
Multidimensional Analysis of the Relationship between Sustainable Living Conditions and Long and Good Health in the European Union Countries

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Anna Murawska¹, Bartosz Mickiewicz², Małgorzata Zajdel³,
Małgorzata Michalcewicz-Kaniowska⁴

Abstract:

Purpose: The main goal of the study is to determine the relationship between two multidimensional phenomena, i.e., sustainable living conditions of households and the long and good health of the populations of the European Union countries. In particular, the analysis focused on showing the differences between EU(28) countries in terms of the research indicators used, the diagnosis of the relationships between them, creating synthetic measures for the investigated phenomena, as well as creating rankings and groups of countries with similar characteristics.

Design/Approach/Methodology: The issues were evaluated using 23 indicators. The empirical data consisted of information from the European Statistical Office. The analysis covered 28 European Union countries. The study was carried out between 2010 and 2018. The empirical data was subjected to statistical analysis using STATISICA and Microsoft Excel software.

Findings: The analyses showed that sustainable living conditions of households in the EU(28) countries affect the number of healthy life years of their populations. In countries that are relatively more often affected by financial issues and limited living conditions, have low income and are at risk of poverty, are exposed to noise and air pollution, their populations are healthy for shorter periods of time, less often perceive their health as good or very good.

Practical Implications: The results are compared with other possible forms of relationships, sustainable living conditions of households with long and good health of the population.

Originality/Value: The study included some detailed calculations involving selected living conditions of households in EU(28) countries and showed how they affect the life expectancy and health.

Keywords: Sustainable living conditions, wealth and prosperity, poverty, development.

JEL codes:

Paper type: Research study.

¹Lecturer, University of Science and Technology, Faculty of Management, Poland,
e-mail: anna.murawska@utp.edu.pl.

²Professor, West Pomeranian University of Technology,
e-mail: Bartosz.Mickiewicz@zut.edu.pl

³University of Science and Technology, Faculty of Management, Poland,
e-mail: m.zajdel@utp.edu.pl

⁴Lecturer, University of Science and Technology, Faculty of Management, Poland,
e-mail: malgorzata.michalcewicz-kaniowska@utp.edu.pl

1. Introduction

Until the mid-20th century, well-being was not really an issue that was discussed within economics, it was only in the 2nd half of the 20th century when it generated great interest. Such discussions gained even more importance when well-being became one of the primary goals of sustainable development. It was also noted that, due to its interdisciplinary nature, this category allows to determine the multidimensional level of human self-fulfilment, which fits in with the concept of sustainable development really well. Along with the new – economic – nature of the category of well-being and its new role as a goal (and a result) of sustainable development, the problem of its measurement became even more pressing (Kryk, 2012).

The article was inspired by the discourse that was dominant in recent years – the discourse on wealth and prosperity of households, good and sustainable living conditions, as well as healthy life on the one hand, and the existing income differentials between populations, poverty, poor living conditions, as well as development of lifestyle diseases and inadequate well-being of the population on the other hand. Despite the fact that the old continent is characterised by a high standard of living compared to other regions of the world, a significant percentage of the inhabitants of the European Union still live in poverty, in unfavourable living conditions; the aging of the population is associated with the spreading of lifestyle diseases and the living conditions of households leave much to be desired and require improvement. Adequate housing conditions might affect a lot of objective phenomena, such as extending the human lifespan or being healthy for longer periods, but also the subjective opinions on the perception of one's well-being or good health.

2. Literature Review

Sustainable development involves the integration of political, economic, and social activities aimed at satisfying needs, while considering natural balance; its goal is to ensure the adequate social well-being (Imiołczyk, 2016). Both in Poland and in European countries, the environmental, social, living, or economic aspects are becoming an important element in public governance, which is why there are more and more international legal regulations concerning the process of improving the quality of socio-economic life.

Kryk (2012) shows that one of the needs existing in all households is health protection. Some people believe that the health of the population is determined mainly by non-medical factors, such as household incomes, social status, social support, education, working conditions, physical (natural and human-made) environment, genetic and biological factors, individual pro-health activities, healthy child development. Another finding revealed a relationship between health and economic growth (Ryć and Skrzypaczek, 2011). Higher level of economic development of the country provides a greater amount of funds that go to the healthcare system, enables the provision of comprehensive and better medical care, guarantees a higher-quality

nutrition and even a better condition of the natural environment, which has an impact on the health of the society. In addition, we cannot forget that better health means better human capital. It is important for the state to provide its citizens with fair health protection. Investing in health care is treated as investing in the development of civilization and in human capital (Frączkiewicz-Wronka, 2009).

Rudawska (2013), on the other hand, raised the issue of health care of the aging European society, with chronic diseases as the greatest burden, and Zalewska (2013) shows that multiple dimensions of public health indicators of European Union residents are improving (Piekut, 2014). The distance between the life expectancy of women and men is smaller and smaller, death rate due to chronic diseases and suicides is declining, the society's exposure to air pollution is not increasing, the declared annoyance caused by noise is decreasing. Czech (2012) is another scholar discussing the problem of meeting the needs of households during the economic slowdown.

According to Polak (2014), socio-economic prosperity should be the prime goal of the state's activity and the main criterion for assessing the situation of the society living there, which is often ignored by political and economic decision-makers. However, coming up with a comprehensive definition of the concept of prosperity seems to be just one of the problems here, another one lies in its accurate measurement. This is a result of the fact that this category, apart from its measurable quantitative aspect, has an immeasurable qualitative one; its perception is influenced by historical, cultural, and social references (Polak, 2014). Prosperity is a gradual, multidimensional, and multifaceted phenomenon and is relative in nature.

Prosperity, well-being, and life satisfaction are influenced by multiple factors, a significant part of which is immeasurable. They are not only related to satisfying the needs for food, housing, health, education, recreation, social security, financial management, but also the needs for good governance, a sense of subjectivity and influence upon the fate of oneself and of the country, respect and recognition, access to information, clean environment, balance between work and leisure, access to livelihoods, stability and predictability of life, security, sense of community ties and social trust, the possibility to articulate one's needs and views, unobstructed channels of social mobility. By the measurable economic criterion in the form of GDP per capita, both the economically liberal countries that base their development on energy resources and the countries with high level of state interventionism in the socio-economic sphere are in the lead. On the other hand, when we use the criteria which consider measures of social development, the leaders consist mostly of the so-called welfare states that pursue extensive social policy.

