

Halásková, Renata; Bednář, Pavel

Article

Evaluation of selected indicators of health care in the context of health care systems: Case of 27 European Union countries

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Evaluation of Selected Indicators of Health Care in the Context of Health Care Systems: Case of 27 European Union Countries

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Renata Halásková 

University of Ostrava, Faculty of Education, Department of Technical and Vocational Education, Czech Republic

Pavel Bednář 

Tomas Bata University in Zlín, Faculty of Management and Economics, Department of Regional Development, Public Administration and Law, Czech Republic

Abstract

Healthcare in European countries is provided through different systems run at national levels. The aim of the article is to evaluate selected health care indicators in EU countries, while accentuating similarities and differences between the EU countries in the context of health care systems. Applying the method of multivariate analysis, eight health care indicators (from the areas of financing, service provision, health status) are evaluated on a set of 27 EU countries in the period 2013-2018. Factor analysis was applied to generate two factors (i. e. expenditures and satisfaction with health care, health status and bed availability in hospitals) from the original indicators of health care. As a next step, hierarchical cluster analysis was utilised to divide the EU countries into six clusters by similarity of the health care factors. The results of the factor analysis demonstrate marked differences between the countries regarding the evaluated health care factors. A higher (lower) level of socio-economic development is the aspect of better (worse) results of health care in most of the countries evaluated. However, according to the evaluated health care factors, clusters of similar countries used different systems of health care by type and source of financing. The findings thus demonstrate both similar and different approaches towards the provision of health care and funding health care systems in EU countries.

Keywords

Health care, Health care financing, Health care indicators, Health care systems, Methods of multivariate analysis

JEL Classification

C38, H51, I15, I18

Introduction

Health care systems in all countries continue to evolve in response to changing demographic factors, simultaneously providing more information about health and health services and greater access to it (OECD, Eurostat and WHO, 2017, p. 20). A precondition for universal health care is to create a system of protection that provides the highest possible level of health (Abihiro and De Allegri, 2015). This system involves three dimensions: who is covered, what services are covered, and how much of the cost is covered (WHO, 2010; Reibling, 2010; Buttice, 2019).

Rising living standards, higher life expectancy, population aging, but also patients' increasing expectations lead to higher expenditures on health care (ČSÚ, 2019; European Commission, 2019). Health care systems are based on a mixture of funding by the public and the private sector. Financing more than 70% of expenditures on health care in two thirds of the EU member states, the public sector plays a substantial role in funding health care services (Łakomy-Zinowik and Horvathova, 2016; Fujii, 2018; Ciasullo et al., 2020). A combination of compulsory insurance and tax revenues account for the majority of costs on health care; some programmes are paid for entirely out of tax revenues (Calusa and Papanicolas, 2015; Gray et al., 2017; Rokicki et al., 2021). Taxation revenue is in many countries supplemented by specific charges or private payments for services which do not fall under the public system (Bentes et al., 2004).

There is a wide variety of health care systems in the given countries. "In the historical context the four models of

Corresponding author:

Renata Halásková, University of Ostrava, Faculty of Education, Fráni Šrámka 3, 709 00 Ostrava
Email: renata.halaskova@osu.cz

health care systems were adopted: the insurance model (German, Bismarck); the socialist model (Soviet, Siemaszko); the national model (British, Beveridge); and the market model (residual, American)" (Raifur, 2019, p. 49). Generally, the current EU countries follow two basic models, namely the insurance model (Bismarck) and the national model (Beveridge model). According to European Commission (2019); Health care in European Union Countries (no year); Health care systems by country, (online 2021) apply European countries four types of health care systems: 1) universal government-funded health system (also known as single-payer healthcare), typical of Nordic countries, Italy, Portugal, Spain, Ireland or Malta; 2) universal public insurance system – used in Belgium, France, Luxembourg, Czech Republic, Poland and other countries; 3) universal public-private insurance system (Austria or Cyprus), and 4) universal private health insurance system (the Netherlands or Germany). "Classifications among healthcare systems distinguish based either on the role of different types of actors or on institutional differences in the areas of financing, service provision, and (access) regulation" (Reibling et al., 2019, p. 611). And "if the organization of the healthcare system is under direct state control", six combinations of regulation, financing, and provision can be delineated (Böhm et al., 2012, p. 12-13). Health care systems have been becoming increasingly complex in the past years due to financing and delivery mechanisms, which has led to the addition of other dimensions (Böhm et al., 2013; Toth, 2016; Reibling et al., 2019). A more comprehensive view on health care systems enables a broader comparison with systems of long-term care or concepts of the welfare state (Wendt, 2009; Popic and Schneider, 2018; Wendt, 2019; Ariaans et al., 2021; Espinosa-Gonzalez et al., 2021).

Results of past researches show areas that were frequently addressed in relation to the evaluation of health care systems and health indicators in European countries (Elola et al., 1995; Mattke et al., 2006; Seke et al., 2013; Ferreira et al. 2018; Ecer and Aktaş, 2019; Ivankova et al., 2019). Based on the funding (the Bismarck model, the Beveridge model) of health care systems and the evaluation of selected health indicators, the researches prove that from the viewpoint of the efficiency of health care systems, countries applying the Beveridge system reach better results compared to the countries that apply the Bismarck health care system (Dinca et al., 2020; Kozuń-Cieślak, 2020). By contrast, from the viewpoint of institutional characteristics of health care systems and the evaluation of the selected health indicators, the National Health Service is considered less just (Ciasullo et al., 2020).

The subject matter of the present research is the application of multivariate analysis – the factor and hierarchical cluster analysis – to evaluate health care indicators in the context of European health care systems. The evaluation of countries with a similar level of social and economic development can reveal the connection between health care systems, levels of health and other health-related indicators, while showing significant differences in approaches towards health care.

