systems

MDPI

Article

Health Spending Patterns and COVID-19 Crisis in European Union: A Cross-Country Analysis

Silvia Marginean * **and Ramona Orastean**

Faculty of Economic Sciences, Lucian Blaga University of Sibiu, 550324 Sibiu, Romania
* Correspondence: silvia.marginean@ulbsibiu.ro

Abstract: The COVID-19 virus outbreak generated new questions about the health policy all over the world. Last several years' evolutions proved that short-term financing solutions could help health systems to deal with shocks, but the research regarding the relationship between the ability to react to unexpected events such as pandemics and steady long-term health policies is limited. The purpose of this paper is to study if EU countries that were consistent in financing national health systems were more prepared to deal with the pandemic shock. Using Current Health Expenditures for 2000–2019, a K-means cluster analysis was conducted, and the 27 EU countries were classified into three groups: high, medium, and low health spenders, with 10, 7, and 10 countries per group, respectively. one-way ANOVA (analysis of variance with one dependent variable) was carried out to identify if there are significant differences between the three groups during the COVID-19 pandemic regarding the general level of preparedness (measured by the Global Health Security Index), impact (measured by excess mortality), and digitalisation as a key factor in implementing successful health and economic policies (measured by the Digital Economy and Society Index). The conclusion was that health systems of the countries from the high health spenders cluster performed better for all three dimensions, followed by medium and low health spenders, showing that better financing could increase the performance and the resilience to future shocks of the health systems.

Keywords: EU health spending; COVID-19 impact; health digitalisation; Global Health Security Index (GHS Index); Digital Economy and Society Index (DESI); COVID-19 excess mortality

check for updates

Citation: Marginean, S.; Orastean, R. Health Spending Patterns and COVID-19 Crisis in European Union: A Cross-Country Analysis. *Systems* **2022**, *10*, 238. https://doi.org/10.3390/systems10060238

Academic Editor: Wayne Wakeland

Received: 17 October 2022
Accepted: 29 November 2022
Published: 1 December 2022

1. Introduction

The COVID-19 virus outbreak generated new questions about health systems and policies all over the world. It is generally accepted that countries should spend more to increase the quality of health care services. Last several years' evolutions proved that short-term financing solutions could help health systems to deal with shocks, but the research regarding the relationship between the ability to react to unexpected events such as pandemics and steady long-term health policies is limited. The purpose of this paper is to study if the EU countries that were consistent in financing national health systems were more prepared to deal with the pandemic shock.

Using data from the WHO Global Health Expenditure Database, this paper analyses health spending for 20 years in 27 European Union countries. Current Health Expenditure as percent of GDP and Current Health Expenditure per capita in USD were selected as key measures for how much each EU country did spend on health between 2000 and 2019. The scope of this paper is to identify homogeneous groups of countries based on their health spending patterns and to determine if there are significantly different reactions to COVID-19 between the identified groups. The research findings could serve as an argument for the possible positive outcomes of EUR 5.3 billion investments through the EU4Health programme 2021–2027 and support the idea of a common health policy as an instrument for crisis preparedness in the EU.

The rest of this paper is organised as follows: the current state of the research on the topic is reviewed in the Introduction, followed by the second part of this paper, which is about research methodology. The research was developed in two distinctive stages: (1) a K-means cluster analysis was conducted to identify the main groups of EU countries based on their long-term health spending pattern; (2) a one-way ANOVA was used to examine the relationship between health spending patterns and the impact of the COVID-19 crisis. Empirical results are presented in the third part, followed by a final section highlighting the main conclusions of the research.

The wide literature on health systems covers different aspects, such as the following: the efficiency of health care systems in different countries or groups of countries, public and private health spending, and the resilience of health systems to shocks, including the financial crisis and the COVID-19 pandemic. Most of these studies make use of OECD or WHO health data and econometric approaches: data envelopment analysis (DEA), cluster analysis, or correlation and regression analysis.

Generally, the literature on public spending in health care focuses on cross-country efficiency analysis; that is, it is based on the inputs (resources) and outputs (outcomes) of very different aspects of the health care system and usually uses the same method (DEA). For example, Afonso and Aubyn [1] evaluated sector efficiency in 24 OECD countries, comparing several resources (doctors, nurses, hospital beds) to outputs (life expectancy, infant survival rate). Joumard et al. [2] focused on health care outcomes (increase in the quality and length of life; equity in access or health status), rather than on outputs, and considered that measured efficiency is influenced by the institutional framework (the allocation of resources between in- and out-patient care, the payment schemes, and the possible existence of incentives for providers). Dutu and Sicari [3] applied DEA (with a two inputs–one output structure and at least one of the variables representing a composite indicator controlling for country-specific factors) to assess the efficiency of welfare spending in OECD countries in 2012, focusing on health care, secondary education, and general public services. They found wide dispersion in efficiency measures across OECD countries and provided quantified improvements for output and input efficiency. In a second paper, the same authors [4] calculated the efficiency scores for health care using life expectancy at birth as a proxy of the health system outcomes and total per capita expenditure on health care as an input variable and the results show significant potential efficiency gains on both output and input sides. Using the same method (DEA), Behr and Theune [5] investigated the efficiencies of the health care systems from 34 OECD countries in 2012 by seeing the effects of different indicators: medical inputs on surgery provision and mortality prevention lifestyle; and income and health expenditure per capita and relative to GDP on life expectancy from birth. They observed strong variations in efficiency across the five analyses: some countries are efficient at producing a particular health care output but very inefficient at producing other outputs.

An empirical characterisation of 29 OECD health care systems for 2007 using cluster analysis identified six groups of countries sharing similar institutions [2]: 1—Germany, the Netherlands, the Slovak Republic, and Switzerland; 2—Australia, Belgium, Canada, and France; 3—Austria, the Czech Republic, Greece, Japan, Korea and Luxembourg; 4—Iceland, Sweden, and Turkey; 5—Denmark, Finland, Mexico, Portugal, and Spain; 6—Hungary, Ireland, Italy, New Zealand, Norway, Poland, and the United Kingdom. In the European Union, Medeiros and Schwierz [6] found evidence about widespread inefficiency in the health care systems. Countries were clustered using efficiency scores for 2012 calculated on 20 DEA-based models and the results show that the Czech Republic, Lithuania, and Slovakia have the lowest efficiency scores in most of the models used; Hungary, Latvia, Poland, and Estonia, although scoring better than the previous group, are also underperformers; Belgium, Cyprus, Spain, France, Luxembourg, Sweden, and the Netherlands consistently score among the top seven performers in most of the models and are clustered in the group of countries with the highest efficiency scores. A two-step cluster analysis based on medical services expenditure in the EU for the period 2004–2015, with a special focus on Poland, Latvia, Lithuania, and Estonia, was conducted by Walczak et al. [7]. The analysis for 2004 does not indicate the existence of significantly different groups but for 2015 shows that four clusters were the best solution.

Public and private health spending comparisons are carried out for a longer time and by groups of countries. For example, the Global Health Expenditure Report [8] provides a broad picture of global patterns of health spending over the past 20 years for WHO members. The most recent report (2021) also gives some early findings about COVID-19 for 16 countries showing that current health spending in 2020 was between USD 12–602 per capita in high-income countries and between USD 3.20–22 per capita in low- and middle-income countries. For the period 1995–2013, Grigorakis et al. [9] examined the impact of macroeconomic and public and private health insurance financing factors on out-of-pocket health care expenditures, by using fixed/random effects and dynamic panel data methodology with a dataset of 26 EU and OECD countries. Balkan and Eastern European countries were analysed in the paper of Stepovic et al. [10] by comparing different macroeconomic and health expenditure indicators in the period 1995–2014 (total health expenditure as percentage of GDP, GDP per capita in USD, and private households' out-of-pocket payments on health as a percentage of total health expenditure) using a linear trend model. They found that most of the countries showed a significant correlation between the observed indicators. For a small set of countries (six EU member states), over the past 50 years, Albulescu [11] compared public and private health expenditure per capita and as a percentage of GDP using bound unit root tests. The results highlight the heterogeneity of the EU health care systems and the need for common solutions to enhance their convergence process. A retrospective analysis of the Romanian health care system in the 1985–2019 period is presented in the paper of Onofrei et al. [12], which computed a sustainability index for public health and the causal relationship between health expenditure and GDP in Romania. The findings show the intergenerational costs of policy incoherence and regulatory fragmentation.

