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PART II

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THE MORTALITY STRUCTURE OF POPULATIONS THE DEMOGRAPHIC AND SOCIO-ECONOMIC SITUATION IN EUROPEAN UNION COUNTRIES: DEVELOPMENT AND DIFFERENTIATION IN THE PERIOD 2011–2014

Abstract. The purpose of the study is to compare the differentiation of the demographic and socio-economic indicators and the structure of mortality of the population in EU countries in the period 2011–2014. The composite indicator of mortality structure revealed the most favourable situation in Finland (134.4%), while the worst situation was found in Hungary (63.8%). The best demographic and socio-economic situation was found in Luxembourg (165.4%) and the worst in Hungary (64.9%), Greece (65.9%) or Lithuania (67.3%). The regression model equation shows that the mortality structure is strongly affected by the variables of life expectancy at birth and education. It is evident that there was a differentiation in the demographic and socio-economic indicators in EU countries in the period 2011–2014, while there was no unambiguous trend of the convergence of the mortality structure among EU countries.

Key words: demographic and socio-economic indicators, cause-specific mortality, composite indicator, European population comparison.

1. INTRODUCTION

The health and mortality of individuals and of the population as a whole is affected by a number of factors to a varying extent and by different methods for conditioning the morbidity and mortality structure (Minicuci *et al.*, 2016). People

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are exposed to a number of health risks over the course of their lives. These have their roots in a number of events, develop over a long period of time, and are influenced by a number of factors. The most important are lifestyle, the level of health care, genetics, and the quality of the environment. However, socio-economic or demographic factors are also very significant (Hübelová *et al.*, 2018). The current interest in health, health condition, and the search for causes of disease is becoming more intense, particularly in relation to social, political, and economic changes, but also to changes in the quality of the environment (Tobiasz-Adamczyk *et al.*, 2011). Population health is generally considered to be one of the most important indicators of regional development and the complex interdisciplinary relationships of demographic, socio-economic, environmental, and political processes (Fraser and George, 2015). The importance of health is also underlined by its inclusion in one of the priorities of the "Global Europe 2050" strategy, which aims to ensure a sustainable economic development of Europe (Eurostat's Report for the European Commission, 2017).

Mortality is an important factor in demographic processes. A very important aspect of the mortality process is the so-called main causes of death (mortality structure). Not only does their value provide information on what the main causes of death are, but mortality structure analyses are one of the elementary values which indicate the health and health condition of the population and determine the level of mortality itself (Šprocha *et al.*, 2015; Vilinová *et al.*, 2017). The level of mortality is influenced by mutually conditioned endogenous and exogenous factors (Caselli *et al.*, 2006). Demographic and socio-economic indicators, which are differentiated at different regional scales (Fraser and George, 2015), are currently considered an important group of exogenous factors. Different types of risk behaviours (smoking, alcohol consumption, etc.) do not occur accidentally, but are determined by a wide range of direct and indirect factors throughout one's life, including socio-economic and macroeconomic factors. For example, in Western European countries, manual workers show more unfavourable risk behaviours, leading to their shorter life expectancy. Therefore, it can be assumed that a change or a difference in the population composition in terms of the economic structure will also cause changes or differences in behavioural risk factors that will be reflected in cause-specific mortality patterns (Spijker, 2014). At the same time, mortality is seen as a key indicator of the success or failure of each state's development and reflects a society's ability to transform economic capital into the health of its population (Shkolnikov *et al.*, 2004).

Consequently, the main aim of our study is to evaluate spatial disparities in the mortality structure and selected demographic and socio-economic indicators among the EU Member States. The partial intent is: 1) to create a dimensionless composite indicator to determine the ranking of EU Member States according to the mortality structure level and socio-economic and demographic indicators; 2) to determine whether EU countries are converging over time on the basis of the values set by the indicators (convergence method); and 3) to assess spatial disparity on the basis of a composite indicator calculated from the averages of the values. On the basis of these objectives, the following research questions are identified: What are the mortality and socio-demographic conditions in the European Union? Which states (regions) show a favourable situation and which are lagging behind? Is there a reduction in the differences, resp. a convergence of EU countries over time?

2. DEMOGRAPHIC AND SOCIO-ECONOMIC FACTORS OF MORTALITY AND HEALTH

Western European countries have seen a decline in total mortality since the late 1970s, and this trend will continue in the near future. In most Eastern European countries, the overall mortality rate dropped later, from the mid to late 1990s, and the decline there should continue in the coming years as well. Such a trend can be predicted fairly accurately over a period of 10–15 years for both total mortality and specific causes of death, since there are certain exogenous variables that affect mortality for such a period (Spijker, 2014). Spijker has long been involved in testing time-series models of cause-specific mortality and exogenous variables to assess the importance of demographic and socio-economic factors and the differentiation in mortality patterns in Europe (Spijker, 2004; 2014; Spijker and Wissen, 2010). These studies illustrate the influence of exogenous factors in the context of the varying political and economic histories of Eastern and Western Europe. Within the Eastern Bloc countries, there has been a significant increase in mortality since the early 1990s in the countries of the former Soviet Union, unlike other Eastern European countries. By contrast, Western European countries show greater homogeneity.

