SELF-ASSESSMENT OF HEALTH STATUS AMONG SENIORS IN THE EUROPEAN UNION

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Abstract
The aim of this paper was to determine the level of self-assessment of health status among the senior population of the European Union (EU). The analysis used quantitative data from Eurostat. An objective division of EU countries was adopted based on their geographical location. The phenomenon was characterised using basic demographic measures, especially selected indicators describing the health conditions of seniors. A statistically advanced method rarely used in social studies – Kohonen self-organising neural networks – was applied. This method identified four types of health self-assessment among the senior population of the EU Member States for the years 2013 and 2022. Based on the typology, the highest level of self-assessment was observed in five countries (Denmark, Ireland, Sweden, Austria, and Belgium), while the lowest concerned eight countries (Estonia, Lithuania, Latvia, Hungary, Romania, Slovakia, Croatia, and Portugal).

1. Introduction

The phenomenon of population aging is most pronounced in Europe and has been the focus of many theoreticians and practitioners for decades. The first studies on demographic aging appeared in the second half of the 20th century and concerned France, where aging began as early as in 1851 (Pressat, 1966). Research focuses both on theoretical and empirical aspects, analysing the impact of aging on demographic phenomena (e.g. Walford, Kurek, 2008; Długosz, Biały, 2013; Sanderson, Scherbov, 2013; Horn, Schweppe (Eds.), 2016; Pytel, 2017; Fernandes et al., 2023). One of significant area of its interest is how population structure changes affect the labour market (e.g. Green, Collis, 2006; Loretto, White, 2006; Temple, McDonald, 2017; Park et al., 2022). Social policy aimed at mitigating the effects of demographic

change and organising care for the elderly also receives much attention (e.g. Ranci, Pavolini, 2015; Ejdys, Halicka, 2018; Porcel-Gálvez et al., 2024; Zhang et al., 2024). Another important area of research on senior issues related to the welfare state is access to education and health services in different age groups (Bambra, 2006; Bell, Rutherford, 2013; Gonçalves Gaia et al., 2024; Cabañero-Garcia et al., 2025).

It should be noted that the level of access to healthcare services is closely related to the issue of seniors' health and is examined across three areas: medical, functional, and self-assessment (Park, Kang, 2025). An extremely important area that reflects various aspects of older adults' health is health self-assessment. It concerns the evaluation or perception by an elderly person of their general health status, including both physical and mental health. It is therefore a fundamental factor representing quality of life and showing a strong correlation with life satisfaction among seniors (Yan et al., 2024). Research on seniors' health self-assessment considers many different determinants, including social elements such as place attachment and social cohesion (Zimmermann, 2024). The multifaceted nature of the factors influencing this self-assessment makes it difficult to clearly interpret why individuals assess their health positively or negatively, and thus makes it necessary to continue research in this area across various temporal and special perspectives. The present study is, in a sense, a continuation of the authors' previous research on the health situation of seniors in European countries (Brambert, Kiniorska, 2023).

2. Rsearch aim, sources and methods

The aim of the study was to determine the level of health self-assessment among the senior population in the 27 countries of the EU. An objective division was adopted based on the geographical location of the Member States, grouping them into four regions: Northern Europe (Denmark, Estonia, Finland, Ireland, Lithuania, Latvia, Sweden), Eastern Europe (Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia,), Southern Europe (Croatia, Cyprus, Greece, Italy, Malta, Portugal, Slovenia, Spain), and Western Europe (Austria, Belgium, France, Germany, Luxembourg, Netherlands). The time frame of the analysis covered the years 2013 and 2022. The data came from Eurostat resources. The research was conducted using basic demographic indicators as well as indicators describing the health conditions of seniors.

The analysis employed a statistically advanced Teuvo Kohonen's method of self-organising neural networks with a topological map (Kohonen, 2001). This multidimensional cluster analysis was used to identify types characterising the health situation of seniors in the studied units in relation to other European countries. Kohonen networks are also known as Self-Organizing Feature Map (SOFM). A key argument for using them in such cluster analyses is their ability to learn from the data set provided in the input matrix. Unlike traditional statistical methods, these networks do not impose any conditions or require assumptions about the variables (Brambert, 2020). Classification with the use of the Kohonen method follows the internal logic of the data, as the network can detect "hidden" patterns within a given dataset. The self-learning process operates in an unsupervised mode, meaning that no output models are defined for the input data. The solution to the problem results from the association of information between the input layer and the competitive layer of neurons. A trained Kohonen network is a set of neurons that specialise in recognising and grouping similar cases (Brambert, 2020; Kiniorska, Brambert, 2021; Kamińska et al., 2025).

During the training of the network, the algorithm identifies the neuron whose centre is closest to a single training instance. The neuron that is nearest to the data case in terms of Euclidean distance, in other words the one with the strongest response to the input value, becomes the winning neuron. In this competitive mechanism, one neuron wins for each data instance, and a high number of wins determines the centres of clusters of similar objects. These groupings are illustrated on the so-called Kohonen map which is a two-dimensional topological matrix represented on a two-factor plane (Kiniorska, Brambert, 2021). Neurons representing similar clusters of features are located next to each other, forming a spatially ordered map that enables the analysis of relationships between clusters. In the Kohonen network, the neighbourhood refers to the group of neurons surrounding the winning neuron, which, together with it – and with decreasing intensity – learn to recognise input values (Brambert, 2020).