There are also studies that looked at the reaction of health systems in times of crisis. A WHO policy summary [13] presented in 2012 the results of a survey of health policy responses to the financial crisis in the European region, which were very different between health systems and dependent on the extent to which countries experienced a significant economic downturn. Using cross-country fixed-effects multiple regression analysis, the authors [14] estimated how government health care expenditure growth in Europe has changed following economic crises. They found that, in the year after an economic downturn, public health care expenditure grows more slowly than would have been expected and cost-shifting policy responses are associated with these slowdowns. An OECD study [15] summarised in 2014 the main findings in the published literature on the effects of the economic crisis and described different health policy reforms. For 34 OECD countries, Morgan and Astolfi [16] observed in 2015 that, since the global financial crisis, health spending has slowed or fallen differently in many countries after years of continuous growth. The resilience of health financing policy to economic shocks (the global financial crisis and the COVID-19 pandemic) was analysed in the paper of Thomson et al. [17]. They observed that responses to the pandemic show evidence of lessons learnt from the 2008 crisis but also reveal weaknesses in health financing policies in Europe that limit national preparedness to face economic shocks, particularly in countries with social health insurance schemes.

Regarding the pandemic period, many works evaluate primarily the responses of health systems to the COVID-19 outbreak. Some results of these studies are as follows:

- By analysing the financial dimension of the EU public health systems during 2010–2018 (total health expenditure to GDP and expenditure per capita) and the connection with pandemic management, Cibik et al. [18] found that below-average health expenditure per capita of the EU countries indicates a better management of the pandemic (measured by number of deaths and mortality per 1000 infected) but not higher amounts allocated to health care;

- To show the countries' readiness for the prevention and diminution of pandemics, Radenovic et al. [19] examined the interdependence between health expenditures and the efficiency of health systems in the EU countries using the Global Health Security Index as the overall measure and its main categories—prevention, detection, and rapid response. The correlation results demonstrated significant correlation between health expenditures, either as percent of GDP or per capita, and the GHS index, prevention, and health system. The results of the regression analysis revealed the positive impact of health expenditures on the efficiency measures;
- To evaluate the efficiency of 31 European countries' health systems in treating COVID-19, for the period January 2020–January 2021, Lupu and Tiganasu [20] used health inputs—COVID-19 cases, physicians, nurses, hospital beds, and health expenditure—and used COVID-19 deaths as an output, and the conclusion was that the inefficiency of the health systems was quite high, even in the Western countries (Italy, Belgium, Spain, UK);
- To analyse the determinants of the measures to limit the spread of COVID-19, Bourdin et al. [21] used the COVID-19 stringency index and patient capacity in intensive care units as indicators of the capacity of countries to have an appropriate health system to absorb the pandemic crisis;
- By studying the health system responses to COVID-19 in Bulgaria, Croatia, and Romania from February 2020 until the end of 2020 based on Health System Response Monitor (HSRM) data, Dzakula et al. [22] identified common problems (workforce shortages, underdeveloped and underutilised preventive and primary care) and some challenges (qualified health workers, digital tools for non-COVID-19 health services, communication to the public and levels of public trust);
- By reviewing the health system responses in six Mediterranean countries (Cyprus, Greece, Israel, Italy, Malta, Portugal, and Spain) during the first six months of the COVID-19 pandemic, Waitzberg et al. [23] observed that, prior to the pandemic, these countries shared similarities in terms of health system resources, which were low compared to the EU/OECD average;
- For three EU countries—Germany, Sweden, and Greece—Tsalampouni [24] found some common responses to the COVID-19 pandemic (universal coverage providing for free COVID-19 treatment, testing, and vaccination) and highlighted the need to strengthen the EU's role in coordinating health care;
- By analysing the vulnerabilities affecting the health budget effort in the EU member states during the health crisis period, Antohi et al. [25] noticed that the change in the financial allocation paradigm from conservative to proactive had beneficial effects over the period 2009–2018;
- The experience of some countries (China, Germany, Iceland, Republic of Korea, Rwanda, Uruguay, and Vietnam) that performed relatively well in coping with the COVID-19 crisis was presented by Islam et al. [26]. The authors suggested that it is necessary to establish universal health care and social protection systems and to improve the governance of these systems even by developing countries;
- The impact of COVID-19 in Asia and the Pacific was summarised by Kwon and Kim [27], who considered that as countries having pandemic preparedness in their resilient health systems were able to better deal with the pandemic and to provide access to essential services, investment into strengthening health systems is a fundamental solution for pandemic preparedness and response.

Summing up, we observe a variety of input and output measures of health system efficiency, various patterns of health spending, and very different health systems' responses to the financial crisis and the pandemic, in previous studies focusing on different sets of countries and time periods.

A number of questions regarding health policy and the efficiency and resilience of health systems remain to be addressed. Although many cross-country analyses were previously conducted, there are not so many centred on the European Union. Such a study could be valuable considering that typically health policies are national and, building on the COVID-19 experience, the EU tries to prove that a common approach and a relevant budget could produce synergic effects across member states.

One significant challenge during COVID-19 was the lack of data about specific health dimensions, necessary to monitor, evaluate, and implement different policies. In less than two years, through cooperation among international institutions, national authorities, scientific communities, and think-thanks, many tools were developed to respond to this need. Databases, complex indicators, and channels for the short-term collection of data emerged. Our paper values these achievements using newly developed indicators (the GHS Index and excess mortality caused by COVID-19) and considering digitalisation (measured by DESI) as a key success factor for the reaction of the health systems to shocks and the implementation of successful health policies. Moreover, the short-term reaction to COVID-19 was analysed in the context of the long-term patterns identified by using data for 20 years, providing some new understandings about the health spending patterns in EU countries.

2. Research Methodology

The aim of the study is to analyse the relationship between the long-term health spending patterns of the EU countries and their ability to react effectively to crises and shocks such as COVID-19. The European Union is a heterogeneous group of countries and there are important differences between member states regarding the health systems and policies. To study long-term health spending behaviour, we selected two indicators from the WHO Global Health Expenditure Database: Average Current Health Expenditure as % of GDP and Current Health Expenditure per capita in USD for 2000–2019. The timeframe was established based on data availability, and the national values for current member states were used. To study the reaction to shocks, in particular to the COVID-19 crisis, we used indicators from the Eurostat database (excess mortality and DESI) and the Global Health Security Index, developed by an international group of experts at the end of 2019 [28].

The premise of the study is that countries with a history of strong and well-financed health systems are able to cope better with shocks. Studying the similarities and differences among EU countries and grouping them based on their health spendings is the first step in our approach. For that, we performed a K-means cluster analysis in SPSS Statistics.

The second step is to identify relevant ways to measure the reaction to COVID-19 and to use them to analyse the differences between the identified clusters. Based on the literature and recent developments in the field, we identified three relevant dimensions for our hypothesis: the impact of COVID-19; general level of preparedness; and digitalisation as a success factor for the implementation of short-term measures and key health policies. For each dimension we selected one indicator: Global Health Security Index for the assessment of the ability to provide health security in time of crisis, as a general measure for readiness of the systems; excess mortality caused by COVID-19, a measure developed by Eurostat, for the impact of COVID-19; Digital Economy and Society Index as a proxy for the ability to timely implement different health policies, relevant for both the reaction during COVID-19 and for the future health policy of the European Union.

The methodology section is organised as follows: first, we present the methodological aspects related to the K-means cluster analysis; second, the methodology of the one-way ANOVA in SPSS Statistics is detailed.

2.1. Cluster Analysis

The first dimension that emerges from the research question is to understand the long-term patterns of health expenditures inside the European Union. Based on previous studies [2,6,7], cluster analysis was identified as the appropriate methodological approach.

Using data from the WHO Global Health Expenditure Database [29], we calculated average Current Health Expenditure as percent of GDP (CHE_gdp) and average Current

Health Expenditure per capita in USD (CHE_pc_usd) for 20 years (2000–2019) to group EU-27 countries based on their health spending behaviour (Table 1).

Table 1. Average values of CHE_gdp and CHE_pc_usd for the EU countries in 2000–2019.

