“Healthcare sector in European countries: Assessment of economic capacity under the COVID-19 pandemic”

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HEALTHCARE SECTOR IN EUROPEAN COUNTRIES: ASSESSMENT OF ECONOMIC CAPACITY UNDER THE COVID-19 PANDEMIC

Abstract

The year 2020 showed certain unpreparedness of the world's countries for the challenges of the COVID-19 pandemic due to the unpopular measures of closed borders and total quarantine. The leading social component that opposes a pandemic is the healthcare system. Thus, the purpose of this paper is to assess the ability of European countries to respond to the COVID-19 pandemic. The cluster modeling was performed using the STATISTICA 7.0 package. As a result of modeling, the studied countries were divided into 4 clusters. The first cluster included nine countries. According to the smallest distance, the core countries in this cluster are Ireland and Bulgaria. The second cluster included seven European countries. The core country in this cluster is Sweden. Five of the studied countries were part of the third cluster. The core country in this cluster is Estonia. The fourth cluster included economically developed European countries with a Scandinavian social economy model and countries with a transitive social economy model. The core country in the fourth cluster is Germany. The recommendations for European countries can be introducing educational activities at the state level among the population on the importance of vaccination against COVID-19, increasing the staffing of the healthcare system, conducting the audit on the effectiveness of using public funds, and developing the medical infrastructure.

Keywords healthcare, Europe, financing, social economy, clusters, pandemic, death rate

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INTRODUCTION

The welfare and health of the population are fundamental goals of the socio-economic development of the European countries. Unfortunately, the pandemic has negatively affected the social development of European countries due to rising mortality, a heavy burden on the healthcare system, and other related problems that include rising unemployment, declining incomes, etc. As a result, EU countries have declared high social standards and based their development on social economy models (liberal, continental, Scandinavian, Mediterranean, and transitive) (Stukalo & Simakhova, 2018).

The difference in the social models of development of European countries is the extent to which the state provides minimal social guarantees, programs, and insurance. Thus, the liberal model provides minimal social guarantees and basic state medicine. The continental model is characterized by compulsory social insurance and the significant social responsibility of employers. The Scandinavian model is represented by a high level of funding for social spending and social pro-

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tection. The Mediterranean model is characterized by considerable attention from the state to pensions, but the social policy is passive. The transitional model is characterized by social instability and social reforms, including the healthcare system.

One of the components of social security in European countries is the healthcare system. European countries strive to achieve maximum quality and accessibility of medicine for all citizens. Low-income groups of the population can receive basic medical care through state insurance policies.

The COVID-19 pandemic has negatively affected the social sphere – education (Boyko et al., 2021; Polianovskyi et al., 2021) and healthcare (Kozlovskyi et al., 2021a; Rađenović et al., 2022). Furthermore, it has shown certain unpreparedness for the mass diseases of the healthcare system, which has manifested itself in the lack of doctors, places in hospitals, and slow adaptation to new requirements.

1. LITERATURE REVIEW

With the advent of the global pandemic COVID-19, research has emerged on its impact and the transformation of various spheres of public life. For example, many publications have focused on the impact of the pandemic on the global education system and its development in a distance format.

Some authors developed a procedure for forming a stable investment attractiveness of regions in the context of COVID-19 (Polozova et al., 2022), as well as substantiate economic development strategies to achieve sustainable development goals in the conditions of global pandemic (Stukalo & Simakhova, 2018; Kozlovskyi et al., 2021a; Brych et al., 2020). In addition, many works of modern scientists (Kozlovskyi et al., 2021b; Koziuk et al., 2020) are devoted to the problem of the greening of socio-economic development and the formation of new welfare economics in new conditions. They discussed connections between environmental quality as a public good and the quality of institutions, the educational level, and resource dependence.

Rađenović et al. (2022) analyzed the effectiveness of healthcare systems in the European Union. They examined the relationship between healthcare expenditures and the effectiveness of healthcare systems. The results determined the positive impact of the detection capacity of the health system on the confirmed cases of COVID-19 pandemics and reducing the number of deaths per 100,000 population.