Literature Review

Different approaches are utilised in the evaluation of health care systems (from the standpoint of financing, service provision, performance, efficiency and quality assessment, satisfaction, or evaluation according to health care indicators). Wendt (2009) analysed three types of health care systems concentrating on expenditures, financing, provision, and approach to healthcare in 15 European countries. For the sake of the comparison of health care systems. Reibling (2010) discusses a broader approach towards health care, with the addition of regulatory features and financial incentives. Popic and Schneider (2018) evaluated health care systems, focusing on differences between Eastern European and Western European countries. They arrived at the conclusion that specific aspects of an institutional approach towards health care systems are crucial to understand the differences between evaluations of health care in these countries. Cylusa and Papanicolas (2015) concentrated on differences in the perception of access to health care using the example of 29 European countries. Although the majority of European countries offer a universal health care coverage, some groups, such as persons with low income, without citizenship, the unemployed, or women, feel a limited access to health care. The authors speak about the connection between low income and perceived barriers between countries. Nevertheless, also other factors affect the limited access to health care in several countries (long waiting times, poor quality care).

Topics discussed in relation to health care systems are efficiency and performance. Research into health policy focused on the question of how healthcare can be managed to improve performance and outcomes (Jeremic et al., 2012; Hejdukova and Kurekova, 2017; Schütte et al., 2018; Stefko et al., 2018; Paolia et al., 2019; Ciasullo et al., 2020; Dinca et al., 2020). Hejdukova and Kurekova (2017) evaluated the performance of health care systems using the example of the V4 countries and applying a comprehensive indicator. Booker et al., (2015) studied potential solutions for supporting the efficiency of the provision of health care service. Schütte et al. (2018) focused on methodologies of the current performance assessment of health care systems to evaluate their reproducibility and transparency. Ciasullo et al. (2020) has done research into the performance of health care systems based on selected angles, such as perceived quality of health care services, affordability of health care, satisfaction with primary and secondary care, or equity in the provision of health care.

Currently, a precondition for fully functional health care systems is fiscal sustainability and maintenance of these values also in the future (Paris et al., 2010; Merickova and Stejskal, 2014; European Commission, 2019; Tambor

et al., 2021). In relation to this, several pieces of research deal with the evaluation of the structure of public expenditures (Merickova et al., 2017) or evaluation health expenditures and financing of health care. Walczak et al. (2018) examined the structure and changes of expenditures on health care in the EU countries with a particular focus on four countries (Poland, Latvia, Lithuania, and Estonia). The authors analysed the structure and changes in expenditures on health according to type in the period 2004-2015. According to the findings, the evaluated Eastern-European countries saw an increase in expenditures on outpatient services, as opposed to expenditures on hospital services. Rokicki et al. (2021) summarised literature on financing health care and analysed changes in the level of expenditure on healthcare in the European Union in the years 2013–2017. The authors considered two factors to define the volume of expenditures on health care: the level of economic development and the share of senior citizens in the EU countries. Tambor et al. (2021) examined the role of government and households in financing healthcare and the trend in health expenditures in eight EU countries of Central and Eastern Europe in years 2000-2018. The authors state that the role of public financing of health care should be strengthened, and they recommend budgetary priorities and the improvement of the quality of the care.

Other pieces of research deal with the analysis of expenditures on health care in relation with selected health care indicators and health outcomes (Aisa et al., 2014; Jakovljevic et al., 2016; Gavurova et al., 2017; Van den Heuvel and Olariu, 2017; Cervantes et al., 2020). In particular, Fujii (2018) evaluated the impact of public and private health expenditures on health outcomes. It was found that in countries with inefficient governments, private health expenditures affect the support of health to a larger degree than public health expenditures. Also, Aisa et al. (2014) analysed the effects of public and private health expenditures in connection with life expectancy in OECD countries. The findings show that public health expenditures affect life expectancy, although the effect of the aggregate expenditures is not unambiguous. With respect to these results, the authors hint at the importance of the role of the public and private health sectors. Cervantes et al. (2020) evaluated the relative significance of globalisation and public expenditures on life expectancy in European countries in the period 1995-2017. The findings have shown that globalisation in European countries has no effect on life expectancy. On the contrary, life expectancy is affected by public expenditures on social protection, public expenditures on health, education level of the population, or public expenditures on environmental protection. Based on these outcomes, the authors state that European countries should pay more attention to the structure of public budgets.

Other authors Martinussen and Rydland (2021) examine the systems of health care in European countries from the angle of decentralisation. They used self-rated health and satisfaction with the health care system as indicators. Their findings confirmed that decentralisation has a positive and significant association with health system satisfaction. However, no connection between decentralisation and self-rated health was proved. An increasingly frequent aspect for the evaluation of health care is patient satisfaction. Using regression analysis, Krot and Rudawska (2017) identified significant determinants of patient satisfaction with medical services. Stefko et al. (2019) evaluated selected indicators of patient satisfaction in relation to economic indices for a selected set of 33 OECD countries. Xesfingi and Vozikis (2016) investigated the relation between patient satisfaction of a health care system and selected indicators (socio-economic, health care). The authors argue that patient satisfaction is an important criterion of health care quality. Apart from that, they reached the conclusion that there is a positive relation between satisfaction of patients and health care provision indicators.

Methodology

The aim of the paper is to evaluate the selected health care indicators with a particular focus on similarities and differences in EU countries and in the context of health care systems. The authors verify two research questions (RQs) which are based on the theoretical background of health care systems and performed researches in the area of health indicators.

RQ1: Is the evaluation of health care (the health care indicators evaluated) associated with the level of socio-economic development in countries of the EU?

RQ2: Is there a similarity in the evaluated health care indicators between countries with the same system of health care (according to the form and source of financing)?