The typology based on the presented method allowed for identification of groups of EU countries that are similar in terms of seniors' health self-assessment. Relatively homogeneous clusters were developed for comparative purposes for the conditions in the years 2013 and 2022. The choice of the upper time limit was due to the lack of data for certain variables for the years 2023-2024. As a result, a complete quantitative data matrix was obtained for the set of 27 EU countries for both years under comparison.

The self-assessment of seniors' health status for the typology using the Kohonen method was specified in the form of 8 indicators:

- Healthy life years for the population aged 65[1], years 2013 and 2022 (X1);
- Percentage of unmet needs for medical examinations among the population aged 65 and over[2], years 2013 and 2022 (X2);
- Percentage of the population aged 65 and over with a very good perception of their health status in the lowest income group (first income quintile), years 2013 and 2022 (X3);
- Percentage of the population aged 65 and over with a very good perception of their health status in the highest income group (fifth income quintile), years 2013 and 2022 (X4);
- Percentage of the population aged 65 and over with a very bad perception of their health status in the lowest income group (first income quintile), years 2013 and 2022 (X5);
- Percentage of the population aged 65 and over with a very bad perception of their health status in the highest income group (fifth income quintile), years 2013 and 2022 (X6);
- Percentage of the population aged 65 and over with moderate depressive symptoms in the lowest income group (first income quintile), years 2014 and 2019 (X7);
- Percentage of the population aged 65 and over with moderate depressive symptoms in the highest income group (fifth income quintile), years 2014 and 2019 (X8).

In order to select the characteristics, certain conditions had to be met: availability and continuity of data, substantive relevance. The selection focused on achieving the broadest and most comprehensive range of data, as well as a cross-sectional coverage of the subject. Therefore, the selected indicators pertain to the length of life at the onset of senior age, older people's perception of how well their medical examination needs are met, and their self-perception of health depending on whether they belong to the lowest or highest income brackets.

Of the selected indicators, 5 are destimulants of health self-assessment, meaning that high and/or increasing values are associated with poorer levels of self-assessed health. Three indicators (variables X1, X3, X4) are stimulants of self-assessment, where high or rising values reflect a better level of health self-assessment among seniors.

The final stages of classification were carried out using the multivariate statistics module in the Statistica 13 software package. Throughout the paper, the term "population aged 65 and over" was interchangeably referred to as: senior population, post-working-age population, oldest age group, the elderly, older people, or seniors – solely for linguistic variety.

3. Results

Depopulation and population aging are becoming some of the most significant developmental challenges for Europe. According to forecasts from the University of Washington, these phenomena are expected to affect, among others, the Baltic countries most severely. The strongest depopulation is projected for Latvia, with a decline of as much as 78.0% – from approximately 1.95 million in 2020 to just 430,000 by 2100. A substantial population decrease is also forecasted for the other Baltic states during the same period: Lithuania by 48.0%, from 2.85 million to 1.47 million, and Estonia by 37.0%, from 1.21 million to 820,000 inhabitants (Gołębiowska, 2020).

The decline in population and the resulting changes in age structure are leading to the aging of society. One of the fundamental variables describing this process is the share of the population aged 65 and over in the total population. In the years under comparison, a very rapidly progressing (even radical) process of aging was observed among EU residents. In 2013, the highest share of seniors in the total population – at least 17.10% (with an average rate of 17.4%) – was recorded in 18 countries (Fig. 1). High and very high values were primarily observed in countries from the following regions (listed by the dominant number of countries in each region, then in ascending order): Northern Europe (e.g., Denmark, Lithuania, Sweden), Southern Europe (e.g., Slovenia, Spain, Greece), and Western Europe (e.g., France, Germany).

By 2022, as many as 24 EU countries had exceeded the indicated threshold for the share of people aged 65 and over (Fig. 2), with very high values (19.35% and above) recorded in over 90.0% of countries, with the exception of Slovakia and Cyprus.

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[1] The indicator measures the number of years a person aged 65 is expected to live in good health. It is an indicator of healthy life expectancy, combining information on mortality and morbidity. The required data include the prevalence (proportions) of the population living in healthy and unhealthy conditions, as well as age-specific mortality information. Health status is defined as the absence of functional limitations or disability.