However, if a synthetic indicator is dominated by respondents' subjective opinions on life satisfaction, poor countries may take the lead, because life satisfaction and optimistic attitudes have their cultural, religious, social and political roots and do not need to be associated with material wealth. With the increasing income diversity of the world community, average values say little about the situation of individual

people, so it seems important to create measures of integrated development. Integrated development and its monitoring should be a priority for contemporary state authorities. For many decades, health has been treated as something that serves the good of individuals and the entire society and should be protected (Żółtaszek and Budny, 2014). Therefore, the progress in medicine driven by technological progress, as well as social, cultural, and economic changes, resulted in a leap from superstition to computed tomography, laser procedures, organ transplants or vaccines. It has become possible to counteract, diagnose and treat many diseases which used to be considered fatal. As a result, the average life expectancy has increased significantly, reaching even 85-90 years in some countries. From the medical point of view, 'diseases of poverty', most of which are infectious, have been replaced by the so-called lifestyle diseases, or diseases of the 21st century. The problem of poverty has been eliminated neither on global scale nor in highly developed countries. The same goes for the problem of infectious diseases. The discussion on the consequences of the development of civilization should include both positive and negative effects of progress, especially in the field of medicine, health care systems, and health economics.

3. Materials and Methods and Description of the Dataset

The main goal of the study was to analyse and diagnose the relationship between the living conditions of households and the long and good health of the population of the European Union (EU-28). The introduction of the study puts forward a hypothesis predicting that European countries are significantly diversified in terms of sustainable living conditions of households (the cause), which in turn creates the differences between countries in terms of the long and good health of the population (the result).

The analyses were based on available indicators monitoring the achievement of Sustainable Development Goals collected by the Eurostat (European Statistical Office). It included, in particular, collecting, compiling and analysis of all available indicators, followed by the selection of indicators describing the two phenomena studied, namely (1) Sustainable Living Conditions of Households (SLCH) and (2) Long and Good Health of the Population (LGHP). The studied phenomena are multidimensional, i.e., they can be described by many different characteristics, thus the decision to build synthetic measures, to prepare a ranking and groups of countries sorted by studied phenomena and to check whether good living conditions of households located in the European Union countries are reflected in the long and good health of the population.

The data came mostly from the collections of the European Statistical Office (Eurostat). The statistical data were analysed and processed for the purposes of this study in several stages.

The first stage of the study involved the collection of statistical data on monitoring the implementation of the seventeen Sustainable Development Goals in 2010-2018. Followed by an in-depth analysis of the content of the collected indicators and the

development of two sets of statistical data using the expert method. The first research area contained independent variables describing 1) Sustainable Living Conditions of Households SLCH (13 indicators), while the other area contained dependent variables describing: 2) Long and Good Health of the Population LGHP (10 indicators). In total, the created database consisted of 23 variables from 2010-2018. Due to the fact that the purpose of the article was to analyse the differences between EU countries-28 (subjects) and to carry out a cause-and-effect analysis, it was decided in the end that the detailed analysis and construction of synthetic measures of the multidimensional phenomena studied would include the data from 2016-2018 (Table 1).

Table 1. *Independent variables (XSLCH) and dependent (YLGHP) included in the study*

| Variable | Description of the indicator |
|--|--|
| Indicators characterizing sustainable living conditions of households (SLCH) | |
| X01 | Total at-risk-of-poverty or social-exclusion rate [in %] |
| X02 | People at risk of income poverty after social transfers (below the risk-of-poverty threshold) [in %] |
| X03 | Share of households affected by financial problems and limited living conditions [in %] |
| X04 | Share of people living in households with very low work intensity [in %] |
| X05 | Share of the population living in a dwelling with a leaking roof, damp walls, floors or foundation or rot in window frames or floor [in %] |
| X06 | Share of the population having neither a bath, nor a shower, nor indoor flushing toilet in their household [in %] |
| X07 | Share of the population living in households that are unable to properly heat their homes [in %] |
| X08 | Share of the population living in households and having problems with noise from neighbours or street noise [in %] |
| X09 | The overcrowding rate (if the house does not have at least one room for the entire household) [in %] |
| X10 | Share of the population reporting unmet needs for medical care and examination [in % of the population aged 16 and more] |
| X11 | Exposure to air pollution by particulate matter (source: EEA) - $\mu\text{g} / \text{m}^3$ |
| X12 | Adjusted gross disposable income of households per capita in PPS |
| X13 | Final energy consumption in households per capita [kg of oil equivalent] |
| Indicators characterizing the long and good health of the population (LGHP) | |
| Y01 | Life expectancy at birth - men [years] |
| Y02 | Life expectancy at birth - women [years] |
| Y03 | Number of healthy years of life at birth - men [years] |
| Y04 | Number of healthy years of life at birth - women [years] |
| Y05 | Number of healthy years of life at 65 - men [years] |
| Y06 | Number of healthy years of life at 65 - women [years] |
| Y07 | Share of people with good or very good perceived health [in % of the population aged 16 or over] |
| Y08 | Obesity rate by body mass index (BMI) [in % of the population aged 18 or over] |
| Y09 | Standardised death rate due to chronic diseases by sex [number per 100 000 persons aged less than 65] |

| | |
|-----|--|
| Y10 | Standardised death rate due to tuberculosis, HIV and hepatitis by sex [number per 100 000 persons] |
|-----|--|

Note: *Indicators X_{01} - X_{10} , X_{12} - X_{13} , Y_{01} - Y_{07} – 2018; X_{11} , Y_{08} – 2017, Y_{09} , Y_{10} – 2016.

Source: Own study based on Eurostat, <https://ec.europa.eu/eurostat/data/database>, date of access 15-28.02.2020.

In the second stage of the study, all indicators collected were subjected to statistical analysis. At the beginning, we identified the subjects (countries) with missing data (no data) and this knowledge was considered at the further stage of eliminating the variables. Then we calculated location measures, variability measures, and asymmetry and kurtosis coefficients for each variable. The hypothesis of normality of variable distribution was verified using the Shapiro-Wilk test. Correlation coefficients between all variables r_{xx} , r_{yy} , r_{xy} were also calculated in order to find the existing correlations between the features of the subjects (countries) and to better prepare for the next stage of the study.