Data

The selected set comprises 27 EU countries (excluding the United Kingdom). Belgium (BE), Bulgaria (BG), the Czech Republic (CZ), Denmark (DK), Germany (DE), Estonia (EE), Ireland (IE), Greece (EL), Spain (ES), France (FR), Croatia (HR), Italy (IT), Cyprus (CY), Latvia (LV), Lithuania (LT), Luxembourg (LU), Hungary (HU), Malta (MT), the Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovakia (SK), Finland (FI), Sweden (SE).

Table 1. Selected health care indicators.

Variable	Abbr.	Description	Unit
Health expenditure on curative and rehabilitative care	HECRC	Healthcare expenditures by function (ICHA-HC) – include expenditures on curative care and expenditures on rehabilitative care.	Percentage of GDP
Long-term care (health) expenditure	LTCE	Healthcare expenditures by function (ICHA-HC) – include expenditures on long-term care (health). The primary goal of long-term care is alleviating pain and suffering and reducing or managing the deterioration in health status in patients with a degree of long-term dependency.	Percentage of GDP
Health care expenditure (government and compulsory contributory health care financing schemes)	HCEGC	Health care expenditures by financing schemes (ICHA-HF) – include government schemes and compulsory contributory health insurance schemes (which are generally part of the social security system and are here after referred to as compulsory schemes).	Percentage of GDP
Curative care beds in hospitals	CCBH	Hospital beds provide information on health curative care – capacities, i. e. on the maximum number of patients who can be treated by hospitals.	Number per 100 000 inhabitants
Self-reported unmet need for medical examination and care	SRUNC	The indicator measures the share of the population aged 16 and over reporting unmet needs for medical care due to one of the following reasons: 'Financial reasons', 'Waiting list' and 'Too far to travel' (all three categories are cumulated). Self-reported unmet needs concern a person's own assessment of whether he or she needed medical examination or treatment (dental care excluded) but did not have it or did not seek it.	Percentage
Life expectancy at birth	LEB	Life expectancy at birth is defined as the mean number of years still to be lived by a person at birth, if subjected throughout the rest of his or her life to the current mortality conditions.	Number of years
Healthy life years at age 65	HLY65	The indicator measures the number of years that a person at age 65 is still expected to live in a healthy condition. HLY is a health expectancy indicator which combines information on mortality and morbidity.	Number of years
Share of people with good or very good perceived health (Self-perceived health)	SPH	The indicator is a subjective measure on how people judge their health in general on a scale from "very good" to "very bad". It is expressed as the share of the population aged 16 or over perceiving itself to be in "good" or "very good" health.	Percentage of population aged 16 or over

Source: Eurostat (2021a, 2021b, 2021c, 2021d)

The data have been obtained from the Eurostat database. Data from the following areas have been used in the analysis: 1) health care expenditures by financing, and expenditure for selected health care function by health care providers – three health care expenditure indicators (Eurostat, 2021a); 2) health care involving two indicators related to service provision and regulation (Eurostat, 2021b, 2021c); 3) health status – three indicators that characterise health care outcomes (Eurostat, 2021d); 4) data from Living conditions and welfare (Income and Living Conditions, Real GDP per capita) (Eurostat, 2021e); and 5) data from Human development report – HDI index. The variables used in the analysis were selected with respect to the availability of data in the period 2013-2018. The variables (health care indicators) are evaluated in the period 2013 - 2018. The factors that pose limits to an in-depth analysis are: 1) the impossibility to make use of all originally intended variables due to the unavailability of data for all 27 EU countries in the evaluated years, and 2) the fact that some variables had to be excluded on account of a weak correlation for a factor analysis. The variables used (the selected health care indicators) are shown in Table 1.

To avoid negative correlations, SRUNC was transformed to the positive indicator by equation $100 - \text{SRUNC}$ (Self-reported met need for medical examination and care). The achieved results presented in Table 2 show several multicollinearity issues ($r > +/- 0.30$, and $p < 0.05$ or $p < 0.01$ respectively) that needed to be solved by explanatory factor analysis (EFA), similarly to Ferreira et al. (2018).

Methods

Cluster analysis is considered one of the standard exploratory multivariate statistical procedures for making typologies in health care systems (Ariaans et al. 2021; Ecer and Aktaş, 2019 or Ferreira et al. 2018). The selected method requires several procedures to ensure non-biased results by A) inspecting the data for collinearity; B) considering different measurement units of the selected indicators. The first step of examining the given dataset is a correlation analysis to detect collinearity among selected indicators. Such a procedure ensures results that are not influenced by multicollinearity in the subsequent cluster analysis.

Table 2. Correlation matrix of the selected health care indicators of EU Countries.

Variable	HCEGC	100-SRUNC	LTCE	HECRC	SPH	LEB	CCBH
100-SRUNC	0.464*						
LTCE	0.842**	0.454*					
HECRC	0.801**	0.306	0.629**				
SPH	0.353	0.048	0.519**	0.346			
LEB	0.551**	0.275	0.571**	0.710**	0.636**		
CCBH	-0.189	-0.026	-0.335	-0.265	-0.311	-0,555**	
HLY65	0.578**	0.324	0.771**	0.552**	0.684**	0.664**	-0.392*

Source: Authors based on Eurostat (2021a-d)

The explanatory factor analysis (EFA) provides uncorrelated latent variables reducing the dimensionality of the selected health care indicators. Several assumptions are supposed to be controlled to perform EFA rigorously. The first assumption - sample size determination is fulfilled by reaching the ratio of 3:1 between the number of cases (the EU members) and variables (health care indicators) following the recommendation in Cattell (1978). The second assumption - detection of multivariate outliers measured by Mahalanobis Distances meets the criteria by not outperforming the threshold value of .001 in probability estimate for outlier identification suggested by Tabachnick and Fidell (2007). Hence, there is an absence of multivariate outliers in the dataset. Due to measuring the health indicators in different scales, a correlation matrix is used as an input matrix for the explanatory factor analysis, producing standardized data opposite the covariance matrix. Principal Component Analysis is employed as the method for reducing the number of variables from the correlation matrix. Varimax orthogonal rotation with Kaiser normalization is performed for uncorrelated factor loadings.

