Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Short Communication

Do the determinants of the COVID-19 mortality rate differ between European Union countries with different adult population pyramids?

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ABSTRACT

Objective: This work aims to determine whether variables such as health expenditure, the total number of physicians, available beds or restrictive public health policies are determinants of the number of deaths due to COVID-19 in the European Union (EU) countries.
Study design: This is a statistical study, evaluating variables associated with COVID-19 mortality in the EU.
Methods: The association of these variables is analysed by means of multiple regression. Three groups of countries are distinguished according to the percentage of population over 65 years of age (terciles), to determine whether the variables affect the mortality rate according to the concentration of the adult population.
Results: In the first tercile, a higher number of physicians will contribute to lower mortality rates. In countries in the second tercile, the number of physicians is not relevant, but healthcare expenditure or the number of beds is. In the older age group, neither variable is significant.
Conclusions: The recruitment of more physicians may contribute to a reduction in deaths in countries with a lower proportion of adult population.

Introduction

In December 2019, a new coronavirus known as COVID-19 emerged in Wuhan (China). Since then, the rapid spread of the virus has caused major health, social, and economic crises worldwide.[1] The governments of the different countries have adopted various measures to alleviate the effects of the pandemic with the aim of reducing the number of infected and dead people. This situation has led to the paralysis of many important sectors of activity, resulting in a serious fall in the Gross Domestic Product (GDP) of many countries.[2] Being faced with this problem, the economic authorities have implemented various reconstruction measures in a wide range of areas to mitigate the devastating effects that this crisis is having and will have.[3]

The coronavirus has also called into question whether countries have the necessary tools to deal with the pandemic. Given the collapse of many hospitals and the continuous transmission of the virus, it is important to carry out a study to determine whether variables such as public spending on health, restrictive policies carried out by governments, the number of physicians or the number of beds available in hospitals are determinants of the total number of COVID-19 deaths.

Methodology

A multiple linear regression was carried out, with the dependent variable being the total number of deaths per million inhabitants (mortality). Given that the elderly population is the most vulnerable to the virus,[4–6] the sample of countries was divided into three groups (terciles) according to the percentage of the adult population. In the first of these are those with a lower percentage of the population over 65 years of age, and in the third are those with a more aged population.

In the first tercile are those countries with the lowest percentage of population over 65: Ireland, Luxembourg, Slovakia, Cyprus, Poland, the United Kingdom, Romania, Malta and Austria. In the third tercile are those with the highest percentage of population over 65: Italy, Greece, Portugal, Finland, Germany, Bulgaria, Croatia, Latvia and France. In the second tercile are the remaining countries: Sweden, Lithuania, Estonia, Slovenia, Czech Republic, Denmark, Spain, Hungary, the Netherlands and Belgium. The data on the

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percentage of the adult population in each country were obtained from the World Bank.

As independent variables, the total expenditure on health care, expressed as a percentage of GDP (Health expenditure), the total number of physicians per 100,000 inhabitants (Physicians) and the number of available beds per 100,000 inhabitants (Beds) were included. These variables have been obtained from the Eurostat database. The restrictive policies imposed by the countries (Policies), measured by the Government Response Stringency Index[7] obtained from One World Data, have also been included as a variable. This index shows the level of stringency or harshness, but not effectiveness, of the policies implemented by the governments of the different countries. It is based on nine response indicators, including school closures, workplace closures or travel bans, and can take a value from 0 to 100 (100 = most stringent). Information on COVID-19 data refers to cumulative cases up to the second week of January 2021.

For each of the established groups by the terciles (i = 1,2,3), the following equation has been estimated:

$$\widehat{Mortality}_i = \beta_0^i + \beta_1^i Policies + \beta_2^i Health\ expenditure + \beta_3^i Beds + \beta_4^i Physicians + \varepsilon \quad (1)$$

This study will make it possible to determine how important variables such as health spending, number of physicians, number of beds and restrictive policies adopted to curb the pandemic affect countries, depending on their greater or lesser concentration of adult population.

