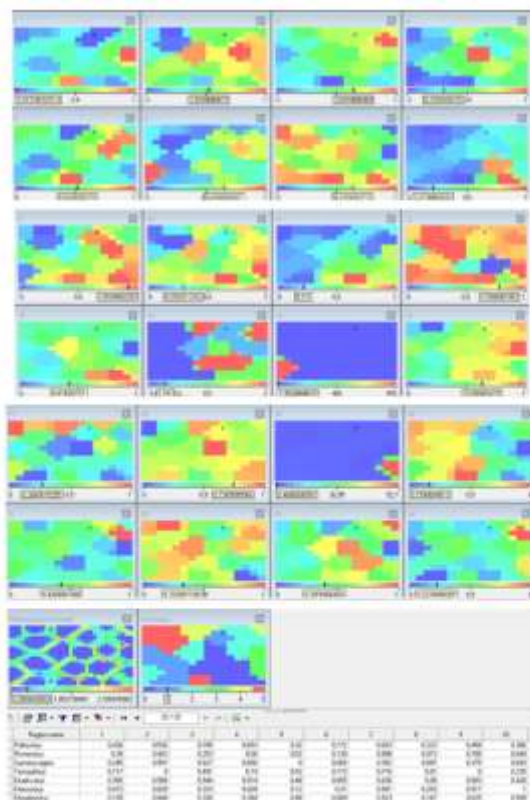


Fig. 1: Kohonen's maps after going through the steps of construction in a software environment

According to the Kohonen's self-organized maps, the regions were divided into five clusters (Table 5).

Table 5. Clusters of regions of Ukraine according to the integrated level of health care

Cluster	Regions included in the cluster	Characteristic
1 (blue and dark blue))	Vinnitsya, Volyn, Zakarpattia, Kirovohrad, Mykolaiv, Kherson, Cherkasy	These are regions whose residents tend to re-evaluate their health compared to the other areas, as a high self-assessment of health quality is not supported by the actual parameters of the health care system. However, the population here is quite physically active. Another advantage of the regions of this cluster is the monitoring of the diet among the people. As for sugar consumption, this cluster leads negatively among others.
2 (azure)	Lviv, Rivne, Khmelnytskyi	The health care system in this group of regions is characterized by a high level of individual indicators related to information work and behavioral components. According to other indicators, the regions of this group are at the average level, significantly not lagging behind other regions.
3 (green)	Dnipropetrovsk, Zaporizhzhia, Odesa, Poltava, Sumy, Kharkiv	These are more financially secure regions in the health care system compared to other territorial units, but this is where their benefits end (excluding the lowest sugar consumption). Regarding all other components, these regions are at an average level and below average.
4 (yellow)	Ivano-Frankivsk, Ternopil, Chernivtsi	It is a group of leading regions in almost all components with a limitation on some indicators. These are regions of the exclusively western part of Ukraine.
5 (red)	Zhytomyr, Kyiv, Chernihiv	It is a group of outsider regions in almost all components, except financial and information, wherein they even lead among other regions.

\* – formulated based on the calculations in Table of Appendix 1

## 4 Discussion

By changing the values of the input indicators, it is possible to assess the feasibility of recommendations for improving the health care system in the regions either individually or in selected groups. For example, after improving one of the components, the researcher could check

changes in the system and modifications that affect the ratio of components. If the indicator improves, then the region can be transferred to another cluster. Conversely, this is considered for the deterioration of the parameters that recognize the successful functioning of the medical care system [58]. Also, it is possible to assess the regions' ability to be moved to a related cluster here, of a different color.

Additionally, it is probable to improve the position of an entire cluster by developing the performance of a particular region in the group. Several indicators tend to change over time for instance, percentage of people vaccinated against COVID-19, percentage of declarations submitted to primary care physicians, advancement of positions of regions. A permanent monitoring of selected indicators helps to identify problematic issues related to regions' development. As a result, it allows adjusting mentioned issues while managing and implementing action strategies. Under optimistic scenarios for improved regional health care systems in Ukraine, it is possible to reduce the number of clusters for example, 3-4 by increasing the values of indicators.