The first part of the results of the Principal Component Analysis complies with suggestions in Kaiser and Rice (1974) following two criteria 1) the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO); and 2) Bartlett's test of sphericity. The KMO value of 0.709 indicates the 'middling' level of the measure, confirming the adequacy of using explanatory factor analysis for the data for structure detection. Bartlett's test supports such a result ($X^2 = 138.2$, $p < .001$), showing that the correlation matrix is not an identity matrix that confirms no perfect correlation. The results of the anti-image matrix of covariance and correlation suggest keeping all used variables in the EFA as no diagonal correlation reached a value of $r < .5$. Two components (latent variables) are detected by applying Kaiser's criterion, i.e., eigenvalues above 1 (Kaiser, 1960), explaining 71.6 % of the total variance. The reliability of the usage of Kaiser's criterion is supported by meeting the measure defined by Field (2009), suggesting an average of more than 0.70 (0.72) in extracted communities in the case of fewer than 30 variables. The Anderson-Rubin method is employed for producing factor scores of the components to each EU country due to ensuring uncorrelated and standardized scores to meet the assumptions of the subsequent cluster analysis. Due to the current number of EU countries - 27 (June 2021), a hierarchical cluster agglomerative algorithm is used to explore the typology of selected health care indicators for the simplicity of its results. Hierarchical clustering offers several methods for linkage criteria to determine the distance between EU countries as a function of the pairwise distances between them in our case. Cluster validation techniques are used for discovering the most appropriate clustering method to fit the data best. In our case, there are no previous assumptions on the clustering structure of the dataset. Therefore, the internal criteria concept is applied to discover the clustering method evaluating quantities that involve the vectors of the data set proximity or dissimilarity matrix (Halkidi et al., 2001). The presented study determines the most appropriate clustering method by employing one of the internal criteria represented by validating the hierarchy of clustering schemes measured explicitly by the Cophenetic Correlation Coefficient - CCC (Halkidi et al., 2001, p. 128), where values above 0.75 are treated as satisfactory. The given validation technique may be accompanied by the second measure of goodness of fit called delta developed by Mather (1976), where values close to zero are considered a better fit in its two versions – delta (0.5) and delta (1). Examining the resulted two-factor scores by all available hierarchical algorithms in NCSS Statistical Software (NCSS 2021 Data Analysis & Graphics), a simple average is detected as the best linkage criteria to determine the number of clusters of EU countries. The Cophenetic Correlation Coefficient (CCC) reaches the value of 0.74, and delta (0.5) or delta (1) equals 0.24 or 0.31 respectively in that case. The CCC value found by us is very close to the assumed limit value - 0.75; however, the computed result can be considered satisfactory and worthy of further examination. The reason is that the CCC value is determined based on the recommendation by Mather (1976), not based on statistical testing. Using simple average linkage, the result of the cluster analysis determines seven clusters detected by the combined rescaled distance among EU countries, selecting the cut-off value of 15 in the dendrogram (see Figure 1). The given procedure respects natural breaks in achieved rescaled distances to present a simple and usable typology of EU countries. The resulted clusters were further analysed using a box plot to determine differences between the given groups from the perspective of individual components.

Results

The selected health care indicators are evaluated in the 27 EU countries in the period 2013-2018 by use of the methods of multidimensional analysis – factor and hierarchical cluster analysis.

Evaluation of Selected Health Care Indicators in EU Countries by use of Factor Analysis

The result of the factor analysis are two factors that have been generated from the original set of eight health care indicators. Their factor loading is shown in Table 3.

Table 3. Rotated component matrix of factor loadings.

	Component 1	Component 2
Health care expenditure (Government and compulsory contributory health care financing schemes) % of GDP (HCEGC)	0.874	0.292
Self-reported met need for medical examination and care (100-SRUNC)	0.774	-0.148
Long-term care (health) expenditure (LTCE)	0.767	0.478
Health expenditure on curative and rehabilitative care (HECRC)	0.711	0.423
Self-perceived health (SPH)	0.171	0.793
Life expectancy at birth (LEB)	0.423	0.779
Curative care beds in hospitals (CCBH)	0.040	-0.748
Healthy life years at age 65 (HLY65)	0.521	0.693

Source: Authors based on Eurostat (2021)

Four variables of the first factor have a high factor loading, namely health care expenditures (government and compulsory contributory health care financing schemes, HCEGC), self-reported met need for medical examination and care (100-SRUNC), long-term care (health) expenditures (LTCE), and health expenditures on curative and rehabilitative care (HECRC), which can be referred to as expenditures and satisfaction with health care.

Table 4. Factor-score of health care for 27 EU countries.

Country	Factor 1		Factor 2		Country	Factor 1		Factor 2	
	factor score	rank	factor score	rank		factor score	rank	factor score	rank
BE	1.01195	7	0.17896	13	LT	0.14184	11	-2.26912	27
BG	-0.59135	22	-0.94863	24	LU	-0.46572	21	0.34787	12
CZ	0.29526	10	-0.61388	18	HU	-0.40771	20	-1.02172	25
DK	1.10697	4	0.72819	9	MT	0.11391	13	1.05185	6
DE	1.89734	1	-0.89689	22	NL	1.02921	6	0.75610	8
EE	-0.35020	18	-0.91837	23	AT	1.34595	2	-0.58353	17
IE	-0.25708	15	1.52352	1	PL	-0.39887	19	-0.78358	20
EL	-1.98257	27	1.47105	3	PT	0.13623	12	-0.38304	16
ES	0.06651	14	1.00607	7	RO	-1.68516	25	-0.36310	15
FR	1.09381	5	0.52866	10	SI	0.38118	9	-0.32109	14
HR	-0.31622	17	-0.85357	21	SK	-0.31335	16	-1.13201	26
IT	-0.68114	23	1.20572	4	FI	0.75008	8	0.39049	11
CY	-1.23200	24	1.06565	5	SE	1.23100	3	1.49152	2
LV	-1.91987	26	-0.65710	19					

Note: Factor 1 - Expenditures and satisfaction with health care; Factor 2 - Health status and beds availability in hospitals

Source: Authors based on Eurostat (2021a-d)

The second factor has a high factor loading in four variables: self-perceived health, i. e. the share of people with good or very good perceived health (SPH), life expectancy at birth (LEB), curative care beds in hospitals (CCBH), and healthy life years at age 65 (HLY65), which are aggregately called health status and beds availability in hospitals. Healthy life years at age 65 falls under both factor 1 and factor 2. However, due to the content and factor loading of 0.693, it falls under factor 2.