[2] The indicator represents the share of the population aged 65 and over reporting unmet medical care needs due to three main reasons: financial constraints, waiting lists, and excessive distance to travel (combined categories). The reported unmet needs are based on the respondent's self-assessment of whether they needed a medical examination or treatment (excluding dental care) but did not receive it or did not seek it.
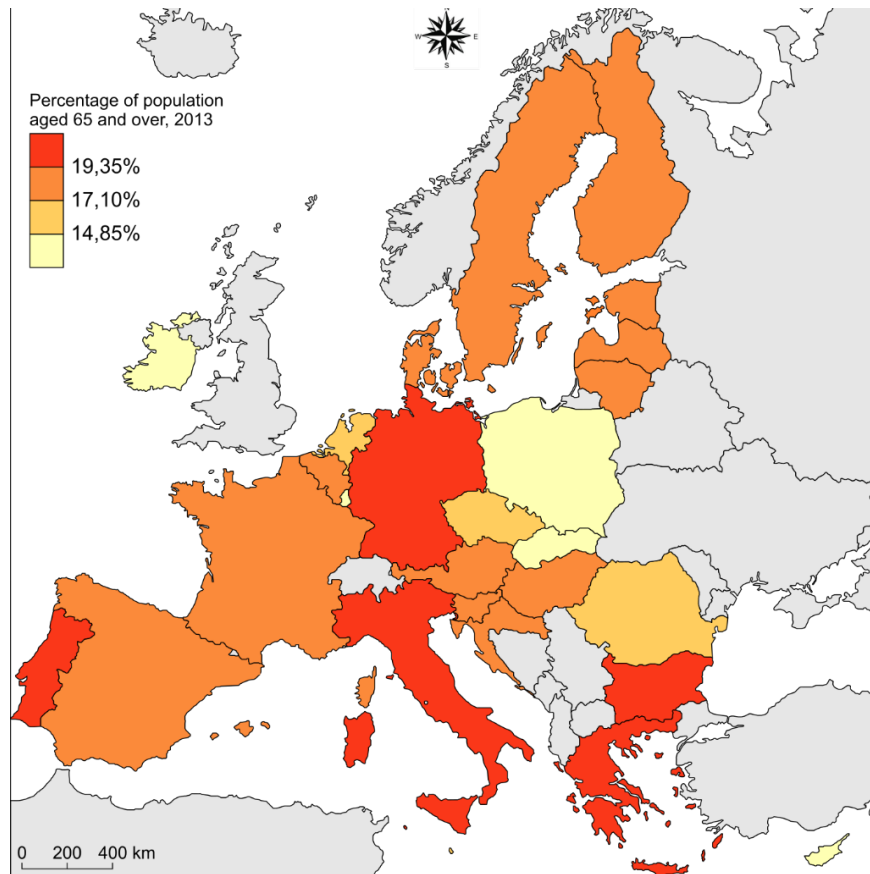
Fig. 1. Percentage of population aged 65 and over in the European Union countries in 2013.
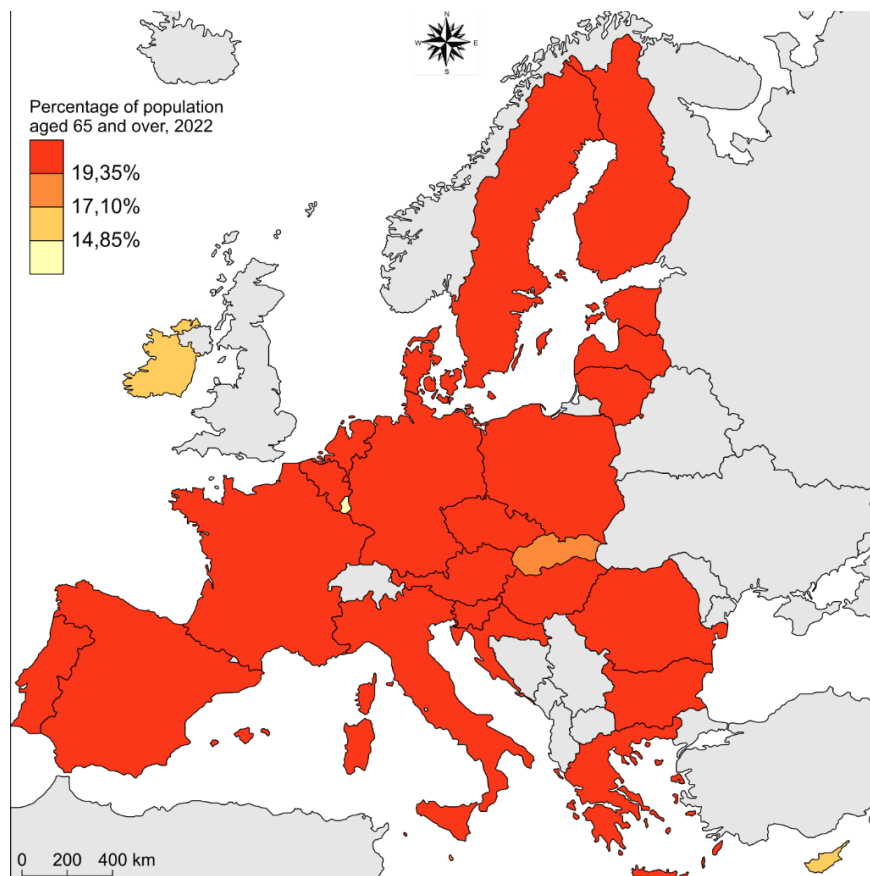Source: own elaboration.

Fig. 2. Percentage of population aged 65 and over in the European Union countries in 2022.
Source: own elaboration.

It is also worth noting that between 2013 and 2022, the studied countries recorded an average increase in the share of the senior population of about 3.0 percentage points, reaching 20.2%. An interesting pattern is that in both timeframes, Southern European countries (Greece, Portugal, and Italy) dominated the top five most aged EU nations. Moreover, the most aged society during these years was Italy, with 21.1% of its population aged 65 and over in 2013, rising to 23.8% in 2022.

The main characteristics of old age are defined as the progressive decline in independent living, a significant reduction in an individual's adaptive capacity in biological and psychosocial dimensions, and a gradual increase in dependence on the surrounding environment. Old age is a stage of life in which a person's health condition tends to deteriorate; therefore, one of the social roles often assumed by seniors is that of a patient (Pierzchalska, Klag, 2008). Changes in the health status of older individuals clearly affect their quality of life (Janiszewska, 2015).

While examining the self-assessment of health among seniors in the EU countries, 4 groups of countries with similar characteristics were identified using the Kohonen method. The cluster recognition process involved grouping the selected set of countries based on 8 variables, using an information matrix with dimensions of 27x8 for both years analysed. In the case of the output matrix for the year 2013, values for variables X7 and X8 were not available for Belgium and the Netherlands and therefore, to avoid excluding these countries from the dataset, values from 2019 were assigned to them. Additionally, in the input layer of the neural network, a training sample size of 100.0% was defined. A Kohonen map with dimensions of 2×2 neurons was used. The typology also required setting training parameters, namely: the number of learning epochs (1,000 cycles), the initial learning rate (0.1), and the initial neighbourhood size (2.0) (Brambert, 2020). The Kohonen network learning error was approximately 0.28 for 2013 and about 0.26 for 2022.