	Country	Average Current Health Expenditure as % of GDP (2000–2019)	Average Current Health Expenditure per Capita in USD (2000–2019)
1	Austria	9.94	4309.20
2	Belgium	9.82	4013.07
3	Bulgaria	7.00	423.87
4	Croatia	7.12	850.24
5	Cyprus	6.16	1622.24
6	Czech Republic	6.78	1172.47
7	Denmark	9.62	5140.74
8	Estonia	5.72	878.93
9	Finland	8.70	3769.47
10	France	10.77	4028.43
11	Germany	10.71	4241.11
12	Greece	8.39	1818.13
13	Hungary	7.21	869.56
14	Ireland	8.14	4391.73
15	Italy	8.46	2756.88
16	Latvia	5.80	671.94
17	Lithuania	6.30	754.78
18	Luxembourg	6.17	5813.21
19	Malta	8.24	1745.61
20	The Netherlands	9.60	4457.89
21	Poland	6.16	683.53
22	Portugal	9.39	1876.40
23	Romania	5.09	385.46
24	Slovakia	6.74	960.05
25	Slovenia	8.22	1720.67
26	Spain	8.37	2296.73
27	Sweden	9.33	4644.59

Source: authors' calculation based on WHO Global Health Expenditure Database

Health care spending has continued to increase in EU countries over the past 20 years. In 2019, prior to the COVID-19 pandemic, EU countries spent, on average, around 8.25% of their GDP on health care, compared to 6.90% in 2000. The cross-country variation is wide, ranging in 2019 from less than 6% in Luxembourg and Romania to more than 10% of GDP in Austria, Belgium, Germany, and France. Furthermore, Germany spent by far the most on health care, equivalent to 11.7% of its GDP in 2019 and 12.5% in 2020. Average per capita in health care spending raised from 1124.35 USD/year in 2000 to 3007.60 USD/year in 2019.

According to Table 1, the average CHE_gdp in the EU-27 for the period 2000–2019 was 7.92% of GDP, while the lowest average value of 5.09% was recorded in Romania and the highest average value of 10.77% in France. The average CHE_pc_usd in the EU-27 for the period 2000–2019 was 3007 USD, with the lowest average value of 385.46 USD in Romania and the highest value of 5813.21 USD in Luxembourg.

Then, we performed a cluster analysis using the K-means cluster procedure in SPSS Statistics to assign the countries to a fixed number of groups whose characteristics are not known but are based on a set of specified variables—average Current Health Expenditure as percent of GDP (CHE_gdp_av) and average Current Health Expenditure per capita in USD (CHE_pc_usd_av).

We determined the number of clusters to be 3 to comply with the condition to use the minimum number of clusters relevant for the set of data (Table 2). We made simulations with 4 and 5 clusters, but the best results were obtained for 3 groups of countries, and the initial cluster centres are evaluated based on the data.

Table 2. Describes the number of the iterations and the changes in the cluster centres.

Iteration History			
Iteration	**Change in Cluster Centres**		
	1	**2**	**3**
1	1020.322	39.724	379.620
2	311.949	618.410	151.062
3	0.000	122.084	151.062
4	0.000	0.000	0.000

Convergence was achieved due to no or small change in cluster centres. The maximum absolute coordinate change for any centre is 0.000. The current iteration is 4. The minimum distance between initial centres is 2371.418.

The final cluster centres are given in Table 3.

Table 3. Final Cluster Centres.

	Cluster 1 (N = 10)	**Cluster 2 (N = 7)**	**Cluster 3 (N = 10)**
CHE_gdp_av	9	8	6
CHE_pc_usd_av	4480.95	1976.66	765.08

The results presented in Table 3 show that we have 3 groups:

- Cluster 1, high health spenders, includes 10 countries—Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, the Netherlands, and Sweden. In the analysed period (2000–2019), these countries spent 4480.95 USD/capita, representing about 9% of their GDP.
- Cluster 2, medium health spenders, includes 7 countries—Cyprus, Greece, Italy, Malta, Portugal, Slovenia, and Spain. In the analysed period (2000–2019), these countries spent 1976.76 USD/capita, representing about 8% of their GDP.
- Cluster 3, low health spenders, includes 10 countries—Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia. In the analysed period (2000–2019), these countries spent 765.08 USD/capita, representing about 6% of their GDP.

2.2. One-Way ANOVA Analysis

The second step in our research is to study the capacities of the EU countries to react to important health shocks such as COVID-19 in the context of previously identified clusters. A one-way ANOVA was carried out to identify if there are significant differences between the three groups during the COVID-19 pandemic regarding the general level of preparedness (measured by Global Health Security Index), the impact (measured by excess mortality), and the digitalisation as a key factor in implementing successful health and economic policies (measured by the Digital Economy and Society Index).

We selected three indicators to evaluate the impact of the COVID-19 pandemic: the Global Health Security Index (GHS Index), excess mortality and the Digital Economy and Society Index (DESI).

The Global Health Security Index is the first comprehensive assessment and benchmarking of health security and related capabilities across 195 countries, launched in October 2019 followed by the second publication in December 2021. It was developed in partnership by the Nuclear Threat Initiative (NTI) with the Johns Hopkins Center for Health Security at the Bloomberg School of Public Health, working with Economist Impact. We selected the GHS Index because it is organised by six categories aimed at assessing country capability to prevent, detect, and respond to biological threats as well as factors that can improve that capability to address infectious disease outbreaks that can lead to international epidemics and pandemics [28]. For the GHS Index, the average value in the EU countries was 56.7 in 2019 and 57.03 in 2021. The minimum was recorded in Malta (37.30 in 2019 and 40.2 in 2021) and the maximum of 75.6 in the Netherlands in 2019 and of 70.9 in Finland in 2021.

According to Eurostat [30], “the monthly excess mortality indicator is based on the exceptional data collection on weekly deaths that Eurostat set up, in April 2020, to support the policy and research efforts related to COVID-19. With that data collection, Eurostat’s target was to quickly provide statistics assessing the changing situation of the total number of deaths on a weekly basis, from early 2020 onwards”. “The number of deaths from all causes is compared with the expected number of deaths during a certain period in the past. The reasons for an excess mortality may vary according to different phenomena. The indicator is simply comparing the total number of deaths from all causes with the expected number of deaths during a certain period in the past (baseline).” Excess mortality was selected as a relevant short-term measure of the impact of COVID-19 in the EU countries, providing information about the additional death amongst the European countries during the pandemic. The annual average for each country was determined, based on the monthly data for 2021 available in the Eurostat database. The European Union experienced a 14.13% excess mortality in 2021, compared to historical monthly data for each country.

The Digital Economy and Society Index (DESI) is a composite index that summarises relevant indicators on Europe’s digital performance and tracks the evolution of EU countries, across five main dimensions: Connectivity, Human Capital, Use of Internet, Integration of Digital Technology, and Digital Public Services [31]. During the pandemic, digitalisation proved to be one of the most important success factors involved in fighting the disease, and a condition for the successful implementation of various responses to the health crisis (communication with patients, apps, diagnosis, contactless health support). DESI is currently the most comprehensive way to measure the digitalisation in EU countries, being a signal of potential gaps influencing the way of dealing with pandemics and a premise for future health policies.

This study uses data from the GHS Index 2019, Eurostat—for excess mortality 2021 and European Commission—for DESI 2019 (Table 4).

We want to determine if countries that spent more on health during the past 20 years were more prepared and had better reactions to the COVID-19 crisis. We considered three dimensions (preparedness, impact and digitalisation) measured by the three indicators above as relevant for the performance of the health systems. A one-way analysis of variance (ANOVA) in SPSS was used to determine if there are any statistically significant differences between the means of the three independent groups identified through cluster analysis: high health spenders (Cluster 1, 10 EU countries), medium health spenders (Cluster 2, 7 EU countries), and low health spenders (Cluster 3, 10 EU countries).

To run the one-way ANOVA, we used the approach available on Laerd Statistics [32].

Table 5 provides an overview of the study design. One purpose of this paper is to investigate the differences in GHS Index, excess mortality, and DESI between EU countries. The chosen methodology aims to answer the question of whether there are any differences between the three types of countries (high, medium, and low health spenders).

Following the K-means cluster analysis that used Current Health Expenditure as percent of GDP (CHE_gdp) and Current Health Expenditure per capita in USD (CHE_pc_usd), the current 27 EU member states were classified into three groups: high health spenders (n = 10, CHE_pc_usd = 4480.95 USD, CHE_gdp = 9%), medium health spenders (n = 7, CHE_pc_usd = 1976.76 USD, CHE_gdp = 8%) and low health spenders (n = 10, CHE_pc_usd = 765.08 USD, CHE_gdp = 6%).