## 5 Conclusion

This paper presents analysis on the further development of the state health care system in the regions of Ukraine. The study identified groups of regions that are leading or underdeveloped in specific healthcare-related components. The significant difference of this study from the existing ones is in applying a complex approach using the complete set of multidirectional indicators relating to the quality of the country's medical system in functioning in a state of risk. Additionally, the study identified areas that require additional attention from the relevant government agencies involved in public health. For the analysis, the Kohonen's self-organized maps were used. This model allowed to visualize clusters of regions and analyze the obtained profiles according to the input indicators. Five clusters were obtained. In each group, regions have a similar level of health care system development. This study could be helpful for the improvement of medium- and long-term programs for the development of health care systems at the national level. Future research will focus on creating recommendations for each cluster. It will allow the development of specific models for improving existing health care systems at the local level.

## References:

- [1] Akkan, C., Karadayi, M. A., Ekinci, Y., Ülengin, F., Uray, N., & Karaosmanoğlu, E., Efficiency analysis of emergency departments in metropolitan areas. *Socio-Economic Planning Sciences*, 69, 2020, doi:10.1016/j.seps.2019.01.001.
- [2] Analytical panels. National Health Service of Ukraine. <https://nszu.gov.ua/e-data/dashboard>.
- [3] Babenko, V., Demyanenko, O., Lyba, V., Feoktystova, O. Assessment the Cost-effectiveness of Information Support for the Business Processes of a Virtual Machine-building Enterprise in the Framework of Industry 4.0. *International Journal of Engineering, Transactions A: Basics*, 34(1), 171-176, 2021. <http://dx.doi.org/10.5829/IJE.2021.34.01A.19>
- [4] Balances and consumption of the main food products by the population of Ukraine. *Statistical yearbook*, State Statistics Service of Ukraine, 2020.
- [5] Bondarenko, A.F., Zakharkina, L.S., Syhyda, L.O., & Saher, L.Yu., The economic and marketing attractiveness of countries: measurement and positioning in terms of economic security. *International Journal of Sustainable Development and Planning*, 15(4), 2020, pp. 439-449.
- [6] Carson, R. Inclusiveness, growth, and political support. *Eastern Economic Journal*, 46(4), 2020, pp. 557-575. doi:10.1057/s41302-020-00171-7.
- [7] Chereshev, V.A.; Verzilin, D.N.; Maksimova, T.G., & Verzilin, S.D., Environmental and socio-economic development of regions: evaluation of regional differentiation. *Economy of Region*, 1, 2013, pp. 33-46.
- [8] Chyzhykov, How changing the behavior of Ukrainians can make the country richer. <https://www.epravda.com.ua/rus/columns/2021/09/16/677896/>.
- [9] Cordes, J., & Castro, M. C., Spatial analysis of COVID-19 clusters and contextual factors in New York city. *Spatial and Spatio-Temporal Epidemiology*, 34, 2020, doi:10.1016/j.sste.2020.100355.
- [10] Coronavirus infection COVID-19. Statistics. <https://news.google.com/covid19/map?hl=ru&mid=%2Fm%2F07t21&gl=UA&ceid=UA%3Aru>.
- [11] Cultural institutions, physical culture and sport of Ukraine. *Statistical yearbook*, State Statistics Service of Ukraine, 2020.

