Assessing the health system efficiency by using avoidable mortality indicators in European countries, 2019

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An efficient health care system is a priority for all developed countries, and it is an important prerequisite for economic prosperity. Efficiency is measured by the ratio of inputs to outputs of a given system. In the case of health care, inputs include health care expenditure and human and material resources. There are several outputs that can be used to assess efficiency. Among the most important and frequently used are avoidable mortality rates. The consequences of avoidable mortality are understandably very unpleasant for those involved. From a national perspective, avoidable mortality also has serious macroeconomic consequences. The aim of this paper is to assess the efficiency of the health care systems of the member states of the European Union using avoidable mortality rates. Data were taken from the latest available online datasets on avoidable mortality published by Eurostat in 2019. Correlation analysis and multivariate statistical analysis were used.

Introduction

Access to health care by the European Commission (2014) is one of the 20 principles of the European Pillar of Social Rights, and one of the three interconnected priorities in the European Semester (EC 2020). Since the Commission's policy was defined in 2014, access to health care has been one of the key elements in the analysis of the health care system (EC 2014). The Commission Communication "On effective, accessible, and resilient health systems" set out three objectives for health care: efficiency, accessibility, and resilience. In this sense, health systems across Europe are to be transformed (Eurostat 2019).

The need to assess the performance of the health care system in the EU-27 is growing. Avoidable mortality rates can be used as indicators of the quality and performance of health care and public health policies. That is one of the reasons why this article addresses them.

Two categories can be distinguished within avoidable mortality – preventable mortality and treatable mortality. They are defined as follows (OECD 2021):

Preventable mortality: Causes of death that can be mainly avoided through effective public health and primary prevention interventions (i.e., before the onset of diseases/injuries, to reduce incidence).

Treatable (or amenable) *mortality*: Causes of death that can be mainly avoided through timely and effective health care interventions, including secondary prevention and treatment (i.e., after the onset of diseases, to reduce case fatality).

In 2019, more than 1 million avoidable deaths under the age of 75 were confirmed in EU-27 countries. Of these, 399 000 were due to treatable causes and 691 000 deaths occurred from preventable causes. In the age category up to 75 years, ischemic heart diseases and lung cancer are the leading causes of all avoidable deaths (Eurostat 2022b).

High numbers of avoidable deaths mean not only great human suffering and social consequences but also significant economic losses. Therefore, it is important and necessary to investigate and eliminate their causes. This article aims to assess the efficiency of the health care systems of the member states of the European Union (EU) using avoidable mortality rates by means of statistical analysis. We will also look at how health care funding and human and technical resources in health care affect avoidable mortality in EU countries.

Literature review

The idea of avoidable deaths can be traced back to the early twentieth century when a confidential investigation into maternal deaths took place in the United Kingdom in 1928. The aim was to identify the errors that occurred and find areas for improvement to avoid unnecessary deaths (Holland 2009).

The very concept of "avoidable" deaths was proposed in 1976 by Rutstein et al. (1976). They outlined a methodology for measuring the quality of medical care based on the number of unnecessary diseases, disabilities, and untimely deaths.

Numerous other studies and publications have been devoted to the issue of avoidable mortality. For example, (Charlton et al. 1983, Holland 1988, 1997, Page et al. 2006, Wheller et al. 2007) were concerned with refining the concept of avoidable mortality. Other authors have examined trends in avoidable mortality, for example: (Nolte–McKee 2004, 2011, Velkova et al. 1997, Kossarova et al. 2013, Simonato et al. 1998).

The 2011 project called Avoidable mortality in the EU (AMIEHS) aimed to establish a uniform and universal definition of avoidable mortality for Europe and to establish a list of its validated indicators that can be routinely monitored in all EU Member States (EC 2011). In 2018, a group of experts was established in collaboration with the Organization for Economic Co-operation and Development

(OECD) and Eurostat to develop an up-to-date list of preventable and treatable causes of mortality.

Gay et al. (2011) show that data on these indicators are available in most OECD countries and can be used to assess the effectiveness of the health system.

Since the 1970s, avoidable mortality and its causes have been considered mainly in relation to premature deaths, so it was necessary to set an age limit based on which it would be possible to clearly decide when premature deaths occurred. In most developed countries, this age limit is set at 75, which also considers life expectancy at birth in those countries of the EU and the OECD that have the lowest life expectancy. The OECD/EU lists (January 2022 version) (OECD 2022) will therefore continue to use this age limit of 75 years.

Obviously, avoidable mortality also has economic consequences, as shown in (Alkire et al. 2018). This study focuses on the macroeconomic consequences of amenable mortality in low- and middle-income countries.

In 2018, the work of Kruk et al. (2018) was published. It focuses on 137 low- and middle-income countries around the world. They were the first to divide avoidable mortality into two categories – mortality due to poor quality of care and mortality due to unavailability of care. According to this study, almost 8 million people die each year due to either of theses causes.

Several authors have addressed the issue of health system efficiency. The approaches have been different. The methodology used was not consistent. Some studies were carried out at the statistical classification of territorial units (NUTS) 2 level, while others were carried out at the national level. Studies on the relation between avoidable mortality and socioeconomic level have also been conducted. Stirbu et al. (2010) examined differences in avoidable mortality based on the educational attainment of the populations of European countries. Other studies, such as (Ahmedin et al. 2008) and (Census 2021), are usually conducted at the national level. Pérez et al. (2014) discuss the strengths and limitations of treatable and preventable mortality in health care systems' performance and their contribution to health inequalities. (Gavurova et al. 2021) evaluated the development of the efficiency of health care systems in OECD countries in the years 2000–2016. (Lupu–Tiganasu 2022) compared the health care performance of European countries during the first and second waves of the COVID-19 pandemic according to the COVID mortality rate.

Of course, avoidable mortality is not the only indicator of the effectiveness of the health care system. Its outcomes can also be measured in other ways. (Ferreira et al. 2018) developed a classification of European countries according to the efficiency of health care based, on four health system outcomes.

The authors of (Fernandez-Crehuet et al. 2019) created an index to measure the reputation of EU countries. The level of health care is one of the factors against which countries have been judged.

Data and methods

The data used in this article are from the latest available datasets on avoidable mortality published online by Eurostat (2022 a, b). In accordance with the aim of this article, twenty-three indicators (Table 1) were selected for further statistical analysis.