Table 4. COVID-19 in EU—preparedness and strength of health systems (GHS Index), impact (excess mortality), and digital performance (DESI).

	Country	GHS Index 2019	Excess Mortality Monthly Average 2021 (%)	DESI 2019
1.	Austria	57.4	11.09	47.7
2.	Belgium	61.9	2.5	46.1
3.	Bulgaria	61.4	34.83	32.7
4.	Croatia	49.8	21.03	38.4
5.	Cyprus	42.3	16.76	37.0
6.	Czech Republic	55	31.79	41.1
7.	Denmark	67.3	6.04	57.9
8.	Estonia	55.6	21.14	52.1
9.	Finland	72	6.69	58.1
10.	France	62.6	8.73	44.0
11.	Germany	65.7	10.11	45.1
12.	Greece	50.6	17.04	30.1
13.	Hungary	55	20.85	35.3
14.	Ireland	55.1	10.65	49.1
15.	Italy	51.9	9.44	38.5
16.	Latvia	59.8	21.31	44.5
17.	Lithuania	54.9	19.98	46.7
18.	Luxembourg	48.6	6.89	51.5
19.	Malta	39.3	16.48	52.0
20.	The Netherlands	67.7	13.95	54.5
21.	Poland	54.3	30.01	33.9
22.	Portugal	58.7	14.49	44.3
23.	Romania	45.5	22.5	27.1
24.	Slovakia	52	45.25	37.7
25.	Slovenia	68.6	17.53	45.9
26.	Spain	60.4	7.46	49.6
27.	Sweden	66.4	2.04	58.4

Source: authors' calculation based on GHS Index, European Commission and Eurostat data

Table 5. Study design.

Null Hypothesis	Alternative Hypothesis	Dependent Variable	Independent Variable	Clusters
There is no difference in pre-pandemic GHS index (2019) between high, medium, and low health spenders.	There is a difference in pre-pandemic GHS index (2019) between high, medium, and low health spenders.	GHS Index 2019		Cluster 1: high health spenders
There is no difference in excess mortality during the COVID-19 crisis (2021) between high, medium, and low health spenders.	There is a difference in excess mortality during the COVID-19 crisis (2021) between high, medium, and low health spenders.	Excess mortality 2021	Type of country	Cluster 2: medium health spenders
There is no difference in pre-pandemic DESI index (2019) between high, medium, and low health spenders.	There is a difference in pre-pandemic DESI index (2019) between high, medium, and low health spenders.	DESI 2019		Cluster 3: low health spenders

A one-way ANOVA analysis for each dimension was conducted then to determine the following:

A. If the preparedness and strength of the health systems (GHS Index) were different for countries with different health spending patterns.

B. If the impact of COVID-19 (excess mortality) was different for countries with different health spending patterns.
C. If the digitalisation (DESI), as one core aspect of the health system performance during the pandemic, was different for countries from the three clusters.

Six assumptions of the one-way ANOVA were considered for each dimension:

#1 The dependent variable is measured at the continuous level:

GHS Index—yes
Excess mortality—yes
DESI—yes

#2 There is one independent variable, type of country, that consists of three independent groups: high, medium, and low health spenders.
#3 Independence of observation is met: there is no relationship between countries from any of the groups.
#4 No significant outliers.
#5 Dependent variables are normally distributed.
#6 There is homogeneity of variances.

Assumptions 4 to 6 were tested using SPSS Statistics.

#4 No significant outliers

For GHS Index, two outliers were identified in the low health spenders group (Figure 1): Bulgaria (score 61.4, O^3 in the Figure 1) and Romania (score 45.5, O^{23} in the Figure 1). For excess mortality (Figure 2) and DESI (Figure 3) there were no outliers in the data, as assessed by an inspection of the boxplots. We decided to keep the outliers because the effect on the analysis was not considered significant.

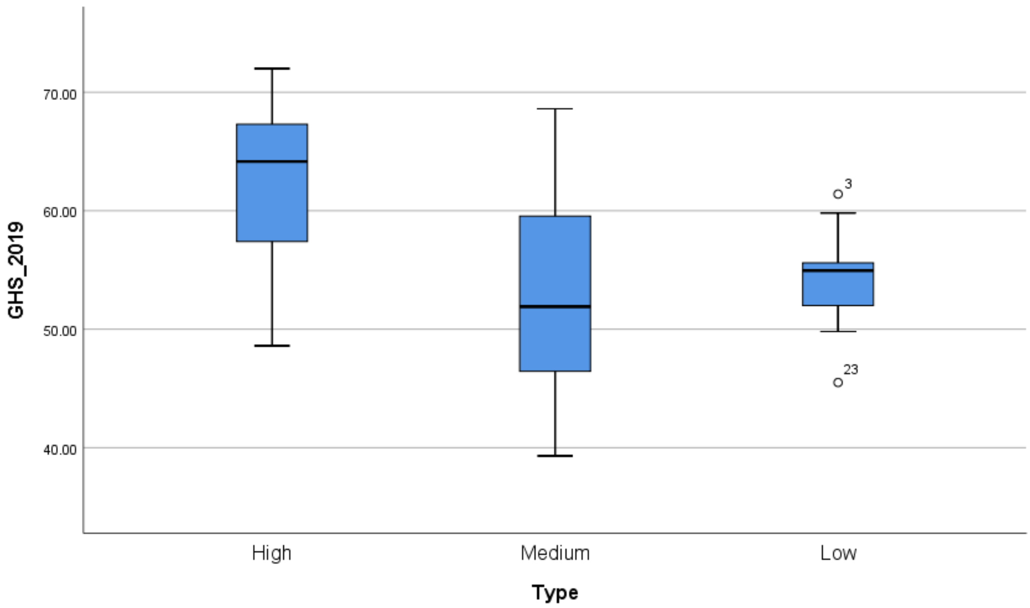

Figure 1. Outliers—GHS Index.

#5 Dependent variables are normally distributed

According to Tables 6 and 7, GHS index and DESI were normally distributed for high, medium, and low health spenders, as assessed by a Shapiro–Wilk's test ($p > 0.05$). Excess mortality for medium and low health spenders was not normally distributed but one-way ANOVA was still considered robust [33].

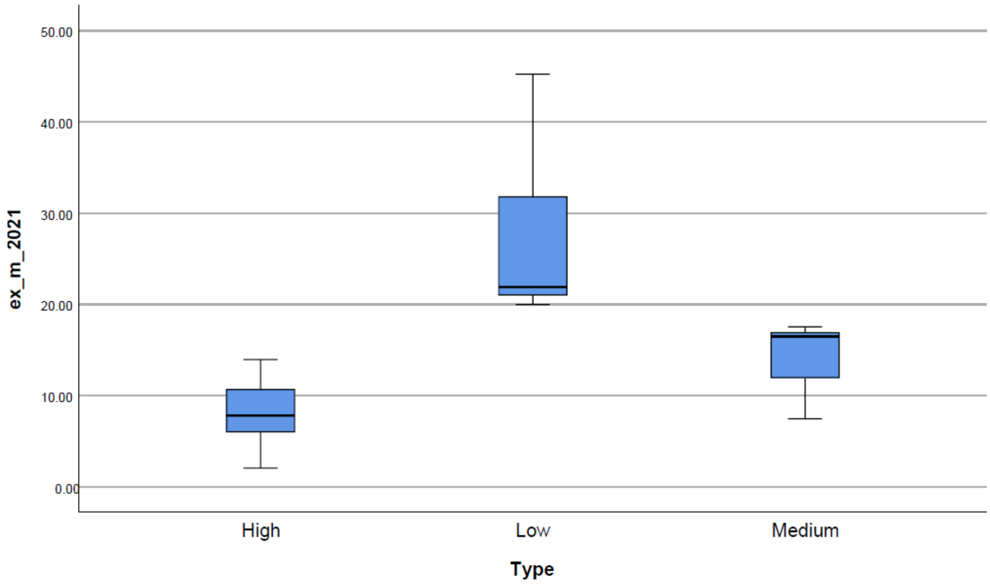

Figure 2. Outliers—excess mortality.