The most important demographic factors affecting the mortality of the population include the level of acquired education. People with a higher level of education usually achieve better living standards (Kino *et al.*, 2017), exhibit higher awareness of health risks and the positive effects of a healthy lifestyle, they are able to recognise possible disease symptoms sooner and place more emphasis on prevention (Marmot *et al.*, 2008). The relationship between education and health was investigated by a case study (Albert and Davia, 2011; using 11 developed European countries as an example), which confirmed a positive correlation between these two variables, especially in the case of tertiary education. There is a confirmed relationship between the level of acquired education and mortality (Spijker, 2014), especially mortality caused by cardiovascular diseases, chronic obstructive pulmonary disease and smoking-related tumours (Davey Smith *et al.*, 1998; Lundberg *et al.*, 2008; Khang *et al.*, 2010). The risk of the first myocardium infarction is deepened in connection with lower education levels (Macintyre *et al.*, 2001).

Analytical convergence studies agree in that there are clear differences in the mortality structure between the West and the East, mainly in relation to cardiovascular diseases as the cause of death. The processes of convergence in the EU-28 group in the years 1965–1995 revealed a deepening difference between the East and the West and also mentioned a convergence between the North and the South of the continent (Meslé and Vallin, 2002). In the period 1995–2009, EU-27 countries showed a convergence in the area of health, mainly thanks to the significant reduction of deaths caused by cardiovascular diseases (-1.557% per year). This reduction was most likely a manifestation of the cardiovascular revolutions, which started much later in Eastern Europe. A significant convergence was also demonstrated in the area of deaths caused by neoplasm (-1.934% per year) and median survival (-0.819% per year). Despite this, a considerable heterogeneity of the cohort must be pointed out (Maynou, 2013).

A study by Aktaş (2017) sorted EU countries and EU candidate countries by socioeconomic indicators, which are closely connected to demography, into five clusters. The first cluster was formed by Eastern European countries (Bulgaria, Rumania, Latvia, etc.). The second included countries of Southern Europe, including Estonia and Slovakia. The remaining clusters included Western and Northern European countries, with a separate cluster formed by Luxembourg alone, and another by Finland and Sweden (Aktaş, 2017). Cluster analyses are also used to evaluate the determinants of health in smaller regions, i.e. (micro)regions.

Another important health determinant is represented by unemployment leading to the onset of fatal diseases caused by stress and the reduced overall immunity of individuals (Lemstra *et al.*, 2015). A loss of employment increases the risk of cardiovascular issues by up to 35.1%, with consideration of indicators such as age, education, etc. (Dupre *et al.*, 2012). A Canadian study (Kraut *et al.*, 2001) discovered a large percentage of the unemployed among diabetic patients and a direct proportion between increased unemployment rates and increased mortality (by up to 2.5%). The assumption of the effect of unemployment on increased mortality and the diabetic patient rate was also mentioned by other authors (Limm *et al.*, 2012; McNamara *et al.*, 2017). Unemployment (especially long-term) is also related to poverty and a lower social status. A higher mortality condition was proved among the low-income population, with a significant contribution to this situation again being represented by stress, largely affecting, inter alia, the cardiovascular system and immunity, thus increasing the risk of myocardium infarction and brain stroke (Wilkinson and Marmot, 2003; Galobardes *et al.*, 2004).

Poverty and poor health state are also connected with GDP per capita. The proportion of people with unsatisfied health needs increased after 2009, especially in the lowest income countries (OECD, 2016), but disparities also exist in advanced countries such as the USA, where 2–4 times higher mortality was found in the low-income population group (Winkleby and Cubbin, 2003). These inequalities can also be found in Europe, as the Western population exhibits the chance for an eight-year-longer survival on average than the population of certain Central and Eastern European Countries (OECD, 2016). The influence of GDP and income inequality on mortality structure has been similar in Western and Eastern European countries, but it is seen to a greater extent in women (Spijker, 2014). The European study of Orwat-Acedańska (2019) used Disability Adjusted Life Year (DALY) as a measure of health. The DALYs level was found to be strongly related to several economic, social and environmental factors, including health care spending, alcohol consumption, and air pollution, as well as GDP growth rates and the length of education. A significant correlation with GDP growth rates has been confirmed, which means that DALYs may be affected by business cycle fluctuations. The significant correlation of DALYs with the length of training confirms the important role of education in improving the level of health in society (Orwat-Acedańska, 2019).

3. THE PRESENT STUDY – INDICATORS, DATA AND METHODS

The input matrix recorded data for 28 EU countries from the period 2011–2014, as in that period data was available for all current Member States. It was necessary to consider the optimum number of indicators (variables) with regard to the number of observations, with the optimum ratio being 1:10 in the opinion of the investigators. In the case of the 28 considered EU countries and data from a four-year period, the resulting matrix included 112 observations. Therefore, the decision was made to use 11 variables with a systematic elimination of non-standardised quantitative data.

The selected health indicators were divided into two categories: a) the mortality structure, and b) demographic and socio-economic indicators. The mortality structure sorted by the most frequent causes of death pursuant to the standardised mortality rate (per 100,000 inhabitants; according to the chosen EU standard; WHO classification; WHO, 2016) included 5 indicators: 1) cardiovascular diseases, 2) diseases of the nervous system, 3) neoplasms, 4) respiratory diseases, and 5) diabetes mellitus. These cause-specific mortality indicators were selected due to their high proportion of total mortality (neoplasms, circulatory system and respiratory diseases) and their dynamics of development (nervous system and diabetes; WHO, 2017). The demographic and socio-economic category consisted of 6 indicators: 1) life expectancy at birth, 2) grey dependency ratio (defined as the number of people aged 65+ per 100 persons aged 15–64), 3) the proportion of people with completed tertiary education in the 15–64 age category, 4) the unemployment rate (the share of the registered unemployed per 100 members of the economically active population, age 15+), 5) the risk of poverty infliction (the proportion of people living below the 60% median annual national income in the total population), and 6) real GDP per capita. Indicators that reflect quality of life and health care, social and economic level, socio-economic status, etc. were chosen in the group of socio-demographic and economic determinants.