Bilenko et al. (2022) used fuzzy set theory to assess the efficiency of tax measures in the EU against the effects of COVID-19. The result of the study demonstrates that the number of tax measures against the effects of COVID-19 does not affect their efficiency.

Orlewska and Klusek (2020) and Śliwa et al. (2021) calculated incidence rates, mortality rates, case fatality rates, and daily cumulative index (DCI) in each voivodeship. The results show that DCI can be considered an indirect indicator of the burden on healthcare compared to the incidence rate alone.

Sun et al. (2021) and Gong et al. (2020) analyzed the achievements of China in the fight against the spread of COVID-19 through the introduction of innovative and specialized healthcare systems, including advanced Fangcang and online hospitals, 5G, big data analysis, and artificial intelligence. Finally, Tessema et al. (2021) discussed the problem of African countries, which has one of the weakest health systems globally. The main setbacks in health system preparation included a lack of available health services for the pandemic, inadequate resources and equipment, and limited testing ability and surge capacity for COVID-19.

Thomas (2022) and Wapner (2020) described how the pandemic reveals the main problems in the healthcare system on the example of America. Bhattacharya et al. (2021) analyzed the results of a study conducted in single and multicenter hospitals in England. Based on field experiments, they established the main causes of the COVID-19 pandemic at the beginning of 2020.

Arsenault et al. (2022) investigated the immediate effect of the pandemic on 31 health services in low-income, middle-income, and high-income

countries. The obtained results demonstrate that disruptions of varying magnitude and duration were found in every country during 2020–2021.

Some European scientists, who have studied the pandemic, have come to the conclusion that the healthcare systems in European countries are ineffective in relation to COVID-19 and need to be reformed (Lupu & Tiganasu, 2022; Kardas et al., 2021).

Deloitte (2020) looked at six issues driving change in the healthcare sector: 1) population aging; 2) increasing demand for care; 3) countries' gradual economic recovery; 4) clinical and technology advances; 5) labor costs; 6) expansion of public and population healthcare systems. The way how stakeholders understand and respond to these issues shapes their ability to navigate from recovering to thriving in the post-pandemic "new normal" and advance their journey along the path to the "future of health".

Today one can say that if there were anti-globalization movements in the past, with the advent of the COVID-19 pandemic in the world, anti-vaccination movements would have intensified. The anti-vaccination movement is not something new in the history of humanity – it originated in the XVIII century. Furthermore, in the XIX century, its supporters staged mass protests, which occasionally broke out in different parts of the world, but the pandemic contributed to its revival. In early 2020, key anti-vaccine theses that were not yet a unified force at the time were that COVID-19 was simply the flu and that the pandemic itself was an artificial problem or a fake. In 2021, the situation changed somewhat. The anti-vaccination movement shaped an organized structure with its own leaders of public opinion, financial and economic assets, and regular events (Garay et al., 2019; Pullana & Dey, 2021). They actively promote their movement as one that opposes human rights violations and calls for opposition to the so-called "state machine" of coercion. Vaccines are often based on religious prejudice, fear, and conspiracy theories due to low education, but many people also lack information and are reluctant to engage in critical thinking.

In the UK, for example, among adults aged 16 to 29 years, 17% reported hesitancy towards the coronavirus vaccine, 30 to 49 years – 13%, compared with 1% of adults aged 80 years and over (Office for National Statistics, n.d.). Nevertheless, positive vaccine sentiment increased in the UK to 94% in 2021.

Nowadays, anti-vaccination movements continue to focus on any problems that arise with the side effects of vaccines, research by doctors who have challenged the traditional view of their usefulness. Unfortunately, the benefits of vaccines in preventing new outbreaks and reducing deaths by anti-vaccines are being ignored.

A gap in the research is the lack of attempt to group European countries by their ability to overcome the challenges of the COVID-19 pandemic.

This paper aims to assess the ability of European countries to respond to COVID-19 pandemic.

2. METHODOLOGY

To achieve the stated goal, the following general scientific methods were used: 1) literature review of the development of the healthcare system of European countries in the context of the COVID-19 pandemic; 2) taxonomical methods to reveal spatial differences in the ability of the health system to meet the challenges of the COVID-19 pandemic; and 3) cluster modeling for grouping European countries by social indicators that characterize the state of the healthcare system.