Four clusters were thus identified, each represented by a single neuron with a specific Cartesian position in the network, namely: cluster A – neuron (1, 1), cluster B – neuron (1, 2), cluster C – neuron (2, 1), cluster D – neuron (2, 2). The clusters were labelled according to the scheme: letter symbol – neuron (Cartesian position of the neuron in the network). These clusters differ in size but are relatively homogeneous in terms of the diagnostic parameters specific to each cluster. To interpret the results of the typology, an original and innovative method of ranking the obtained types was applied. The data for each unit were adjusted to match the cluster arrangement in the form of a complete matrix, and the nature of the variables within each aggregate was analysed. Averages were calculated for the entire population and it was checked which units fell below or above the average in terms of feature values. The clusters were compared based on the rank of features, calculated as the average within each subset for individual variables from the dataset. The clusters were interpreted in the order corresponding to the Cartesian position of the neuron in the network.

In 2013, cluster A (the type characterised by a very good self-assessment of senior health) consisted of 6 (22.2%) EU Member States (Fig. 3). It was the third-largest cluster by size, composed equally of countries from Northern and Western Europe (3 countries each). The units from Western Europe (Austria, Belgium, and the Netherlands) accounted for the highest proportion within this cluster (50.0%) compared to the other clusters (Fig. 4).
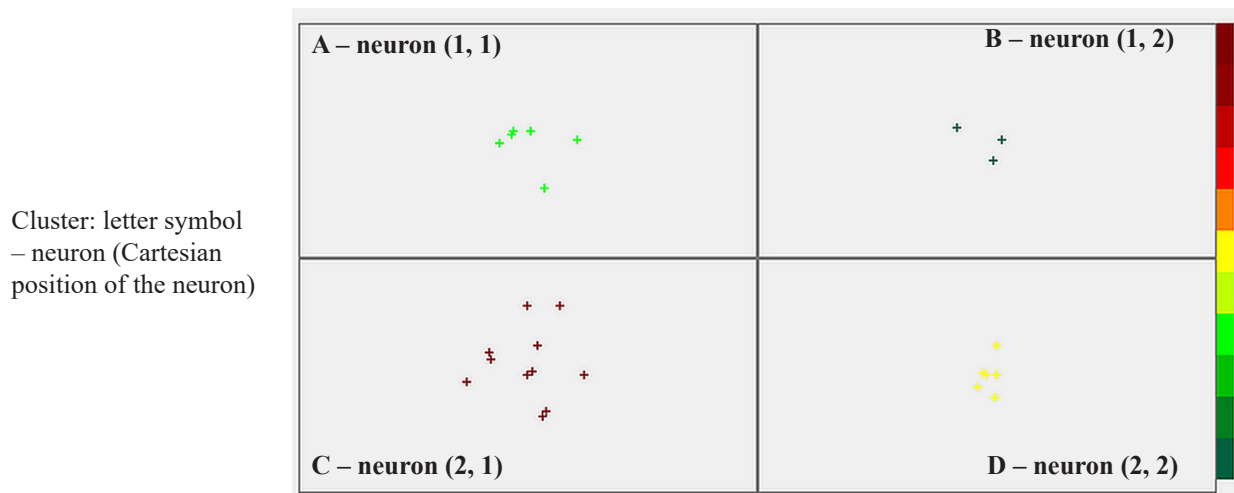

Fig. 3. Clusters of the EU countries according to the types of seniors' self-assessment of health in 2013 presented on a Kohonen topological map with dimensions of 2x2 neurons.
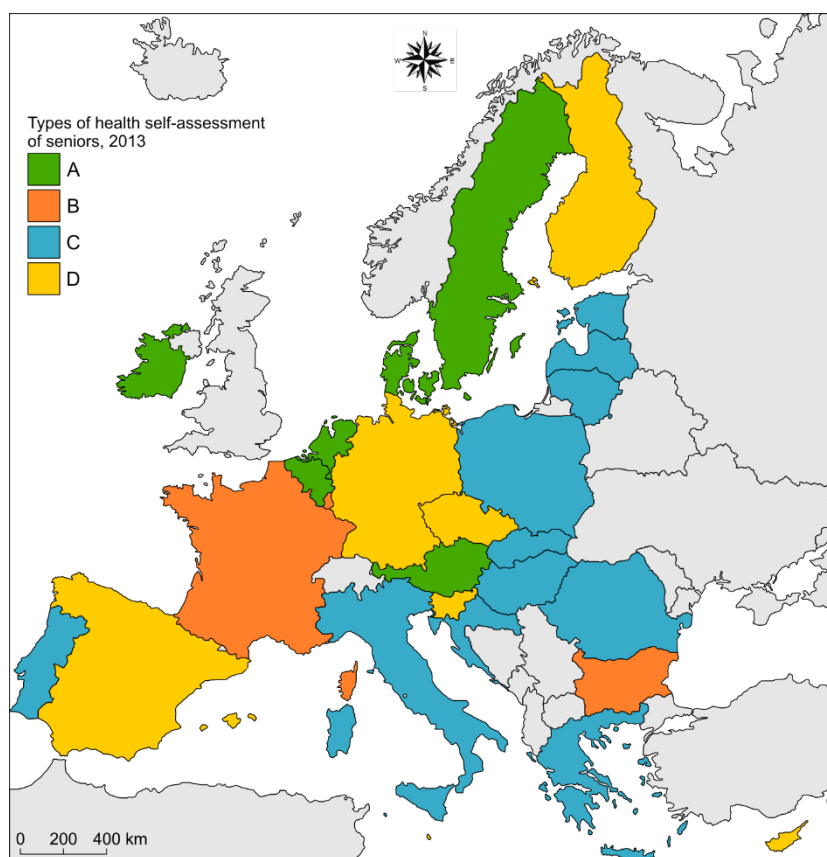Source: own elaboration.

