

## ORIGINAL ARTICLE

# BEHAVIORAL, SOCIAL, ECONOMIC AND LEGAL DIMENSION OF THE PUBLIC HEALTH SYSTEM OF UKRAINE: DESCRIPTIVE, CANONICAL AND FACTOR ANALYSIS

DOI: 10.36740/WLek202112102

**Serhiy V. Lyeonov, Olha V. Kuzmenko, Vitaliia V. Koibichuk, Pavlo M. Rubanov, Vladyslav A. Smiianov**

SUMY STATE UNIVERSITY, SUMY, UKRAINE

**ABSTRACT**

**The aim** is to develop an integrated indicator that characterizes the degree of satisfaction of the population with medical services.

**Materials and methods:** integrated indicator was formed in terms of three stages for 24 regions of Ukraine and Kyiv. At the first stage, the expediency of using five influential groups of input indicators (behavioral, physical, economic, social and legal orientation) with a total of 59 features using descriptive modeling is substantiated. At the second stage, canonical correlation models were developed for the most correlated complex features, which form an indicator of the population satisfaction degree with the received medical services: physical condition features, social and behavioral orientation qualities. The third stage of factor modeling (using orthogonal transformation methods Varimax, Quartimax and Equimax) allowed identifying the five most influential factors for the formation of an integrated indicator and the development of econometric models for the healthcare state.

**Results:** the necessity to improve the medical service quality and innovation in healthcare reform is confirmed since there were no regions where citizens were fully satisfied with the medical service level. The population of most Ukrainian regions (76% of regions), including Kyiv, is rather dissatisfied with the received medical services.

**Conclusions:** the study results provide ample opportunities for healthcare workers, medical professionals, and public authorities to ensure quality and timely adjustment of existing rules and regulations within the Health Care Reform, improving the level of public satisfaction with the received medical services, and the immediate improvement of the nation's health.

**KEY WORDS:** healthcare, level of satisfaction with medical services, physical condition, socio-behavioral aspect, rating indicator

Wiad Lek. 2021;74(12):3126-3134

**INTRODUCTION**

The life and health of the population is the key to the prosperity of the economy and a force that determines the ability to compete on the world stage [1, 2]. The Cabinet of Ministers of Ukraine approved the Concept of Reform in 2016, and the Ministry of Health has developed an action plan for its implementation. The first stage began on January 1, 2018 – the state must pay for medical services under the medical guarantee program. One of the most well-known areas of reform is introducing «Affordable Medicines» program to reduce the financial burden on patients with cardiovascular disease, bronchial asthma, type II diabetes. Since April 2019, the National Health Service has reimbursed medicines. The total list of medicines includes 264 units, 85 of which can be obtained by prescription free of charge, and others – with a small surcharge. As part of the second stage of medical reform, which began in April 2020, the rules for concluding contracts of patients with family doctors were created, and an electronic user system was created to apply for a doctor's appointment and obtain test results.

Today, there are many questions about the transparency of healthcare [3, 4]. The medical reform that has been actively implemented over the last three years needs analysis and

evaluation [5]. For example, during one year, the procedure for reimbursement of drugs changed three times: first, clinics were involved, then local governments, then the National Health Service of Ukraine. Accordingly, citizens could not receive their legal free medicines during the changes. Two separate big problems are the quality of medicines and the level of medical staff professionalism [6, 7].

**THE AIM**

The aim is to carry out theoretical analysis and qualitative and quantitative evaluation of indicators in terms of physical, social, behavioral, economic and legal factors that determine the population satisfaction degree with medical services, based on multidimensional statistical modeling.

**MATERIALS AND METHODS**

The use of factor analysis tools was first discovered in 1978 in Hightower W. L. [8] to combine indicators into a single index in the health index development. When calculating Socio-Economic Status Indices, the principal components method was used as a standard construction method, where the calculated index was determined by

the projection on the first major component [9]. Masters K. S., Wallston K. A. [10] Masters K. S., Wallston K. A. explored the advantages of canonical correlation using the Multidimensional Health Locus of Control (MHLC) scales concerning measures of coping, affect, and values. In the study [11], the authors use canonical correlation tools to explore the relationship between functional fitness (FF) and health-related quality of life (HRQoL) in older adults, and to identify the key subdimensions of FF and HRQoL influencing their overall relationship. Innovative approaches to healthcare management are presented in [12, 13]. The work of scientists Hinrichs, G., Bundtzen, H. [14], who study the global pandemic impact on the personal insurance sale, is of great interest. Scientists Kascha, M., Palienko, M., Marchenko, R. [15] conduct a prognostic analysis of the Covid-19 development based on seasonal fluctuations. A detailed bibliometric analysis of the legal aspects of health care is presented in [16, 17].

The research methodology is based on the indices collected by the Kyiv International Institute of Sociology during June-August 2019 for the sociological survey «Health Index. Ukraine». The purpose of this study is to determine the actual level of Ukrainian citizens' satisfaction with medical care [18]. Healthcare reform in Ukraine was launched in 2016, but its full implementation, the transition to a new level of health services began in 2018. The main goal of the reform is to create a patient-oriented system capable of providing medical care for all citizens in Ukraine at the level of developed European countries. Thus, the Law of Ukraine «On State Financial Guarantees of Medical Care» [19] introduced fundamental changes in the healthcare system: the state will finance the provided medical care, not beds. The patient has the right to choose the medical institution and the doctor. His or her experience and satisfaction with the received medical service plays a crucial role in choosing a medical institution. Therefore, the study of the population satisfaction with the received medical services as a complex integrated index, undoubtedly determined by the factors of economic, social, legal environment, is an important task today.