- [12] Denysiaka, O., Ukrainians annually spend about 39 billion in pharmacies, – Lyashko. <https://portal.lviv.ua/news/2021/09/16/ukraintsi-shchorichno-vytrachaiut-v-aptekakh-blyzko-39-mlrd-liashko>.
- [13] Felisberto, E., Teruya Uchimura, L. Yu., Rodrigues Fusaro, E., Ferreira, M. P., d' Ávila Viana, A. L., Evaluation performance in health regions in Brazil. *Revista Brasileira de Saude Materno Infantil*, 17, 2021, pp. 259-270.
- [14] Gupta, J., & Vegelin, C., Sustainable development goals and inclusive development. *International Environmental Agreements: Politics, Law and Economics*, 16(3), 2016, pp. 433-448. doi:10.1007/s10784-016-9323-z.
- [15] Halkos G.E., Nickolaos G.T., A conditional nonparametric analysis for measuring the efficiency of regional public healthcare delivery: An application to Greek prefectures. *Health Policy*, 103 (1), 2011, pp. 73-82.
- [16] Haun, J.N., Patel, N.R., French, D.D. et al., Association between health literacy and medical care costs in an integrated healthcare system: a regional population based study. *BMC Health Services Research*, 15, 2015, pp. 249. <https://doi.org/10.1186/s12913-015-0887-z>.
- [17] Health index. Ukraine. <http://health-index.com.ua/>.
- [18] Health institutions and disease of the population of Ukraine. *Statistical yearbook*. State Statistics Service of Ukraine, 2018.
- [19] Helne, T., Well-being for a better world: The contribution of a radically relational and nature-inclusive conception of well-being to the sustainability transformation. *Sustainability: Science, Practice, and Policy*, 17(1), 2021, pp. 221-231. doi:10.1080/15487733.2021.1930716.
- [20] Herremans, I. M., Nazari, J. A., & Mahmoudian, F. (2016). Stakeholder relationships, engagement, and sustainability reporting. *Journal of Business Ethics*, 138(3), 2016, pp. 417-435. doi:10.1007/s10551-015-2634-0.
- [21] Household self-assessment of their status of health and availability of selected kinds of medical services [http://ukrstat.gov.ua/druk/publicat/Arhiv\\_u/17/Arch\\_snsz\\_zb.htm](http://ukrstat.gov.ua/druk/publicat/Arhiv_u/17/Arch_snsz_zb.htm).
- [22] How have the preferences and interests of Ukrainians in the media changed after the 2019 elections? and the beginning of the COVID-19 pandemic (August 2020) <https://razumkov.org.ua/napriamky/sotsiologic-hni-doslidzhennia/yak-zminylys-upodobannia-ta-interesy-ukraintsiiv-do-zasobiv-masovoi-informatsii-pislia-vyboriv-2019r-ta-pochatku-pandemii-covid19-serpen-2020r>.
- [23] Ignatyevs, S., Diegtiar, O.A., Osypenko, K.V., Gaponiuk, O.I., Omelchenko, V.Ya., & Cherkasov, A.V., Engagement of regional stakeholders in territory marketing of Latvian regions. *Journal of Advanced Research in Law and Economics*, 9(6), 2018, pp. 1972-1985.
- [24] Kadar, B., Reicher, R. Zs. Innovations in health care management: the effect of the pandemic on the labour market change. *Marketing and Management of Innovations*, 4, 2020, pp. 120-130. <http://doi.org/10.21272/mmi.2020.4-09>.
- [25] Koibichuk, V., Jakubowska, A., Drozd, S., & Sydorenko, A., An overview of the elemental and functional content of the health indicators system as an economic category. *Health Economics and Management Review*, 2(2), 2021, pp. 8-14. <https://doi.org/10.21272/hem.2021.2-01>.
- [26] Kuzmenko, O., Vasylieva, T., Vojtovič, S., Chygryn, O., Snieška, V., Why do regions differ in vulnerability to covid-19? spatial nonlinear modeling of social and economic patterns. *Economics and Sociology*, 13(4), 2020, pp. 318-340. doi:10.14254/2071-789X.2020/13-4/20.
- [27] Labor force by sex, type of area and age groups [http://www.ukrstat.gov.ua/operativ/operativ2017/rp/eans/eans\\_u/arch\\_eansmv\\_u.htm](http://www.ukrstat.gov.ua/operativ/operativ2017/rp/eans/eans_u/arch_eansmv_u.htm).
- [28] Letunovska, N., Saher, L., Vasylieva, T., & Lieonov, S. Dependence of public health on energy consumption: a cross-regional analysis. *1st Conference on Traditional and Renewable Energy Sources: Perspective and Paradigms for the 21st Century*, Vol. 250, 04014 <https://doi.org/10.1051/e3sconf/202125004014>
- [29] Letunovska, N., Lyuolyov, O., Pimonenko, T., Aleksandrov V. Environmental management and social marketing: a bibliometric analysis. *E3S Conferences*, 234, 00008. DOI: 10.1051/e3sconf/202123400008.
- [30] Lyulyov, O., Vakulenko, I., Pimonenko, T., Kwilinski, A., Dzwigol, H., Dzwigol-Barosz, M., Comprehensive assessment of smart grids: Is there a universal approach? *Energies*, 14(12), 2021, doi:10.3390/en14123497.
- [31] Malyarets, L. M., Iastremska, O. M., Herashchenko, I. M., Iastremska, O. O., Babenko, V. O., Optimization of indicators for management of enterprise: Finance,