Table 1

Table of variables

Indicator	Units	Label
Health care expenditure		
Health care expenditure by all providers	Purchasing power standard (PPS) per inhabitant	E1
Curative care and rehabilitative care	PPS per inhabitant	E2
Long-term care (health)	PPS per inhabitant	E3
Preventive care	PPS per inhabitant	E4
Health care recourses – Health care staff		
Practicing medical doctors	Per 100,000 inhabitants	M1
Practicing nurses	Per 100,000 inhabitants	M2
Health care recourses – Health care facilities		
Available beds in hospitals	Per 100,000 inhabitants	F1
Computed Tomography Scanners	Per 100,000 inhabitants	F2
Magnetic Resonance Imaging Units	Per 100,000 inhabitants	F3
Causes of death – the mortality rate		
Certain infectious and parasitic diseases (A00-B99)	Standardized death rate	D1
Neoplasms (C00-D48)	Standardized death rate	D2
Endocrine, nutritional and metabolic diseases (E00-E90)	Standardized death rate	D3
Mental and behavioral disorders (F00-F99)	Standardized death rate	D4
Diseases of the circulatory system (I00-I99)	Standardized death rate	D5
Diseases of the respiratory system (J00-J99)	Standardized death rate	D6
External causes of morbidity and mortality (V01-Y89)	Standardized death rate	D7
Other causes of death	Standardized death rate	D8
Avoidable mortality		
Preventable mortality – male	Standardized death rate	A1
Preventable mortality – female	Standardized death rate	A2
Treatable mortality – male	Standardized death rate	A3
Treatable mortality – female	Standardized death rate	A4
Education		
Tertiary education (levels 5–8; from 15 to 64 years)	Percentage	T1
Poverty		
At risk of poverty rate (cut-off point: 60% of median equivalised income after social transfers)	Percentage	P1

As mentioned above, efficiency is measured by the ratio of the inputs to the outputs of the system. Inputs to the health care system include health care expenditure (variables E1–E4), human resources (variables M1 and M2), and physical equipment (variables F1, F2, F3). Two possible health care system outcomes were selected for further analysis. Variables D1–D8 represent mortality rates by causes of death. Variables A1–A4 are avoidable mortality rates disaggregated by sex and type. The last two variables are not directly related to health care because avoidable mortality rates are also influenced by many factors outside the health system itself. We selected two indicators for analysis that are important from our perspective. These are the proportion of college-educated individuals in the population (T1) and the proportion of people at risk of poverty (P1).

Data for the calculation of preventable and treatable causes of mortality are drawn from Eurostat's data collection on causes of death. Causes of death data are available for the EU Member States on an annual basis. From 2011 onward, the publication of data on the causes of death has been mandatory for all EU Member States. Indicators of preventable and treatable causes of mortality are calculated and published annually. Annual data on such deaths are provided in absolute numbers and as standardized mortality rates according to age and sex. The standardization is based on the Revision European Standard Population (2013). The standardized mortality rates used in this article are calculated per 100,000 inhabitants in 2019.

Multidimensional comparative analysis techniques and cluster analysis were used to achieve the set objective. We can also consider them as methods of the linear ordering of multidimensional objects using a synthetic variable created from the initial variables. The number of applications of these methods can be found in publications on statistics and econometrics, for example (Kuc 2012, Pacáková–Kopecká 2018, Pacáková–Jindrová 2019, Müller-Frączek 2019).

At the beginning of the analysis, the type of each variable must be defined. It is necessary to identify whether the high values of a variable positively influence the analyzed processes (such variables are called stimulants) or whether their low values are favorable (these are called destimulants). The initial variables are usually expressed in different units of measurement and must be standardized to create a synthetic (aggregate) variable. Several formulas can be used for standardization. We used Formula (1) for stimulants and Formula (2) for destimulants.

$$b_{ij} = \frac{x_{max} - x_{ij}}{x_{max} - x_{min}} \tag{1}$$

$$b_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}} \tag{2}$$

The synthetic variable allows for replacing the whole set of initial standardized variables into one aggregated (synthetic) variable. There are a variety of methods for creating a synthetic variable. In this article, for the *i*-th country, $i = 1, 2, \dots, n,$ has been calculated as the average of the values $b_{i,j}$, $j = 1, 2, \dots, k,$ where the subscript *i* stands for the country number, and subscript *j* stands for the variable number.

The match of the ordering of the countries by each pair of synthetic variables can be quantified using Spearman's rank correlation coefficient, which for any two variables *X*, *Y* can be calculated according to the formula

$$R_S = 1 - \frac{6 * \sum_{i=1}^{n} (i_x - i_y)^2}{n * (n^2 - 1)} \tag{3}$$

where the values of i_x, i_y are the ranks of the values of the variables X and Y. The correlation coefficient ranges between –1 and +1 and represents the degree of compliance of the ranks.

The objective of cluster analysis is to classify multidimensional objects into a small number of mutually exclusive groups based on the similarities among the objects. The cluster analysis procedure is designed to group observations (countries) into clusters based on similarities among them. To create clusters of observations, it is important to have a measure of "similarity". We use Euclidian distance for measuring the distance between two multidimensional objects (i.e., countries).

Ward's method, which has been used for clustering, defines the distance between two clusters in terms of the increase in the sum of squared deviations around the cluster means that would occur if the two clusters were joined. The results of the analysis can be displayed in several ways, including a dendrogram. Working from the bottom up, the dendrogram shows the sequence of joins that were made between clusters. Lines are drawn connecting the clusters that are joined at each step, while the vertical axis displays the distance between the clusters where they are joined.

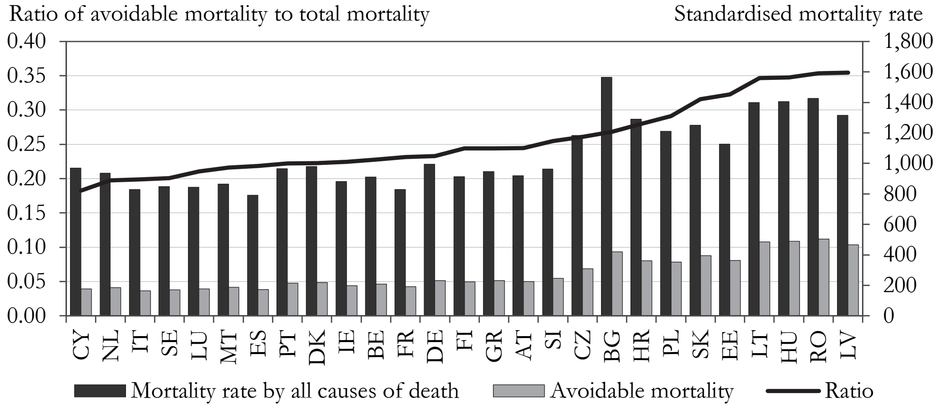
This frequently used statistical method is described in detail in many publications, for example (Hair et al. 2007).