Fig. 4. Spatial differentiation of similar European Union countries in terms of self-assessment of health of the population aged 65 and over according to the Kohonen method in 2013.
Source: own elaboration.

Overall, this was a very good aggregation in the context of the indicators used. Based on the analysis of the average ranks of each variable within this cluster, it was found that 7 features held a rank of 1, and 1 feature had a rank of 4, which placed this group in the 1st position in terms of average rank (Tab. 1). The units in this cluster were the least diverse in terms of the selected features, which was determined by (based on the balance of values more favourable than the overall average) positive – better-than-average – indicator values, namely:

• a very high number of healthy life years at age 65 (X1); a very high share of the population aged 65 and over with a very good perception of their health in the lowest income group (X3); and a very high share of seniors (well above the EU average) with a very good perception of health in the highest income group (X4);

• a very low percentage of unmet medical needs (X2); and a very low percentage of seniors with a very bad perception of health in both the lowest and highest income groups (X5, X6)[3].

To a lesser extent, the structure of this cluster was influenced by the minimal (most favourable compared to the average for the entire population) percentage of the post-working-age population with moderate depressive symptoms in the lowest income group (X7)[4].

Only 3 countries (11.1%) were classified into the second cluster (B), characterised by an average self-assessment of seniors' health. These countries were located in Western Europe (2) and Southern Europe (1). The analysis of the average rank of each variable in this cluster showed: 5 features with a rank of 3, 2 with a rank of 4, and 1 feature with a rank of 2, placing the group in the 3rd position based on average ranks.

The defining features of cluster B (based on the balance of values more favourable than the overall average) were primarily:

• a low percentage of seniors in the lowest income group (first quintile) who perceived their health as very good (X3);

• a high percentage of the post-working-age population with a very bad perception of health in the lowest income group (X5), as well as a very high (least favourable) percentage of seniors with

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[3] The share of units in the cluster with values more favourable than the average for the community was in the range of 90%–100%.

[4] The share of units in the cluster with values lower than the average for the community was in the range of 50%–74%.

Tab. 1. Ranks according to the mean value of a specific diagnostic variable within the clusters of health self-assessment of seniors in the European Union countries in 2013 – Kohonen method

Cluster	Ranks of variables by mean scores within cluster								Average of ranks	Rank of a cluster	Self-assessment of health status of seniors
	X1	X2	X3	X4	X5	X6	X7	X8			
A	1a	1	1	1	1	1	1	2	1,1	1	very good
B	2	3	3	3	3	3	4	4	3,1	3	average
C	4	4	4	4	4	4	3	3	3,8	4	bad
D	3	2	2	2	2	2	2	1	2,0	2	good

Remarks: a the ranks of variables within clusters were bolded to indicate which features determined a given cluster.
Source: own elaboration.

moderate depressive symptoms in both the lowest and highest income groups (X7, X8)[5].

It is also important to note the influence on the structure of cluster B of the high number of healthy life years among the population reaching senior age (X1), but, on the other hand, also of the large percentage of seniors with a very bad perception of health in the highest income group (X6)[6].

In turn, the worst aggregation, indicating bad self-assessed health status among seniors, was represented in 2013 by cluster C, which included 11 (40.7%) EU Member States. This cluster consisted of 4 countries from Eastern Europe, 4 from Southern Europe, and 3 from Northern Europe (the Baltic states). The Eastern European countries (Hungary, Poland, Slovakia, and Romania) accounted for the largest share (66.7%) compared to the other clusters. Very importantly, the unfavourable level of self-assessed health among the oldest part of the population concerned countries that formed the most geographically compact area of the EU (72.7% of the countries in this class), according to the described typology. Starting from Estonia, through Poland, and ending in Romania – they form a coherent north-south spatial arrangement (Fig. 4).

The analysis of the rank of the mean value of the given variable in this cluster showed: 6 characteristics with a rank of 4, and 2 with a rank of 3, which placed the aggregate in the 4th place based on the average rank. Therefore, unlike Group A, this cluster is mainly a result of similarities (based on a balance of values more favourable than the average for the population) in the following areas:

• a very low number of healthy life years for the population aged 65 and over (X1), as well as a very small share of seniors with a very good perception of health in both the lowest and highest income groups (X3, X4);

• a very high share of the elderly population with a very bad perception of health in both selected income groups (first and fifth quintile) (X5, X6)[7].

In the last cluster (D), one quarter (7) of the EU Member States were included, located mainly in Southern Europe (4), and to a lesser extent across the remaining three geographic regions (1 per each). The units from the south of the "old continent" (Cyprus, Malta, Slovenia, Spain) represented half of the units in the region compared to the other clusters.

The analysis of the rank of the mean value of the given variable in this cluster showed: 6 characteristics with a rank of 3, 1 with a rank of 1, and 1 feature with a rank of 3, which placed the aggregate in the 2nd place based on average ranks, allowing the self-assessed health status of seniors in these countries to be classified as good.