Results

Mortality rates vary considerably among the countries of the European Union (EU). The highest incidence per death is in Belgium (1709.27 per million inhabitants) and the lowest is in Finland (106.26 per million inhabitants). Germany (11.47%) is the country with the highest public health expenditure (as a percentage of GDP), and on the opposite side is Luxembourg (5.29%). The country with the highest number of beds per 100,000 inhabitants is Germany (800.23) and Sweden has the fewest (213.79). Greece is the country with the most medical professionals per 100,000 inhabitants (561.81) compared with Poland (257.47), which has the fewest. Tougher restrictive measures have been implemented in Italy, which has the highest Government Response Index (87.96) compared to Croatia, which has the lowest (41.67). The average of the EU countries for this index is 68.58.

The multiple regression analysis (Table 1) shows that the COVID-19 mortality rate is affected differently by the variables depending on whether the countries have a higher or lower rate of the older adult population.

If we focus on the group of EU countries with the lowest population over 65 years of age, we can see that the number of physicians has a significant correlation. Countries with a higher number of physicians per capita have managed to have lower mortality rates. This demonstrates the importance of medical professionals during this pandemic in their work to reduce the number of deaths. The countries with higher healthcare spending within this group have had more deaths, coinciding with the results of the work of Khan et al. at the global level.[8] This shows that higher spending is not a prerequisite for reducing the number of deaths.[9,10] Those with more restrictive policies have had more deaths, due to the fact that in countries where the incidence of the virus has been lower, it has not been necessary to implement such a restrictive policy as in those where the number of deaths grew exponentially.

In group 2, as in group 1, higher health expenditure will not prevent a higher number of deaths, and the more restrictive countries have had more deaths. On the other hand, in group 3, where the EU countries with a higher percentage of the elderly population are concentrated, none of the variables is significant.

Conclusions

The rapid spread of COVID-19 has affected the whole world, especially the European continent. In this work, we have analysed, by means of a multiple regression, whether variables such as the total expenditure on health care, total number of doctors, total number of beds available, or the policies imposed are associated with the number of COVID-19 deaths in EU countries.

For this purpose, three groups of countries were established according to the percentage of the adult population (terciles). Differences were found between these groups. In the group of EU countries with the smallest population over 65, the number of physicians is correlated with the mortality rate. A higher number of physicians per inhabitant will contribute to a lower death rate. However, in the other two groups, this variable is not relevant. This demonstrates the importance of medical professionals during this pandemic in their work to reduce the number of deaths, especially in those countries with a lower percentage of the population over 65 years of age, since their probability of survival with adequate care is much higher. It should also be noted that countries with higher health spending in the first two groups have had more deaths, demonstrating that more spending is not synonymous with a reduction in the number of deaths. The countries with more restrictive measures have a higher number of deaths. On the other hand, in group 3, where the EU countries with the oldest population are concentrated, none of the variables is significant. This means that in this population group, the virus is quite lethal and the incidence of these variables is not determinant in their outcome, unlike, for example, in the first group, where the recruitment of

Table 1
Multiple regression model.

Variables	Tercile 1			Tercile 2			Tercile 3		
	Unstandardised coefficients	Standardised coefficients	p-value	Unstandardised coefficients	Standardised coefficients	p-value	Unstandardised coefficients	Standardised coefficients	p-value
(Constant)	−657.55 (655.08)		0.37	−8845.77 (806.55)		0.05	−522.45 (1005.78)		0.61
Policies	19.24[b] (7.89)	0.805	0.07	64.59[b] (6.66)	1128	0.06	8.15 (12.12)	0.294	0.52
Health expenditure	116.53[b] (51.02)	0.748	0.08	508.88[a] (43.83)	1536	0,05	3.44 (81.21)	0.016	0.96
Beds	0.33 (0.44)	0.206	0.49	2.50[a] (0.23)	1028	0.05	0.15 (0.83)	0.066	0.85
Physicians	−3.07[a] (1.14)	−0.939	0.05	−0.01 (0.53)	−0.002	0.98	−1.09 (1.95)	−0.238	0.59

Standard error in parentheses.
[a] Significant at the 5% level.
[b] Significant at the 10% level.

more medical professionals could be important to contribute to a reduction in deaths.

This shows the importance of having an adequate number of medical professionals to deal with the pandemic. In those EU countries with smaller adult populations, it has been significant to have more doctors to reduce the number of deaths. Given that higher public health spending does not prevent more deaths in these countries, it would be advisable to redistribute resources and hire more health personnel.

Author statements

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Competing interests

None declared.

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