## RESULTS AND DISCUSSION

It is proposed to use five complex features that correspond to physical, social, behavioral, economic and legal indices to form models that determine the impact of factors on the indicator of the population satisfaction in Ukraine with the medical service quality in all regions. The factor of human physical data is based on the values of body mass indices (BMI, (kg/m<sup>2</sup>)): K1\_1 – the share of people with a BMI less than 18.5; K1\_2 – the share of people whose BMI exceeds 25; K1\_3 – the share of people with BMI >= 30. The coefficient K1\_1 indicates insufficient body weight. Given the determination of the disease progression probability, it corresponds to a low level of cardiovascular, increased – bronchopulmonary, low levels of endocrine diseases. The value of the coefficient K1\_2 corresponds to the body mass within normal limits. Accordingly, the probability

of disease among people with this indicator is low. The coefficient K1\_3 indicates obesity, which entails an average level of cardiovascular disease probability, a low level – bronchopulmonary, average level of endocrine diseases.

Indicators that form the social factor are: K2 – knowledge of 3 symptoms of stroke; K3 – % of patients who were examined by a dentist, K4 – % of men who were examined by a urologist, K5 – % of women who were examined by a gynecologist, K6 – % of women who gave a smear for cytological examination, K7 – % of women who underwent mammography, K8 – % of patients who underwent fluorography, K9 – % of patients who underwent cardiogram for prophylactic purposes, K10 – % of patients who underwent at least two of these examinations.

Behavioral indices suggest the use of indicator K11 – have children under 18 and know about their health; indices that answer the question «What do you do when you get sick.» These are indicators: K12 – self-treated folk remedies without drugs, K13 – self-treated with drugs, K14 – seek advice from a pharmacist / pharmacist at the pharmacy, K15 – call an ambulance, K16 – see a family doctor / district therapist, K17 – seek to a specialty physician, K18 – turn to a hospital specialist, K19 – turn to specialists in alternative medicine, K20 – consult with doctors who are their relatives and friends, K21 – search for treatment of similar symptoms, diseases in the Internet, K22 – succeed to other actions, K23 – do nothing, K24 – depends on the symptoms. Behavioral indices also include indicators that describe the reasons for not seeing a doctor: K25 – too expensive (services, drugs, transport), K26 – do not trust medical staff, their qualifications, K27 – bad attitude of staff, rudeness, K28 – long queues in hospitals, K29 – no transport connection, K30 – know how to treat, from previous experience, K31 – do not know who to turn to, K32 – expected the disease to pass on its own, not very worried, K33 – other reasons. Behavioral indices that characterize the most important aspects of medical care: K34 – effectiveness of treatment, K35 – courtesy of doctors in communicating with patients and their relatives, K36 – clarity of medical explanations to patients, K37 – territorial convenience of the medical institution, K38 – sanitation conditions under which medical care is provided, K39 – work schedule, K40 – possibility to receive the necessary diagnostic examination free of charge, K41 – clarity and transparency of payment for care, K42 – observance of hygiene examinations and procedures by medical staff, K43 – availability of necessary equipment.

It is proposed to use the following indices that form the economic factor: K44 – the share of people who had experience in obtaining drugs in the program «Affordable Medicines», K45 – the share of people who paid to a charity fund or other organization, K46 – the share of people who paid in the pay-office according to official rules, K47 – share of persons who paid informally, K48 – share of persons who paid for medical supplies, K49 – share of persons who refused ambulatory care due to lack of funds.

The main problems in the healthcare that determine the indices of legal orientation are described by coefficients: K50 – corruption in the Ministry of Health, K51 – informal

payments to doctors - the so-called «fees», «thanks», K52 – negligence of medical staff, K53 – lack of modern equipment, K54 – lack of professionalism, incompetence of medical staff, K55 – high cost of medicines, K56 – high cost of treatment, K57 – unsatisfactory sanitary and hygienic condition of institutions, K58 – lack of medical staff, K59 – inconvenient schedule, long queues.

All indicators are relative, have a single scale of measurement, calculated based on a nationally representative sociological survey and characterize the share of respondents according to the relevant criterion that forms the content of the indicator. The adequacy of the feature space determines the correctness of economic and mathematical models based on which they are developed.

We have a significant dimension of the input data set, which affects the formation of the population satisfaction indicator with healthcare. Therefore, we use aggregate summary indices that characterize the social and economic-legal factor aspects. Secondly, we use the median values for behavioral indicators to reduce the multidimensionality of the feature space. Before modeling, it is necessary to describe each elementary feature using the descriptive statistics tools statistically. The use of descriptive statistics tools allows to obtain new information, quickly understand, systematize and comprehensively evaluate it in the form of tables, graphs, numbers and explore trends in the value change of the feature considering the real conditions of their formation.

The first modeling stage will be a descriptive analysis of the input data set in the applied statistical package Statgraphics Centurion. According to the recommendations of descriptive statistics from the system of indicators, one should first exclude those indicators, the variation coefficient of which is less than 5%. There were no such indicators in the input data set. It is recommended to use indicators in which the values of the coefficients Standard skewness and Standard kurtosis go beyond the interval (-2; 2) because these statistics outside the range of -2 to +2 indicate significant departures from normality, which would tend to invalidate any statistical test regarding the standard deviation.