Analysis

The avoidable mortality rate as a measure of deaths from causes that should not occur in the presence of timely and effective interventions could be considered both as a measure of the performance of the health systems and as a measure of the quality of health care.

Figure 1

The ratio of avoidable mortality to total mortality and standardized mortality rates (total) – by all causes of death and avoidable mortality, EU-27, 2019



Note: See Annex Table A1 for country abbreviations here and in other Figures.
Source: Own work based on the Eurostat database (2022a).

The ratio of avoidable mortality to total mortality by all causes of death (Figure 1) is different in EU countries. It ranges from 18.3% (in Cyprus) to 35.5% (in Lithuania). This ratio is smaller than 20% only in three countries – Cyprus, Netherlands (19.8%), and Italy (19.9%). In Slovakia, Estonia, Latvia, Hungary, Romania, and Lithuania the value of this ratio is greater than 30%.

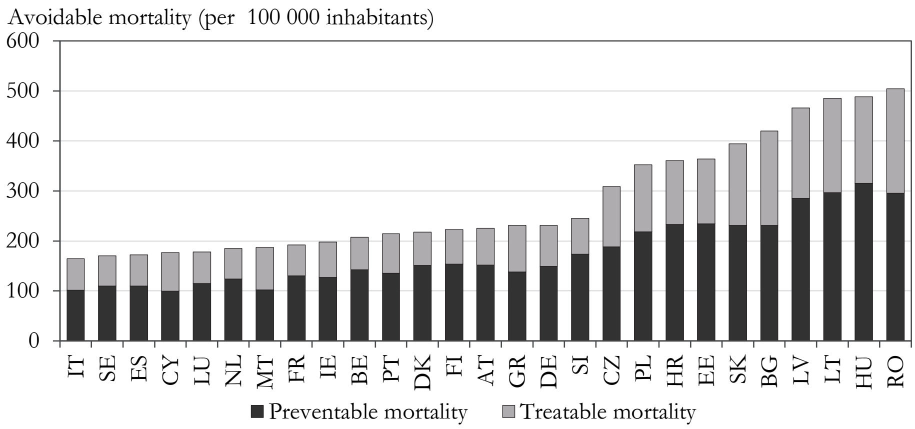
In Figure 2 the lowest standardized rate of avoidable mortality can be observed in Italy (165 per 100,000 inhabitants). At the other end of the spectrum lie the postsocialist countries. In these countries, the rate of avoidable mortality exceeded 300 per 100,000 inhabitants (309 per 100,000 inhabitants in Czechia). The highest rates of avoidable mortality were in Romania with rates of 504 per 100,000 inhabitants.

In 2019, (in Figure 2) the highest preventable mortality rate among the western, southern, and Nordic Member States was 154 per 100,000 inhabitants in Finland, while the lowest rate among the eastern and Baltic Member States was 173 per 100,000 inhabitants in Slovenia. However, among the eastern and Baltic Member States, there was also quite a lot of diversity. As already noted, Romania, Latvia, and Hungary had the highest rates, in Hungary, this rate is 315 per 100,000 inhabitants. In contrast, Slovenia and Czechia reported rates of 173 and 188 per 100,000 inhabitants respectively, with the remaining eastern and Baltic Member States reporting rates between 219 and 296 per 100,000 inhabitants.

Among the EU-27 Member States (in Figure 2), the lowest rates of treatable mortality in 2019 were recorded in Sweden, the Netherlands, France, Spain, Luxemburg, Italy, Belgium, Denmark, and Finland (all under 70 per 100,000 inhabitants); Sweden recorded the lowest rate (60 per 100,000 inhabitants). The highest treatable mortality rate was 208 per 100,000 inhabitants in Romania, while the other postsocialist states recorded rates between 120 and 189 per 100,000 inhabitants.

Figure 2

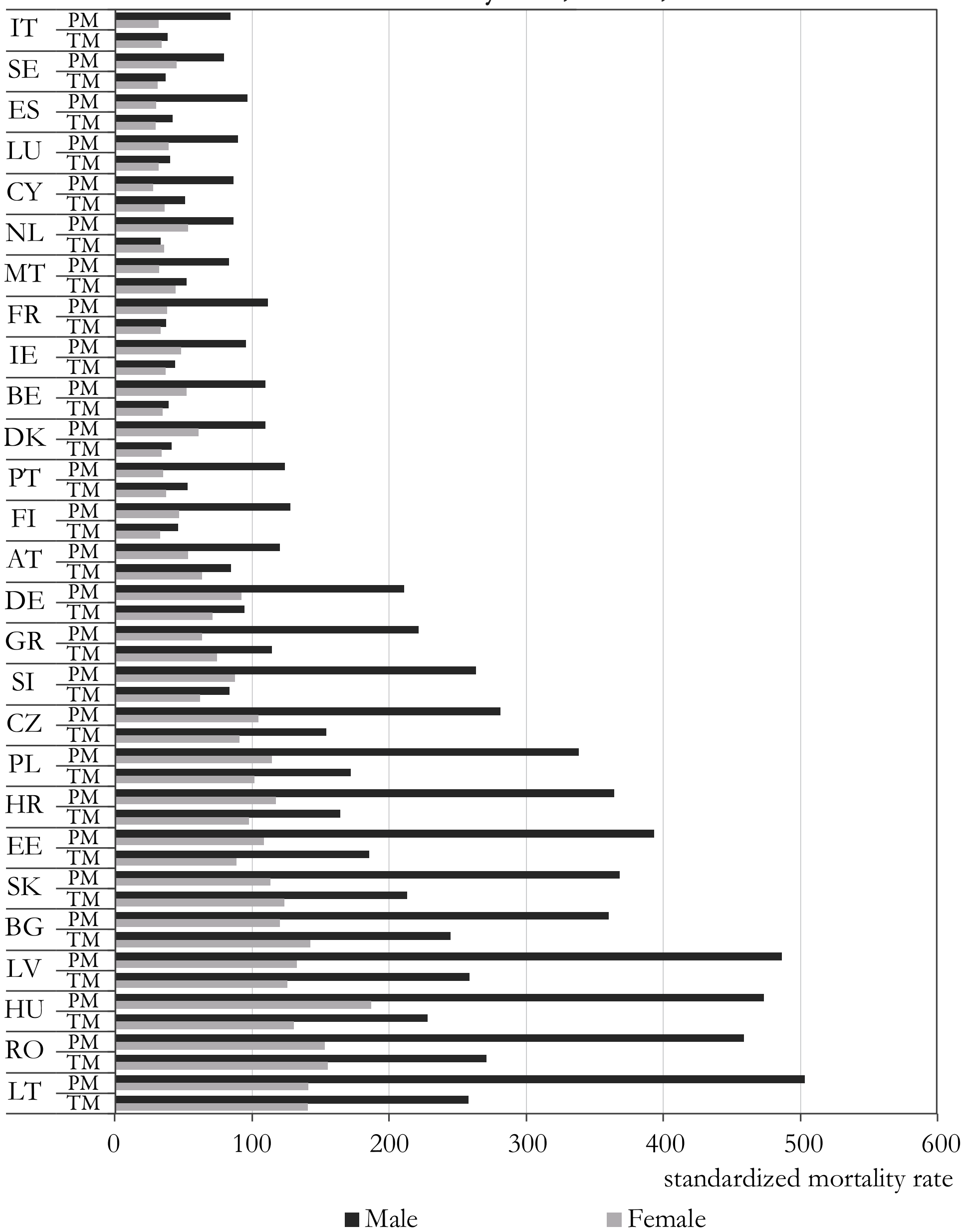
Avoidable mortality – standardized mortality rates (total), EU-27, 2019