The data came from the ECHI Data Tools and Eurostat databases (2018) and was processed in the STATISTICA 12 software. The analyses were based on the composite indicator method (CI; expressed as an index in %). Two CIs were formed for each of the EU countries: 1) a CI for the evaluation of the standardised mortality structure, and 2) a CI presenting the socio-demographic and socio-economic situation. The use of indicator weights was chosen in the case of the mortality structure CI, since some diseases were considered more serious and their mean prevalence was many times higher than the prevalence of other diseases (applied weights, which were determined by the severity of a disease: cancer 0.25; cardiovascular diseases 0.25; respiratory diseases 0.2; diseases of the nervous system 0.1; diabetes 0.2). Furthermore, the data was standardised so that the originally incommensurable data of the sub-indicators became comparable. The *min-max* method was used to standardise and construct the composite indicator (Hendl, 2012). It was calculated for *max* type indicators as:

$$B_j = \frac{X_j - \min\{X_j\}}{\max\{X_j\} - \min\{X_j\}} \cdot 100 \tag{1}$$

It was calculated for *min* type indicators as:

$$B_j = \frac{\max\{X_j\} - X_j}{\max\{X_j\} - \min\{X_j\}} \cdot 100 \tag{2}$$

The last step in assembling the composite indicator is weighing and aggregation. Weighing takes place on the basis of the specified weights by multiplying the standardised data by a given weight. Subsequently, the values are aggregated. Aggregation was carried out by the weighted sum method. The result of this aggregation is a dimensionless CI, on the basis of which we can determine the order of selected statistical units – EU Member States (Hudrlíková, 2014).

The convergence method was chosen to determine the convergence of EU countries over time based on the values of the set indicators.

Two concepts of convergence were defined: 1) beta convergence, based on the assumption that units converge at a point in time (logarithmic values of the variable at the beginning and at the end of the studied period, their mean growth coefficients subsequently transformed to logarithms; a logarithm was used for asymmetric data distribution), and 2) sigma convergence for variability measurement with standard deviation application. The convergences were compared both for the mortality CI and for the demographic and socio-economic situation CI. For beta convergence measurements, average growth coefficients were calculated from the variables at the beginning and end of the reference period using the formula:

$$\bar{k} = \sqrt[n]{\frac{y_n}{y_0}} \tag{3}$$

Subsequently, these average growth coefficients were logarithmised and the regression line equation was determined by the least squares method:

$$\log \bar{k} = a + \beta \log y_0 \tag{4}$$

According to the slope of the line β, we determined the prevailing tendency. If $\beta < 0$, a convergence occurs, if $\beta > 0$, the predominant tendency is divergence (Hebák, 2013).

Sigma convergence uses variability to measure values, measured by the standard deviation. This should decrease in case of a convergence over time, but in the case of a divergence the deviation increases. In the case of a sigma convergence, we need data from all sub periods and then we calculate standard deviations from the logarithmic data. According to the resulting values, we determined their tendencies (Hebák, 2013).

Cluster analysis is a multivariate statistical method, working with a large number of variables. It was used for the evaluation of spatial disparities on the basis of the CI indices calculated for the averaged period of 2011–2014. An agglomerative clustering was used, the main task of which was to divide the file into several subfiles containing elements with similar variable values. Inside the clusters, the objects in the values of the variables were as homogeneous as possible, while the differences between the clusters must be as large as possible (Hendl, 2012). The aim is to maximise inter-cluster variability while minimising intra-cluster variability. Every object has to belong to one cluster with certainty. The variables were standardised before their entry into the analysis and their mutual correlation was ruled out. Clustering was carried out as hierarchical, when clusters were created gradually, in individual steps. The total number of clusters was then equal to n - 1 (Hebák, 2013). Distance measurements using a square of Euclidean distance were used to assess the similarities between clusters:

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \tag{5}$$

Based on this method, a distance matrix was created between objects to allow the closest elements to join in a cluster, and a new distance matrix was created. Thus, it was continued until one total cluster was formed, with a matrix of distances of individual object pairs serving as the primary basis for the clustering procedure. Clusters were created using the Ward method, which uses variance. This was calculated for each pair of elements in each step. Clusters always occur between pairs with the lowest sum of variance. This is done until all objects are merged into one cluster (Hendl, 2013). The optimal number of clusters was determined according to the distance matrix and the graph of the distance of the connection of individual objects (Hebák, 2013).

4. THE RESULTS

4.1. Evaluation of EU countries based on the composite indicator

The formed CI of a standardised mortality structure found the most favourable situation in Finland (134.4%), France (126.5%), and Sweden (120.2%). A very good situation was also found in South European countries: Greece (118.4%), Italy (112.2%), and Spain (111.4%), and countries with strong economies, such as Luxembourg (113.1%), Austria (108.4%), and Germany (108.1%). Countries accessing the EU later above-average CI values included Estonia (109.7%), Lithuania (107.8%), Malta (105.2%), and Cyprus (103.8%). The worst results were achieved by Hungary (63.8%), followed by Slovakia (74.9%), Croatia (76.4%), and the Czech Republic (80.7%).