In the third stage of the study, the created database was screened using the substantive and formal criteria of variable properties (Zeliaś, 2000, pp. 36-37), which allowed for an analysis and selection of diagnostic variables for the construction of synthetic measures of two multidimensional phenomena of SLCH and LGHP examined in the article. Since some data for some of the countries was missing in the 23 indicators collected for 2016-2018, it was not included in the further analysis. They were the following variables: X_{11} , X_{12} and Y_{08} and Y_{10} . Then, the variables with a degree of variance that was not high enough ($V_s < 10\%$) (Nowak 1997, p. 12) and those excessively correlated with each other were removed from the set of potential diagnostic features (Hellwig 1981, p. 57; Nowak 1984, p. 127).

The following indicators were eliminated from the set of potential diagnostic variables due to the low coefficient of variance: Y_{01} ($V_s=4.62\%$), Y_{02} ($V_s=2.53\%$), Y_{03} ($V_s=8.60\%$), Y_{04} ($V_s=8.75\%$). In the end, the following variables qualified for further analysis: X_{01} , X_{02} , X_{03} , X_{04} , X_{05} , X_{06} , X_{07} , X_{08} , X_{09} , X_{10} , X_{13} and Y_{05} , Y_{06} , Y_{07} , Y_{09} . The set of diagnostic variables was reduced using the Hellwig's method. Based on the correlation matrix, the threshold value of the r^* coefficient was calculated according to the rule suggested by Nowak (1984):

$$r^* = r_{02} - \lambda(r_{02} - r_{01})$$

where:

$$r_{01} = \min_i \min_j |r_{ij}|, \quad r_{02} = \max_i \max_j |r_{ij}|$$

Whereas λ falls within the range $0 < \lambda < 1$ and is the number chosen by the researcher (it is assumed that $\lambda=0.5$). Variables, for which the correlation coefficient for the absolute value was higher than the critical value, were eliminated from the set of variables (the so-called satellite variables). On the other hand, central and isolated variables, i.e. those between which the correlation coefficient did not exceed the adopted threshold value r^* ,

formed the final set of diagnostic features. The final set of diagnostic features consisted of the following independent X_{ij} and dependent Y_{ij} variables:

1. $X_{03}, X_{04}, X_{05}, X_{08}, X_{10}$, which qualified for creating a synthetic measure of Sustainable Living Conditions of Households (SLCH);
2. Y_{05}, Y_{07}, Y_{09} , which qualified for creating a synthetic measure of Long and Good Health of the Population (LGHP).

Creating a synthetic measure of multidimensional phenomena requires the classification of diagnostic variables to a set of stimulants or destimulants, while using the expert method. If the set of diagnostic variables includes both stimulants (causing an increase in the studied phenomenon) and destimulants (causing a decrease in the studied phenomenon), all destimulants should be transformed into stimulants, so that all variables contain information on the examined object in the same direction. The set of stimulants included the following variables: $S: \{X_{04}, Y_{05}, Y_{07}\}$, while the set of destimulants was as follows: $D: \{X_{03}, X_{05}, X_{08}, X_{10}, Y_{09}\}$. The transformation of the destimulants into stimulants was made using the following formula:

$$x_{ij} := c_j - x'_{ij}, (i = 1, \dots, n; j = 1, \dots, k),$$

where $x_{ij}(i=1, \dots, n; j=1, \dots, k)$ is the value of j -this variable in i -this multidimensional object Q ; x'_{ij} : are realizations of the destimulant variable, where c_j means a certain constant, with ':=’ meaning substitution (Zeliaś, 2000).

In another, fourth, stage of the analysis, the variables were treated as equal, using the unit weight system. The reduced data set, which still contained the most important elements, was standardized, according to the following formula:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j}, \quad \text{where: } \bar{x}_j = \frac{1}{n} \sum_{i=1}^n x_{ij}, \quad S_j = \left[\frac{1}{n} \sum_{i=1}^n (x_{ij} - \bar{x}_j)^2 \right]^{0.5},$$

where z_{ij} is the standardized value of the diagnostic variable x_i .

Table 2. Statistical characteristics of diagnostic variables describing Sustainable Living Conditions of Households (SLCH) of the European Union countries (EU28)

| Variable | S/D | \bar{x}_{UE28} | x_{min} | x_{max} | V_s | R | Ds | As | K |
|----------|-----|------------------|-------------------|------------------|--------|-------|--------|------|-------|
| X_{03} | D | 6.62 | 1.30 (Luxembourg) | 20.90 (Bulgaria) | 74.52 | 19.60 | 16.08 | 1.49 | 1.84 |
| X_{04} | S | 8.53 | 4.50 (Czechia) | 14.60 (Greece) | 30.48 | 10.10 | 3.24 | 0.44 | -0.33 |
| X_{05} | D | 14.61 | 4.60 (Finland) | 30.20 (Cyprus) | 42.95 | 25.60 | 6.57 | 0.69 | 0.33 |
| X_{08} | D | 16.44 | 8.00 (Croatia) | 28.20 (Malta) | 34.56 | 20.20 | 3.53 | 0.45 | -0.23 |
| X_{10} | D | 2.75 | 0.10 (Austria) | 16.40 (Romania) | 123.12 | 16.30 | 164.00 | 2.75 | 9.43 |

Note: S – stimulant, D – destimulant, \bar{x}_j – average value for 28 EU countries, x_{min} – minimum value for the country, x_{max} – maximum value for the country, V_s – coefficient of variation in %, R – range (max-min), D – distance – (max/min), As – asymmetry, K – kurtosis.

Source: Own study based on Eurostat, <https://ec.europa.eu/eurostat/data/database>, date of access: 15-28. 02.2020.

Table 3. Statistical characteristics of diagnostic variables describing Long and Good Health of the Population (LGHP) of the European Union countries (EU28)

| Variable | S/D | \bar{y}_{UE28} | y_{min} | y_{max} | V_s | R | Ds | As | K |
|-----------------|-----|------------------|-------------------|------------------|-------|--------|------|-------|-------|
| Y ₀₅ | S | 8.80 | 4.00 (Slovakia) | 15.60 (Sweden) | 31.68 | 11.60 | 3.90 | 0.36 | 0.16 |
| Y ₀₇ | S | 67.06 | 44.00 (Lithuania) | 84.10 (Ireland) | 14.65 | 40.10 | 1.91 | -0.85 | 0.30 |
| Y ₀₉ | D | 133.09 | 78.70 (Sweden) | 243.70 (Hungary) | 37.18 | 165.00 | 3.10 | 1.06 | -0.19 |

Note: S – stimulant, D – destimulant, \bar{x}_j – average value for 28 EU countries, x_{min} – minimum value for the country, x_{max} – maximum value for the country, V_s – coefficient of variation in %, R – range (max-min), D_s – distance – (max/min), A_s – asymmetry, K – kurtosis.