Social indicators that were determined to be used for cluster modeling are healthcare financing, coverage of the population by doctors, global indicators that contain sub-indices on the state of the healthcare system (Human Development Index (HDI) and Social Progress Index (SPI)), as well as indicators of morbidity and mortality from COVID-19.

Cluster modeling was performed using the STATISTICA 7.0 package. The main purpose of cluster analysis is the division of European countries into homogeneous groups according to social indicators of health system development. This classification provides an opportunity to identify the determinants of the development of each group and promising trajectories for the development of healthcare during the COVID-19 pandemic. The

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advantage of cluster modeling over other types of economic and mathematical analysis is the possibility of using different in-nature criteria, and indicators of countries' development.

The solution of cluster analysis is a breakdown that satisfies the criterion of optimality. It can be an intergroup sum of squares of deviations:

$$W = \sum_j \left(X_j - \overline{X} \right)^2, \quad (1)$$

where X_j – vector of measuring of the *j*-th country, $\overline{X}$ – middle vector; *j* – 1, …., number of countries.

For cluster modeling, 28 European countries with different levels of socio-economic development and models of social economy were considered. National and global social indicators were used to characterize the development of the healthcare system and COVID-19 morbidity and mortality rates (Table 1).

The Euclidean Distances Single Linkage method was chosen for cluster modeling (Figure 1). The results of cluster modeling are given in the dendrogram of the grouping of European countries by national and global social indicators (Figure 2).

Table 1. Social indicators of the healthcare system in some European countries

Source: UNDP (n.d.), Deloitte (2019), World Health Organization (2020), Worldometers (2021).

№	Country	HDI	SPI	Share of healthcare expenditures in GDP, %	Number of doctors per 1,000 inhabitants	Total COVID-19 cases per 1,000,000 population	COVID-19 death per 1,000,000 population
1.	Denmark	0.930	90.09	10.3	4.0	69.172	470
2.	Switzerland	0.946	89.89	12.1	4.3	101.540	1.292
3.	Austria	0.914	86.40	10.3	3.7	97.391	1.267
4.	Norway	0.954	90.95	10.0	2.9	39.402	168
5.	Finland	0.925	89.56	9.4	3.8	29.263	213
6.	Ireland	0.942	87.97	7.8	3.3	93.652	1.096
7.	Sweden	0937	89.45	11.0	4.0	115.582	1.475
8.	Netherlands	0.933	88.31	10.7	3.6	128.070	1.080
9.	Cyprus	0.873	83.14	6.8	2.0	101.782	473
10.	Italy	0.883	85.69	9.0	4.0	79.583	2.194
11.	Belgium	0.919	86.77	10.5	3.1	121.334	2.242
12.	Germany	0.939	88.84	11.2	4.3	56.614	1.153
13.	Spain	0.893	87.47	9.2	3.9	107.433	1.871
14.	UK	0.920	87.98	9.9	2.8	135.623	2.073
15.	Slovenia	0.902	85.80	8.5	3.0	171.199	2.323
16.	France	0.891	87.97	11.1	3.2	110.114	1.801
17.	Poland	0.874	81.25	6.5	2.4	82.142	2.058
18.	Estonia	0.882	83.98	6.7	3.5	154.470	1.213
19.	Portugal	0.850	87.12	9.0	5.1	107.962	1.792
20.	Slovakia	0.857	80.43	7.1	2.5	94.932	2.421
21.	Hungary	0.845	78.77	7.4	3.2	92.670	3.239
22.	Bulgaria	0.816	76.17	8.2	4.0	91.612	1.711
23.	Ukraine	0.750	66.97	6.7	3.0	70.896	1.662
24.	Serbia	0.799	71.59	9.1	3.1	136.138	1.197
25.	Lithuania	0.869	81.30	6.7	4.3	159.906	2.288
26.	Latvia	0.854	80.42	6.2	3.2	124.766	1.883
27.	Russia	0.824	69.71	5.6	3.8	60.233	1.690
28.	Belarus	0.817	73.90	6.3	4.1	64.999	502

Source: Developed by the authors.