According to the demographic and socio-economic CI, the best situation was clearly found in Luxembourg (165.4%). This classification was applied to both by dint of the very high GDP per capita and the favourable values of the other individual indicators forming the CI (one of the highest chances for survival, a high percentage of people with completed tertiary education, a low unemployment rate, the grey dependency ratio, and a low rate of the poverty-stricken). A good demographic and socio-economic situation was also found in the Netherlands (CI 137.6%), Great Britain (130.7%), Cyprus (130.8%), Sweden (128.8%), Ireland (128.7%), Finland (128.2%), and Denmark (126.8%). The top ten further included Belgium (124.9%), and France (122.2%). This group mainly included the EU founding states and the countries accessing the EU in the first accession waves. Out of the Central and South-East European countries, a relatively good evaluation existed in Slovenia (107.8%), Malta (106.5%), and the Czech Republic (102.8%), while the worst CI values were achieved by Bulgaria (34.3%), Romania (50.2%), Latvia (53.9%), and Croatia (56.9%). Relatively unfavourable results were also achieved by Hungary (64.9%), Greece (65.9%), Lithuania (67.3%), and Portugal (75.0%).

To compare the results for the two CIs, a ladder diagram was formed according to which the EU countries could be divided into 3 main groups: 1) countries with very similar results (whether favourable, average or unfavourable) of both CIs, i.e. the mortality structure and the demographic and socio-economic situation. In the positive sense, these groups included, above all, Sweden and Luxembourg, but also for example Finland, and France. On the other extreme, negative values of both CIs were achieved by Hungary, Croatia, Slovakia, Portugal, and Poland. Malta and Slovenia showed stabilised average values; 2) countries with an above-average CI index of the mortality structure but a weak socio-demography CI (this mainly applies to countries of Southern Europe: Greece, Italy, and Spain); and 3) countries with a low mortality structure CI but an above-average demographic and socio-economic situation CI (this is mainly the case of the North Sea shore countries: Ireland, Denmark, and Great Britain; Fig. 1).

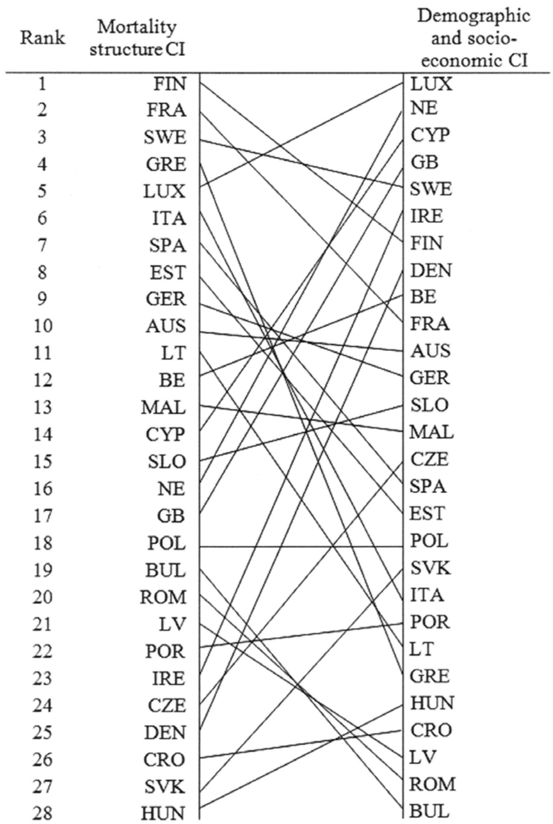

Fig. 1. Ladder diagram of mortality rate CI and demographic and socio-economic situation CI (in the European Union countries, period 2011–2014)

Source: own work based on ECHI Data Tools and Eurostat databases (2018).

4.2. Convergence measurement in EU countries

Although the point diagram line for beta-convergence measurement of the mortality structure CI in the period 2011–2014 was characterised by a negative direction typical of a convergence, the determination coefficient was very low ($r^2 = 0.0298$; $100R^2 = 3\%$). Therefore, the correlation diagram analysis was considered desirable: 1) the first quadrant countries (e.g. Finland, France or Sweden) showed both above-average baseline values of their CIs and the quickest growth rates. In these countries with initially favourable mortality Cis, a further improvement of the mortality condition was observed; 2) the second quadrant countries (Slovakia, Ireland, Denmark, etc.) combined below-average baseline values with a quick growth rate of the measured index. These countries may be said to be quickly improving their initially poor mortality situation; 3) the third quadrant included countries (such as the Czech Republic, Croatia, Hungary, Bulgaria, etc.) with a below-average baseline index showing a further decrease in time, i.e. a worsening of their mortality situation; and 4) and the last quadrant was typical of countries like Greece, Malta, Estonia, etc. where the above-average baseline values decreased over time, i.e. their mortality situation also worsened as time passed (Fig. 2).

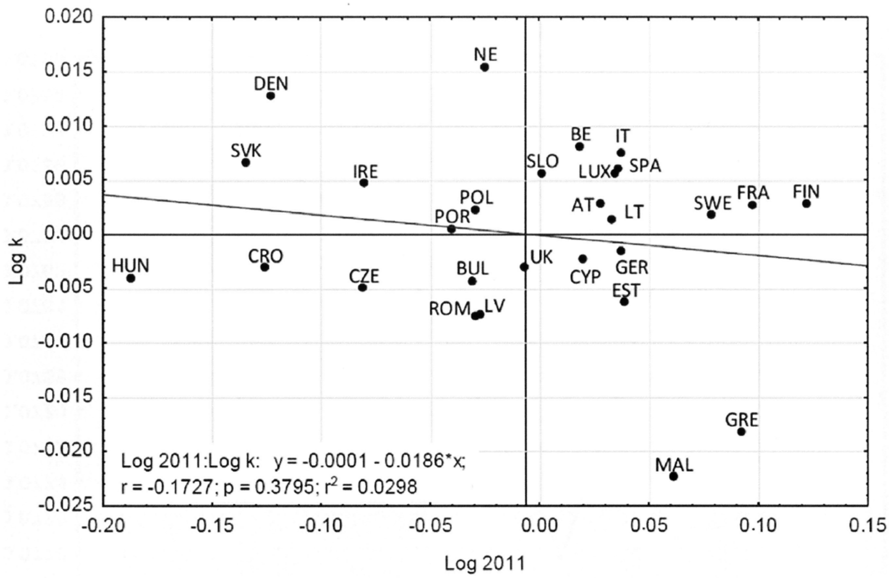

Fig. 2. Graphic representation of beta-convergence for mortality structure CIs (in the European Union countries, period 2011–2014)

Source: own work based on ECHI Data Tools and Eurostat databases (2018).