Table 4 shows results of the factor score (health care factors 1 and 2) in the 27 EU countries in the period 2013-2018.

As regards factor score 1 (Expenditures and satisfaction with health care – HCEGC, LTCE, HECRC, 100-SRUNC), DE (1.89734), AT (1.34595), SE (1.23100), DK (1.10697) achieve the best results, as opposed to EL (-1.98257), LV (-1.91987), RO (-1.68516) and CY (-1.23200), which reach the worst results. Concerning factor score 2 (Health status and beds availability in hospitals - SPH, LEB, HLY65, CCBH), IE (1.52352), SE (1.49152), EL (1.47105), IT (1.20572) or MT (1.05185) achieve the best results, whereas LT (-2.26912), SK (-1.13201), HU (-1.02172), BG (-0.94863) and EE (-0.91837) reach the worst results in terms of factor score 2, i. e. health status and curative care beds in hospitals (per 100 000 inhabitants). The results of the analysis of the health care factors show the approach of the countries towards health care.

Evaluation of Health Care Factors in EU Countries in the Context of Socio-economic Development

In the period 2013-2018, health care factors (factor score 1 and factor score 2) are evaluated by the order of EU countries in the context of socio-economic development (Table 5). For the purposes of the evaluation, socio-economic development is represented by socio-economic indicators, including HDP per capita, Human development index (HDI), Mean and median equivalised net income.

Table 5. Rank of EU countries by health care factors and selected socio-economic indicators in 2013-2018.

Country	Health care factors		Socio-economic indicators			
	Factor-score 1 - rank	Factor-score 2 - rank	Human development index (0 to 1)	GDP per capita (Euro)	Mean equivalised net income (Euro)	Median equivalised net income (Euro)
BE	7	13	0.913	37 582	24 040	22 259
BG	22	24	0.806	6 715	4 101	3 316
CZ	10	18	0.883	16 870	8 971	7 991
DK	4	9	0.929	48 998	31 900	28 637
DE	1	22	0.933	37 675	23 865	20 982
EE	18	23	0.869	16 673	9 784	8 373
IE	15	1	0.929	53 942	25 517	22 000
EL	27	3	0.866	16 387	8 895	7 756
ES	14	7	0.886	23 677	15 936	13 802
FR	5	10	0.895	33 383	25 042	21 572
HR	17	21	0.828	11 157	6 374	5 725
IT	23	4	0.878	27 762	18 324	16 162
CY	24	5	0.863	22 117	17 755	14 653
LV	26	19	0.843	12 938	7 187	6 000
LT	11	27	0.854	13 657	6 864	5 563
LU	21	12	0.901	92 282	39 251	34 420
HU	20	25	0.837	11 868	5 404	4 783
MT	13	6	0.871	22 520	15 261	13 554
NL	6	8	0.928	41 575	24 801	22 222
AT	2	17	0.905	40 600	26 315	23 694
PL	19	20	0.857	11 375	6 554	5 743
PT	12	16	0.843	17 887	10 373	8 673
RO	25	15	0.807	8 592	2 845	2 493
SI	9	14	0.892	19 553	13 278	12 396
SK	16	26	0.851	14 907	7 466	7 012
FI	8	11	0.917	39 505	26 455	23 820
SE	3	2	0.927	46 457	27 531	25 438

Note: Factor 1 - Expenditures and satisfaction with health care; Factor 2 - Health status and beds availability in hospitals

Source: Authors based on Eurostat (2021e)

In the period 2013-2018 as average, countries DK, SE, FI, NL, FR, BE, DE, and AT showed the best or above-average results of health care factors. These countries mainly reach the highest rank of factor score 1 (i. e. high volume of allocated expenditures by the type of health care and patients' satisfaction with health care). Also, these countries (except for DE and AT) reach better results in factor score 2 (health status of the population and available bed care in hospitals). These are the economically most advanced countries in the EU, which are also characterised by a high economic level and high living standards. Conversely, countries such as BG, RO, LV, LT, HU, HR, SK, PL reach worse results in terms of health factors 1 and 2, ranking at the lower positions in the factor scores. These countries are also characterised by a lower level of socio-economic development, represented by GDP per capita, HDI or income indicators; LU is an exception among the evaluated countries. For more details, see Table 5.

Similarities Between EU Countries according to Health Care Factors by use of Hierarchical Cluster Analysis

Hierarchical cluster analysis was applied to evaluate the similarity of the selected EU countries in terms of factors 1 and 2 in the period 2013-2018. Factor 1, expenditures and satisfaction with health care, includes HCEGC, LTCE, HECRC, 100 – SRUNC; factor 2, health status and bed availability in hospitals, includes SPH, LEB, HLY65, CCBH. Results of the cluster analysis, namely the factor scores for factor 1 and 2, are shown in the dendrogram (Figure 1a). The division into the six clusters by internal similarity of the factor score (for components 1 and 2) is captured in the boxplot (Figure 1b). Applying the given approach, however, Lithuania makes a cluster consisting of one member, which is not supposed to be an appropriate result for further examination of the typology. To solve the issue a discriminatory analysis was used (see Sokal and Rohlf, 1962). The analysis indicates that Lithuania might belong to other post-socialist EU countries clusters. This finding was verified by the change of Lithuania's affiliation to one of post-socialist EU countries clusters – the third cluster. Testing this assumption by repeating the discriminatory analysis, a full identification of the predicted and existing groups affiliation of the EU countries to the clusters was achieved. Hence, six clusters were identified as the final solution of the health care indicators typology in the EU countries.