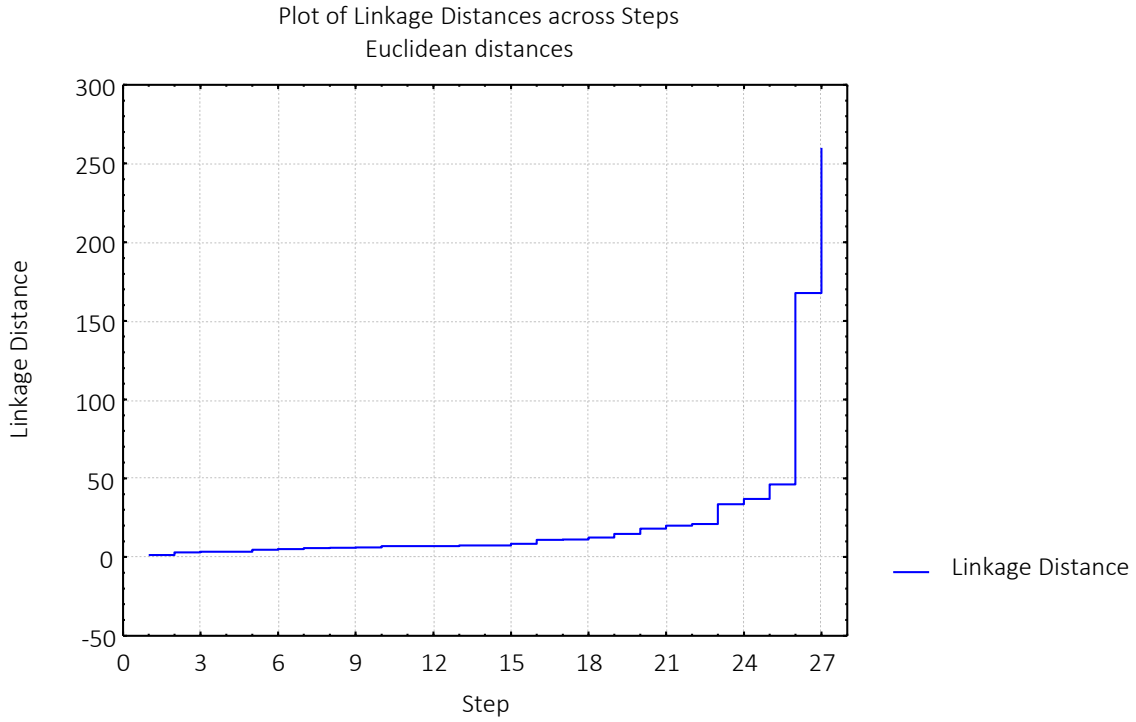

Figure 1. Plot of linkage distances

Source: Developed by the authors based on UNDP (n.d.), Deloitte (2019), World Health Organization (2020), Worldometers (2021).