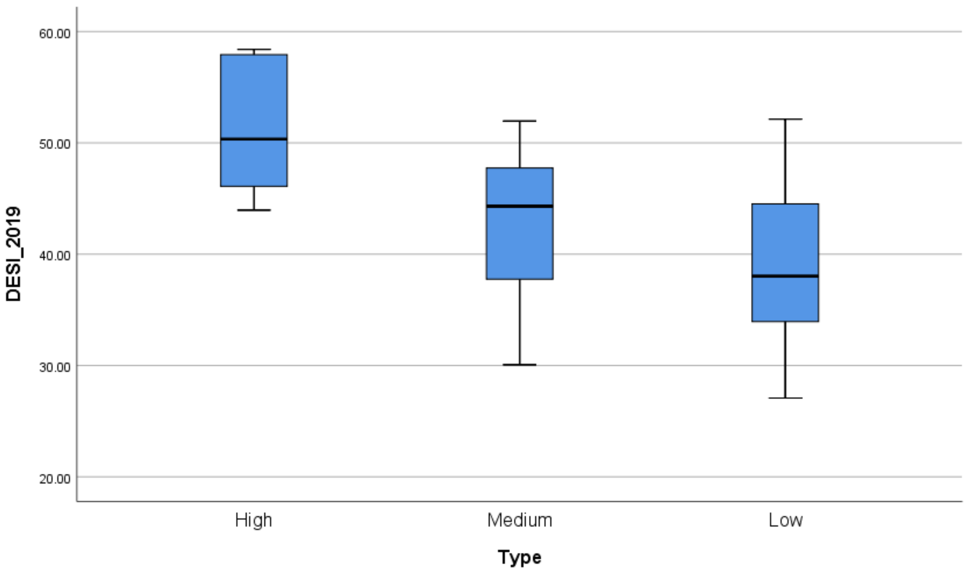

Figure 3. Outliers—DESI.

Data are presented as mean ± standard deviation.

The preparedness for pandemic crisis (GHS index) increased from the medium (n = 7, 53.1 ± 10.3), to low (n = 10, 54.3 ± 4.5), to high (n = 10, 62.5 ± 7.0) health spenders, in that order. The impact of the pandemic crisis (excess mortality) increased from the high (n = 10, 7.9 ± 3.8), to medium (n = 7, 14.2 ± 4.1), to low (n = 10, 26.9 ± 8.4) health spenders. The degree of digitalisation (DESI) increased from the low (n = 10, 38.9 ± 7.4), to medium (n = 7, 42.5 ± 7.7), to high (n = 10, 51.2 ± 5.7) health spenders, in that order.

#6 There is homogeneity of variances

There was homogeneity of variances, as assessed by Levene's test for equality of variances for the GHS Index ($p = 0.074$) and for DESI ($p = 0.709$). However, the assumption of homogeneity of variances was violated, as assessed by Levene's test for equality of variances ($p = 0.018$), for excess mortality (Appendix A.1).

Table 6. Tests of normality.

	Type	Kolmogorov–Smirnova			Shapiro–Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
GHS_2019	High	0.178	10	0.200 *	0.943	10	0.583
	Medium	0.138	7	0.200 *	0.968	7	0.884
	Low	0.197	10	0.200 *	0.944	10	0.597
Excess mortality_2021	High	0.123	10	0.200 *	0.960	10	0.781
	Medium	0.286	7	0.086	0.799	7	0.040
	Low	0.298	10	0.012	0.799	10	0.014
DESI_2019	High	0.181	10	0.200 *	0.893	10	0.181
	Medium	0.166	7	0.200 *	0.963	7	0.847
	Low	0.131	10	0.200 *	0.987	10	0.991

* This is a lower bound of the true significance, a Lilliefors Significance Correction.

Table 7. Descriptives.

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
GHS_2019	High	10	62.4700	6.99302	2.21139	57.4675	67.4725	48.60	72.00
	Medium	7	53.1143	10.32528	3.90259	43.5650	62.6636	39.30	68.60
	Low	10	54.3300	4.55413	1.44014	51.0722	57.5878	45.50	61.40
	Total	27	57.0296	8.18680	1.57555	53.7910	60.2682	39.30	72.00
Excess mortality_2021	High	10	7.8690	3.79104	1.19883	5.1571	10.5809	2.04	13.95
	Medium	7	14.1714	4.06346	1.53584	10.4134	17.9295	7.46	17.53
	Low	10	26.8690	8.40578	2.65814	20.8559	32.8821	19.98	45.25
	Total	27	16.5400	10.23258	1.96926	12.4921	20.5879	2.04	45.25
DESI_2019	High	10	51.2427	5.65843	1.78935	47.1949	55.2905	43.95	58.39
	Medium	7	42.4726	7.69355	2.90789	35.3573	49.5880	30.06	51.96
	Low	10	38.9550	7.37454	2.33203	33.6796	44.2304	27.08	52.12
	Total	27	44.4180	8.60113	1.65529	41.0155	47.8205	27.08	58.39

For two of the three variables (GHS Index and DESI) we have homogeneity of variances. We ran a one-way ANOVA. In both cases, we found statistically significant differences between high, medium, and low health spenders: GHS Index—F(2,24) = 4.512, $p = 0.022 < 0.05$; DESI—F(2,24) = 25.796, $p = 0.000 < 0.05$ (Table 8). For these variables, the results from the Tuckey post hoc test are relevant (Appendix A.2).

For excess mortality, the assumption of homogeneity of variances was not met and the results of the Games–Howell post hoc test are relevant (Appendix A.2). Because of that, a modified version of the ANOVA is used, Welch's ANOVA, and the results of the Welch's ANOVA are found in the Robust Tests of Equality of Means table (Table 9). The excess mortality value was statistically significantly different for high, medium, and low health spenders, Welch's F(2, 14.543) = 21.583, $p < 0.0005$. Because the Welch's ANOVA is statistically significant, a post hoc test Games-Howell is considered: there was an increase in excess mortality from 7.9 ± 3.8 for high health spenders to 14.2 ± 4.1 for medium health spenders and to 26.9 ± 8.4 for low health spenders. There was an increase of 19.00 (95%CI, 11.3 to 26.7) from low health spenders to high health spenders, which was statistically significant ($p < 0.001$).

An effect size for one-way ANOVA was calculated using omega squared ($\omega 2$). Partial eta squared for GHS Index was 0.273, for excess mortality 0.683 and for DESI 0.411 (Appendix A.3).

Table 8. ANOVA.

		Sum of Squares	df	Mean Square	F	Sig.
GHS_2019	Between Groups	476.166	2	238.083	4.512	0.022
	Within Groups	1266.451	24	52.769		
	Total	1742.616	26			
Excess mortality_2021	Between Groups	1858.016	2	929.008	25.796	0.000
	Within Groups	864.331	24	36.014		
	Total	2722.347	26			
DESI_2019	Between Groups	790.705	2	395.353	8.376	0.002
	Within Groups	1132.759	24	47.198		
	Total	1923.464	26			

Table 9. Robust Tests of Equality of Means.

		Statistic [a]	df1	df2	Sig.
GHS_2019	Welch	4.895	2	12.573	0.027
Excess mortality_2021	Welch	21.583	2	14.543	0.000
DESI_2019	Welch	9.152	2	14.027	0.003

[a]. Asymptotically F distributed.

3. Results

The main findings of our study can be summarised as follows.

The cluster analysis revealed that based on their long-term health spending patterns, the current 27 EU member states could be grouped into three clusters, with three different spending patterns: high health spenders—countries that spent on average 4480.95 USD/capita/year, 9% of GDP, in the analysed 20 years before the pandemic, registering both the highest amount per capita and the highest percentage of GDP allocated to their health system; medium health spenders—countries that spent 1976.76 USD/capita/year, 8% of GDP, medium values for both indicators, with a special remark on the absolute value of health spending per capita that was less than a half compared with the first group; low health spenders—countries that spent on average 765.08 USD/capita/year, 6% of GDP, registering both the lowest per capita value (five times less than the first group) and the lowest percentage of GDP allocated to health.

As we concluded based on one-way ANOVA analysis, there are statistically significant differences between the three groups regarding GHS Index 2019 (health system preparedness), excess mortality 2021 (COVID-19 impact), and DESI 2019 (digital preparedness).