In the case of the sigma-convergence measurement standard deviations of the mortality structure, CI logarithmic values were calculated for all the studied periods. The standard deviation value progress did not exhibit any clear trend over time, but it rather oscillated. After the initial growth, it dropped again in 2014 with minimum differences between the individual compared years (Fig. 3). It is evident that there is no unambiguous trend of convergence or divergence of the mortality structure CI between EU countries in 2011–2014.

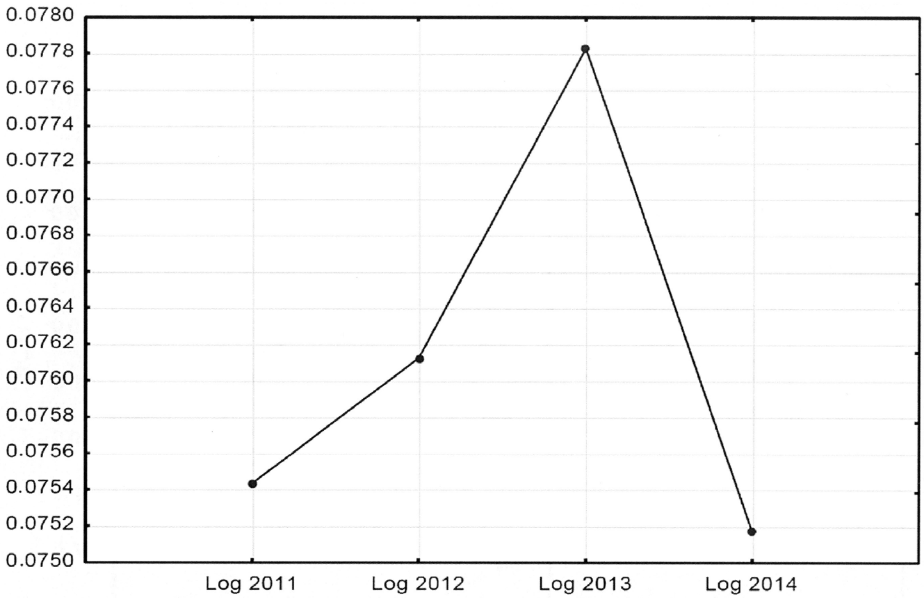

Fig. 3. Sigma-convergence of the mortality structure CI (in the European Union countries, period 2011–2014)

Source: own work based on ECHI Data Tools and Eurostat databases (2018).

The mean growth coefficient of the demographic and socio-economic CI in the period 2011–2014 again showed a negative line direction with a very low determination coefficient ($r^2 = 0.1283$; $100R^2 = 12.83\%$). According to the correlation diagram analysis: 1) the first quadrant countries showed an above-average baseline CI value and above-average CI growth (typical examples include Luxembourg, Austria, Ireland, the Czech Republic, etc.); 2) the second quadrant countries (e.g. Poland, Slovakia, Estonia) showed a below-average baseline value and above-average growth rate of the CI index; 3) the third quadrant was represented by countries (Italy, Greece, Romania, and Portugal) with a below-average baseline index value and a below-average CI growth rate; and 4) the countries located in the fourth quadrant were characterised by above-average initial values but a below-average growth rate of the measured CI (Cyprus, Finland, the Netherlands, etc.,) (Fig. 4).

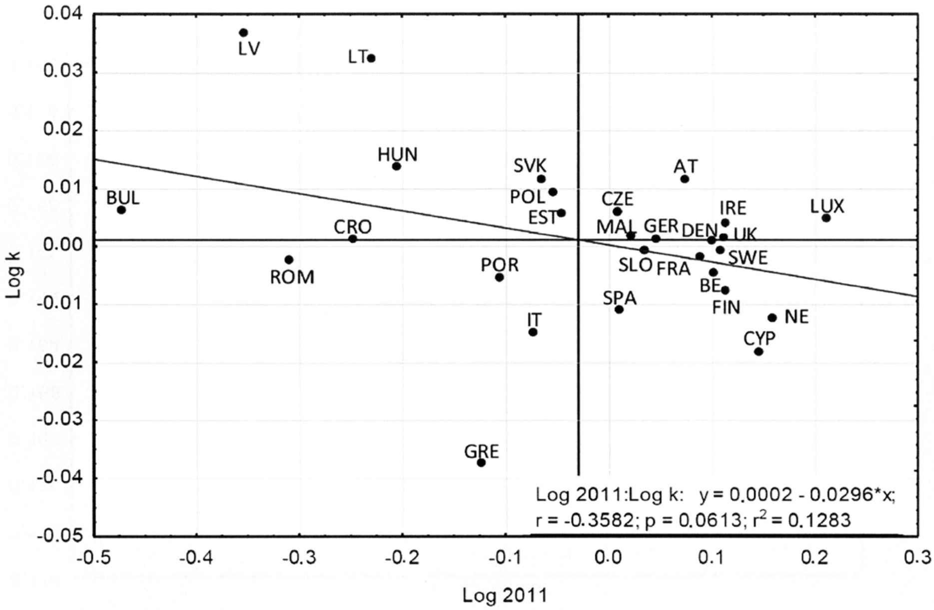

Fig. 4. Graphic representation of beta-convergence for demographic and socio-economic CIs (in the European Union countries, period 2011–2014)

Source: own work based on ECHI Data Tools and Eurostat databases (2018).