The most important common features that defined the fourth cluster (based on the balance of values in the subset above the average for the population) were:

• a low percentage of: unmet medical examination needs among the population aged 65 and over (X2); seniors with a very bad perception of health in the highest income group (X6); the post-working-age population with moderate depressive symptoms in the lowest income quintile group (X7)[8].

Secondarily, the structure of the cluster was influenced by 2 indicators: a low percentage of people aged 65 and over with a very bad perception of health in the lowest income group (X5); and a very low (most favourable compared to the population average) percentage of people aged 65 and over with moderate depressive symptoms in the highest income group (X8)[9].

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[5] The share of units in the cluster with values more favourable than the average for the community was in the range of 25%–49%.
[6] The share of units in the cluster with values more favourable than the average for the community was in the range of 90%–100%.

[7] The share of units units in the cluster with values more favourable than the average for the community was in the range of 0%–24%.
[8] The share of units in the cluster with values lower than the average for the community was in the range of 75%–89%.
[9] The share of of units in the cluster with values lower than the average for the community was in the range of 50%–74%.

   In the case of self-assessment of health status among seniors in 2022, cluster A – the type with a very good self-assessment of health – is the group to which 9 countries (33.3%) were assigned by the Kohonen neural network algorithm (Fig. 5). This is the largest cluster, comprising nearly half of the EU countries from Northern Europe (4), one-third from Western Europe (3), and the remainder from Southern Europe (2). The Northern European countries (Denmark, Finland, Ireland, and Sweden) accounted for the largest share (57.1%) of this subset compared to the other aggregates (Fig. 6).
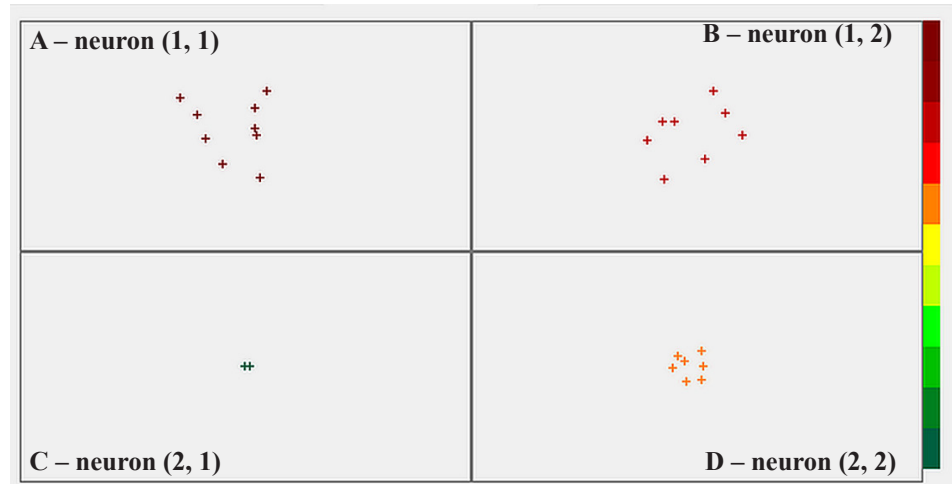

Fig. 5. Clusters of the EU countries by types of seniors' self-assessment of health status in 2022 presented on a Kohonen topological map with dimensions of 2x2 neurons.
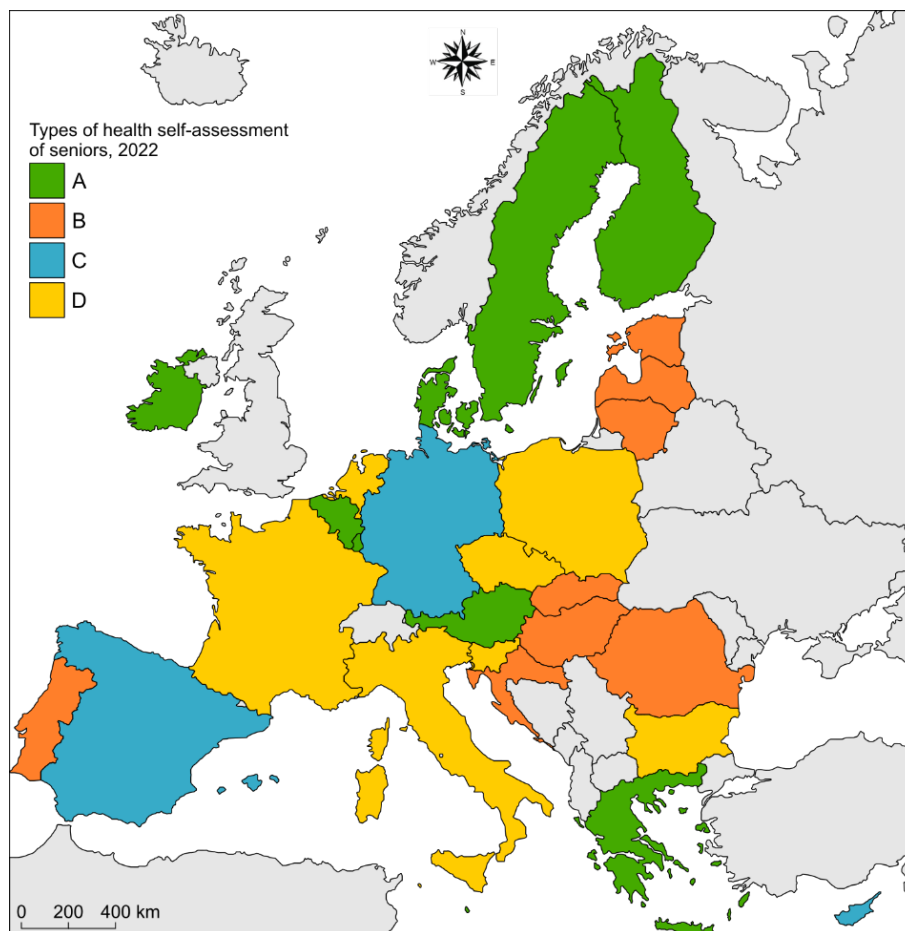Source: own elaboration.