In the second stage of the study, a canonical analysis revealed the degree and significance of the relationship between complex features of physical, social, behavioral, economic, and legal orientation. It is crucial for forming the Ukrainian population satisfaction index for each region and Kyiv with the quality of received medical services. In addition, this procedure enables to reduce the multidimensional feature space to a system of pairs of the most correlated features, to obtain a statistical assessment of their significance and a statistical evaluation of the relationship between elementary features. From a mathematical point of view, the problem of canonical analysis is aimed at identifying the correlation between the weighted sums, i.e., between linear combinations, called canonical variables, from each set of quantities corresponding to the explanatory and resultant features.

The canonical analysis to establish the relationship between the complex features of the Ukrainian citizens' satisfaction with medical care was implemented in the Statgraphics Centurion package using the Describe / Multivariate Methods / Canonical Correlations.

This procedure allowed to obtain standardized source data and present them in table I, with  $p \geq q$ , where  $p$  – number of features of the 1<sup>st</sup> equation of the system,  $q$  – number of features of the 2<sup>nd</sup> equation of the system. Analysis of the relationship between the canonical variables U and V is represented by the formula (1):

$$\begin{cases} U = a_1y_1 + a_2y_2 + \dots + a_p y_p, \\ V = b_1x_1 + b_2x_2 + \dots + b_q x_q. \end{cases} \quad (1)$$

Weights of coefficients  $a_i, (i = \overline{1, p})$  and  $b_j, (j = \overline{1, q})$  are calculated when solving a problem on its values. Depending on what values the coefficients  $a_i, b_j$  acquire, the values of the canonical variables and the canonical correlation coefficient  $r$  will change. It determines the relationship between the two sets of variables and the relationship density between the canonical variables:

$$r = \frac{\text{cov}(U, V)}{\sqrt{\text{var}(U) \cdot \text{var}(V)}}. \quad (2)$$

The canonical analysis was performed for five pairs of complex features regarding the formation of the satisfaction indicator with the medical service quality. Table II shows the statistical description of the canonical correlations between social orientation indices and the behavioral component. A group of behavioral indices used their median values regarding decision-making in the disease, the reasons for not seeing a doctor and the most important aspects of ambulatory care. The median values are used because they are not sensitive to emissions.

The result of the canonical correlation procedure includes three pairs of linear combinations based on variables  $K_2 - K_{10}, Me1, Me2, Me3$ .

However, the statistically significant is a relationship ( $P - \text{Value} \leq 5\%$ ) of the first pair, the correlation coefficient between them  $r_{U_1, V_1} = 0,895126$ . The model of canonical correlations between the component of social and behavioral orientation is as follows:

$$\begin{cases} U_1 = 0,476K_2 - 0,163K_3 + 0,977K_4 + 0,513K_5 + 0,496K_6 - \\ - 0,009K_7 - 1,096K_8 - 1,641K_9 + 0,404K_{10} \\ V_1 = 0,859Me1 + 0,333Me2 + 0,135Me3 \end{cases} \quad (3)$$

The same calculations of the canonical correlations were performed for all pairs of the complex features regarding the health level formation. The correlation models between social and legal indices and between legal and physical indices became statistically significant. The correlation coefficient between features of legal and physical orientation is  $r_{U_1, V_1} = 0,919208$ , the model is represented by formula (4):

**Table I.** Formation of initial data in canonical analysis

Number of observations	The first system of features				The second system of features			
	$Y_1$	$Y_2$	...	$Y_p$	$X_1$	$X_2$	...	$X_q$
1	$y_{11}$	$y_{12}$	...	$y_{1p}$	$x_{11}$	$x_{12}$	...	$x_{1q}$
...	...	...	...	...	...	...	...	...
N	$y_{n1}$	$y_{n2}$	...	$y_{np}$	$x_{n1}$	$x_{n2}$	...	$x_{nq}$

Source: developed by the authors with Statgraphic Centurion package

**Table II.** Statistical description of canonical correlations between components of social and behavioral orientation

Number	Eigenvalue	Canonical Correlation	Wilks Lambda	Chi-Square	D.F.	P-Value
1	0,801251	0,895126	0,0998434	40,3227	27	0,0478
2	0,361698	0,601413	0,502358	12,0477	16	0,7407
3	0,212978	0,461495	0,787022	4,19122	7	0,7575

Source: developed by the authors with Statgraphic Centurion package

$$\begin{cases} U_1 = -0,084K_{50} - 0,842K_{51} + 0,960K_{52} + 0,571K_{53} + 0,264K_{54} - \\ - 0,809K_{55} + 1,148K_{56} + 0,220K_{57} - 0,303K_{58} + 0,408K_{59} \\ V_1 = 0,970K_{1-1} + 0,250K_{1-2} - 0,130K_{1-3} \end{cases} \quad (4)$$

The correlation coefficient between features of the social and legal orientation is  $r_{U_1V_1} = 0,970474$ , the model is represented by formula (5):

$$\begin{cases} U_1 = -0,385K_{50} + 0,384K_{51} + 0,510K_{52} + 0,188K_{53} - 0,024K_{54} - \\ - 0,370K_{55} + 0,537K_{56} + 0,059K_{57} - 0,346K_{58} + 0,235K_{59} \\ V_1 = -0,434K_2 - 1,200K_3 + 0,410K_4 + 1,233K_5 - 0,901K_6 + \\ + 0,028K_7 - 2,825K_8 - 0,035K_9 + 3,073K_{10} \end{cases} \quad (5)$$

During the third stage, we perform the factor analysis using Principal Components Analysis and various methods of the factor load rotation to analyze the input data, define the people's satisfaction regarding medical service level by regions, and select representative features for further modeling of the regression models for healthcare state description. The factor analysis was carried out in the program Statgraphics Centurion using methods Varimax, Quartimax and Equimax based on the input data, presented in Table III.