Source: Own study based on Eurostat, <https://ec.europa.eu/eurostat/data/database>, date of access: 15-28. 02.2020.

The next step involved creating a development pattern whose coordinates were determined by the greatest maximum values:

$$z_{oj} := \max_i z_{ij}$$

The obtained pattern was used for calculating the multidimensional distances for each country surveyed, using the Euclidean metric and the following formula:

$$d_{io} = \left[\sum_{j=1}^k (z_{ij} - z_{oj})^2 \right]^{0.5}$$

where d_{io} – distance of the object Q_i ($i=1, \dots, n$) from the hypothetical (abstract) reference object Q_o .

In order to normalize the synthetic variable d_{io} , as well as to obtain a measure whose increasing values would indicate the development of the studied phenomenon, the so-called relative synthetic variables (synthetic measures) were created:

$$z_i := 1 - \frac{d_{io}}{d_o}, \text{ where: } d_o = \bar{d}_o + 3S_o,$$

where:

$$\bar{d}_o = \frac{1}{n} \sum_{i=1}^n d_{io}, \quad S_o = \left[\frac{1}{n} \sum_{i=1}^n (d_{io} - \bar{d}_o)^2 \right]^{0.5}$$

The created synthetic (taxonomic) measures with probability close to 1 take values in the range [0.1]. The closer the value of the synthetic indicator calculated for the country to 1, the higher level of development or quality of the studied phenomenon, and the closer it is to zero the lower it is (Zeliaś, 2000).

The fifth stage of the study consisted of creating a ranking and groups of countries by the studied phenomena. The ranking of countries was based on the constructed synthetic measures. Then, in order to isolate typological groups consisting of countries with a similar level of studied phenomena, we carried out an analysis of differences in the level of the value of the synthetic variable, according to the rule formulated by Nowak (1990). The classes of spatial units were obtained on the basis of the ranges of the synthetic variable value built based on the arithmetic mean \bar{z} and the standard deviation S_z . The set of objects is divided into four groups including objects with synthetic variable values from the following disjoint intervals. These groups meet the condition of separability and completeness:

Group I: $z_i \geq \bar{z} + s_z$,

Group II: $\bar{z} \leq z_i < \bar{z} + s_z$,

Group III: $\bar{z} - s_z \leq z_i < \bar{z}$,

Group IV: $z_i < \bar{z} - s_z$,

where:

$$\bar{z} = \frac{1}{n} \sum_{i=1}^n z_i, \quad s_z = \left[\frac{1}{n} \sum_{i=1}^n (z_i - \bar{z})^2 \right]^{0.5}$$

The objects within a given typological (synthetic) group are organized by value of the synthetic measure. Isolating the homogeneous and disjoint groups of the most similar objects facilitates the substantive analysis and conclusions. In addition, it is possible to immediately compare different typological groups in terms of the level of phenomena studied.

The last, sixth, stage of the study included an analysis of the relationship between two studied phenomena, i.e., sustainable living conditions of households (SLCH), long and good health of the population (LGHP). For that purpose, the correlation coefficient (of the relationship) between the SLCH synthetic measure and the LGHP synthetic measure was calculated. It was calculated using the Pearson correlation coefficient:

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}},$$

where:

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i, \quad \bar{y} = \frac{1}{n} \sum_{i=1}^n y_i.$$

The correlation coefficient value falls within the closed interval $r_{xy} \in [-1.1]$. The higher its absolute value, the stronger the linear relationship between the variables. $r_{xy} = 0$ means no linear relationship between features, $r_{xy} = 1$ means positive linear relationship between features, while $r_{xy} = -1$ means negative linear relationship between features, i.e. if the variable x increases, y decreases and vice versa. Possible

significance of the relationship (effect) of Sustainable Living Conditions of Households on Long and Good Health of the Population of the European Union countries was determined with a probability of $p=0.05$.

4. Empirical Results

Living conditions of households of the European Union (EU-28) countries are significantly differentiated, which was confirmed for all variables included in the study (X_{01} - X_{13}), and the coefficient of variation ranged between $V_s=23\%$ (for X_{02} and X_{12}) and $V_s=211\%$ (for X_{06}). In 2010-2018, living conditions of households were improving steadily and this was the case for almost all indicators included in the study. After 2010, the total at-risk-of-poverty-and-social-exclusion rate decreased by 1.9 per cent and in 2018, it was 21.9%. This indicator has the lowest value in the Czech Republic (12.2%), and the highest – in Romania (32.5%). The above-mentioned indicator X_{01} is a component of three indicators X_{02} , X_{03} and X_{04} . ‘People at risk of income poverty after social transfers’ X_{02} is the only indicator whose value increased after 2010 by 0.6 per cent and in 2018, it was 17.1%; it was the lowest in the Czech Republic (9.6%), and the highest in Romania (23.5%). Other indicators, i.e. ‘share of households affected by financial problems and limited living conditions’ X_{03} and ‘share of people living in households with very low work intensity’ X_{04} decreased by 2.6 and 1.5 per cent respectively. The values of variables X_{03} and X_{04} were the lowest in 2018 in Luxembourg and in the Czech Republic (1.3% and 4.5% respectively), and the highest in Bulgaria and in Greece (20.9% and 14.6% respectively).

13.9% of the EU(28) population lives in households with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor (X_{05}), which is less, however, than in 2010 by 2.2 per cent. The highest number of such dwellings can be found in Cyprus (30.2%), and the lowest number in Finland (4.6%). On the other hand, 1.7% of the EU (28) population declare that they have neither a bath, nor a shower, nor flushing toilet in their household (X_{06}) (less than in 2010 by 0.9 per cent). The highest number of such households can be found in Romania (25.6%), and countries where the dwellings are fully equipped include Germany, Ireland, Malta, the Netherlands, Austria, and Sweden.