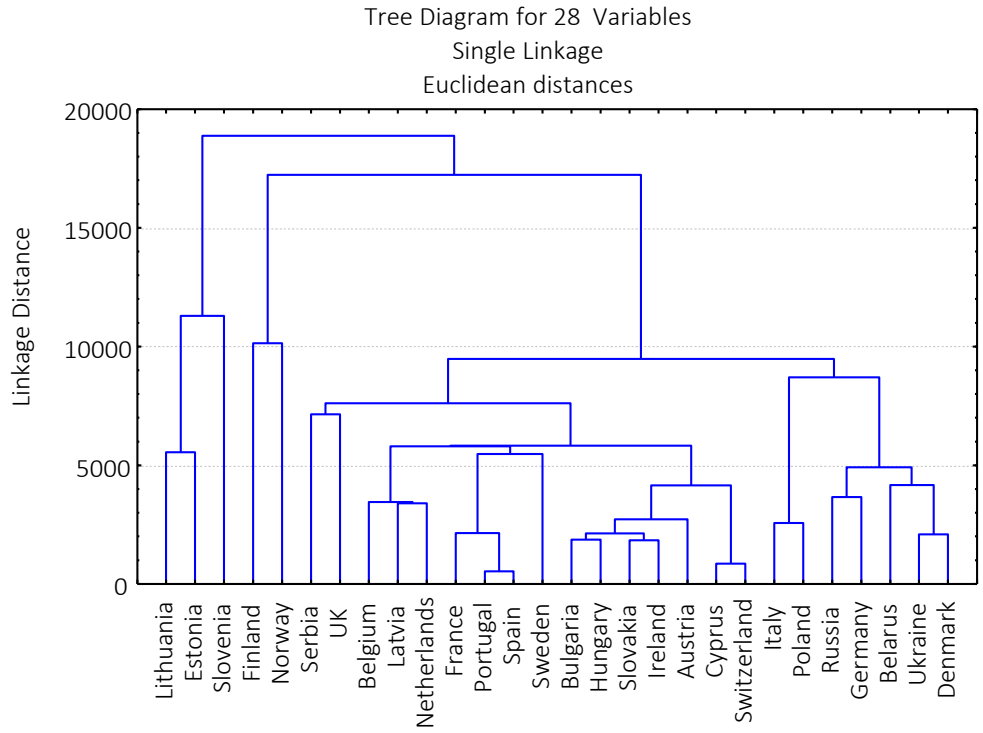

Figure 2. Dendrogram of the grouping of European countries by social indicators of healthcare system development

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The results of means and standard deviations of cluster analysis are given in Table 2.

Table 2. Means and standard deviations of cluster analysis

Source: Developed by the authors.

Country	Mean	Std.Dev.
Denmark	11624.44	28193.01
Switzerland	17156.37	41342.48
Austria	16459.92	39651.09
Norway	6612.09	16063.84
Finland	4930.03	11920.95
Ireland	15807.99	38138.04
Sweden	19526.95	47060.75
Netherlands	21542.31	52189.41
Cyprus	17057.57	41506.73
Belgium	20612.78	49351.09
Germany	9644.98	23014.47
Spain	18233.96	43704.68
UK	22966.37	55196.34
Slovenia	28936.44	69700.21
France	18669.16	44804.28
Poland	14048.25	33368.94
Estonia	25962.78	62957.23
Portugal	18308.80	43926.62
Slovakia	16240.40	38562.80
Hungary	15999.55	37582.74
Bulgaria	15568.02	37259.93
Ukraine	12105.81	28808.70
Italy	13646.10	32314.02
Serbia	24084.50	54965.19
Lithuania	27047.13	65093.60
Latvia	21122.57	50780.17
Russia	10332.90	24455.11
Belarus	10929.73	26489.14

3. RESEARCH RESULTS

Clustering of countries was performed using the K-means method to form optimal clusters by minimizing intergroup variation and maximizing intergroup variation. As a result of modeling, the studied countries were divided into 4 clusters. Figure 3 shows what values on average acquire social indicators of healthcare development for each cluster.

Table 3 shows the Euclidean Distances between Clusters Distances below diagonal squared distances above diagonal. The longest distance between cluster 1 and cluster 4 indicates opposing health systems in terms of coping with the challenges of the coronavirus pandemic. The closest distance is between cluster 3 and cluster 4.

The first cluster included nine countries; it became the largest (Table 4). According to the smallest distance, the core country in this cluster is Ireland, and Bulgaria also has a short distance. Italy has the longest distance, i.e., it is the country that is furthest from the core of the first cluster.

Table 3. Euclidean distances between clusters distances below diagonal squared distances above diagonal

Source: Developed by the authors.

	No. 1	No. 2	No. 3	No. 4
No. 1	0	14464.01	38405.36	38999.0
No. 2	120.2664	0	6446.72	7754.64
No. 3	195.9729	80.29	0	406.94
No. 4	197.4816	88.06	20.17	0

Table 4. Countries and clusters

Source: Developed by the authors.

Clusters	Country	Distance
1st cluster	Switzerland	3568.3
	Austria	1879.9
	Ireland	434.79
	Cyprus	3699.1
	Poland	4357.6
	Slovakia	907.96
	Hungary	610.58
	Bulgaria	489.99
	Italy	5403.6
2nd cluster	Sweden	376.11
	Netherlands	4744.9
	Belgium	1998.2
	Spain	3688.1
	France	2593.3
	Portugal	3471.8
	Latvia	3389.1
3rd cluster	UK	6494.7
	Slovenia	8078.8
	Estonia	1377.7
	Serbia	6676.0
	Lithuania	3498.9
4th cluster	Denmark	5462.4
	Norway	6698.8
	Finland	10835.0
	Germany	357.65
	Ukraine	6173.3
	Russia	1844.2
	Belarus	3759.2

The main characteristics of the countries included in the first cluster according to social indicators of healthcare development are the following: high Human Development Index, low rates of doctor supply (2-4 doctors per 1,000 population), and

Source: Developed by the authors.