- production, marketing, personnel, *Estudios De Economia Aplicada*, 38(4), 2020. <http://dx.doi.org/10.25115/eea.v38i4.4028>
- [32] Mansour, S., Al Kindi, A., Al-Said, A., Al-Said, A., Atkinson, P., Sociodemographic determinants of COVID-19 incidence rates in Oman: Geospatial modelling using multiscale geographically weighted regression (MGWR), *Sustainable Cities and Society*, 65, 2021, doi:10.1016/j.scs.2020.102627.
- [33] Media and trust in Ukrainian and Russian media <http://kiis.com.ua/?lang=ukr&cat=reports&id=425&page=1>.
- [34] Mezentseva N.I., Batychenko, S.P., Mezentsev, K.V. *Morbidity and population health in Ukraine: socio-geographical dimension*. Kyiv: DP "Print Servis", 2018.
- [35] Molotok, I. Does fiscal decentralization influence on management efficiency of country innovative development? *Marketing and Management of Innovations*, 1, 2020, pp. 54-62. <http://doi.org/10.21272/mmi.2020.1-04>.
- [36] Not only alcohol and cigarettes: the Ministry of Health named the causes of a record number of heart diseases in Ukraine <https://www.ukrinform.ua/rubric-society/3269868-ne-lise-alkogol-i-sigareti-u-moz-nazvali-pricini-rekordnoi-kilkosti-hvorob-serca-v-ukraini.html>.
- [37] Number of Internet users by regions. [http://www.ukrstat.gov.ua/operativ/operativ2019/zv/zv\\_reg/kaI\\_reg/kaI\\_reg0419\\_u.htm](http://www.ukrstat.gov.ua/operativ/operativ2019/zv/zv_reg/kaI_reg/kaI_reg0419_u.htm).
- [38] Panda, P., Chakraborty, A., Dror, D. M., Bedi, A. S., Enrolment in community-based health insurance schemes in rural bihar and uttar pradesh, India, *Health Policy and Planning*, 29(8), 2014, pp. 960-974. doi:10.1093/heapol/czt077.
- [39] Population of Ukraine. *Demographic yearbook*. State Statistics Service of Ukraine, 2020.
- [40] Population's self-perceived of health status and availability of selected types of medical aid. Kyiv. [http://ukrstat.gov.ua/druk/publicat/kat\\_u/2021/zb/03/zb\\_snsz\\_20.pdf](http://ukrstat.gov.ua/druk/publicat/kat_u/2021/zb/03/zb_snsz_20.pdf).
- [41] Rudenko, L.A., Smiianov, V.A., Smiianova, O.I., Basic principles of behavioral economics and prospects for their application in the public system, *Wladomosci lekarskie*, 73 (9 cz 2), 2020, pp. 2026-2030.
- [42] Sharma, G. D., Talan, G., Srivastava, M., Yadav, A., & Chopra, R., A qualitative enquiry into strategic and operational responses to covid-19 challenges in South Asia, *Journal of Public Affairs*, 20(4), 2020, doi:10.1002/pa.2195.