Table III demonstrates that Me1 – median values for behavioral indices  $K_{12} - K_{24}$ ; Me2 – median values for behavioral indices  $K_{25} - K_{33}$ ; Me3 – median values for behavioral indices  $K_{34} - K_{43}$ ;  $I_s$  – integral index of the social indices  $K_2 - K_{10}$ , defined based on the weighted geometric mean (6),  $I_p$  – integral index of the economic and legal indices  $K_{50} - K_{59}$  (7).

This convolution procedure allows calculating the average rate of dynamics [20]:

$$I_s = \sum_{j=1}^{n_j} \sqrt[9]{\prod_{j=1}^9 K_j^{n_j}}, \quad (6)$$

where  $I_s$  – generalized rating assessment of the social indicators;  $\sum n_j$  – the sum of the frequencies;  $K_j$  – the studied indicator ( $j = \overline{1,9}$ );  $n_j$  – the frequency of the studied value (variant) for the j-indicator.

$$I_p = \sum_{j=1}^{n_j} \sqrt[10]{\prod_{j=1}^{10} K_j^{n_j}}, \quad (7)$$

where  $I_p$  – generalized rating assessment of the legal indicators;  $\sum n_j$  – the sum of the frequencies;  $K_j$  – the studied indicator ( $j = \overline{1,10}$ );  $n_j$  – the frequency of the studied value (variant) for the j-indicator.

Describe/Multivariate methods/Factor Analysis performs the Principal Components Analysis in the program Statgraphics Centurion. We use rotation of axes by methods Varimax, Quartimax, Equimax to obtain factor analysis results, which can be interpreted.

When using the orthogonal transformation methods Varimax, Quartimax, Equimax, authors received five most influential factors of the Ukrainans' health formation with own numbers  $\lambda_i \geq 1$  (Kaiser's rule) [21]: to remain those factors, own numbers of which are more than 1. These are first five factors F1, F2, F3, F4 and F5 with own numbers  $\lambda_1 = 4,582$ ,  $\lambda_2 = 2,453$ ,  $\lambda_3 = 1,912$ ,  $\lambda_4 = 1,522$ ,  $\lambda_5 = 1,342$ . Each factor has its main component, which maximally loads variables, included to it. Together main components explain 73,83% of the output data variability. The 1<sup>st</sup> factor has the largest contribution, which explains 28,64% of the whole variability. The dispersion rate is lower for the second factor – 15,33%, for the third factor – 11,95%, for the fourth factor – 9,52%, for the fifth – 8,39%. The final factor loads are given in Table IV using orthogonal transformation of the output matrix by VARIMAX method.



**Table III.** Initial data array to investigate models of the citizens' health level

Region	K1_1	K1_2	K1_3	K2	Is	K11	Me1	Me2	Me3	K44	K45	K46	K47	K48	K49	Ip
Vinnitsya	0,022	0,562	0,197	0,071	0,354	0,852	0,017	0,017	0,191	0,178	0,227	0,191	0,113	0,568	0,297	0,275
Volyn	0,019	0,548	0,171	0,067	0,312	0,810	0,027	0,095	0,155	0,221	0,074	0,099	0,115	0,365	0,223	0,267
Dnipropetrovsk	0,045	0,549	0,187	0,153	0,448	0,849	0,032	0,161	0,165	0,208	0,111	0,117	0,058	0,367	0,346	0,275
Donetsk	0,021	0,598	0,234	0,164	0,332	0,824	0,013	0,076	0,140	0,256	0,024	0,040	0,048	0,255	0,181	0,218
Zhytomyr	0,023	0,489	0,204	0,056	0,361	0,835	0,012	0,116	0,198	0,186	0,253	0,116	0,072	0,412	0,267	0,268
Zakarpattia	0,042	0,554	0,154	0,043	0,203	0,747	0,042	0,190	0,180	0,278	0,141	0,114	0,124	0,206	0,222	0,298
Zaporizhzhya	0,031	0,634	0,225	0,108	0,307	0,921	0,015	0,089	0,222	0,307	0,013	0,052	0,003	0,242	0,444	0,294
Ivano-Frankivsk	0,033	0,516	0,230	0,003	0,251	0,837	0,064	0,062	0,243	0,240	0,131	0,164	0,195	0,327	0,212	0,280
Kyiv	0,019	0,543	0,229	0,214	0,318	0,896	0,024	0,094	0,170	0,107	0,098	0,079	0,080	0,568	0,386	0,277
Kirovohrad	0,007	0,528	0,155	0,012	0,077	0,925	0,039	0,144	0,134	0,246	0,113	0,091	0,010	0,526	0,052	0,258
Luhansk	0,009	0,489	0,119	0,178	0,401	0,917	0,035	0,060	0,217	0,258	0,027	0,113	0,007	0,480	0,337	0,261
Lviv	0,046	0,507	0,125	0,092	0,343	0,884	0,028	0,084	0,192	0,178	0,180	0,112	0,302	0,611	0,420	0,315
Mykolaiv	0,022	0,525	0,202	0,025	0,218	0,973	0,035	0,080	0,179	0,144	0,097	0,063	0,053	0,465	0,453	0,286
Odesa	0,017	0,524	0,185	0,119	0,300	0,793	0,023	0,143	0,196	0,142	0,227	0,198	0,262	0,562	0,362	0,280
Poltava	0,031	0,509	0,226	0,073	0,380	0,844	0,020	0,113	0,193	0,216	0,155	0,144	0,214	0,555	0,259	0,290
Rivnen	0,037	0,558	0,182	0,057	0,296	0,887	0,038	0,060	0,186	0,250	0,208	0,148	0,111	0,509	0,310	0,280
Sumy	0,035	0,517	0,120	0,038	0,274	0,613	0,023	0,140	0,255	0,206	0,115	0,296	0,036	0,502	0,534	0,269
Ternopil	0,026	0,556	0,205	0,019	0,285	0,745	0,028	0,000	0,103	0,186	0,194	0,029	0,112	0,536	0,153	0,257
Kharkiv	0,024	0,535	0,124	0,039	0,275	0,514	0,023	0,121	0,214	0,186	0,408	0,361	0,377	0,780	0,475	0,295
Kherson	0,008	0,525	0,166	0,087	0,390	0,889	0,037	0,023	0,151	0,093	0,097	0,188	0,022	0,567	0,334	0,257
Khmelnytsky	0,019	0,551	0,220	0,148	0,384	0,734	0,034	0,090	0,172	0,197	0,075	0,074	0,141	0,503	0,224	0,305
Cherkasy	0,038	0,511	0,228	0,017	0,344	0,923	0,038	0,108	0,242	0,215	0,178	0,027	0,075	0,565	0,468	0,287
Chernivtsi	0,024	0,527	0,191	0,071	0,339	0,905	0,023	0,050	0,180	0,149	0,113	0,110	0,104	0,521	0,292	0,291
Chernihiv	0,021	0,556	0,196	0,155	0,415	0,916	0,009	0,063	0,131	0,213	0,072	0,034	0,000	0,347	0,246	0,232
City of Kyiv	0,034	0,465	0,151	0,049	0,321	0,791	0,039	0,146	0,181	0,234	0,101	0,186	0,086	0,455	0,444	0,305