Fig. 6. Spatial differentiation of the EU countries similar in terms of self-assessment of health status among the population aged 65 and over according to the Kohonen method in 2022.
Source: own elaboration.

Cluster A was one-third larger than in 2013. Compared to the clusters from the reference year, the composition of the group was formed by the EU countries originating from the following clusters (neurons): D (good self-assessed health) – 2 countries (Finland, Malta), B (average self-assessment) – 1 country (Luxembourg), C (bad self-assessment) – 1 country (Greece), constituting 44.4% of the analysed aggregate (Tab. 2). Thus, 5 countries (excluding the Netherlands) did not change their position in the neuron matrix, together representing more than half of the subset. As a result, in the identified subgroups of the EU countries, there was either an improvement in self-assessed health status or no change of the highest level of health self-assessment among the oldest citizens.

Similarly to 2013, in a synthetic overview, it is a very good cluster in the context of the indicators used. Based on the analysis of the average value ranks for the given variables in this cluster, it was found that 6

characteristics held a rank of 1, placing the aggregate in the 1st position according to average rank (Tab. 3). Its units were the least diverse in terms of the selected characteristics.

The shape of the cluster was determined (based on the balance of values in the subset more favourable than the population average) by positive (better than average), very good indicator values, namely:
- a very high percentage (significantly above average compared to the entire set of countries) of seniors with a very good perception of health in both income quintile groups (X3, X4);
- a very low percentage of seniors with: a very bad perception of health in the highest income group (X6); and moderate depressive symptoms in the wealthiest segment of the population (X8)[10].

An additional strong and positive influence on the structure of cluster A in 2022 came from the following parameters: a very high number of healthy life years among the population reaching senior age (X1), and

Tab. 2. The structure of transitions between clusters of the EU countries based on the level of self-assessment of seniors' health in 2022 compared to 2013 – Kohonen method

Clusters in 2013 (health self-assessment of seniors)	Clusters in 2022 (health self-assessment of seniors)							
	A (very good)		B (bad)		C (good)		D (average)	
	No. of countries	% A	No. of countries	% B	No. of countries	% C	No. of countries	% D
A (very good)	5	55.6	0	0.0	0	0.0	1	14.2
B (average)	1	11.1	0	0.0	0	0.0	2	28.6
C (bad)	1	11.1	8	100.0	0	0.0	2	28.6
D (good)	2	22.2	0	0.0	3	100.0	2	28.6
Total	9	100.0	8	100.0	3	100.0	7	100.0

Source: own elaboration.

Tab. 3. Ranks according to the mean value of a specific diagnostic variable within the clusters of self-assessed health status of seniors in the EU countries in 2022 – Kohonen method

Cluster	Ranks of variables by mean scores within cluster								Average of ranks	Rank of a cluster	Self-assessment of health status of seniors
	X1	X2	X3	X4	X5	X6	X7	X8			
A	1	3	1a	**1**	1	**1**	2	**1**	1,4	1	very good
B	**4**	4	**4**	**4**	**4**	4	3	3	3,8	4	bad
C	3	**1**	3	2	3	3	**1**	**2**	2,3	2	good
D	2	2	**2**	**3**	2	2	**4**	**4**	2,6	3	average

Remarks: a the ranks of variables within clusters were bolded to indicate which features determined a given cluster.
Source: own elaboration.

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[10] The share of units in the cluster with values more favourable than the average for the community was in the range of 75%–89%.

– among the destimulants – a very low percentage of seniors with a very bad perception of health in the lowest income group (X5)[11].

Cluster B in 2022 reflected a bad level of self-assessed health status among seniors in the EU countries. This second-largest subset included 8 (29.6%) Member States. It comprised 3 countries each from Northern and Eastern Europe, and 2 from Southern Europe. The Eastern European countries (Romania, Slovakia, Hungary) represented half of the region's units compared to the other clusters.

This second cluster was over 2.5 times larger than in 2013. Compared to the clusters from the reference year, its entire composition consisted of EU countries previously classified in cluster C, which also had bad level of self-assessed health status among seniors (the Baltic states, Slovakia, Hungary, Romania, Croatia, Portugal). Thus, all countries changed their position in the neural network over the studied period. However, in qualitative terms, there was no improvement in the level of self-assessed health status in these countries.

An analysis of the average value ranks for the given variables in this cluster showed the following: 6 characteristics with a rank of 4, and 2 with a rank of 3, which placed the aggregate in the 4th position based on average rank. Therefore, in contrast to the first group, the defined nature of cluster B was primarily shaped (based on the balance of values in the subset less favourable than the population average) by the most unfavourable (worse than average) indicators concerning:

• a very low expected number of healthy life years for the population reaching age 65 (X1), as well as a very small percentage of seniors with a very good perception of health in both the lowest and highest income groups (X3, X4);
• a very high percentage of the senior population with a very bad perception of health in the lowest income group (X5)[12].

Countries classified in cluster C, on the other hand, demonstrated good self-assessed health status of seniors in 2022. An analysis of the average value ranks for the given variables in this cluster showed: 4 characteristics with a rank of 3, 2 with a rank of 1, and 2 features with a rank of 2, which placed the aggregate in the 2nd position based on average rank. This was the smallest cluster – it included 3 (11.1%) countries, located in Southern Europe (Cyprus, Spain) and Western Europe (Germany).