In 2018, 18.3% of the population lived in households that are not sufficiently heated (X_{07}), there were fewer such declarations compared to 2010 by 2.2 per cent. The highest number of such households can be found in Bulgaria (33.7%), and the lowest in Austria (1.6%). On the other hand, 18.3% of the population EU(28) (X_{08}) suffered due to noise from neighbours and street noise, in 2010 it was 20.5%. The highest percentage of such answers came from the population inhabiting Malta (28.2%), and the lowest Croatia (8.0%). Another measure of the living conditions of households is the overcrowding rate which represents the percentage of households that do not have at least one room for the entire household (X_{09}). In 2018, the indicator for EU(28) was 15.5% (in 2010, 17.7%), the smallest one could be found in Cyprus (2.5%), and the biggest in Romania (46.3%). The sustainable living conditions of households can also

be described by share of the population reporting unmet needs for medical care and examination (X_{10}), which is 2.0% in the EU(28) (in 2010, 3.1%), the lowest in Austria (0.1%), and the highest in Estonia (16.4%).

Members of households in the EU(28) are also exposed to air pollution by particulate matter (X_{11}), with residents of Poland being the most exposed group (23.8 $\mu\text{g}/\text{m}^3$), and residents of Finland – the least exposed one (4.9 $\mu\text{g}/\text{m}^3$). Final energy consumption in households per capita (X_{13}) in the EU(28) is 560 kg of oil equivalent, with the highest consumption in Finland (1032 kg), and the lowest in Malta (183 kg). This indicator can be seen as stimulating appropriate living conditions of households, as well as gross disposable income of households per capita in PPS (X_{12}), which allows to meet multiple needs related to the proper functioning of households. The average income for EU(28) countries in 2018 was 22,824 PPS (in 2010, 19,653 PPS), with the highest in Luxembourg (33,332 PPS), and the lowest in Bulgaria.

Table 4. Relationships between independent variables X characterizing Sustainable Living Conditions of Households (SLCH) of the European Union countries (EU28)

| Variable | Correlation coefficient r_{xx} between independent variables X | | | | | | | | | | | | |
|----------|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | X_{01} | X_{02} | X_{03} | X_{04} | X_{05} | X_{06} | X_{07} | X_{08} | X_{09} | X_{10} | X_{11} | X_{12} | X_{13} |
| X_{01} | 1.00 | 0.93 | 0.67* | 0.26 | 0.21 | 0.61* | 0.51* | 0.00 | 0.26 | 0.31 | 0.05 | -0.21 | -0.39 |
| X_{02} | 0.93* | 1.00 | 0.41 | 0.18 | 0.15 | 0.49* | 0.33 | 0.07 | 0.17 | 0.43 | -0.08 | -0.08 | -0.31 |
| X_{03} | 0.67* | 0.41 | 1.00 | -0.06 | 0.16 | 0.77* | 0.58* | -0.13 | 0.58* | 0.07 | 0.49* | -0.60* | -0.55* |
| X_{04} | 0.26 | 0.18 | -0.06 | 1.00 | 0.01 | -0.18 | 0.11 | 0.09 | -0.43* | -0.25 | -0.48* | 0.46* | 0.21 |
| X_{05} | 0.21 | 0.15 | 0.16 | 0.01 | 1.00 | -0.16 | 0.60* | 0.26 | -0.39 | -0.14 | 0.06 | -0.06 | -0.37 |
| X_{06} | 0.61* | 0.49 | 0.77* | -0.18 | -0.16 | 1.00 | 0.12 | 0.03 | 0.64* | 0.27 | 0.31 | -0.42 | -0.24 |
| X_{07} | 0.51* | 0.33 | 0.58* | 0.11 | 0.60* | 0.12 | 1.00 | 0.12 | 0.05 | -0.10 | 0.22 | -0.35 | -0.66* |
| X_{08} | 0.00 | 0.07 | -0.13 | 0.09 | 0.26 | 0.03 | 0.12 | 1.00 | -0.29 | -0.41 | -0.13 | 0.50* | -0.11 |
| X_{09} | 0.26 | 0.17 | 0.58* | - | -0.39 | 0.64* | 0.05 | -0.29 | 1.00 | 0.18 | 0.72* | -0.55* | -0.29 |
| X_{10} | 0.31 | 0.43 | 0.07 | 0.43* | -0.25 | 0.27 | -0.10 | -0.41 | 0.18 | 1.00 | -0.27 | -0.39 | 0.11 |
| X_{11} | 0.05 | -0.08 | 0.49* | - | 0.06 | 0.31 | 0.22 | -0.13 | 0.72* | -0.27 | 1.00 | -0.49* | -0.47* |
| X_{12} | -0.21 | -0.08 | -0.60* | 0.48* | -0.06 | -0.42 | -0.35 | 0.50* | -0.55* | -0.39 | -0.49* | 1.00 | 0.57* |
| X_{13} | -0.39 | -0.31 | -0.55* | 0.21 | -0.37 | -0.24 | - | -0.11 | -0.29 | 0.11 | -0.47* | 0.57* | 1.00 |
| | | | | | | | 0.66* | | | | | | |

Note: r_{xx} – correlation coefficient, *- determined correlation coefficients are significant with $p < 0.05$, Missing data were removed by cases.

Source: Own study based on Eurostat, <https://ec.europa.eu/eurostat/data/database>, date of access: 15-28. 02.2020.

There are relationships between the variables characterizing SLCH, which allows us to make a few observations. In those countries where households are at high risk of poverty and social exclusion, there are co-existing financial problems, limited living conditions, lack of basic household equipment such as a bath, shower, or toilet, as well as problems with house heating,

There are some interesting results regarding the indicator X_{04} that describes household work intensity. It turns out that the increased percentage of households with very low work intensity does not go hand in hand with the overcrowding rate of households, as well as exposure to air pollution by particulate matter, while the increased share of

people living in households with very low work intensity is accompanied by the increased gross disposable household income.

The overcrowding rate of households increases together with the increased share of households affected by financial problems and limited living conditions, having no basic household equipment and exposed to air pollution by particulate matter, i.e. mainly in large urban agglomerations. On the other hand, this indicator decreases along with the increased percentage of households with very low work intensity and increased income (Table 4).

The EU(28) countries are characterized by a slightly less differentiated indicators describing Long and Good Health of the Population residing in EU countries(28), this applies in particular to variables Y_{01} - Y_{04} , with insignificant variation $V_s < 10\%$. In terms of other indicators Y_{05} - Y_{10} , coefficient of variation V_s ranged between 15% (Y_{07}) and 87% (Y_{10}).