Source: developed by the authors

The econometric model based on the Varimax method for factor F1 for defining the impact made by indices of the physical, social, behavioral, economic and legal orientation on the indicator, characterizing the people's satisfaction with medical services in Ukrainian regions, is given by formula (8):

$$F_1 = 0,258I_p - 0,153I_s - 0,311K_2 + 0,202K_{1_1} + 0,101K_{1_2} - 0,130K_{1_3} - 0,737K_{11} - 0,155K_{44} + 0,846K_{45} + 0,564K_{46} + 0,797K_{47} + 0,477K_{48} + 0,063K_{49} - 0,204Me1 + 0,081Me2 + 0,061Me3 \quad (8)$$

The results from the evaluation of the gross impact of weighting factors based on rotation methods Varimax, Quartimax and Equimax are given in Table V.

Estimated Community is the share of each dispersion variable, which can be explained by factors. Indicators K45 (the share of people, who paid to the charity fund account or another organization), K46 (the share of people who paid at the desk according to the official rules) and K48 (the share of people, who paid for medical goods), are the most influential for further investigation of regression models to define the healthcare state. The gross dispersion share for indicators K1, K3, K4 is 0,834084, 0,819164 and 0,842121.

The qualitative description of the healthcare structure requires investigation of the integral feature [22] using all main components or their great quantity. So, we use values of all five factor loads. The factor loading results enable to form the integral indicator of the people's satisfaction with medical services in the country (Table VI).

The integral indicator  $I_{ds}$  – degree of Ukrainians' satisfaction with medical services is calculated based on the normalized factor loads (9) and weighted geometric mean.

$$y_{ij} = \frac{1}{1 + e^{-3 \frac{x_{ij} - p_i}{q_i - p_i}}}, \quad (9)$$

where  $y_{ij}$  – the normalized value of the  $i$ -factor of the  $j$ -region's,  $q_i$  – the value of the indicator  $x_{ij}$ , at which the conversion function takes a value not less than 0,95;  $p_i$  – the value of the indicator  $x_{ij}$ , at which the conversion function becomes 0,5 [23]. We emphasize that according to the conversion criterion the level of the converted values depends on the  $q_i$  and  $p_i$ . Median  $i$ -factor corresponds to  $p_i$ , maximum value of  $i$ -factor ( $i = 1, 5$ ) –  $q_i$ .

**Table IV.** Factor Loading Matrix After Varimax Rotation

Indicator	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
I_p	0,257889	0,754768	-0,0926343	-0,267667	0,0193271
I_s	-0,152878	0,239971	-0,244005	0,746428	0,151798
K1_1	0,201975	0,712875	0,398331	-0,0763275	0,188514
K1_2	0,100863	-0,291556	0,530543	0,336836	0,46344
K1_3	-0,130406	-0,0480444	0,0638423	0,112065	0,832349
K11	-0,737362	-0,0145942	-0,207371	-0,0638905	0,444101
K2	-0,310565	-0,0980176	-0,0193065	0,784598	0,0313413
K44	-0,155333	0,0698959	0,829812	-0,172227	-0,0271792
K45	0,845633	0,123281	-0,268636	-0,156376	-0,0846777
K46	0,563505	0,200991	-0,148057	-0,0157972	-0,662615
K47	0,797279	0,298493	-0,179168	-0,112243	0,0165194
K48	0,477446	0,0763086	-0,751858	-0,0219269	-0,206332
K49	0,0633321	0,722783	-0,190498	0,298535	-0,321978
Me1	-0,203671	0,24558	-0,056333	-0,770896	-0,0516701
Me2	0,0810659	0,318154	0,481575	-0,129232	-0,451194
Me3	0,0610066	0,75171	0,0486831	-0,0573281	-0,275677