The three groups considered for one-way ANOVA were: high health spenders (n = 10), medium health spenders (n = 7), and low health spenders (n = 10). A one-way ANOVA analysis for each dimension was conducted to determine the following:

A. If the preparedness and strength of the health systems (GHS Index 2019) was different for countries with different health spending patterns. There were no outliers, as assessed by boxplots, excepting Romania and Bulgaria, in the low health spenders group. Data were normally distributed for each group, as assessed by a Shapiro–Wilk test ($p > 0.05$); there was homogeneity of variances, as assessed by a Levene's test of homogeneity of variances ($p = 0.074$ for GHS Index). Data are presented as mean ± standard deviation. The GHS score was statistically significantly different between different groups, $F(2, 24) = 4.512$, $p < 0.0005$, $\omega 2 = 0.273$. The GHS score decreased from the high spenders group (62.47 ± 6.99) to the low (54.33 ± 4.55) and medium groups (53.11 ± 10.32). Tukey post hoc analysis revealed that the decrease from the high group to the medium group (9.36, 95% CI (0.42 to 18.30)) was statistically significant ($p = 0.039$), as well as the decrease from the high group to the low group (8.14, 95% CI (0.03 to 16.25), $p = 0.049$).

B. If the impact of COVID-19 (excess mortality 2021) was different for countries with different health spending patterns. There were no outliers, as assessed by boxplots. Data were normally distributed only for high spenders as assessed by a Shapiro–Wilk test ($p > 0.05$); there was heterogeneity of variances, as assessed by a Levene's test of homogeneity of variances ($p = 0.018$ for excess mortality). Data are presented as mean ± standard deviation. Excess mortality percentage was statistically significantly different between different groups, $F(2, 24) = 25.796$, $p < 0.0005$, $\omega 2 = 0.683$. Excess mortality increased from the high spender's group (7.97 ± 3.79) to the medium (14.17 ± 4.06) and low groups (26.87 ± 8.41). Tukey post hoc analysis revealed that the decreases from the high group to the low group (19.0, 95% CI (12.30 to 25.70), $p = 0.000$) as well as from the medium to the low group (12.70, 95% CI (5.31 to 20.08), $p = 0.001$) were statistically significant.

C. If digitalisation (DESI 2019), as one core aspect of the health system performance during the pandemic and a condition for future health policies, was different for countries from the three clusters. There were no outliers, as assessed by boxplots. Data were normally distributed for each group, as assessed by a Shapiro–Wilk test ($p > 0.05$); there was homogeneity of variances, as assessed by a Levene's test of homogeneity of variances ($p = 0.71$ for digitalisation). Data are presented as mean ± standard deviation. The digitalisation score was statistically significantly different between different groups, $F(2, 24) = 8.376$, $p < 0.0005$, $\omega 2 = 0.411$. The digitalisation score decreased from the high spenders group (51.24 ± 5.66) to the medium (42.47 ± 7.69) and low groups (38.96 ± 7.37). Tukey post hoc analysis revealed that the decrease from the high group to the medium group (8.77, 95% CI (0.32 to 17.23)) was statistically significant ($p = 0.041$), as well as the decrease from the high group to the low group (12.29, 95% CI (4.61 to 19.96), $p = 0.001$). Tukey post hoc analysis also showed a decrease from the medium group to the low group (3.52, 95% CI (4.9 to 11.94)), but it was not statistically significant ($p = 0.560$).

Although the two-step analysis performed using K-means cluster and one-way ANOVA in SPSS Statistics provided interesting results and good answers to the research questions, we should include some points to discuss. It was an atypical situation for the GHS Index, where the order between the high, medium, and low spenders was not maintained, with low spenders registering a small advance compared to the medium group. Nevertheless, Tukey post hoc analysis for GHS Index revealed that the decrease from medium to low (1.22, 95% CI (7.72 to 10.16)) was not statistically significant ($p = 0.939$). Moreover, there were two situations where the results of Tukey post hoc analysis were not statistically significant: for excess mortality, the increase from the high group to the medium group (6.30, 95% CI (1.08 to 13.68)) was not statistically significant ($p = 0.105$); for digitalisation, the decrease from the medium group to the low group (3.52, 95% CI (4.94 to 11.97)) was not statistically significant ($p = 0.560$).

The analysis identified three statistically significant clusters in the EU, considering the average health spending between 2000 and 2019 (absolute annual per capita value and percent of GDP). The results are in line but not identical to previous studies. For example, Medeiros and Schwierz [6] studied the efficiency of the health systems and, according to their results, Bulgaria, Spain, and Cyprus should be included in the high performer cluster, but according to our results, Bulgaria is included together with another nine countries in the low-spending group and Spain and Cyprus are included in Cluster 2, together with the medium health spenders. In addition, it should be mentioned that our results provided a more balanced number of countries per cluster (10-7-10) compared to similar studies, which could be a plus, particularly in designing tools for health policies at the EU level. As an example, Walczak et al. [7] studied 30 countries, and their results for the classification into three clusters include only two countries in Cluster 1, four countries in Cluster 2, and 24 countries in Cluster 3. The differences between our results and previous studies could be explained by the variables considered and by the fact that we used the average values for 20 years instead of a single year.

Regarding the one-way ANOVA analysis, our results statistically prove the idea that the group of countries with long-term high spending patterns (4480.95 USD/capita/year, 9% of GDP) was more prepared to deal with the pandemic shock for all three dimensions considered in the study (GHS Index—15% higher, excess mortality—70% lower, and DESI values—31% higher compared to the low-spending countries). Our hypothesis that countries with a history of strong and well-financed health systems are able to cope better with shocks was confirmed and the results are in line with the literature. Nevertheless, several contributions to the existing literature in this part of the study could be emphasised: the focus on the current EU countries, which will soon start to implement and apply common health policy, could provide an useful insight for future decisions; though there are studies about the relationship between health spending and the performance of the health systems, those are often geographically limited (fewer countries), and they are not focused on the behaviour during a health crisis; we considered a different set of indicators, using recently developed indicators such as GHS and excess mortality; we covered the long-term in our attempt to identify patterns (most studies group countries/rely on a single year).

4. Discussion

Some discussions regarding the selected indicators could contribute to a better understanding of the results. For cluster analysis, we used WHO data, available for 20 years, and there were some decisions to make. The selection of variables for cluster analysis involved several statistical tests that included some other indicators such as out-of-pocket (OOPS) as percent of Current Health Expenditure (CHE), domestic general government health expenditure (GGHE-D) as percent of GDP, etc. The most relevant for our research objective to group the EU countries in homogeneous clusters (minimum outliers, cluster centres, number of iterations necessary to stabilise the results) proved to be Current Health Expenditure as percent of GDP and Current Health Expenditure per capita in USD. Regarding the year, we used average values for the period studied, considering that one of our research objectives was to connect long-term behaviour with short-term impact and reaction. For one-way ANOVA analysis, the selection of the indicators was the result of the effort to match the research questions and objectives with data availability and the literature review, during the research design process. While GHS Index was selected because of the novelty and specificity, considering that the indicator was developed particularly to evaluate the preparedness of the countries to react to a health crisis, for impact of COVID-19 and for the digitalisation, the choice of excess mortality and DESI was influenced more by a qualitative evaluation of the recently developed studies and data availability.

As we already mentioned, a few limitations of our study should be considered for policy implications and future research. Data availability induced some limitations, influencing both indicator selection and the years analysed. For future research, the use of the post-COVID information (values for 2021–2022) could bring some new insights and increase the relevance of the results. Moreover, a dynamic research field has already emerged from the need to measure the impact of the pandemic and from the general commitment to use the COVID-19 experience to design stronger health systems. As much as new tools are developed, the study could be extended and improved. However, although the results of this study are relevant for the EU, because of the regional specificity and the level of integration, analysis should be carried out with a different panel selection if the aim is to extrapolate the results.

To conclude the discussions, the results of the classification of EU countries into three groups based on their 20-year average spending on health, and the analysis of variance between groups for three dimensions (preparedness and strength of the health systems, impact of COVID-19, and digitalisation) using SPSS Statistics are interesting and could be considered for future research and in designing and implementing health policies.

5. Conclusions

The purpose of this paper was to study if the European Union countries that were consistent in financing national health systems were more prepared to deal with the pandemic shock. The main achievements, including contributions to the literature, can be summarised as follows: grouping the EU countries into three relevant clusters based on their long-term health spending behaviour; proving that long-term health spending patterns influence the ability of countries to deal with crises. These conclusions could be used for future research on health systems: the groups of countries identified through K-means clustering proved to be relevant for differences and similarities between EU countries for several dimensions; this paper uses newly developed indicators such as the GHS index and excess mortality, opening a path for future research in the field.