The sigma-convergence of the demographic and socio-economic CI did not show any clear convergence trends. In the first years, the standard deviation clearly decreased, indicating a convergence of the countries. In 2014, however, the standard deviation grew again, which reduced the demonstrativeness of the measured model. No clear convergence could be indicated in this case either and in this case the sigma-convergence actually confirms the result of beta-convergence as well (Fig. 5).

According to the beta-convergence results, EU countries and regions wary. There are countries with a favourable and improving mortality structure (Finland, France or Sweden) and countries with an unfavourable and worsening mortality structure (Greece, Malta, Estonia, etc.). This analysis revealed a deepening difference between regions in the EU, especially between the regions of the Northern and Western Europe and the regions of the Southern and Eastern Europe, as is confirmed by earlier research (Meslé and Vallin, 2002). It is evident that there is no unambiguous trend of a sigma-convergence or divergence of the mortality structure CI between EU countries in 2011–2014.

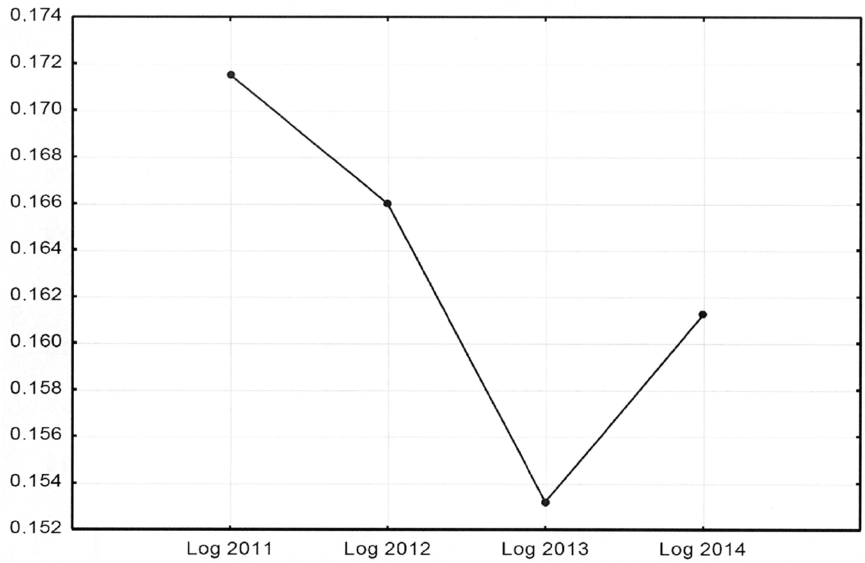

Fig. 5. Sigma-convergence of demographic and socio-economic CIs (in European Union countries, period 2011–2014)

Source: own work based on ECHI Data Tools and Eurostat databases (2018).

4.3. Cluster analysis

The method of cluster analysis offered a spatial grouping of EU countries on the basis of their CIs of the mortality structure and the demographic and socio-economic situation (CI indices calculated for the averaged period 2011–2014). The cluster analysis divided EU Member States into 5 clusters (based on dendrogram analysis, the distance diagram and a subsequent consideration of the possible variants of the clustering process were terminated in step 24). EU countries and their clusters are shown in a point diagram with the *x* axis showing values of mortality structure CIs and the *y* axis representing the demographic and socio-economic situation CIs (Fig. 6).

The CI of the mortality structure found the best situation in Finland (134.4%), France (126.5%), and Sweden (120.2%). The worst situation was found in Hungary (63.8%), followed by Slovakia (74.9%), Croatia (76.4%), and the Czech Republic (80.7%). The best demographic and socio-economic situation according to the compiled composite indicator was found in Luxembourg (165.4%), the Netherlands (137.6%), and in Great Britain (130.7%). The countries of Central and South-Eastern Europe with relatively good results included Slovenia

(107.8%), Malta (106.5%), and the Czech Republic (102.8%). The CI of the demographic and socio-economic situation in Germany (113.4%), and also in Austria (121.7%), was rather unfavourable, although they belong more to the advanced EU countries.

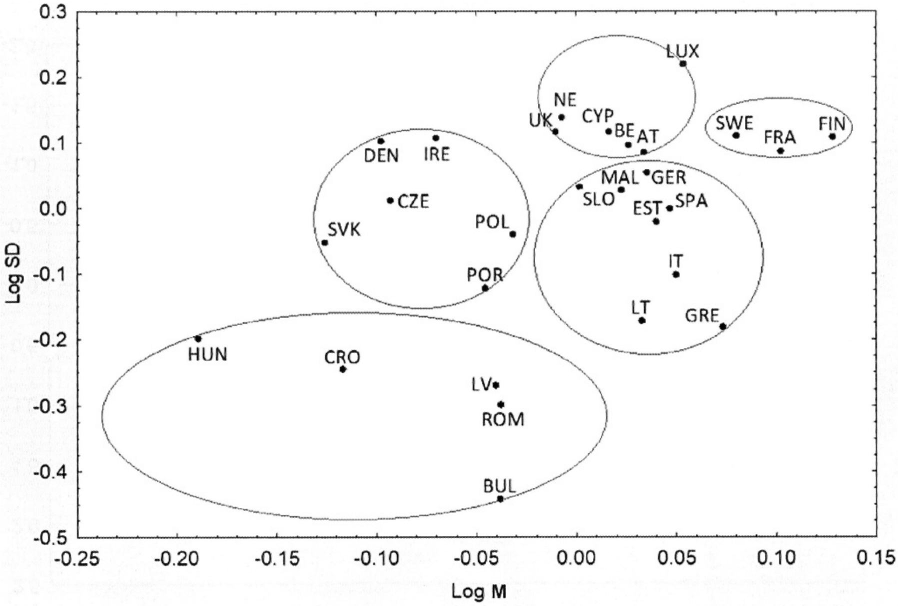

Fig. 6. Point diagram showing the formed clusters (in European Union countries, period 2011–2014)
Source: own work based on ECHI Data Tools and Eurostat databases (2018).