Source: developed by the authors with Statgraphic Centurion package

**Table V.** Weighted impact of indicators

Variable	Estimated Community	Specific Variance	Variable	Estimated Community	Specific Variance
I_p	0,716781	0,283219	K45	0,834084	0,165916
I_s	0,720694	0,279306	K46	0,819164	0,180836
K1_1	0,749016	0,250984	K47	0,769725	0,230275
K1_2	0,704889	0,295111	K48	0,842121	0,157879
K1_3	0,728753	0,271247	K49	0,755508	0,244492
K11	0,788226	0,211774	Me1	0,701915	0,298085
K2	0,723007	0,276993	Me2	0,559984	0,440016
K44	0,748003	0,251997	Me3	0,650444	0,349556

For interpretation of the obtained results regarding integral indicator of the people's satisfaction degree, we suggest the scale:  $I_{ds} < 0,2$  – completely dissatisfied,  $0,2 \leq I_{ds} < 0,5$  – rather dissatisfied,  $0,5 \leq I_{ds} < 0,7$  – rather satisfied,  $0,7 > I_{ds}$  – completely satisfied.

Unfortunately, there were no regions with population completely satisfied with medical services. Citizens of Zaporizhya, Dnipropetrovsk, Poltava and Khmelnytsky regions are rather satisfied with quality of medical services. Citizens of Kharkiv and Kirovohrad regions are dissatisfied; the degree of satisfaction with medical services is 0,146 and 0,140. The population of most Ukrainian regions (76% of regions), including city of Kyiv, is rather dissatisfied with medical services. According to the results of the survey conducted by the Kyiv Institute of Sociological Research and the International Foundation "Renaissance" [18], the main reasons leading to such situation are: doctors' attitude to patients, medical staff, professionalism of doctors, efficiency (effectiveness) of treatment, conditions in which medical care is provided (repair,

cleanliness of premises, including bathrooms) [24]. The obtained results of factor analysis are also recommended for the development of regression multifactor models of the impact made by indicators of physical, social, behavioral, economic and legal orientation on the formation of the healthcare sector [25, 26]. For example, model (12), built in the Statgraphics Centurion package using the Backward Stepwise Selection procedure for factor F1, calculated by the Varimax method, is statistically significant. It is confirmed by the criteria of Darbin-Watson (DW-statistic), Student (t-statics), Fisher (Fst) (Tables VII, VIII).

$$HCS = -5,28403 + 23,3914K_{45} + 16,472K_{46} \quad (10)$$

where HCS – the level of healthcare system, K45 – the share of people who paid to the charity fund account a or another organization, K46 – the share of persons who paid at the box office in accordance with official rules.

From an economic point of view, the interpretation of model (10) is as follows: the greater the value of the HCS

**Table VI.** Normalized values of the factor loads and integral indicator regarding the people's satisfaction with received medical services

Region	F1	F2	F3	F4	F5	Ids
Vynnytsya	0,633	0,324	0,308	0,691	0,539	0,472
Volyn	0,449	0,150	0,718	0,445	0,491	0,403
Dnipropetrovsk	0,429	0,705	0,782	0,796	0,501	0,624
Donetsk	0,266	0,014	0,909	0,932	0,953	0,311
Zhytomyr	0,566	0,433	0,466	0,555	0,331	0,462
Zakarpattia	0,561	0,736	0,952	0,054	0,198	0,335
Zaporizhzhya	0,294	0,559	0,953	0,818	0,913	0,651
Ivano-Frankivsk	0,536	0,784	0,710	0,023	0,516	0,325
Kyiv	0,419	0,286	0,279	0,884	0,710	0,462
Kirovohrad	0,406	0,026	0,725	0,025	0,283	0,140
Luhansk	0,282	0,327	0,450	0,725	0,118	0,324
Lviv	0,713	0,953	0,291	0,334	0,145	0,395
Mykolaiv	0,411	0,500	0,393	0,190	0,579	0,389
Odesa	0,730	0,642	0,286	0,529	0,096	0,369
Poltava	0,621	0,705	0,474	0,500	0,482	0,549
Rivne	0,576	0,612	0,636	0,229	0,500	0,481
Sumy	0,712	0,926	0,634	0,362	0,004	0,225
Ternopil	0,566	0,039	0,460	0,331	0,887	0,312
Kharkiv	0,953	0,946	0,182	0,218	0,002	0,146
Kherson	0,434	0,114	0,120	0,673	0,329	0,265
Khmelnytsky	0,500	0,395	0,547	0,655	0,688	0,546
Cherkasy	0,497	0,923	0,500	0,216	0,563	0,489
Chernivtsi	0,496	0,415	0,312	0,533	0,598	0,459
Chernihiv	0,264	0,029	0,697	0,953	0,896	0,340
City of Kyiv	0,563	0,917	0,566	0,143	0,037	0,274

Source: developed by the authors with Statgraphic Centurion package

**Table VII.** Statistical characteristics for the regression model

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	-5,98002	0,864653	-6,91609	0,0000
K45	21,6702	3,69485	5,86498	0,0000
K46	15,8606	3,48473	4,55146	0,0002
K48	2,1393	2,25074	0,95049	0,3527

Source: developed by authors

**Table VIII.** Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	212,719	3	70,9063	57,95	0,0000
Residual	25,6956	21	1,2236		
Total (Corr.)	238,415	24			

Source: developed by authors

indicator, the more people applied to medical institutions, made payments to a charity fund, or paid to medical institutions. The higher the *HCS* value, the worse the population's health in the region. For the state, it is an alarm signal

[27-31] since a large number of payments in medicine is an indicator of poor health. The security system management should carefully monitor all the factors that led to the fact that many citizens seek medical services.