The focus of the study was the European Union, but the research could be extended to other countries. Data from the WHO Global Health Expenditure Database include information for more than 190 countries and the GHS index is available for 195 countries. Moreover, in the years to come, at least at the EU level, we can expect newly developed indicators on health digitalisation that could be a step forward in the study of the relationship between health system performance and the level of digitalisation.

Looking at the values of the indicators in each group (Cluster 1—Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, the Netherlands, and Sweden; Cluster 2—Cyprus, Greece, Italy, Malta, Portugal, Slovenia, and Spain; Cluster 3—Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia), the EU health policy could aim to reach a better convergence in order to build the European Health Union (Table 10).

Table 10. Clusters' features.

	Cluster 1 High Health Spenders	Cluster 2 Medium Health Spenders	Cluster 3 Low Health Spenders
CHE_gdp (average 2000–2019, %)	9	8	6
CHE_pc_usd (average 2000–2019, USD)	4480.95	1976.76	765.08
GHS Index (2019, score)	62.47	53.11	54.33
Excess mortality (2021, %)	7.87	14.17	26.87
DESI (2019, score)	51.24	42.49	38.95

The excess mortality indicator developed by Eurostat to estimate the impact of the COVID-19 pandemic provided the best evidence for the importance of long-term commitments in building strong health systems and policies. The GHS index proved to be relevant for our hypothesis that high health spenders are more prepared to deal with crises, though the differences between the other two groups were not so high. Our study shows that countries from the third cluster (low health spenders) suffered the worst impact, with an excess mortality almost 27% higher compared to the pre-pandemic values. The impact on the other clusters was much lower, but still was twice higher for medium health spenders (14.17%) compared to high health spenders (7.87%). The ability of countries to effectively react to challenges and crises in those days is significantly related to digitalisation. Our results indicate that countries with a higher level of digitalisation performed better during the COVID-19 years. Even though there are no data available about health digitalisation and we used DESI as a proxy, the results are a signal of the potential benefits of investing in health digitalisation, an assumed objective of the EU4Health programme 2021–2027.

The general conclusion of the research is that the health systems of the countries from the high health spenders cluster performed better for all three studied dimensions, followed by medium and low health spenders, showing that better financing could increase the performance and the resilience to future shocks of the health systems.

Author Contributions: Conceptualisation, S.M. and R.O.; methodology, S.M. and R.O.; software, S.M.; validation, S.M. and R.O.; formal analysis, S.M.; investigation, S.M. and R.O.; resources, S.M. and R.O.; data curation, S.M.; writing—original draft preparation, S.M. and R.O.; writing—review and editing, S.M. and R.O.; visualisation, S.M. and R.O.; supervision, S.M.; project administration, S.M.; funding acquisition, S.M. All authors have read and agreed to the published version of the manuscript.

Funding: Project financed by Lucian Blaga University of Sibiu & Hasso Plattner Foundation research grants LBUS-IRG-2020-06.

Data Availability Statement: The data presented in this study are openly available online. Details about the sources are presented in the paper (references [28–31]).

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Appendix A.1. Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
GHS_2019	Based on mean	2.905	2	24	0.074
	Based on median	2.430	2	24	0.109
	Based on median and with adjusted df	2.430	2	19.882	0.114
	Based on trimmed mean	2.869	2	24	0.076
Excess mortality_2021	Based on mean	4.754	2	24	0.018
	Based on median	1.102	2	24	0.348
	Based on median and with adjusted df	1.102	2	12.961	0.361
	Based on trimmed mean	4.052	2	24	0.030
DESI_2019	Based on mean	0.349	2	24	0.709
	Based on median	0.189	2	24	0.829
	Based on median and with adjusted df	0.189	2	20.183	0.829
	Based on trimmed mean	0.334	2	24	0.720

Appendix A.2. Multiple Comparisons

Dependent Variable		(I) Type	(J) Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
GHS_2019	Tukey HSD	High	Medium	9.35571 *	3.57984	0.039	0.4158	18.2956
			Low	8.14000 *	3.24865	0.049	0.0272	16.2528
		Medium	High	−9.35571 *	3.57984	0.039	−18.2956	−0.4158
			Low	−1.21571	3.57984	0.939	−10.1556	7.7242
		Low	High	−8.14000 *	3.24865	0.049	−16.2528	−0.0272
			Medium	1.21571	3.57984	0.939	−7.7242	10.1556
	Games–Howell	High	Medium	9.35571	4.48558	0.144	−2.9823	21.6937
			Low	8.14000 *	2.63899	0.019	1.3074	14.9726
		Medium	High	−9.35571	4.48558	0.144	−21.6937	2.9823
			Low	−1.21571	4.15983	0.954	−13.2168	10.7854
		Low	High	−8.14000 *	2.63899	0.019	−14.9726	−1.3074
			Medium	1.21571	4.15983	0.954	−10.7854	13.2168

Dependent Variable		(I) Type	(J) Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Excess mortality_ 2021	Tukey HSD	High	Medium	−6.30243	2.95740	0.105	−13.6879	1.0830
			Low	−19.00000 *	2.68380	0.000	−25.7022	−12.2978
		Medium	High	6.30243	2.95740	0.105	−1.0830	13.6879
			Low	−12.69757 *	2.95740	0.001	−20.0830	−5.3121
		Low	High	19.00000 *	2.68380	0.000	12.2978	25.7022
			Medium	12.69757 *	2.95740	0.001	5.3121	20.0830
	Games–Howell	High	Medium	−6.30243 *	1.94834	0.017	−11.4748	−1.1301
			Low	−19.00000 *	2.91597	0.000	−26.7364	−11.2636
		Medium	High	6.30243 *	1.94834	0.017	1.1301	11.4748
			Low	−12.69757 *	3.06994	0.003	−20.7513	−4.6438
		Low	High	19.00000 *	2.91597	0.000	11.2636	26.7364
			Medium	12.69757 *	3.06994	0.003	4.6438	20.7513
DESI_2019	Tukey HSD	High	Medium	8.77009 *	3.38562	0.041	0.3152	17.2250
			Low	12.28774 *	3.07240	0.001	4.6151	19.9604
		Medium	High	−8.77009 *	3.38562	0.041	−17.2250	−0.3152
			Low	3.51765	3.38562	0.560	−4.9372	11.9725
		Low	High	−12.28774 *	3.07240	0.001	−19.9604	−4.6151
			Medium	−3.51765	3.38562	0.560	−11.9725	4.9372
	Games–Howell	High	Medium	8.77009	3.41432	0.065	−0.5295	18.0697
			Low	12.28774 *	2.93942	0.002	4.7417	19.8338
		Medium	High	−8.77009	3.41432	0.065	−18.0697	0.5295
			Low	3.51765	3.72749	0.624	−6.3536	13.3889
		Low	High	−12.28774 *	2.93942	0.002	−19.8338	−4.7417
			Medium	−3.51765	3.72749	0.624	−13.3889	6.3536

*. The mean difference is significant at the 0.05 level.

Appendix A.3. Tests of Between-Subjects Effects

Dependent Variable: GHS_2019.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	476.166[a]	2	238.083	4.512	0.022	0.273
Intercept	84,206.688	1	84,206.688	1595.767	0.000	0.985
Type	476.166	2	238.083	4.512	0.022	0.273
Error	1266.451	24	52.769			
Total	89,556.840	27				
Corrected Total	1742.616	26				

[a]. R Squared = 0.273 (Adjusted R Squared = 0.213).

Dependent Variable: Excess mortality_2021.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1858.016 [a]	2	929.008	25.796	0.000	0.683
Intercept	6977.052	1	6977.052	193.733	0.000	0.890
Type	1858.016	2	929.008	25.796	0.000	0.683
Error	864.331	24	36.014			
Total	10,108.780	27				
Corrected Total	2722.347	26				

[a]. R Squared = 0.683 (Adjusted R Squared = 0.656).

Dependent Variable: DESI_2019.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	790.705 [a]	2	395.353	8.376	0.002	0.411
Intercept	51,337.490	1	51337.490	1087.698	0.000	0.978
Type	790.705	2	395.353	8.376	0.002	0.411
Error	1132.759	24	47.198			
Total	55,193.323	27				
Corrected Total	1923.464	26				

[a]. R Squared = 0.411 (Adjusted R Squared = 0.362).