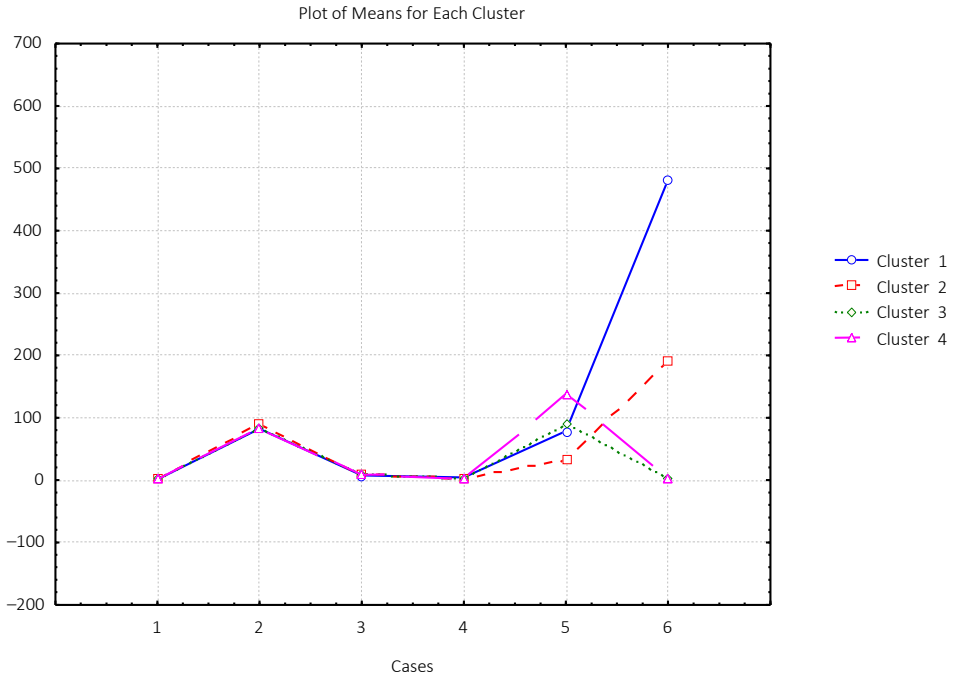

Figure 3. Plot of means for clusters 1-4

high mortality rate from the COVID-19 (1,200-3,200 deaths per 1,000,000 population). The exception is Cyprus, where the COVID-19 mortality rate is low. It is the country of the Mediterranean social economy model with special attention to the demographic situation, aiming to maintain the birth rate, government subsidies to the population, and the social sector that positively influences the social conditions and healthcare system of the country.

The second cluster included seven European countries (Table 4). The core country of this cluster is Sweden, which has the shortest distance. The Netherlands has the longest distance. The second cluster covered developed European countries. The main characteristics of the healthcare system progress in these countries are mostly high indicators of the Human Development Index, a high share of healthcare expenditures (5 of the 7 countries in the cluster have 9.2-11.2% healthcare expenditures in GDP), and 3-4 doctors per 1,000 population. As a result, the countries in the second cluster have average rates of morbidity (80,000-120,000 per 1 million population) and mortality rate from COVID-19 (1,000-2,000 per 1 million population) compared to other European countries.

Five of the studied countries were part of the third cluster, which became the smallest one (Table 4). The core country of the cluster is Estonia, with the shortest distance. Slovenia has the longest distance from the center of the cluster. The countries of the third cluster have the highest rates of COVID-19 morbidity (135,000-170,000 per 1 million population), 2.8-4.3 doctors per 1,000 population, and relatively high government spending on healthcare (6.7-9.9% of GDP). The paper assumes that due to sufficient funding for healthcare, the countries included in the third cluster have a mortality rate from COVID-19 at almost the same level as the countries of the second cluster, with a much higher incidence rate.