## CONCLUSIONS

1. The descriptive analysis allowed to form a multivariable space of social-behavioral and economic-legal indicators that are relevant to form the indicator of the degree of satisfaction with the medical services received by the population of Ukraine in 24 regions and Kyiv and to determine the state of healthcare.
2. The analysis of canonical correlations revealed systems of pairs of the most correlated complex features that form an indicator of the satisfaction degree of the country's population with the received medical services. These are features of a person's physical condition, features of social and behavioral orientation.
3. Factor analysis performed by various methods of orthogonal transformation (Varimax, Quartimax, Equimax) using the analysis of the main components allowed to reduce the dimensionality of  $R^{16}$  source space to five factor features of population satisfaction with the quality of medical services and the three most influential indicators of healthcare. Such indicators were people who paid to the account of a charity fund or other organization, people who paid at the box office following the official rules, and people who paid for medical supplies.
4. The obtained results provide ample opportunities for healthcare workers to identify reservations about the potential improvement of the healthcare system through the development of statistically significant regression models, to analyze the factors that are relevant.
5. For public authorities, the results of the study provide an opportunity for quality and timely adjustment of rules and regulations under the Health Reform to improve the characteristics of public satisfaction with the level of medical services and medical care, on the one hand, and direct health promotion nation. A healthy nation is a developed and competitive country.

## REFERENCES

1. Kraft M.H.G. The Role of Health Promotion in Management Development. A Systematic Review of Training Concepts in an Organizational Context. *Business Ethics and Leadership*, 2021; 5(1): 89-97. doi:10.21272/bel.5(1).89-97.2021
2. Formankova S., Trenz O., Faldik O., Kolomaznik J., Vanek P. The future of investing-sustainable and responsible investing. *Marketing and Management of Innovations*, 2018; 2: 94-102. doi:10.21272/mmi.2018.2-08
3. Gallo P., Mihalcova B., Vegsoova O., et al. Innovative Trends in Human Resources Management: Evidence for the Health Care System. *Marketing and Management of Innovations*, 2019; 2: 11-20. doi:10.21272/mmi.2019.2-01
4. Smiiianov V. A., Vasilyeva T. A., Chygryn O. Y., et al. Socio-economic patterns of labor market functioning in the public health: challenges connected with COVID-19. *Wiad. Lek.* 2020; 73(10): 2181-2187.
5. Tiutiunyk I., Humenna Yu., Flaumer A. Covid-19 impact on business sector activity in the EU countries: digital issues. *Health Economics and Management Review*, 2021; 2(1): 54-66. doi:10.21272/hem.2021.1-06
6. Ray A. Containing Airborne Transmission of COVID-19 and Its Implications for Global Economic Recovery. *Business Ethics and Leadership*, 2021; 5(1): 81-88. doi:10.21272/bel.5(1).81-88.2021
7. Vasilyeva T., Kuzmenko O., Kuryłowicz M., Letunovska N. Neural network modeling of the economic and social development trajectory transformation due to quarantine restrictions during covid-19. *Economics and Sociology*, 2021; 14(2): 313-330. doi:10.14254/2071-789X.2021/14-2/17
8. Hightower W. L. Development of an Index of Health Utilizing Factor Analysis. *Medical Care*. 1978; 16: 245-55.
9. Vyas S, Kumaranayake L. (2006). Constructing socio-economic status indices: how to use principal components analysis. *Health Policy and Planning*, 21(6), 9-468. <https://doi.org/10.1093/heapol/czl029>
10. Masters K. S., Wallston K. A. Canonical Correlation Reveals Important Relations between Health Locus of Control, Coping, Affect and Values. *Journal of Health Psychology*. 2005; 10(5): 719-731 doi:10.1177/11359105305055332
11. Chung P-K, Zhao Ya., Liu Ji-D., Quach B. A canonical correlation analysis on the relationship between functional fitness and health-related quality of life in older adults. *Archives of Gerontology and Geriatrics*. 2017; 68: 44-48. doi:10.1016/j.archger.2016.08.007
12. 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*, 2020; 4: 120-130. doi:10.21272/mmi.2020.4-09
13. Tomcikova L., Svetozarovova N., Cocolova J. Challenges and Priorities in Talent Management During the Global Pandemic Caused by COVID-19. *Marketing and Management of Innovations*, 2021; 2: 94-103. doi:10.21272/mmi.2021.2-08
14. Hinrichs G., Bundtzen H. Impact of COVID-19 on personal insurance sales – Evidence from Germany. *Financial Markets, Institutions and Risks*, 2021; 5(1): 80-86. doi:10.21272/fmir.5(1).80-86.2021
15. Kascha M., Palienko M., Marchenko R. Forecast of COVID-19 progress considering the seasonal fluctuations. *Health Economics and Management Review*, 2021; 2(2): 71-82. doi:10.21272/hem.2021.2-07
16. Aliyeva Z. The Law Aspects in Health Management: A Bibliometric Analysis of Issues on the Injury, Damage and Harm in Criminal Law. *Marketing and Management of Innovations*, 2020; 3, 293-305. doi:10.21272/mmi.2020.3-21
17. Mentel G., Vasilyeva T., Samusevych Y., et al. The evaluation of economic, environmental and energy security: Composite approach. *International Journal of Global Environmental Issues*, 2020; 19(1-3), 177-195. Retrieved from <https://www.scopus.com/record/display.uri?eid=2-s2.0-85105783764&origin=resultlist>
18. Indeks zdrowia. Ukraina. URL: <http://health-index.com.ua/reports> (Accessed 12 Jul2021)
19. Zakon Ukrainy „Pro derzhavni finansovi garantii medycznigo obsluguwannia naselenia”. URL: <https://zakon.rada.gov.ua/laws/show/2168-19#Text> (Accessed 12 Jul2021)
20. Bilan Yu., Brychko M., Buriak A., Vasilyeva T. Financial, business and trust cycles: the issues of synchronization. *Zb. rad. Ekon. fak. Rij.*, 20219; 37(1): 113-138. doi:10.18045/ZBEFRI.2019.1.113.
21. Braeken J., van Assen M. A. L. M. An empirical Kaiser criterion. *Psychological Methods*, 2017; 22(3): 450-466. doi:10.1037/met0000074
22. Vasylieva T., Jurgilewicz O., Poliakh S., et al. Problems of measuring country's financial security. *Journal of International Studies*, 2020; 13(2): 329-346. doi:10.14254/2071-8330.2020/13-2/22
23. Us H., Malyarets L., Chudaieva I., Martynova O. Multi-Criteria Optimization of the Balanced Scorecard for the Enterprise's Activity Evaluation: Management Tool for Business-Innovations. *Marketing and Management of Innovations*, 2018; 3: 48-58. doi:10.21272/mmi.2018.3-04