Source: Own work based on the Eurostat database (2022a).

Figure 3

Preventable (PM) and treatable (TM) mortality rates by sex – standardized mortality rates, EU-27, 2019



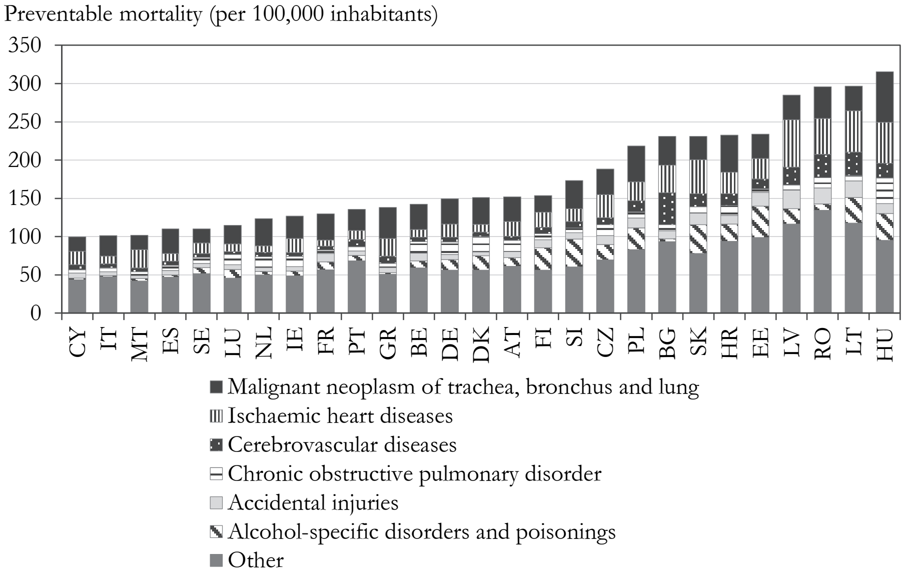
Source: Own work based on the Eurostat database (2022a).

The graph in Figure 3 shows that the avoidable mortality rate (both preventable and treatable) is different for males and females (ordered by total avoidable mortality by country). Large gender differences can be observed especially in preventable mortality rates. In all cases, the preventable mortality rate is higher for males than for females. The differences are particularly large in postsocialist countries, especially in the Baltics.

The main five causes of preventable mortality (OECD 2021) in 2019 were cancer – 31%, injuries – 21%, circulatory system diseases – 19%, alcohol, and dru effects – 14%, and respiratory system – 8% (others – 7%). In Figure 4 the diseases most prominent in mortality rates, belonging to the abovementioned categories, are represented.

Figure 4

Standardized mortality rates for the main chosen causes of preventable mortality (total), EU-27, 2019

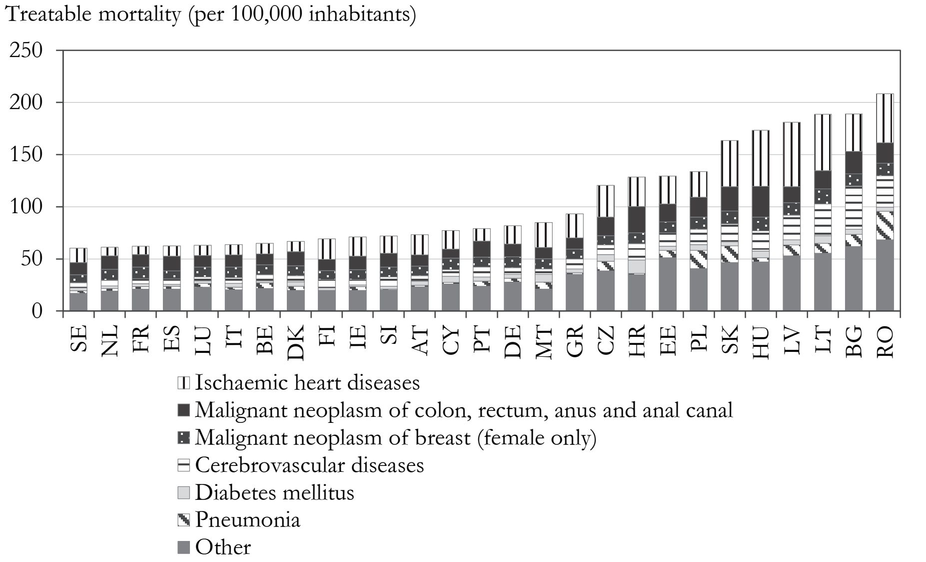


Source: Own work based on the Eurostat database (2022a).