Paradoxically, as a result of cluster modeling, the fourth cluster included economically developed European countries with a Scandinavian social economy model (Denmark, Norway, Finland, and Germany) and countries with a transitive social economy model (Ukraine, Belarus, and Russia). The core of the fourth cluster was Germany, with the shortest distance. Norway has the longest distance (Table 4).

The countries included in the fourth cluster are characterized by the lowest level of morbidity (30,000-70,000 per 1 million population) and mortality from

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COVID-19 (exceptions are Russia and Ukraine). For Ukraine, from the pandemic beginning, the worst-case scenario has been projected, which envisages a reduction of expenses and closure of companies (Yousuf et al., 2019), dismissal of personnel, increase in accounts payable, and decrease in purchasing power. Now the country is the leader in the high mortality from COVID-19 among European countries. In addition, for the countries of the transitive social economy model, the environmental problem is relevant, as the state of environmental pollution causes respiratory diseases and reduces the immunity of the population. This is a negative factor in a pandemic condition.

For the Scandinavian social economy models, which are part of the fourth cluster, this fact is natural because they have a high Human Development Index, Social Progress Index, a high share of public expenditures for healthcare, developed medical support, human orientation of the economy, high living standards, and effective public administration in the social sphere.

The low death rate from the COVID-19 in Belarus with a relatively average level of funding can be explained by the high quality of medicine and the efficient use of public funds in the healthcare system.

It should be noted that the number of fully vaccinated populations among the countries also differs (Figure 4).

According to Figure 4, the highest vaccination rate of the population has Portugal (90%), Spain (82%), Denmark (81%), Ireland (78%), Italy, Belgium, France (76%), Finland (75%), Austria, Sweden (74%), Germany, Norway (73%), Netherlands (72%) and UK (71%) – the most economically developed countries of Europe. The lowest level of vaccination of the population has Bulgaria (29%), Ukraine (34%) and Belarus (43%).

4. DISCUSSION

The results of the study almost correspond to the research assumption. As a result of cluster modeling, European countries were grouped into 4 clusters according to their ability to withstand the threat of the COVID-19 pandemic. Moreover, the countries of the third and fourth clusters with high public expenditures for the healthcare system

Source: Developed by the authors based on Our World in Data (n.d.).