Cluster C was nearly three-quarters smaller than in 2013. Compared to the clusters from 2013, the composition of the group was formed solely by the Member States originating from cluster (neuron) D, which was also characterised by good self-assessed health status of seniors. This marks the second instance in which all countries changed their position in the ordered neuron matrix. However, in qualitative terms, the defined level of self-assessed health status did not improve in these countries.

The formation of cluster C was primarily influenced by characteristics (based on the balance of values in the subset more favourable than the population average), such as:

• a very low percentage of unmet medical examination needs among the population aged 65 and over (X2); a very low percentage of seniors with moderate depressive symptoms in the lowest income group (X7); and a low percentage of seniors with moderate depressive symptoms in the wealthiest population group (X8)[13].

In the fourth cluster – D (average self-assessment of seniors' health) – 7 (6.9%) EU countries were classified in 2022. It included 3 countries from Eastern Europe and 2 each from Southern and Western Europe. The Eastern European countries (Czech Republic, Bulgaria, and Poland) represented the second half of the region's countries compared to the other clusters.

The size of this cluster did not change compared to 2013. In relation to the clusters from a decade earlier, its composition was formed by countries originating from the following clusters (neurons): B (average self-assessment of health) – 2 (France, Bulgaria), C (bad self-assessment) – 2 (Italy, Poland), and A (very good self-assessment) – 1 (the Netherlands), accounting for as much as 71.4% of the analysed aggregate (Tab. 2). Only 2 countries (Czech Republic and Slovenia) maintained their position in the neuron matrix. However, in qualitative terms, these 2 countries from cluster D in 2013 (which at the time represented a type with good self-assessed health), along with the Netherlands, experienced a deterioration in seniors' self-assessment of health. Stagnation at an average level of self-assessed health status applied to France and Bulgaria. Meanwhile, improvement in self-assessed health status was observed in Italy and Poland.

The analysis of the average rank of each variable in this final group revealed: 5 characteristics with a rank of 2, 2 with a rank of 4, and 1 feature with a rank of 3, which positioned the aggregate in the 3rd place

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[11] The share of units in the cluster with values more favourable than the average for the community was in the range of 90%–100%.

[12] The share of units in the cluster with values more favourable than the average for the community was in the range of 0%–24%.

[13] The share of units in the cluster with values lower than the average for the community was in the range of 90%–100%.

based on average rank. The most important common features that defined the character of this cluster (based on the balance of values in the subset more favourable than the population average) were:

- a high percentage of low-income seniors (first quintile) who perceived their health as very good (X3), but a low percentage of high-income seniors (fifth quintile) who perceived their health as very good (X4);
- a very high (least favourable) percentage of seniors with moderate depressive symptoms in both the lowest and highest income groups (X7, X8)[14].

To a lesser extent, the structure of the cluster was influenced by a low percentage of unmet medical needs among people aged 65 and over (X2), and a low percentage of seniors with a very bad perception of their health in the lowest income group (X5)[15].

It is worth noting that in the study of self-assessed health status among seniors in the EU countries in 2013 and 2022, only cluster A – neuron (1, 1) – maintained consistency in the character of self-assessment types as a result of the applied self-learning neural network mechanism. In the remaining cases, discrepancies in the character of the cluster types were as follows:

- B – neuron (1, 2): a type with average self-assessed health status versus a type with bad self-assessed health status;
- C – neuron (2, 1): a type with bad self-assessed health status versus a type with good self-assessed health status;
- D – neuron (2, 2): a type with good self-assessed health status versus a type with average self-assessed health status.

4. Conclusions

The health conditions of the oldest age group in the EU population are evolving at varying pace. Identifying the specific types of seniors' health self-assessment using the Kohonen algorithm made it possible to determine that in one quarter (7) of the EU Member States, the level of self-assessed health status among older individuals changed. In this synthetic perspective, an improvement in the level of self-assessed health status was observed in as many as 6 countries, particularly in Southern European countries (Malta, Greece, and Italy), followed by individual countries from Northern Europe (Finland),

Western Europe (Luxembourg), and Eastern Europe (Poland). A deterioration in the overall level of self-assessed health status was observed only in the case of the Netherlands (Western Europe).

Besides that, the EU countries that were classified in both compared years within the group of states with the best parameters of seniors' self-assessed health status, as compared to other clusters, were: Denmark, Ireland, and Sweden (Northern Europe); Austria and Belgium (Western Europe). The most important characteristics of health self-assessment in this noteworthy cluster were: a very high proportion (significantly above average compared to the entire group of countries) of seniors with a very good perception of their health in both income quintile groups, and a very low proportion of seniors with a very bad perception of health among the highest-income population group. On the other hand, the EU countries that in 2013 and 2022 were grouped among those with the worst parameters of seniors' self-assessed health status, compared to other clusters, were: Estonia, Lithuania, and Latvia (Northern Europe); Hungary, Romania, Slovakia (Eastern Europe); Croatia and Portugal (Southern Europe). The most important characteristics of seniors' self-assessed health status in this least favourable cluster were: a very low expected number of healthy life years for the population reaching age 65, a very small proportion of seniors with a very good perception of health in both the lowest and highest income population groups, as well as a very high proportion of older people with a very bad perception of health in the least affluent population group.

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[14] The share of units in the cluster with values more favourable than the average for the community was in the range of 0%–49%.
[15] The share of units in the cluster with values more favourable than the average for the community was in the range of 75%–100%.

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