- [43] Smiianov, V. A., Lyulyov, O. V., Pimonenko, T. V., Andrushchenko, T. A., Sova, S., Grechkovskaya, N. V., The impact of the pandemic lockdown on air pollution, health and economic growth: system dynamics analysis, *Wiadomosci Lekarskie*, 73(11), 2020, pp. 2332-2338.
- [44] Smiianov, V. A., Vasilyeva, T. A., Chygryn, O. Y., Rubanov, P. M., Mayboroda, T. M., Socio-economic patterns of labor market functioning in the public health: challenges connected with Covid-19, *Wiadomosci Lekarskie*, 73(10), 2020, pp. 2181-2187.
- [45] State Statistics Yearbook (2020). State Statistics Service of Ukraine. Kyiv.
- [46] Stefko, R., Gavurova, B., Rigelsky, M., & Ivankova, V., Evaluation of selected indicators of patient satisfaction and economic indices in oecd country, *Economics and Sociology*, 12(4), 2019, pp. 149-165. doi:10.14254/2071-789X.2019/12-4/9.
- [47] Tables of births, deaths and average life expectancy. [http://database.ukrcensus.gov.ua/PXWEB2007/ukr/publ\\_new1/2021/zb\\_tabl\\_nar\\_2020.pdf](http://database.ukrcensus.gov.ua/PXWEB2007/ukr/publ_new1/2021/zb_tabl_nar_2020.pdf).
- [48] Tama, E., Molyneux, S., Waweru, E., Tsoba, B., Chuma, J., Barasa, E., Examining the implementation of the free maternity services policy in Kenya: A mixed methods process evaluation, *International Journal of Health Policy and Management*, 7(7), 2018, 603-613. doi:10.15171/ijhpm.2017.135.
- [49] Teletov, A., Letunovska, N., Melnyk, Yu., Four-vector efficiency of infrastructure in the system of providing regional socially significant needs taking into account the concept of marketing of changes, *Bioscience Biotechnology Research Communications*, 12(3), 2019, pp. 637-645.
- [50] The 2021 Medical Guarantees Program has started: the list of free medical services has been expanded and detailed, <https://nszu.gov.ua/novini/startuvala-programa-medichnih-garantij-2021-perelik-bezoplat-516>.
- [51] Uchimura, Liza Yurie Teruya et al., Evaluation performance in health regions in Brazil, *Revista Brasileira de Saúde Materno Infantil*, 17 (1), 2017, pp. 259-270. <https://doi.org/10.1590/1806-9304201700S100012>.
- [52] Vaccination map: the situation in the regions of Ukraine. <https://www.slovoidilo.ua/2021/08/30/novyna/>