This result was caused by the high grey dependency ratio in the population of Germany and Austria, with a high proportion of individuals above 65. The grey dependency ratio variable, however, did not significantly correlate with the mortality rates in EU countries. Therefore, the process of demographic ageing, more or less manifested in all European countries, does not significantly affect the increase of mortality as a consequence of the most serious chronic non-infectious diseases. Life expectancy increases mainly due to reduced mortality in middle-aged to elderly persons related to reduced mortality caused by cardiovascular diseases. In Central and South-Eastern Europe, life expectancy is lower on average, and yet the cases of premature death form a significant share in the overall mortality. The above presented values of the mortality structure and demographic and socio-economic indicators demonstrate higher mortality related to cardiovascular and neoplasm diseases in these very countries with a lower life expectancy. This trend may be explained by a demographic 'retardation' behind

Western Europe (Rothenbacher, 2013). While population ageing trends and their main causes (low natality and fertility and an increasing life expectancy) are clear, not enough is known about the consequences of population ageing (Börsch-Supan *et al.*, 2013).

The formulation of the qualitative evaluation of the cluster characteristics was supported by Fig. 7 showing standardised values of individual clusters. The 5 clusters were assessed on the basis of the following scale derived from cluster values in relation to the average (Fig. 7): highly above average (cluster 1) – above average (cluster 2) – average (cluster 5) – below average (cluster 3) – very much below average (cluster 4).

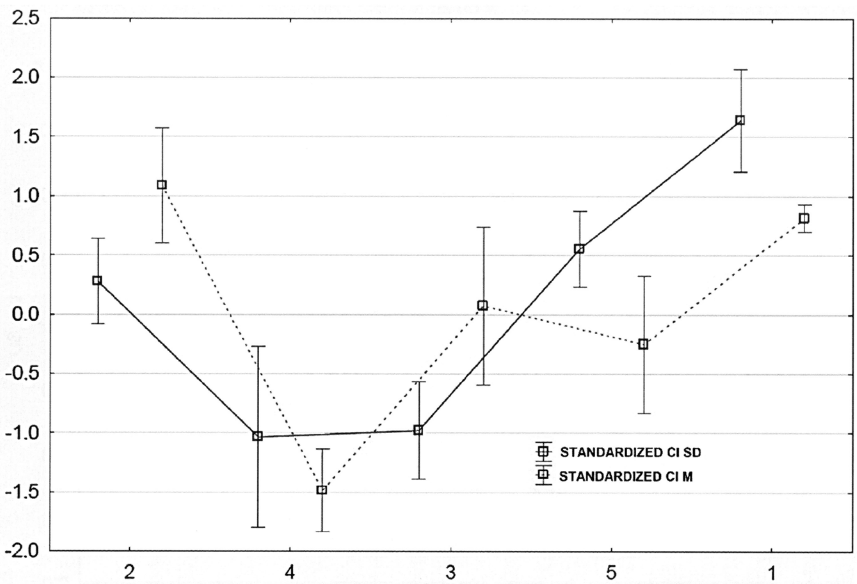

Fig. 7. Standardised cluster values (in European Union countries, period 2011–2014)
Source: own work based on ECHI Data Tools and Eurostat databases (2018).

Cluster 1 – highly above average (Finland, Sweden, France): a high value of the mortality structure index in the EU (i.e. very good situation in the mortality structure). Equally, a very high level of the demographic and socio-economic situation index. Cluster 2 – above average (Belgium, Luxembourg, Netherlands, Great Britain, Austria, Cyprus): slightly above-average values of the mortality structure index. The best or at least positive results of the demographic and socio-economic situation. Cluster 5 – average (Estonia, Lithuania, Slovenia, Germany, Italy, Malta, Spain, Greece): high mortality structure index values (the countries compared very well in the mortality structure with the other EU countries). The demographic and socio-economic situation was rather heterogeneous (the cluster mostly includes countries with below-average values of the socio-demographic index, with the exception of Germany and Slovenia where the value of this index is above-average). Cluster 3 – below average (Denmark, Ireland, Czech Republic, Poland, Slovakia, Portugal): a low mortality structure index (i.e. above-average mortality rates). A demographic and socio-economic situation oscillating around the EU mean (with some countries showing above-average values). Cluster 4 – very much below average (Bulgaria, Romania, Croatia, Hungary, Latvia): low to very low values of the mortality structure index and a very low demographic and socio-economic index (Fig. 8).