The four main causes of treatable mortality (OECD 2021) in 2019 are circulatory system diseases – 36%, cancer – 27%, respiratory system – 9%, and diabetes and other endocrine diseases – 8% (others – 20%). Figure 5 shows the diseases most represented in mortality rates, belonging to the abovementioned categories.

Figure 5

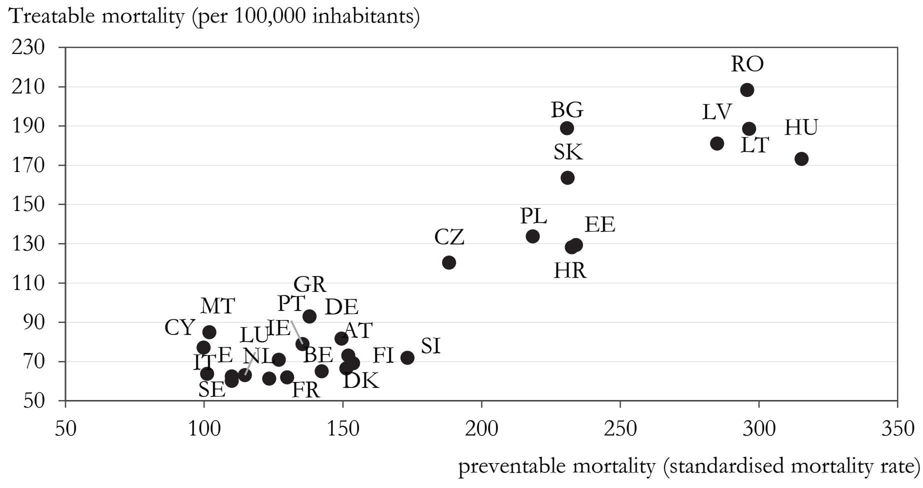
Standardized mortality rates for the main chosen cases of treatable mortality (total), EU-27, 2019



Source: Own work based on the Eurostat database (2022a).

Figure 6

Comparison of the EU-27 countries by preventable and treatable mortality (total), 2019



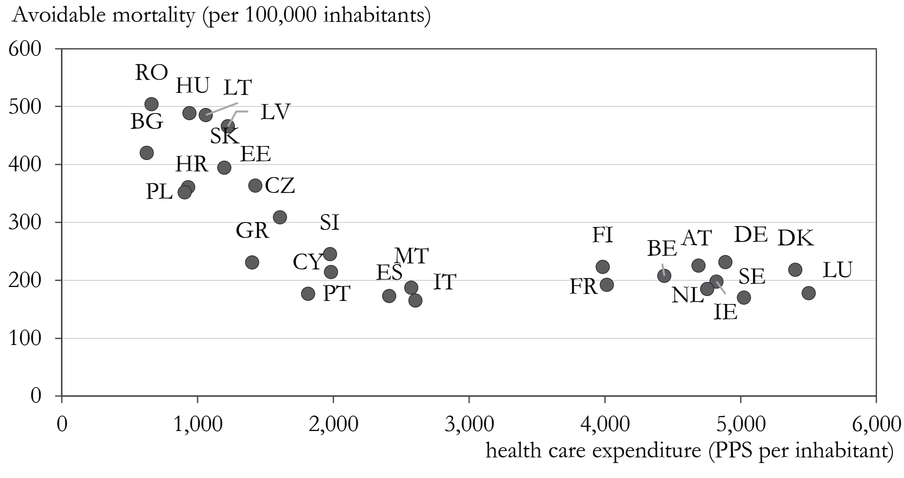
Source: Own work based on the Eurostat database (2022a).

Describing the situation of avoidable mortality in the EU-27 countries, in Figure 6 we can see the comparison of preventable and treatable mortality rates. There are three groups of countries. The two groups contain postsocialist countries: with high values of preventable mortality and high values of treatable mortality (Romania, Lithuania, Latvia, Hungary) and countries with middle values of preventable mortality and middle or high values of treatable mortality (Czechia, Poland, Croatia, Estonia, Slovakia, and Bulgaria). The third group contains old member states of the EU and Slovenia.

Health care expenditures are one of the main causes that affect avoidable mortality. The situation in the EU countries varies according to these conditions. In Figure 7 we can compare the situation in the EU countries. The first group of countries contains the postsocialist countries except for Slovenia. These countries are characterized by a very high value of avoidable mortality and a lower value of health care expenditure by all providers (in purchasing power standard per inhabitant). The second group of countries contains Slovenia and southern European countries (Greece, Cyprus, Portugal, Malta, Spain, and Italy). These countries are characterized by middle or low values of avoidable mortality and low or middle levels of health care expenditure by all providers. The last group of countries is characterized by middle or low values of avoidable mortality and high values of health care expenditure by all providers. In this third group, we can find Finland, France, Belgium, Netherlands, Austria, Germany, Denmark, Sweden, Luxembourg, and Ireland.

Figure 7

Comparison of the EU-27 countries by health care expenditure and avoidable mortality (total), 2019

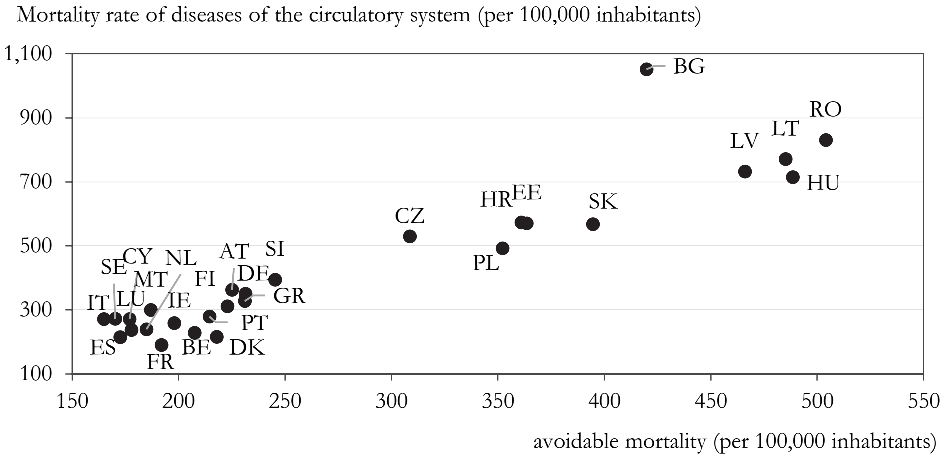


Source: Own work based on the Eurostat database (2022a).