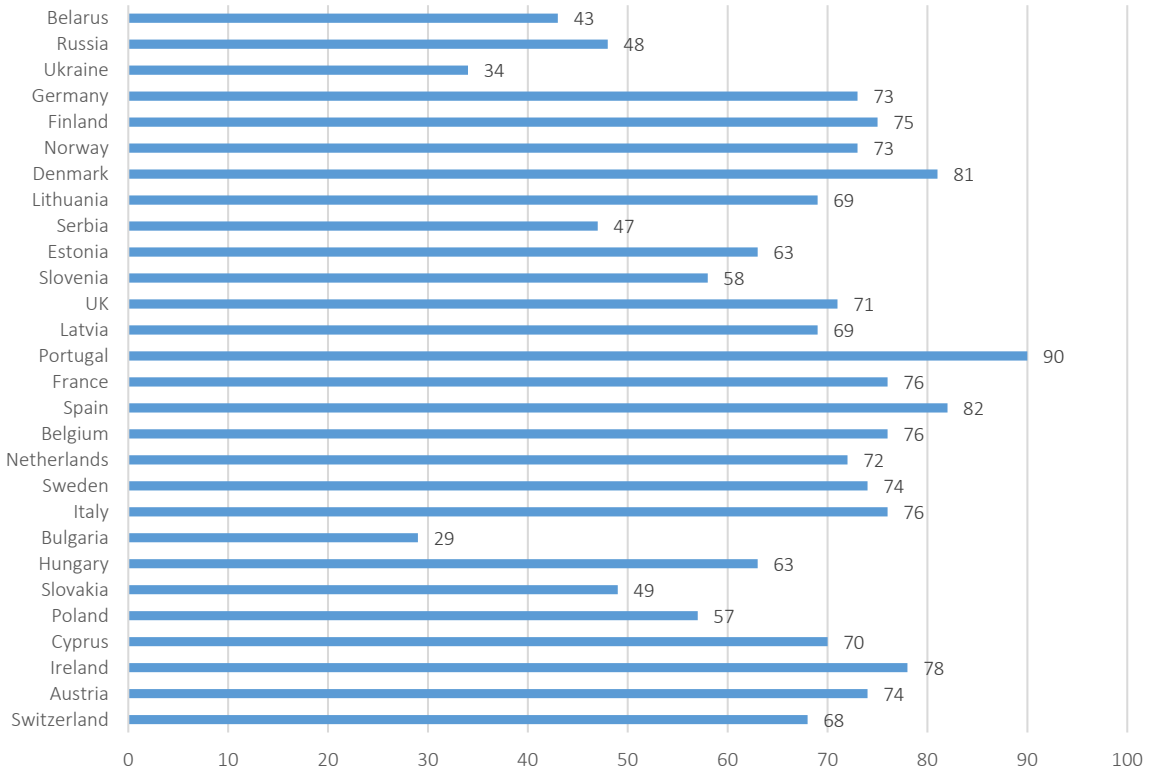

Figure 4. Share of people fully vaccinated against COVID-2019, January 2022

and high social security obviously had a higher capacity to resist the pandemic than the European countries of the first and second clusters.

The results of the study are entirely new, as previously in the scientific literature there were no attempts to group European countries by social indicators of the healthcare system and its ability to withstand the COVID-19 pandemic. Previous publications mainly considered the effectiveness of existing healthcare systems (Rađenović et al., 2022) and the need to reform them (Lupu & Tiganasu, 2022; Kardas et al., 2021). This study made practical recommendations for the countries of the first and second clusters, based on the results of cluster modeling.

Since March 2022, the number of cases of coronavirus in some countries of Asia and Europe has begun to increase again. One can predict a new wave of pandemic restrictions. This is partly due to the fact that countries have different levels of vaccination. As shown by the results of cluster modeling, the level of vaccination of the population is higher in the countries of the first and second clusters, compared with the third and fourth clusters. Clusters that have a higher death rate from coronavirus have a higher vaccination rate.

The study concerned only European countries; therefore, it would be important to compare this result with Asian countries. Furthermore, European countries have similar features to the standard European social model implemented by the European Union. Thus, future directions of the research will be comparing the effectiveness of the healthcare system in Europe and Asia with an estimation of the vaccination results to finding an effective healthcare model in conditions of the COVID-19 pandemic.

CONCLUSION

Based on the aim of the study, namely, to assess the ability of European countries to resist the COVID-19 pandemics and group them by social indicators that characterize the state of the healthcare system, the study conducted a cluster modeling of European countries on relevant social indicators. As a result, European countries were grouped into four clusters according to the capabilities of their healthcare system to meet the challenges of the pandemic.

Thus, based on the results of cluster modeling, the paper proved that European countries with high public expenditures for the healthcare system and high social security (high Human Development Index and Social Progress Index) can meet the challenges of the pandemic. The third and fourth cluster countries demonstrated this trend. So, the scientific assumption of the study was partially confirmed, as some of the fourth countries with transition economies had low expenditures on the healthcare system.

In contrast, countries in the first and second clusters have a lower potential to meet the challenges of the COVID-19 pandemic. Therefore, the practical recommendations for these countries for the development of the healthcare system are: 1) increase the staffing of the healthcare system to 4-5 doctors per 1,000 population; 2) conduct a state audit on the effectiveness of using public funds in the field of healthcare to improve it; and 3) develop the medical infrastructure.

The study came to the conclusion that for European countries in the first and second clusters, it is also imperative to carry out educational activities at the state level among the population on the importance of vaccination against COVID-19, as this is what helps to prevent deaths from this serious disease.

The proposed directions will drive positive changes in the development of healthcare and will meet the challenges of the COVID-19 pandemic in 2022 and 2023. A contribution to the theory is the grouping of European countries with the effectiveness of the healthcare system in combating the pandemics. However, the limitations of the study are the lack of uniform statistics on the private health sector in European countries, which did not allow the introduction of such indicators in the cluster model of the study.

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