After 2010, the life expectancy of EU(28) residents increased gradually and in 2018, it was 78.3 years for men (Y_{01}) (in 2010 – 76.9), and for women – 83.6 years (Y_{02}) (in 2010 – 82.8). Men in the EU(28) live the longest in Italy (81.2 years), and women – in Spain (86.3 years), men live the shortest in Latvia (70.1 years), and women – in Bulgaria (78.6 years). The long and good health of the population depends mostly on the number of healthy years of life of men and women, both at birth and at 65. The data for 2018 show that, on average, men in the EU(28) live (Y_{03}) 63.4 years at birth (in 2010 – 61.7 years), and women (Y_{04}) – 63.8 years (in 2010 – 62.6 years). The smallest number of healthy years of life applies to both men and women in Latvia (51 and 53.7 years respectively), while the biggest number of healthy years of life applies to men in Sweden (73.7 years) and women in Malta (73.4 years). At 65, on the other hand, the average number of healthy years of life for EU countries(28) in 2018, was 9.9 years for men (Y_{05}) (in 2010 – 8.7 years), and for women (Y_{06}) – 10.0 years (in 2010, 8.8 years). The smallest number of healthy years of life at 65 applies to both men and women in Slovakia (4 years and 4.6 years respectively), and the biggest number – to men and women in Sweden (15.6 and 15.8 years respectively).

In 2018, 69.2% of the EU(28) population perceived their health as good or very good (Y_{07}) (in 2010 – 68.2%), which can be seen as a high percentage, despite Europe dealing with the spread of lifestyle diseases, such as allergies and oncological diseases, or diseases affecting older people, such as diabetes or hypertension. The highest number of answers pointing to positive perception of health was given by the Irish (84.1%), and the lowest – by the residents of Lithuania (44.0%).

Other indicators that may reflect good health of the population include obesity rate (Y_{08}), death rate due to chronic diseases (Y_{09}) and due to tuberculosis, HIV and hepatitis (Y_{10}). The 2017 data show that 14.9% of the EU(28) population aged 18 and more is obese, with the highest number in Malta (25.5%), and the lowest number in Romania (10.2%). In 2016, the standardised death rate due to chronic diseases in

EU(28) countries was 119 per 100,000 persons, (in 2010 – 135.6/100,000), with the highest in Hungary (243.7), and the lowest in Sweden (78.7). On the other hand, death rate due to infectious diseases in 2016 was 2.6 per 100,000 persons (in 2010 – 3.6/100,000), with the highest in Latvia (10.5), and the lowest in Finland (0.7).

The data in Table 5 show that the indicators describing Long and Good Health of the Population are significantly inter-correlated. The variable Y_{08} , or the obesity rate being the exception. Life expectancy of the population in EU(28) countries increases along with the number of healthy years at birth and at 65. At the same time, countries with high number of healthy years of life have a higher percentage of persons with good and very good perceived health. On the other hand, we can observe an inverse relationship between the total number of years of life and healthy life of the population, good and very good perceived health, and mortality rates due to chronic and infectious diseases (Table 5).

Table 5. Relationships between dependent variables Y characterizing Long and Good Health of the Population (LGHP) of the European Union countries (EU28)

| Variable | Correlation coefficient r_{yy} *between dependent variables Y | | | | | | | | | |
|----------|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | Y_{01} | Y_{02} | Y_{03} | Y_{04} | Y_{05} | Y_{06} | Y_{07} | Y_{08} | Y_{09} | Y_{10} |
| Y_{01} | 1.00 | 0.91* | 0.60* | 0.33 | 0.77* | 0.69* | 0.68* | -0.02 | -0.95* | -0.64* |
| Y_{02} | 0.91* | 1.00 | 0.47* | 0.24 | 0.65* | 0.57* | 0.42 | 0.04 | -0.91* | -0.40 |
| Y_{03} | 0.60* | 0.47* | 1.00 | 0.92* | 0.91* | 0.91* | 0.69* | -0.03 | -0.52* | -0.55* |
| Y_{04} | 0.33 | 0.24 | 0.92* | 1.00 | 0.77* | 0.83* | 0.53* | 0.05 | -0.28 | -0.39 |
| Y_{05} | 0.77* | 0.65* | 0.91* | 0.77* | 1.00 | 0.98* | 0.71* | 0.07 | -0.72* | -0.56* |
| Y_{06} | 0.69* | 0.57* | 0.91* | 0.83* | 0.98* | 1.00 | 0.70* | 0.09 | -0.65* | -0.56* |
| Y_{07} | 0.68* | 0.42 | 0.69* | 0.53* | 0.71* | 0.70* | 1.00 | -0.28 | -0.58* | -0.74* |
| Y_{08} | -0.02 | 0.04 | -0.03 | 0.05 | 0.07 | 0.09 | -0.28 | 1.00 | 0.00 | 0.09 |
| Y_{09} | -0.95* | -0.91* | -0.52* | -0.28 | -0.72* | -0.65* | -0.58* | 0.00 | 1.00 | 0.59* |
| Y_{10} | -0.64* | -0.40 | -0.55* | -0.39 | -0.56* | -0.56* | -0.74* | 0.09 | 0.59* | 1.00 |

Note: r_{yy} – the correlation coefficient, * – designated correlation coefficients are significant with $p < 0.05$, Missing data were removed by cases.

Source: Own study based on Eurostat, <https://ec.europa.eu/eurostat/data/database>, date of access: 15-28. 02.2020.

On the other hand, the analysis of the r_{xy} relationship between all independent (x) and dependent (y) indicators brought some interesting results which could lead to equally interesting conclusions. The life expectancy of both women and men increases with the increase in gross disposable household income and in the percentage of people living in households with very low work intensity, as demonstrated by significant positive correlation coefficients. In turn, the life expectancy of the EU's population decreases with the increase in the percentage of people affected by financial problems and limited living conditions, living in houses that do not have basic equipment, such as a bath tub, shower or toilet, and do not have enough living space. In addition, it turns out that those EU(28) residents who more often report their unmet needs for a medical examination, but also with a higher percentage of households with very low work intensity are those who are more likely to live a higher number of healthy years at birth and at 65.

Diagnostic variables isolated as a result of the used method allowed for the calculation of synthetic measures of the analysed multidimensional phenomena, i.e. the synthetic measure Z_{iSLCH} (sustainable living conditions of households) and the synthetic measure Z_{iLGHP} (long and good health of the population) in EU (28) countries. The synthetic measures helped to create a ranking of EU (28) countries from the first to 28th place and groups of countries with high (I), medium (II), low (III) and very low (IV) level of studied phenomena (Table 6).