References

1. Afonso, A.; Aubyn, M.S. Nonparametric Approaches to Educational and Health Expenditures Efficiency in OECD Countries. *J. Appl. Econ.* **2005**, *8*, 227–246. [CrossRef]
2. Joumard, I.; André, C.; Nicq, C. *Health Care Systems: Efficiency and Institutions*; Elsevier: Amsterdam, The Netherlands, 2010. [CrossRef]
3. Dutu, R.; Sicari, P. Public Spending Efficiency in the OECD. OECD Economics Department Working Papers No. 1278. 2016. Available online: https://www.oecd-ilibrary.org/economics/public-spending-efficiency-in-the-oecd_5jm3st732jnq-en (accessed on 8 March 2022). [CrossRef]
4. Dutu, R.; Sicari, P. Public Spending Efficiency in the OECD: Benchmarking Health Care, Education, and General Administration. *Rev. Econ. Perspect.* **2020**, *20*, 253–280. [CrossRef]
5. Behr, A.; Theune, K. Health System Efficiency: A Fragmented Picture Based on OECD Data. *Pharm. Open* **2017**, *1*, 203–221. [CrossRef] [PubMed]
6. Medeiros, J.; Schwierz, C. *Efficiency Estimates of Health Care Systems in the EU*; European Commission Directorate-General for Economic and Financial Affairs: Brussels, Belgium, 2015.
7. Walczak, R.; Piekut, M.; Kludacz-Alessandri, M.; Sloka, B.; Simanskiene, L.; Paas, T. Health Care Spending Structures in Poland, Latvia, Lithuania and Estonia Over the Years as Compared to Other EU Countries. *Found. Manag.* **2018**, *10*, 45–58. [CrossRef]
8. WHO. *Global Expenditure on Health: Public Spending on the Rise?* World Health Organization: Geneva, Switzerland, 2021.
9. Grigorakis, N.; Floros, C.; Tsangari, H.; Tsoukatos, E. Macroeconomic and financing determinants of out of pocket payments in health care: Evidence from selected OECD countries. *J. Policy Model.* **2018**, *40*, 1290–1312. [CrossRef]
10. Stepovic, M.; Rancic, N.; Vekic, B.; Dragojevic-Simic, V.; Vekic, S.; Ratkovic, N.; Jakovljevic, M. Gross Domestic Product and Health Expenditure Growth in Balkan and East European Countries—Three-Decade Horizon. *Front. Public Health* **2020**, *8*, 492. [CrossRef] [PubMed]
11. Albulescu, C.T. Health Care Expenditure in the European Union Countries: New Insights about the Convergence Process. *Int. J. Environ. Res. Public Health* **2022**, *19*, 1991. [CrossRef] [PubMed]
12. Onofrei, M.; Cigu, E.; Gavriluta Vatamanu, A.F.; Bostan, I.; Oprea, F. Effects of the COVID-19 Pandemic on the Budgetary Mechanism Established to Cover Public Health Expenditure. A Case Study of Romania. *Int. J. Environ. Res. Public Health* **2021**, *18*, 1134. [CrossRef] [PubMed]
13. Mladovsky, P.; Srivastava, D.; Cylus, J.; Karanikolos, M.; Evetovits, T.; Thomson, S.; McKee, M. *Health Policy Responses to the Financial Crisis in Europe*; WHO: Geneva, Switzerland, 2012.
14. Cylus, J.; Mladovsky, P.; McKee, M. Is there a statistical relationship between economic crises and changes in government health expenditure growth? an analysis of twenty-four European countries. *Health Serv. Res.* **2012**, *47*, 2204–2224. [CrossRef] [PubMed]
15. Gool, K.v.; Pearson, M. Health, Austerity and Economic Crisis. *OECD Health Work Pap.* **2014**, *76*, 1–54. [CrossRef]
16. Morgan, D.; Astolfi, R. Financial impact of the GFC: Health care spending across the OECD. *Health Econ. Policy Law* **2015**, *10*, 7–19. [CrossRef] [PubMed]
17. Thomson, S.; García-Ramírez, J.A.; Akkazieva, B.; Habicht, T.; Cylus, J.; Evetovits, T. How resilient is health financing policy in Europe to economic shocks? Evidence from the first year of the COVID-19 pandemic and the 2008 global financial crisis. *Health Policy* **2022**, *126*, 7–15. [CrossRef] [PubMed]
18. Cibik, L.; Melus, M. Funding of Public Health Care in EU Countries in 2010–2018: Preparation for the COVID-19 Pandemic? In Proceedings of the International Scientific Conference "Public Administration 2020", Pardubice, Czech Republic, 19 November 2020.
19. Radenovic, T.; Radivojevic, V.; Krstic, B.; Stanisic, T.; Zivkovic, S. The Efficiency of Health Systems in Response to the COVID-19 Pandemic: Evidence from the EU Countries. *Probl. Ekorozw.—Probl. Sustain. Dev.* **2022**, *17*, 7–15. [CrossRef]
20. Lupu, D.; Tiganasu, R. COVID-19 and the efficiency of health systems in Europe. *Health Econ. Rev.* **2022**, *12*, 14. [CrossRef] [PubMed]
21. Bourdin, S.; Ben Miled, S.; Salhi, J. The Drivers of Policies to Limit the Spread of COVID-19 in Europe. *J. Risk Financ. Manag.* **2022**, *15*, 67. [CrossRef]

22. Džakula, A.; Banadinović, M.; Lovrenčić, I.L.; Vajagić, M.; Dimova, A.; Rohova, M.; Minev, M.; Scintee, S.G.; Vladescu, C.; Farcasanu, D.; et al. A comparison of health system responses to COVID-19 in Bulgaria, Croatia and Romania in 2020. *Health Policy* **2022**, *126*, 456–464. [CrossRef] [PubMed]
23. Waitzberg, R.; Hernández-Quevedo, C.; Bernal-Delgado, E.; Estupiñán-Romero, F.; Angulo-Pueyo, E.; Theodorou, M.; Kantaris, M.; Charalambous, C.; Gabriel, E.; Economou, C.; et al. Early health system responses to the COVID-19 pandemic in Mediterranean countries: A tale of successes and challenges. *Health Policy* **2022**, *126*, 465–475. [CrossRef] [PubMed]
24. Tsalampouni, A. Health systems in the European Union and policy responses to COVID-19: A comparative analysis between Germany, Sweden, and Greece. *J. Public Health Res.* **2022**, *11*, 22799036221129413. [CrossRef] [PubMed]
25. Antohi, V.M.; Ionescu, R.V.; Zlati, M.L.; Mirica, C.; Cristache, N. Approaches to Health Efficiency across the European Space through the Lens of the Health Budget Effort. *Int. J. Environ. Res. Public Health* **2022**, *19*, 3063. [CrossRef] [PubMed]
26. Islam, S.N.; Cheng, H.W.J.; Helgason, K.; Hunt, N.; Kawamura, H.; LaFleur, M. *Variations in COVID Strategies: Determinants and Lessons*; DESA Working Paper; Department of Economic and Social Affairs: New York, NY, USA, 2020; Volume 172.
27. Kwon, S.; Kim, E. Sustainable Health Financing for COVID-19 Preparedness and Response in Asia and the Pacific. *Asian Econ. Policy Rev.* **2022**, *17*, 140–156. [CrossRef]
28. GHS Index. Available online: https://www.ghsindex.org/ (accessed on 8 March 2022).
29. WHO. Global Health Expenditure Database. Available online: https://apps.who.int/nha/database/Select/Indicators/en (accessed on 4 March 2022).
30. EUROSTAT. Excess Mortality Metadata. Available online: https://ec.europa.eu/eurostat/cache/metadata/en/demo_mexrt_esms.htm (accessed on 8 March 2022).
31. EuropeanCommission. Digital Agenda Data. Available online: https://digital-agenda-data.eu/datasets/digital_agenda_scoreboard_key_indicators/indicators (accessed on 8 March 2022).
32. LaerdStatistics. One-Way ANOVA Using SPSS Statistics. Statistical Tutorials and Software Guides. Available online: https://statistics.laerd.com/ (accessed on 2 June 2022).
33. Maxwell, S.E.; Delaney, H.D. *Designing Experiments and Analyzing Data: A Model Comparison Perspective*, 2nd ed.; Psychology Press: New York, NY, USA, 2004.