suspilstvo/karta-vakcynacziyi-sytuacziya-oblastyax-ukrayiny-30-serpnya.

- [53] Vainieri, M., Vola, F., Soriano Gomez, G., Nuti, S., How to set challenging goals and conduct fair evaluation in regional public health systems. Insights from Valencia and Tuscany Regions, *Health Policy*, 120 (11), 2016, pp. 1270-1278. <https://doi.org/10.1016/j.healthpol.2016.09.011>
- [54] What diseases were the cause of death of Ukrainians in 2015-2020. <https://slovoidilo.ua/2021/02/16/infografika/obshhestvo/kakie-bolezni-stanovilis-prichinoj-smerti-ukraincev-2015-2020-godax>.
- [55] World Development Report. Investing in Health. New York: Oxford University Press. <https://openknowledge.worldbank.org/handle/10986/5976>
- [56] Yarovenko, H.M. (2020). Use of Kohonen maps to analyze the information security level of countries taking into account their development. *Economic Space*, 157, 118-124. <https://doi.org/10.32782/2224-6282/157-21>.
- [57] Zaporozhets, E., Babenko, V., Gaponova, E., Nehrey, M., Ryzhikova, N., Life Expectancy of Population of the Country: The Role of Health Services Effectiveness, *Research in World Economy*, 10(4), 2019, pp. 86-91. <https://doi.org/10.5430/rwe.v10n4p86>.
- [58] Pasko O., Chen F., Ryzhikova N., Birchenko N. Corporate Governance Attributes and Accounting Conservatism: Evidence from China. *Studies in Business and Economics*. Volume 16 (2021) - Issue 3 (December 2021). pp. 173–189. Published Online: 24 Jan 2022. <https://doi.org/10.2478/sbe-2021-0053>

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#### **Conflict of Interest**

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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#### **Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)**

Nataliia Letunovska has designed the methodology.  
Liudmyla Saher has created model.  
Liubov Syhyda was responsible for the statistical data.  
Alona Yevdokymova has compiled the literature review.

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This research was conducted within the theme "Economic and mathematical modeling and forecasting, development of methodological and

Appendix 1. Average values of indicators in clusters

Indicator	1st cluster	2nd cluster	3rd cluster	4th cluster	5th cluster
Average life expectancy at the age of 60, years	17,77	17,99	17,81	18,02 <sup>1</sup>	17,26 <sup>2</sup>
Mortality rate in the age category of 35-44 years, per 100 thousand people of the appropriate age	702,9	733,4	805,4	526	949,8
The number of deaths from diseases of the circulatory system, per 100 thousand people	1053	945,1	1133,2	1023,6	1290,4
The number of deaths from malignant neoplasms per 100 thousand population	189,4	180,3	231	171	206,1
Self-assessment of health at the levels not lower than "good" , % of respondents	58,4	42,3	42,7	38,3	31
Coverage of vaccination against tuberculosis in newborns, %	84	92,3	87,3	93	75,7
Percentage of people vaccinated against COVID-19, %	14,1	14,2	15,3	12,7	17,2
Incidence of AIDS, persons per 10 thousand population	10	4,8	14,5	2,6	10,9
The number of hospitals , units per 100 thousand population	4,3	4,7	4,6	5,9	4,3
Ratio of doctors per 10 thousand population	32,9	40,6	39,8	51,1	33,1
Population per average health worker, persons	111,7	98,3	110,3	97,7	104
Payments under the contracts of the Medical Guarantee Program, UAH billion	0,8	1,21	1,42	0,8	0,88
The percentage of declarations submitted to primary care physicians, %	83	87,7	82,7	85,3	88
Level of trust in Ukrainian television, in %	88,2	95	68	95	81,3
The number of Internet subscribers per 1000 population	0,08	0,07	0,15	0,16	0,08
Popularity of search queries "disease prevention", in points	58,6	73,7	54,5	87	44,3
Knowledge about the symptoms of a stroke, % of respondents	50,9	61	51,8	26,3	48
Consumption of milk and dairy products per 1 person per year, kg	207,9	205,1	164,8	252,5	210,2
Consumption of fruits, berries, and grapes per 1 person per year, kg	57	55,9	57,1	59,5	63
Consumption of fish and fish products per 1 person per year, kg	13	10,1	12,2	9,7	14,8
Sugar consumption, per 1 person per year, kg	31,5	29,6	28,1	29,9	30,1
The number of people engaged in physical culture and sports, per 1 thousand people	259	96,6	158,5	76,6	86,9
Number of smokers per 1,000 people	179,8	151,3	189	153,7	152,8
Population with obesity,%	17,7	14,2	16,6	16,3	20,7

1 – the best value of the indicator among other groups of regions;

2 – the worst value of the indicator among other regions