24. Antonyuk N., Plikus I., Jammal M. Sustainable business development vision under the covid-19 pandemic. *Health Economics and Management Review*, 2021; 2(1), 37-43. doi:10.21272/hem.2021.1-04
25. Baydas A., Yalman F., Bayat M. Consumer Attitude Towards Organic Food: Determinants of Healthy Behaviour. *Marketing and Management of Innovations*, 2021; 1: 96-111. doi:10.21272/mmi.2021.1-08
26. Bilan Y., Vasilyeva T., Kryklii O., Shilimbetova G. The creative industry as a factor in the development of the economy: Dissemination of european experience in the countries with economies in transition. [Kūrybinė industrija kaip ekonomikos plėtros veiksnys: Europietiškosios patirties sklaida pereinamojo laikotarpio ekonomikos šalyse] *Creativity Studies*, 2019; 12(1): 75-101. doi:10.3846/cs.2019.7453
27. Kouassi K. B. Public Spending and Economic Growth in Developing Countries: a Synthesis. *Financial Markets, Institutions and Risks*, 2018; 2(2): 22-30. doi: 10.21272/fmir.2(2).22-30.2018
28. Dutta P., Dutta U., Hasan S., Sarkar S., Sana T. Educate, Empower And Protect People Through Timely Authentic Information: Explore How Bangladeshi Newspapers Response To COVID-19 Pandemic. *SocioEconomic Challenges*, 2020; 4(3): 93-103. doi:10.21272/sec.4(3).93-103.2020
29. 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*, 2020; 13(4): 318-340. doi:10.14254/2071-789X.2020/13-4/20
30. Gyan Chandra Kashyap, Parul Puri, Shri Kant Singh. Respiratory Health Upshots due to Contaminated Living Environment: A Cross-Sectional Study of the Industrial Belt of Kanpur City, India. *SocioEconomic Challenges*, 2020; 4(1): 17-27. doi:10.21272/sec.4(1).17-27.2020
31. Vasylieva T., Kuzmenko O., Rashid M. N., et al. Innovations in government management of the healthcare system: forecasting of covid-19 consequences in social, investment and business development. *Marketing and Management of Innovations*, 2020; 4: 11-25. doi:10.21272/mmi.2020.4-01

*The study was performed within the theme «Economic and mathematical modeling and forecasting, development of methodological principles for creating a roadmap for health-care system reforming in Ukraine considering behavioral, social, economic and legal determinants» (basic funding of the Ministry of Education and Science, order of 16. 04 2021 № 434, Agreement BF / 24-2021).*

#### **ORCID and contributionship:**

*Serhiy V. Lyeonov: 0000-0001-5639-3008A, E  
Olha V. Kuzmenko: 0000-0001-8520-2266C, D  
Vitaliia V. Koibichuk: 0000-0002-3540-7922C, D  
Pavlo M. Rubanov: 0000-0002-9415-8786B  
Vladyslav A. Smiianov: 0000-0002-4240-5968F*

#### **Conflict of interest:**

*The Authors declare no conflict of interest*

---

#### **CORRESPONDING AUTHOR**

**Vitaliia V. Koibichuk**

Sumy State University,  
2, Rymskogo-Korsakova st., Sumy, Ukraine  
tel: +380999573657  
e-mail: v.koibichuk@uabs.sumdu.edu.ua

**Received:** 03.06.2021

**Accepted:** 25.11.2021

---

**A** – Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis,  
**D** – Writing the article, **E** – Critical review, **F** – Final approval of the article