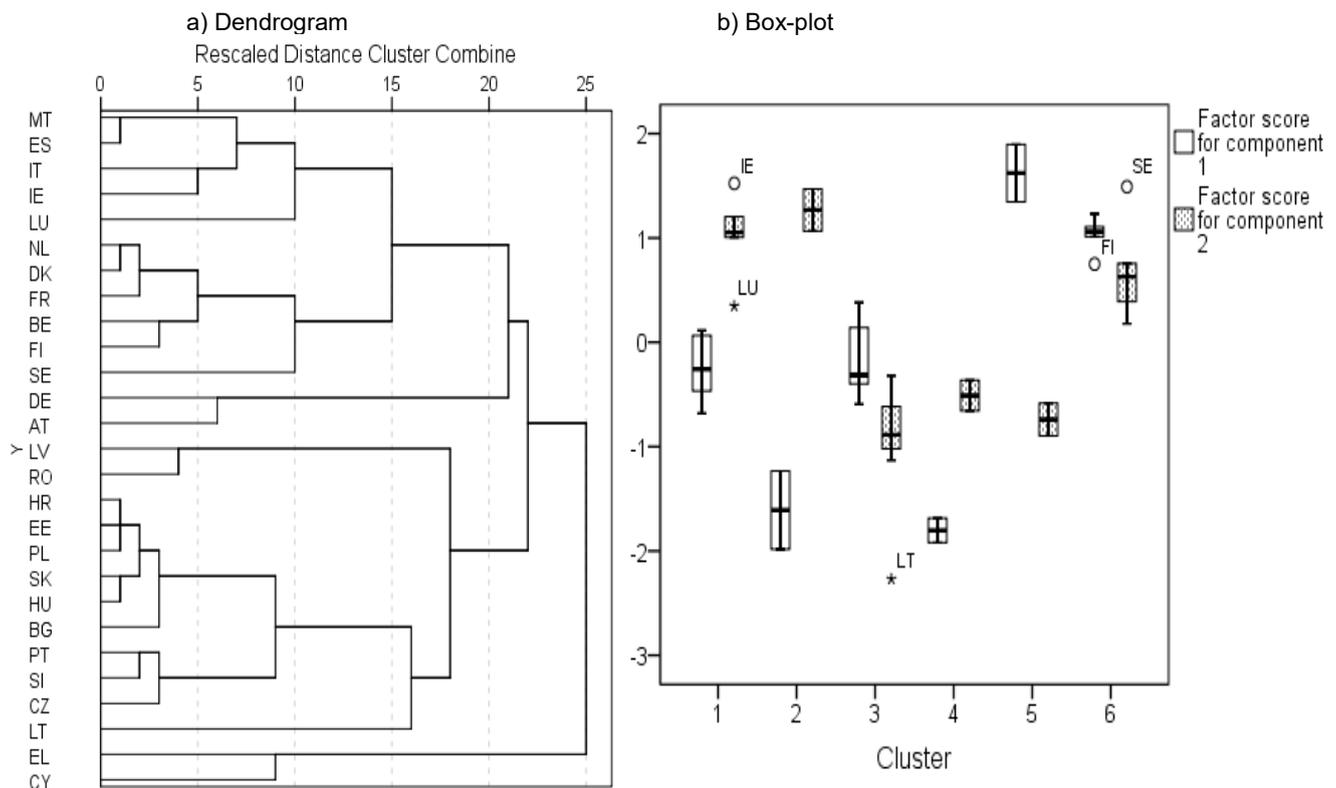


Fig. 1. Results of EU countries by similarity in health care factors.

Note: Factor score for component 1 - Expenditures and satisfaction with health care; Factor score for component 2 - Health status and beds availability in hospitals

Source: Authors.

The first cluster consists of LU, MT, IT, ES, IE. It is a group of Southern and North-western European countries which, compared to the other EU countries, reach a below-average factor score 1 (expenditures, and satisfaction with health care), namely in terms of lower allocated health expenditures on curative and rehabilitative care and long-term care. However, on average the countries reach the second-best factor score 2 (health status and beds availability in hospitals). These countries are characterised by the longest life expectancy at birth, a higher share

of people with good or very good perceived health and the number of years that a person at age 65 is still expected to live in a healthy condition due to a lower number of curative care beds in hospitals. As regards the health status and beds availability in hospitals – factor score 2, LU reaches a markedly lower score of 0.34787 (an extreme value). By contrast, IE reaches a higher factor score 2 (1.52352) and represents an outlier value.

The second cluster consists of two South-European countries, CY and EL. The countries demonstrate one of the worst results of factor 1 – expenditures and satisfaction with health care in comparison to the other EU countries. This is caused by a low representation of expenditures on long-term health care, health care expenditures (government and compulsory contributory health care financing schemes), and a low rate of satisfaction with health care. In contrast to that, countries in this cluster reach better results in health status and beds availability in hospitals (factor score 2). The better results of factor 2 are related to life expectancy at birth and a higher share of people with good or very good perceived health with respect to the number of curative care beds in hospitals per 100,000 inhabitants.

The third cluster is composed of ten countries of Central and East Europe: BG, CZ, EE, HR, HU, LT, PL, PT, SI, and SK. These countries are characterised by an average factor score 1 – expenditures and satisfaction with health care. Compared to the other EU countries, these countries reach the worst average factor score 2 – health status and beds availability in hospitals. This is caused mainly by a shorter life expectancy at birth, a lower share of people with good or very good perceived health due to a higher number of curative care beds in hospitals per 100,000 inhabitants. When compared to the other countries in the cluster, LT reaches a three times lower factor score 2 (-2.26912) and represents an extreme value.