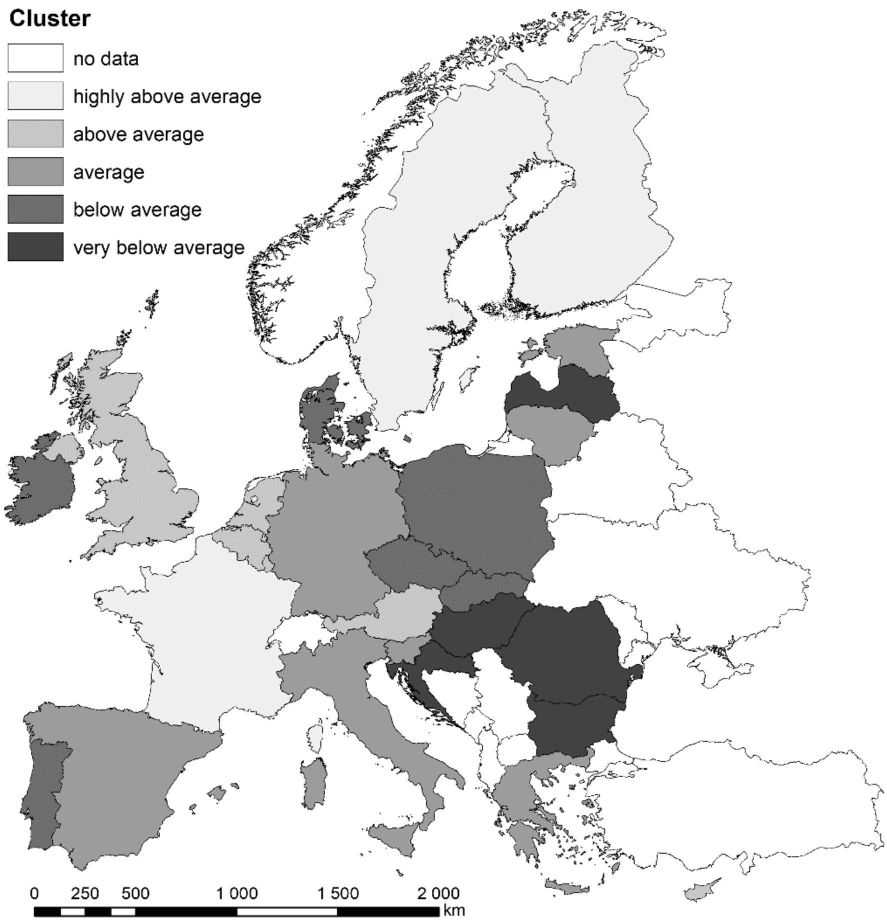

Fig. 8 . Classification and evaluation of EU countries by cluster (period 2011–2014)
Source: own work based on ECHI Data Tools and Eurostat databases (2018).

This territorial structure visibly corresponds to the cluster analysis results for the socio-economic indicators arrived at in the study by Aktaş (2017) and confirms the continuing differentiation between Western (and Northern) Europe and the countries of Eastern Europe (Spijker, 2010; 2014). A major demographic and socio-economic factor conditioning the health of the population also includes education level (Albert and Davia, 2011). The level of education also influences the value of the demographic and socio-economic CIs in our study. Countries with a below-average value of the proportion of people with completed tertiary education were placed in the second half by the demographic and socio-economic CI (Malta, Czech Republic, Slovakia, Italy, Portugal, Croatia, and Romania). These results were also proved by a study on the context of the growth in education and the improvement of mortality in selected European countries and in Russia. Over 80% of the total life expectancy increase is attributable to improved mortality within educational categories (for example, in Finland and the Czech Republic improvements are seen in all educational groups; Shkolnikov *et al.*, 2006). In contrast, the cohort of the analysed European countries showed an increase in, e.g. diabetes-related mortality, in lower-education groups in the study by Vandenheede (2015).

5. CONCLUSION

An OECD report (2016) states that although the quality of health in the EU is generally improving, the differences among EU countries persist, and notes that every year, hundreds of thousands of people in the EU die as a consequence of diseases that could be prevented. Despite efforts to eliminate economic disparities and regional differences, they persist between EU regions, which are reflected in the structure of mortality and the rates of development (Spijker, 2014). In the context of the demographic and socio-economic health determinants, emphasis must be placed on equal opportunities, social justice, and solidarity in the society. Our analysis shows that inequalities in mortality patterns and demographic and socioeconomic determinants are universal in European countries and threaten health inequalities (McNamara *et al.*, 2017). At the same time, social cohesion must be supported along with an improved response to demographic, social and economic changes (Marmot, 2017). In addition, to improve the quality of healthcare and the interconnection to the individual political spheres, it is further necessary to emphasise, for example, the employment policy in the context of which it is necessary to create new job opportunities, support disadvantaged groups on the job market and thus reduce unemployment, and eliminate disadvantageous work conditions. It is further needed to assure the optimum minimum wage level reducing the risk of poverty among the working population and increasing household income. In the economic context, it is necessary to formulate strategies supporting sustainable economic growth in compliance with health protection guidelines and favourable environmental care (OECD, 2016). Finally, health inequalities are reflected in the demographic structure, geographic aspects and customs and the culture of the population (Brandt *et al.*, 2012).

The critical assessment of the study – the indicator and time period selection might be questioned but both were determined by the limited data availability. For example, there is a short three-year period for convergences, but they still indicate a definite trend of change in development. A certain generalisation of the results cannot be excluded in connection with the investigation of the effects of the analysed determinants either, due to the size of the cohort. The results could be more accurate with a focus on a lower number of countries or case studies of particular countries. The objective of the study, however, was not only to analyse the relationship between the selected demographic and socio-economic factors and human health (morbidity and mortality), but also to apply this relationship to all EU Member States. Another research direction is to expand the study to include environmental factors and to extend the time series with more recent data so that it is possible to assess the convergence of EU countries more objectively and to compare the change and development of the monitored indicators.

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