The presented results of the study show that the highest level of sustainable living conditions of households can be found in Ireland, Finland, Croatia, and Sweden. They were the top four countries in the ranking and were included in the first group of countries with high level of SLCH. They were followed by eleven countries (places from 5 to 15), such as Italy, Spain, Austria, Denmark, Belgium, France, Czech Republic, Luxembourg, Slovakia, Lithuania, and Poland.

These countries qualified to the second group with a medium level of SLCH. On the other hand, Group III with low level of sustainable living conditions of households included countries such as the UK, the Netherlands, Germany, Hungary, Malta, Slovenia, Bulgaria, i.e. the next seven countries in the ranking (places from 16 to 22). The last, 4th group with very low level of living conditions of households included countries that ended up in places from 23 to 28, i.e. Latvia, Romania, Portugal, Greece, Cyprus, and Estonia.

Another multidimensional phenomenon, which was recognized as a result of specific living conditions of households, concerns long and good health of the population residing in the EU (28) countries. The created synthetic measures of LGHP have shown that the first places in the ranking (from 1 to 4) and the qualification to the first group applies to countries such as Sweden, Ireland, Malta and Spain, which means that residents of these countries are relatively more likely to live healthy for the longest time and express their satisfaction with the state of their health, and they are relatively less likely to suffer from chronic and infectious diseases.

The second group consists of 12 countries with a medium level of LGHP (places from 5 to 16): Belgium, the Netherlands, Italy, Denmark, Cyprus, the UK, France, Germany, Finland, Luxembourg, Greece, Austria. The third group with low level of LGHP (places from 17 to 21) includes such countries as Slovenia, Czech Republic, Bulgaria, Poland, Portugal. On the other hand, the fourth group of countries with very low level of LGHP (the places in the ranking – from 22 to 28) consists of Croatia, Romania, Slovakia, Estonia, Hungary, Latvia, and Lithuania.

In those countries that have the lowest ranking, life expectancy and healthy life is the shortest, residents of these countries are the least likely to perceive their health as good or very good and are the most likely to suffer from chronic and infectious diseases (Table 6).

Table 6. Classification (ranking and groups) of the EU (28) countries by a synthetic measure describing SLCH and LGHP

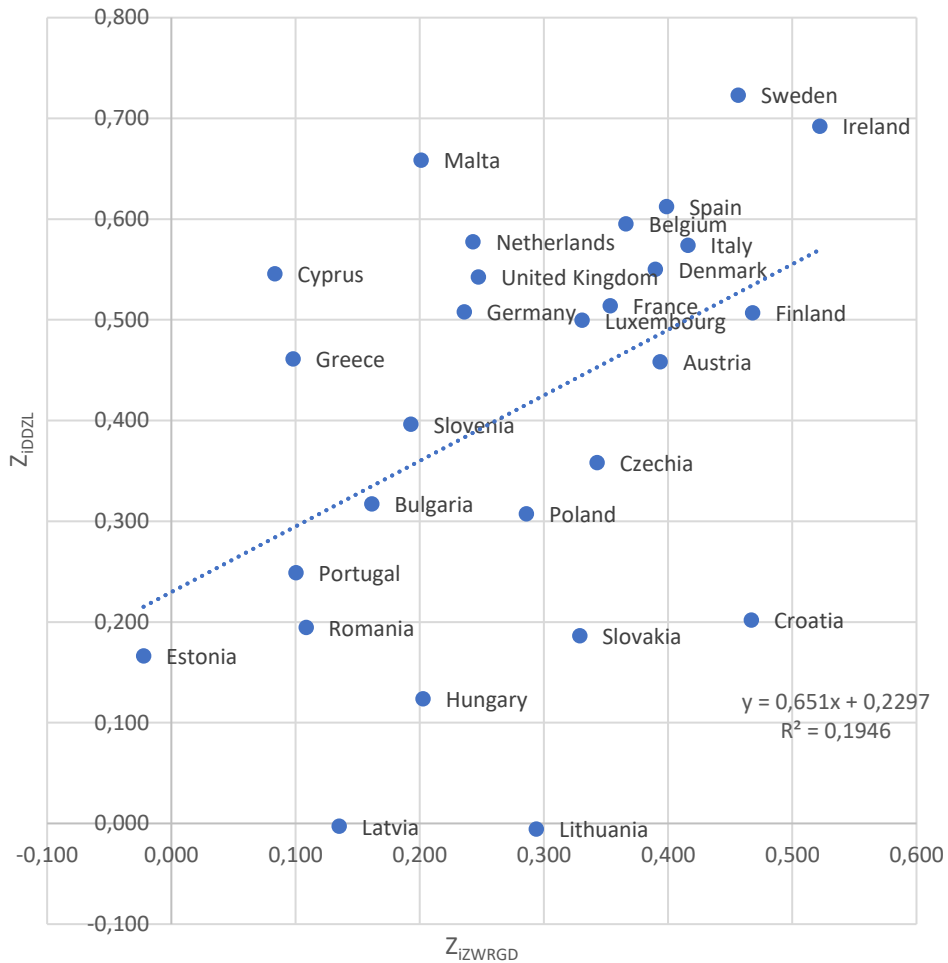
| SLCH | | | | LGHP | | | | | |
|--------------------|----------------------|-----------------|-------|--------------------|----------------------|-----------------|-------|----------|-----|
| Z _{iSLCH} | Place in the ranking | EU (28) country | Group | Z _{iLGHP} | Place in the ranking | EU (28) country | Group | | |
| 0.522 | 1 | Ireland | I | 0.723 | 1 | Sweden | I | | |
| 0.468 | 2 | Finland | | 0.692 | 2 | Ireland | | | |
| 0.467 | 3 | Croatia | | 0.658 | 3 | Malta | | | |
| 0.456 | 4 | Sweden | | 0.612 | 4 | Spain | | | |
| 0.416 | 5 | Italy | II | 0.595 | 5 | Belgium | II | | |
| 0.399 | 6 | Spain | | 0.577 | 6 | Netherlands | | | |
| 0.394 | 7 | Austria | | 0.574 | 7 | Italy | | | |
| 0.390 | 8 | Denmark | | 0.550 | 8 | Denmark | | | |
| 0.366 | 9 | Belgium | | 0.546 | 9 | Cyprus | | | |
| 0.353 | 10 | France | | 0.542 | 10 | United Kingdom | | | |
| 0.343 | 11 | Czechia | | 0.514 | 11 | France | | | |
| 0.331 | 12 | Luxembourg | | 0.508 | 12 | Germany | | | |
| 0.329 | 13 | Slovakia | | 0.507 | 13 | Finland | | | |
| 0.294 | 14 | Lithuania | | 0.499 | 14 | Luxembourg | | | |
| 0.286 | 15 | Poland | | 0.461 | 15 | Greece | | | |
| 0.247 | 16 | United Kingdom | | 0.458 | 16 | Austria | | | |
| 0.243 | 17 | Netherlands | | III | 0.396 | 17 | | Slovenia | III |
| 0.236 | 18 | Germany | | | 0.358 | 18 | | Czechia | |
| 0.203 | 19 | Hungary | | | 0.317 | 19 | | Bulgaria | |
| 0.201 | 20 | Malta | 0.307 | | 20 | Poland | | | |
| 0.193 | 21 | Slovenia | 0.249 | | 21 | Portugal | | | |
| 0.161 | 22 | Bulgaria | 0.202 | | 22 | Croatia | | | |
| 0.135 | 23 | Latvia | IV | 0.195 | 23 | Romania | IV | | |
| 0.108 | 24 | Romania | | 0.186 | 24 | Slovakia | | | |
| 0.100 | 25 | Portugal | | 0.166 | 25 | Estonia | | | |
| 0.098 | 26 | Greece | | 0.123 | 26 | Hungary | | | |
| 0.083 | 27 | Cyprus | | -0.003 | 27 | Latvia | | | |
| -0.022 | 28 | Estonia | | -0.006 | 28 | Lithuania | | | |