The most common causes of death in EU countries are diseases of the circulatory system and cancer illness (OECD 2020). Figure 8 shows the situation in the EU countries in 2019 through a comparison of avoidable mortality and mortality rate of diseases of the circulatory system. The situation in postsocialist countries except for Slovenia shows high levels of avoidable mortality and middle and high levels of mortality rates for diseases of the circulatory system. The highest mortality rate of diseases of the circulatory system can be found in Bulgaria (1,052 per 100,000 inhabitants) compared to the lowest mortality rate of diseases of the circulatory system in France (190 per 100,000 inhabitants).

Figure 8

Comparison of the EU-27 countries by avoidable mortality and mortality rate of diseases of the circulatory system (total), 2019



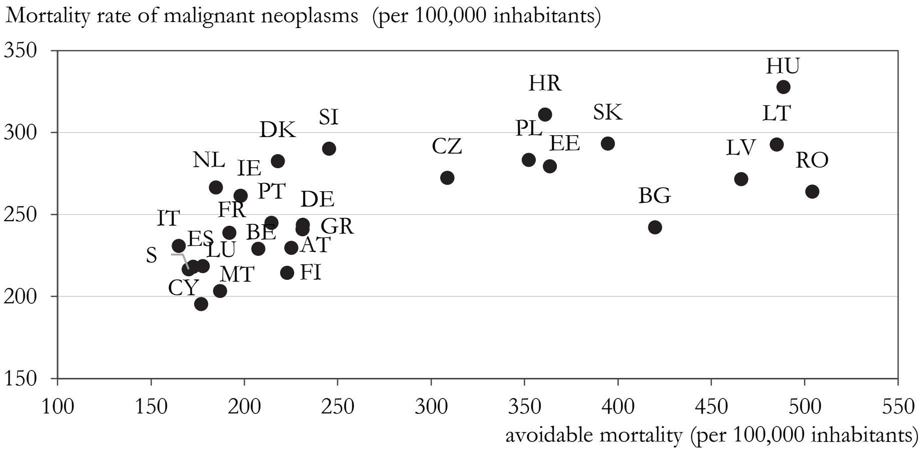
Source: Own work based on the Eurostat database (2022a).

In Figure 9 we can compare the situation in EU countries concerning avoidable mortality and the mortality rate of malignant neoplasms. Avoidable mortality clearly divides countries into 3 groups but the differences due to the mortality rate of malignant neoplasms are not as large as those due to avoidable mortality. The lowest mortality rate of malignant neoplasms is in Cyprus (195 per 100,000 inhabitants) with a low value of avoidable mortality. The highest mortality rate of malignant neoplasms is in Hungary (328 per 100,000 inhabitants) with a high value of avoidable mortality.

The amount of expenditure on preventive care does not affect preventable mortality as much as we expected, see Figure 10. In the upper left corner, there are points representing postsocialist countries concentrated. Here, expenditure on preventive care is low and preventable mortality is high compared to other European countries. The remaining points form the horizontal band. Here, preventable mortality is in the range from 100 to 200 regardless of the amount of expenditure. Thus, the key influence on preventable mortality must be something other than the amount of expenditure on preventive care. It can be the structure of mentioned expenditures, the availability of preventive care, the individual approach of the inhabitants of the given country to their health, or other factors. However, this is beyond the scope of this paper.

Figure 9

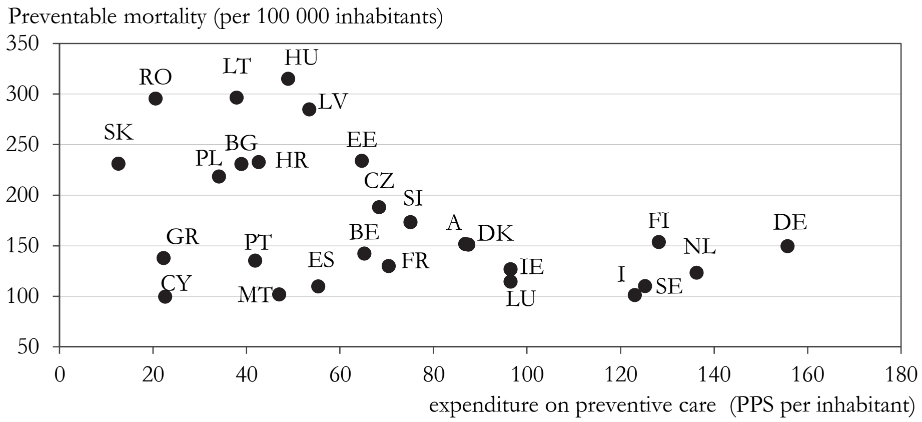
Comparison of the EU-27 countries by avoidable mortality and mortality rate of malignant neoplasms (total), 2019



Source: Own work based on the Eurostat database (2022a).

Figure 10

Comparison of the EU-27 countries by preventable mortality and expenditure on preventive care (total), 2019



Source: Own work based on the Eurostat database (2022a).

The logical question is as follows: what influences avoidable mortality the most? As mentioned above, avoidable mortality is a crucial indicator of the efficiency of health care. It is therefore desirable to look at the inputs into the health system and assess which of these are most likely to influence the resulting avoidable mortality rate. In addition, other factors that may influence avoidable mortality rates should also be considered. These include the standard of living of the population, the level of education, and various legislative provisions governing access to alcohol, tobacco, and other addictive substances. Two socioeconomic factors have been included in the following analysis: P1 – At risk of poverty rate and T1 – Percentage of the population aged 15–64 with tertiary education.

As stated above, the method of multidimensional comparison was used. The synthetic variables were calculated from the variables given except for variables D1–D8 representing the mortality rates of causes of death. Variables E1–E4, M1–M2, and F1–F3 are stimulants, so Formula (1) was used for calculating synthetic variables. Variables A1–A4 are destimulants, and for the calculation of synthetic variables, Formula (2) was used. We denoted the synthetic variable calculated from variables E1–E4 as SE, representing health care expenditures. The synthetic variable SM was calculated from variables M1–M2 representing health care staff. The synthetic variable SF was calculated from variables F1–F3 representing health care facilities. The synthetic variable SA was calculated from variables A1–A4 representing avoidable mortality. For the purpose of correlation analysis the variable T1 - tertiary education – was standardized as a stimulant according to Formula (1), and the variable P1 - at risk of poverty rate - was standardized as a destimulant according to Formula (2). They are denoted ST and SP, respectively.