The fourth cluster comprises East-European countries LV and RO. Compared to the other EU countries, they reach the worst average factor score 1 – expenditures and satisfaction with health care. This is caused by the lowest allocated expenditures on health care and patients' lower satisfaction with health care. These countries are also characterised by below-average factor score 2 – health status and beds availability in hospitals. This is caused by a lower number of healthy life years at age 65 and a lower share of people with good or very good perceived health with respect to a higher number of beds of curative care in hospitals.

The fifth cluster is composed of two Central-European countries, AT and DE. When compared to the other EU countries, these countries are characterised by the best factor score 1 – expenditures and satisfaction with health care. These countries allocate a higher volume of expenditures on health care by function and typically show a high rate of patients' satisfaction with health care. Conversely, in factor score 2 – health status and beds availability in hospitals, these countries reach relatively bad results. These countries demonstrate a lower share of people with good or very good perceived health with respect to the highest number of beds of curative care in hospitals.

The sixth cluster comprises selected countries of West and North Europe: BE, DK, FI, FR, NL, SE. These countries reach the best results in health care when compared to the other countries. They reach the second-best results in factor score 1 (the highest volume of allocated expenditures on health care by functions and a relatively high satisfaction with health care). Regarding factor score 1 (Expenditures and satisfaction with health care), FI (0.75008) represents an outlier value. Regarding factor score 2 (health status and beds availability), the countries reach results slightly above average. The countries are characterised by a higher number of healthy life years at age 65 and the highest share of people with good or very good perceived health with respect to a lower number of beds of curative care in hospitals. Compared to the other countries in the cluster, SE reaches a higher value in factor score 2 (1.49152) and represents an outlier value.

Discussion

In the present research, two research questions were verified in relation with the evaluated health care indicators in the EU countries. Research question (RQ1) verified whether “The evaluation of health care (the health care indicators evaluated) is associated with the level of socio-economic development in countries of the EU?” The results of factor scores 1 and 2 of the EU countries in the context of socio-economic indicators (Table 5) show that the eight countries with the top or above-average results of health care factors (DK, SE, FI, NL, FR, BE, DE, AT) also show a higher economic level and standards of living. The strength of the relationship between the variables evaluated by means of the Pearson correlation coefficient (r) (for more information, see Cohen, 2013) shows a moderate correlation between the selected socio-economic indicators (GDP per capita, HDI, median equivalised net income) on the one hand and health factor 1 - Expenditures and satisfaction with health care (correlation coefficient r up to 0.32); and health factor 2 - Health status and available beds in hospitals (correlation coefficient r up to 0.49) on the other. Conversely, the eight countries with the worst or below-average results of health care factors (BG, RO, LV, LT, HU, HR, SK, PL) also reach lower socio-economic levels. A moderate correlation (r from 0.37 to 0.41) is observed in these countries between the selected socio-economic indicators and factor 1 – Expenditures and satisfaction with health care, and a moderate negative correlation (r from -0.35 to -0.49) between the selected socio-economic indicators and factor 2 – Health status and available beds in hospitals. Also, other countries (ES, MT, SI), with moderately above-average results of health care

factors according to the ranking of the countries, demonstrate an average to moderately above-average socio-economic levels. This is confirmed by a moderate to strong correlation between the selected socio-economic indicators and health factor 1 (r from 0.47 to 0.98), and health factor 2 (r from 0.76 to 0.89). Based on the results of the present research, it can be said that health care is related to the level of socio-economic development in the majority of the EU countries. Consequently, the answer to research question (RQ1) is affirmative (YES).

The researches carried out (e.g. Xesfingi and Vozikis, 2016; Fehr et al., 2018; Ranabhat et al., 2018; Mattiuzzi et al., 2021) show that health care outcomes are affected not only by economic levels of the individual countries, but also by the “supply of health care, the accessibility to health services, their effectiveness, efficiency and quality, as well as provider and patient satisfaction” (Paris et al., 2010, p. 29). European countries apply a variety of “the public/private mix in the provision of hospital services according to the type of care (acute, rehabilitation, long-term)” (Paris et al., 2010, p. 30). Apart from the range and quality of health care, health and health condition of the population is affected by other factors, such as the environment, social and cultural environment, education or lifestyle.

Research focused on the evaluation of public health indicators carried out earlier (Klazinga et al., 2001; Jeremic et al., 2012; Seke et al., 2013) confirms that public health represents a significant outcome, but a precondition of sustainable development as well. Seke et al. (2013, p. 6) analysed “28 variables (public health sustainable development indicators) for 31 European countries with the use of an I-distance method analysis”. Their results show that “Scandinavian and certain Western European countries reach top places due to their high level of living standards. These countries are followed by a group of Mediterranean countries”. Based on these finding, the authors argue that “investment in human health, especially in health services, in health promotion, and healthy lifestyles are a factual and recognisable requisite for sustainable public health.”

Table 6. Clusters of EU countries by similarity of health factors and types of health care systems.