Note: Z_i – the value of a synthetic measure, SLCH – Sustainable Living Conditions of Households, LGHP – Long and Good Health of the Population

Source: Own study.

The study attempted to verify whether there is a correlation between the regional diversification of the synthetic measure of sustainable living conditions of households and the regional diversification of the synthetic measure of long and healthy life of the population in EU (28) countries, and thus whether the living conditions of the population translate to their longer life in general and longer healthy life. The calculated correlation coefficient r_{xy} between the synthetic measure Z_{iSLCH} and Z_{iLGHP} is 0.441142*. This relationship is significant at the level of $p=0.05$. As a result, it can be concluded that sustainable living conditions of households in the European Union countries affect the long and good health of their populations. The higher level of living conditions the longer the country's population live a healthy life. The relationship is significant, however at an average level (Figure 1).

Figure 1. A scatter graph displaying the synthetic measure of SLCH and LGHP for the EU (28) countries



Source: Own study.

The levels of both studied multidimensional phenomena of SLCH and LGHP are visibly inter-convergent in such countries as: Estonia, Portugal, Bulgaria, Slovenia, Poland, Czech Republic, Luxembourg, Austria, Denmark, France, Italy, Finland, and Ireland. In these countries, the number of healthy years of life clearly increases along with appropriate living conditions of households. However, the Figure shows that adequate living conditions of households do not translate into long and good health of the population in all countries. The most visible discrepancies can be found in countries such as Cyprus, Greece, or Malta, which are characterized by poor living conditions of households, but with a relatively higher number of healthy life years and life satisfaction. On the other hand, countries such as the Czech Republic, Slovakia, Croatia, Lithuania and Poland are characterized by a relatively high level of living

conditions, but with lower number of healthy years of life and lower number of people perceiving their health as good or very good, when compared to other countries.

5. Conclusions

Proper management of living conditions of households is an important factor for the population to reach an adequate level of well-being. The visible differences between the EU (28) countries regarding living conditions prove that not all households are able to generate and manage incomes and dispose the resources in the same way. However, it should be emphasized that this depends not only on the resourcefulness of the households themselves, but also on the historical background, the country's level of economic development, and the priorities of social policy. In order to compensate for the differences in living conditions of households, the EU (28) countries, by implementing adopted strategies and sustainable development goals, have been introducing aid programs for years, which caused that the percentage of households affected by financial problems and limited living conditions, at risk of poverty, with very low work intensity, or suffering from noise and air pollution has been decreasing since 2010. The synthetic measure of Z_{iSLCH} showed that a high level of sustainable living conditions of households among all EU (28) countries can be found in Ireland, Finland, Croatia, and Sweden, and a very low level – in Latvia, Romania, Portugal, Greece, Cyprus, and Estonia.

Goal 3 of sustainable development in the EU is to ensure healthy lives and promote well-being for all at all ages. Actions of particular countries supporting the goal strive to increase life expectancy, including healthy life expectancy, to combat the multiple diseases and emerging health threats, as well as to increase general public satisfaction when it comes to perceived health and life. The study showed that all of the above-mentioned tasks were met in the period between 2010 and 2018. The life expectancy of the EU (28) members increased, the number of healthy years of life was higher and people were more likely to express positive opinions about life and less likely to get chronic and infectious diseases. The study has shown that the inhabitants of Sweden, Ireland, Malta, and Spain had the highest level of the long and good health of the population indicator (Z_{iLGHP}), while the inhabitants of Croatia, Romania, Slovakia, Estonia, Hungary, Latvia, and Lithuania had the lowest level.

The dependence analysis has proven that certain living conditions of households of the EU (28) countries affect the log and good health of the populations. However, the relationship is moderately significant. There are countries such as Cyprus, Greece, or Malta, which have relatively poor living conditions while enjoying relatively longer healthy life, compared to other countries. On the other hand, in Croatia or the Czech Republic, good living conditions do not translate into the number of healthy life years.

The sustainable development goals are aimed at improving the living conditions and well-being of societies, and this trend has been visible in the EU (28) countries in recent years. In the context of implementing the sustainable development policy, it is

also important to smooth away the differences between individual countries in terms of good living conditions or healthy lives. Unfortunately, despite multiple countries implementing programs to help people with financial problems and despite the effective financing of healthcare systems, the EU Member States are still significantly diversified in terms of living conditions, as well as long and good health of the population. In the context of the proven impact of household conditions on the number of healthy life years of EU residents, it is worth considering whether policy of the entire EU and individual countries in the field of distribution of funds for the sustainable functioning of households in terms of living conditions, healthy life and well-being of the population is only a dream or an actual activity.

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