Table 2 shows Spearman's rank correlation coefficients from the relevant row of the corresponding correlation matrix. The critical value of Spearman's correlation coefficient for $n = 27$ (countries) and the significance level $a = 0.05$ is 0.382 (Critical values of Spearman's rank correlation coefficient 2022). Statistically significant values of Spearman's correlation coefficient are marked in red.

Table 2

Spearman's rank correlation coefficients – for synthetic variables

Denomination	SE (Health care expenditures)	SM (Medical staff)	SF (Health care facilities)	ST (Tertiary education)	SP (At risk of poverty)
SA (Avoidable mortality)	0.6770	0.4664	–0.5665	0.4731	0.1325

Synthetic variables SE (health care expenditures), SM (medical staff), and SF (health care facilities) represent inputs to the health care system, and SA (avoidable mortality) is its output. Synthetic variables ST (tertiary education) and SP (at risk of poverty) are factors outside the health system itself, but with possible influence on avoidable mortality. We will assess the dependence of the outputs on the input values. The variable SE – health care expenditures have the most significant effect on avoidable mortality. As expected, the corresponding correlation coefficient is positive.

This means that the higher the health care expenditures, the lower the avoidable mortality rate. The analysis also confirmed a positive correlation between SA and SM (health care staff). Similarly, this means that the higher the number of health care staff, the lower the avoidable mortality rate. A more detailed correlation analysis was performed for the initial variables that enter into the synthetic variables SM and SA. A strong correlation was found between the number of practicing nurses and avoidable mortality. In contrast, the correlation between the number of practicing doctors and the components of avoidable mortality was found to be insignificant. The negative value of Spearman's correlation coefficient for the SF (health care facilities) may be surprising. We can interpret this as follows: with the increasing equipment of medical facilities (expressed by decreasing values of the synthetic variable SF), the value of the synthetic variable SA increases. Upon closer examination, we found that this unexpected negative value is caused by the initial variable F1 – Available beds in hospitals. Notably, a significant correlation does not prove a causal relationship between the variables involved. Higher numbers of hospital beds are typical of the postsocialist countries of the Union, and the avoidable mortality rate is also higher in these countries compared to other European countries.

Another output of the correlation analysis is a significant correlation between avoidable mortality and the level of education of the population. A significant relationship between avoidable mortality and the poverty rate was not observed. These results were subjected to further investigation. In this, avoidable mortality was not viewed as a single aggregate variable. Rather its components A1–A4 were considered separately (see Table 1). The output is presented in Table 3.

Table 3

Spearman's rank correlation coefficients – initial variables: A1–A4, T1, P1

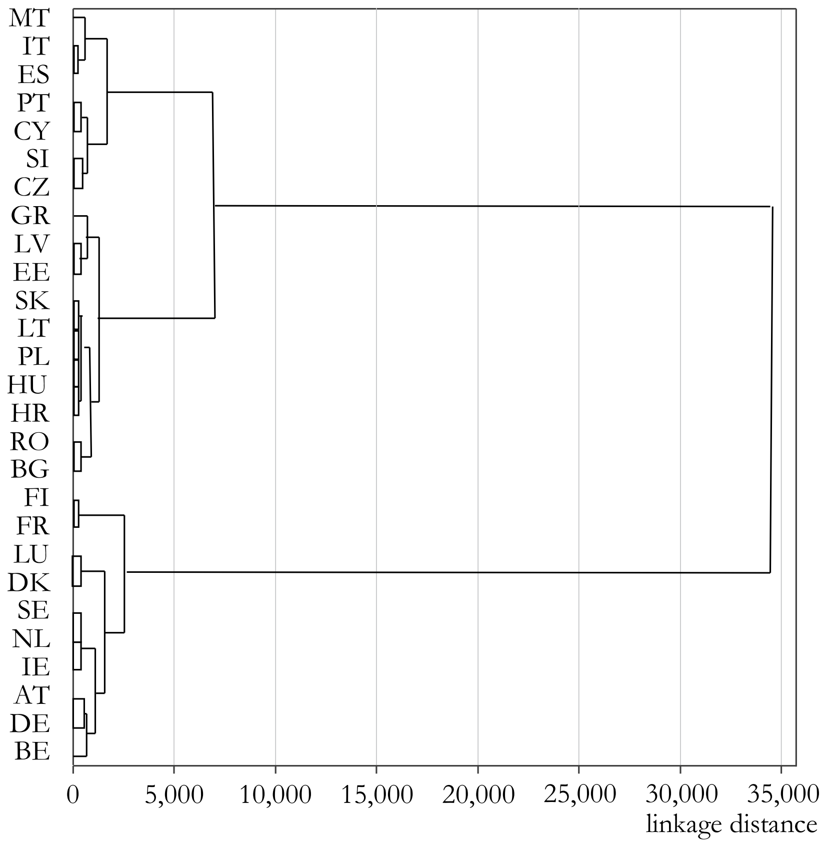
Denomination	A1	A2	A3	A4
	Preventable mortality		Treatable mortality	
	male	female	male	female
T1 (Tertiary education)	–0.3634	–0.3389	–0.4178	–0.4919
P1 (At risk of poverty rate)	0.3763	0.1183	0.4691	0.4381

Significant correlations are again shown in red in Table 3. These are correlations between treatable mortality (for males and females) and the variables T1 (tertiary education) and P1 (poverty rate). As expected, the correlation coefficients between T1 and the individual components of avoidable mortality A1–A4 are negative. Thus, the higher the proportion of college-educated persons in a country's population is, the lower the avoidable mortality rate. In contrast, the correlation coefficients between P1 and A1–A4 are all positive. Countries with higher rates of exposure to poverty also have higher rates of all components of avoidable mortality.

The next step was to carry out a cluster analysis using the input variables listed in Table 1. The dendrogram in Figure 11 shows the result of the cluster analysis using Ward's method with Euclidean distances. It can be observed that the countries were relatively quickly divided into three large clusters. The first includes Malta, Spain, Italy, Portugal, Cyprus, Slovenia, and Czechia. Greece, Romania, Hungary, Croatia, Poland, Slovakia, Bulgaria, and the Baltic states are in the second cluster. In the third cluster, we find Western European and Nordic countries. From the dendrogram, we can ascertain, among others that the highest degree of similarity is shown by the pairs Spain – Italy, Hungary – Croatia, and Portugal – Cyprus. A certain degree of similarity can be traced between the first and the second cluster, while the third cluster differs very significantly from the first two (see Figure 11).