Clusters of countries according to factor 1 and factor 2			Health care systems		
cluster/country	average rank Factor 1	average rank Factor 2	Health care model	% population with health coverage financed by public funds	Predominant source of financing for public health expenditure
First cluster ES, IE, IT, LU, MT	4	2	Bismarck model (LU) Beveridge model (ES, IE, IT, MT)	LU (95.2%) ES, IE, IT, MT (100%)	(LU) - Social security (ES, IE, IT, MT) -Taxes
Second cluster CY, EL	5	1	Mix system - Bismarck and Beveridge (EL) Beveridge model (CY)	EL (86%), CY (83%)	(EL) - Social security 53%, Taxes 47% (CY) -Taxes
Third cluster BG, CZ, EE, HR, HU, LT, PL, PT SI, SK	3	6	Bismarck model (BG, CZ, EE, HR, HU, LT, PL, SI, SK) Beveridge model (PT)	BG (88.2%), CZ 100%), EE (94%), HR (100%), HU (95%), LT (100%), PL (91%), SI (100%), SK (93.8%), PT (100%)	(BG, CZ, EE, HR, HU, LT, PL, SI, SK) - Social security (PT) -Taxes
Fourth cluster LV, RO	6	4	Bismarck model (RO) Beveridge model LV)	RO (86%), LV (100%)	(RO) - Social security (LV) - Taxes
Fifth cluster AT, DE	1	5	Bismarck model (DE) Mix system - Bismarck and Beveridge (AT)	AT (99.9%), DE (89.2%)	(AT) - Social security 60%, Taxes 40% (DE) - Social security
Sixth cluster BE, DK, FI, FR, NL, SE	2	3	Bismarck model (BE, FR, NL) Beveridge model (DK, FI, SE)	BE (99%), FR (99.9%), NL (99.9%), DK, FI, SE (100%)	(BE, FR, NL) - Social security (DK, FI, SE) -Taxes

Source: Authors; European Commission (2019); Health care in European Union Countries (no year); Health care systems by countries (online 2021)

In the present research, RQ2 verified whether “There is a similarity in the evaluated health care indicators between countries with the same system of health care (according to the form and source of financing)?” Results of the EU countries by similarities of the evaluated health care factors (Figures 1 a, b), including characteristic feature of health care systems in the individual countries, are captured in Table 6. The results demonstrate certain similarities of the evaluated health care factors (indicators):

- in countries with a universal insurance health care system (EE, HR, HU, SK, PL, BG) and (CZ, SI), in the

third cluster, or some countries in the sixth cluster (FR, NL, BE);

- in countries with a universal government-funded health system (ES, IT, MT in the first cluster, or (DK and FI) in the sixth cluster. However, this generally only concerns specific countries in the clusters;
- in specific countries whose health care systems are financed from various sources (tax-based financing, insurance-based financing, mixed financing through insurance and taxes). This generally concerns countries in the second cluster (CY, EL), fourth cluster (LV, RO), or specific countries in the sixth cluster (for more information, see Table 6).

Despite certain similarity between the countries according to the evaluated health factors, the results of health care in the majority of the evaluated EU countries have shown no direct connection between the forms and sources of financing of health care systems. Consequently, the answer to research question (RQ2) is negative (NO).

Similarly to the present research, also other authors have examined sets of selected health care indicators, applying methods of multivariate analysis, such as Ecer and Aktas (2019) or Ferreira et al. (2018). Specifically, Ecer and Aktas (2019) evaluated 14 health care indicators (health status or healthcare quality of services) on a set of 28 selected EU countries by use of the k-means clustering method. In order to define similar countries according to health care indicators, the authors decided to divide the countries into three and four clusters, and to adopt four different initial solution approaches. Their results proved the division into four clusters by the similarity of the selected health care indicators to be the most suitable. In comparison to the results of the present study, Ferreira et al. (2018) analysed selected health and socio-economic indicators by means of factor and cluster analysis. They made an analysis of three created health care factors using a set of 28 EU countries that represented fundamental functions of health care systems (service provision, financing, and regulation). On the basis of the results of their research, the EU countries were divided into five clusters by the similarity of the evaluated factors. Some results of the study by Ferreira et al. (2018) are in line with the results of our research, where the EU countries were divided into six clusters according to similarity of health factors. By contrast, other results differ. As opposed to the research by Ferreira et al. (2018), basic functions of health care systems are only partially regarded in our research analysing eight indicators of health care (evaluating two health factors). In addition, the present research is focused on the evaluation of countries by socio-economic development and similarity of health care systems according to the form and source of financing.

Differences in the results can be associated with not only the chosen number of health indicators, the focus and character of health indicators used in the analysis, or the time period of the research, but also the manner that the analysis is carried out. Due to the limited availability and the character of data about the countries, the present research is somewhat limited in 1) the use of the selected health care indicators, and 2) the application of research methods, which prevented the authors from performing an in-depth analysis.

Conclusion

Health care in European countries is provided through a variety of systems run at national levels. A precondition for universal health care is to create a system of protection that provides the highest possible level of health. The aim of the paper was to evaluate selected indicators of health care with a specific focus on similarities and differences in EU countries and in the context of health care systems. The health care indicators (from the areas of financing, service provision, and health status) were evaluated on a set of 27 EU countries in the period 2013 - 2018 by means of multivariate analysis. Factor analysis was applied to generate two health care factors (expenditures and satisfaction with health care, health status and bed availability in hospitals). The results of the factor analysis according to the evaluated health care factors define the areas of health care that are emphasised in the individual countries. A moderate correlation has been confirmed between the health care factors and the level of socio-economic development in the majority of the countries.

The output of cluster analysis led to the division of countries into six clusters by similarity in health care factors. According to both health care factors, the most similar from the selected set of countries are countries in the third cluster (Croatia, Estonia, Poland) or countries in the sixth cluster (Denmark, the Netherlands, France). According to financing and satisfaction with health care (factor 1), the largest differences can be seen between the countries with the best ranking (Austria, Germany) and the countries with the worst ranking (Latvia, Romania). According to the health status and beds availability in hospitals (factor 2), the largest differences are seen between the countries with the best average ranking, Greece and Cyprus (second cluster), and the countries with the worst ranking, Lithuania, Slovakia, Hungary (third cluster). However, according to the evaluated health care factors, clusters of similar countries used different systems of health care by type and source of financing. The reached results demonstrate similar as well as different approaches towards the provision of health care and the financing of health care systems in individual EU countries. Based on the findings of this research, the topic for follow-up research can be a detailed analysis of selected European countries with a focus on health care systems and the specifics of the provision and financing of health care.

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