Figure 11

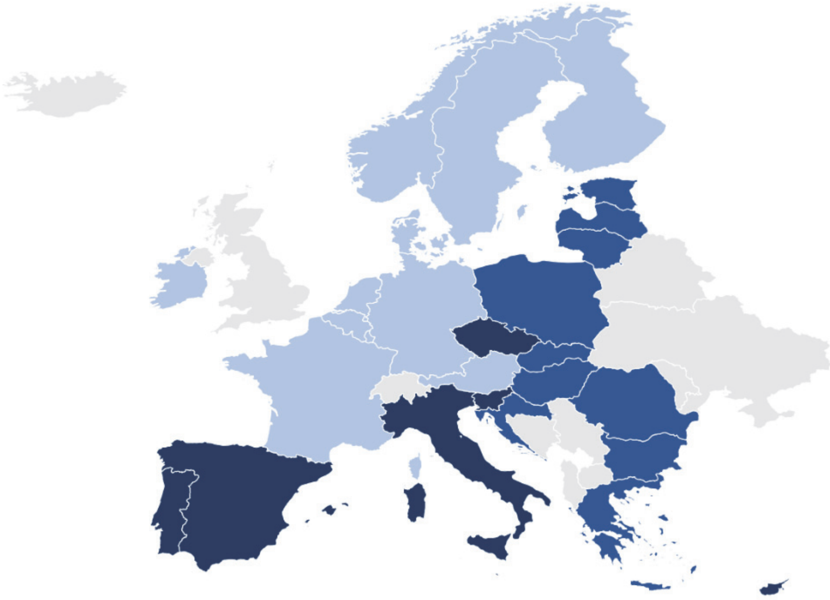
Dendrogram, 2019



The results of the cluster analysis are also shown in the cartogram in Figure 12.

Figure 12

Cartogram, 2019



Countries belonging to the first cluster are shown in dark blue in the cartogram. Countries from the second cluster are shown in medium blue in the cartogram. Light blue indicates the countries belonging to the third cluster (Figure 12).

Of the countries compared, the lowest preventable mortality rates were found in Cyprus, Italy, Malta, and Spain. France, the Netherlands, Spain, and Italy had the lowest treatable mortality rates. In contrast, the highest preventable mortality rates were in Lithuania, Romania, Latvia, and Hungary. The treatable mortality rate was the highest in Lithuania, Bulgaria, Latvia, and Romania. Based on the total avoidable mortality rate, we can divide the compared European countries into three groups. Countries with a low avoidable mortality rate (less than 200 deaths per 100,000 inhabitants) include Italy, Spain, Cyprus, Sweden, the Netherlands, France, and Luxembourg. The second group includes Malta, Ireland, Belgium, Portugal, Denmark, Greece, Finland, Austria, Germany, Slovenia, and Czechia. In these countries, the avoidable mortality rate is 200–350 per 100,000 inhabitants. Poland, Croatia, Estonia, Slovakia, Bulgaria, Lithuania, Hungary, Romania, and Latvia are among the countries with the highest avoidable mortality. It is obvious that the distribution of countries according to the avoidable mortality rate is only partially consistent with the results of the cluster analysis. On the other hand, in line with the results of the correlation analysis, we can see from the data thet the rule "the higher the health care expenditures, the lower the avoidable mortality rate" generally applies.

Discussion and conclusions

The results obtained can be compared with those of other studies with a similar focus. Ferreira et al. (2018) developed a classification of European countries according to the efficiency of health care based, on four health system outcomes. This clustering is somewhat different from the output of the cluster analysis above. Both analyses agree that we can roughly divide EU countries into three groups according to the efficiency of health care: Western European countries, Southern European countries, and postsocialist countries.

For the health care system to be able to provide health care at the desired level and to respond flexibly to dynamic care requirements, it must be efficient. The efficiency of the system is measured by the ratio of its inputs and outputs. Inputs to the health care system can be represented by care expenditure, personnel, and material provision of care. Outputs can be evaluated by a large number of indicators; avoidable mortality is one of the important indicators.

It has been shown that increasing health care costs can lead to a reduction in avoidable mortality. Lower avoidable mortality then has positive economic consequences. The funds spent on improving health care are therefore meaningfully spent. On the other hand, limited access to good quality health care goes hand in hand with higher avoidable (both preventable and treatable) mortality, which will then have adverse macroeconomic consequences.

The concept of avoidable mortality notwithstanding its many limitations has provided a means to examine the quality of health care provided by a health care system and to identify topics for further detailed investigation. Avoidable mortality can by no means serve as an absolute measure of the quality of health care, but it can point to weaknesses in the health care system.

Although deaths due to some causes fall into the category of avoidable deaths, they cannot always be prevented because of a number of factors. Thus, the avoidable mortality rate can only be reduced to a certain extent. Nevertheless, it is important to strive for the maximum possible reduction in avoidable mortality.

As mentioned in the paper, there are a number of factors that influence avoidable mortality. In addition to inputs into the health system, these include socioeconomic factors (level of education of the population, sanitation in the area, level of exposure to poverty, etc.) and environmental factors. Various legislative conditions governing the availability of alcohol, tobacco products, and other addictive substances or regulations governing the use of chemicals in agriculture, may also have an impact. Of these, educational attainment and at-risk-of-poverty rates were included in the analysis.

Annex

Table A1

Abbreviations of Member States of the European Union

Belgium	(BE)	Greece	(EL)	Lithuania	(LT)	Portugal	(PT)
Bulgaria	(BG)	Spain	(ES)	Luxemburg	(LU)	Romania	(RO)
Czechia	(CZ)	France	(FR)	Hungary	(HU)	Slovenia	(SI)
Denmark	(DK)	Croatia	(HR)	Malta	(MT)	Slovakia	(SK)
Germany	(DE)	Italy	(IT)	Netherlands	(NL)	Finland	(FI)
Estonia	(EE)	Cyprus	(CY)	Austria	(AT)	Sweden	(SE)
Ireland	(IE)	Latvia	(LV)	Poland	(PL)		

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