Public Health and Sustainable Development: Assessing SDG3 across the Countries of the European Union

Elżbieta Sobczak[1], Dariusz Głuszczuk[2]

[1] Wroclaw University of Economics and Business, Faculty of Economics and Finance, Komandorska 118/120, 53-345 Wrocław, Poland, e-mail: sobczak.elzbieta@ue.wroc.pl, ORCID: https://orcid.org/0000-0003-1912-7493

[2] Wroclaw University of Economics and Business, Faculty of Economics and Finance, Komandorska 118/120, 53-345 Wrocław, Poland, e-mail: dariusz.gluszczuk@ue.wroc.pl, ORCID: https://orcid.org/0000-0003-4471-3187

ABSTRACT

Objective: To classify EU countries by their degree of implementation of Sustainable Development Goal 3 – good health and well-being; to identify the changes which have occurred in two years, 2016 and 2020.

Research Design & Methods: The study used methods of multivariate statistical analysis with a particular emphasis on cluster analysis methods, including Ward's method and *k*-means. Using Ward's hierarchical clustering, a preliminary determination of the number of EU country groups was made using a dendrogram of linkages, integration distances, and classification steps. The Calinski-Harabasz index was used for the final selection of the optimal number of classes.

Findings: In both 2016 and 2020, two classes of the EU countries emerged, differing significantly in terms of their SDG3 implementation levels. The class presenting a higher level of public health and well-being included the Member States of the EU prior to its expansion eastward. Greece

(a country with longer term EU membership), Cyprus, Malta and Slovenia (of the EU's new enlargement) were among the other class.

Implications/Recommendations: The changes that occurred in SDG3 implementation in EU countries from 2016 to 2020 are positive. Most of the indicators we tracked changed for the better, indicating that the actions taken by EU Member State governments effectively improve public health and well-being. Future efforts should focus on improving preventable mortality, reducing obesity, and extending healthy life.

Contribution: The article is intended to broaden the knowledge on sustainable development implementation levels for good health and well-being and to identify the changes which occurred in this area between 2016 and 2020, the two years examined.

Article type: original article.

Keywords: public health, good health and well-being, sustainable development, European Union.

JEL Classification: Q56, C38.

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1. Introduction

Sustainable development is based on the concept of progressive, harmonious change across three dimensions – economic, social and environmental. Public health is a key dimension of the social sphere (Zalewska, 2015). Life expectancy is the main determinant of public health, and positive trends can be noted in many countries, especially highly developed ones. Extending the human lifespan has become possible thanks to effective control of infectious diseases, improved sanitation, better food quality and greater availability, increasingly healthy eating habits, improved road safety and other preventive public health measures (Cianciara, 2018).

On the other hand, there continue to be significant risks to human health and life, including unbalanced diet, a lack of or very little physical activity, being overweight or obese, excessive alcohol consumption, and smoking (Johnson *et al*., 2016; Azzopardi-Muscat *et al*., 2017), air pollution, climate change, poverty, inadequate living conditions, human activity-related accidents and disasters (Wojteczek, 2019). These factors often lead to chronic diseases – and consequently premature death – and many of them are associated with modern lifestyles.

Lalonde (1974) observed that human health depends largely (53%) on lifestyle. Physical environment (21%), genetic factors (16%) and, most importantly, the healthcare system (10%) have much less influence. Two studies have confirmed these general conclusions (Wysocki, 2007; Cianciara, 2018), as did a 2002 report by the World Health Organization (WHO, 2002), which found that the key to public health is not treatment, but prevention of disease by eliminating environmental, socioeconomic and cultural risks, including those related to lifestyle (Zalewska, 2015).

An appropriate framework for debate on the factors that shape public health can be found in the 2030 Agenda for Sustainable Development. With regard to this framework, the present research pursues answers to two questions:

1. What changes occurred in the level of SDG3 implementation in EU countries between 2016 and 2020, and can they be assessed positively?

2. What differences in the level of SDG3 implementation existed between EU countries in 2016 and 2020?

Our overarching purpose is to understand the diversity and classification of EU countries regarding the implementation level of SDG3 as it applies to good health and well-being in the years 2016 and 2020. It is also to identify changes which have occurred in this regard in the five years under consideration.

2. Health, Public Health and Sustainable Development: A Literature Review

Health is not mere the opposite of disease or disability, but a state of physical, mental and social well-being (Bickenbach, 2015; Eckermann, 2018). Within this triad of subjective well-being, physical health is manifest in the proper functioning of the body; mental health is expressed in the ability to think logically, articulate and perceive feelings, and overcome anxiety and stress; social health takes the form of an individual's proper existence in society. The protection of holistic well-being is addressed by the field known as public health (WHO, 2023).

According to Acheson's (1988, p. 24) definition, which has been adopted by the WHO European Region, public health is "the science and art of preventing disease, prolonging life and promoting health through the organized efforts of society." In pragmatic terms, public health as framed and addressed by health policies and programmes plays a crucial role. They include measures aimed at controlling and preventing disease, protecting the environment, promoting education and health, and making healthcare universally accessible (Wysocki, 2007).

Health is important for both the individual and society as a whole. It should be perceived in terms of (Korporowicz, 2011; Michaluk-Mazurek, 2019):

– value enabling an individual or a specific community to fulfil aspirations and the need to achieve satisfaction,

– a resource conditioning social and economic development,

– a means to everyday life determining its quality.

The importance of health was uniquely emphasised in the Rio Declaration on Environment and Development. The document accepts that "human beings are at the centre of the sustainable development process; they have the right to live healthy and creative lives in harmony with nature" (ONZ, 1992). This rule, upheld in the global programme *Transforming Our World: Agenda for Sustainable Develop-*

ment 2030 (Agenda 2030), indicates not only the high importance of health, but also its connection to sustainable and harmonised shaping of progressive change (Mazur-Wierzbicka, 2017). Among the 17 Sustainable Development Goals (SDGs) eligible for implementation by 2030, the objective need to *strive for a healthy life for all people of all ages and promote well-being* has been recognised (SDG3). Success in this regard conditions the implementation of the global development agenda in each of its three pillars – environmental, economic and social (Peña-Sánchez, Ruiz-Chico & Jiménez-García, 2021), and these correlations are not one-sided. That there is a feedback loop between sustainability and public health has been widely accepted (Macassa, 2021). Sustainable development is not possible in the absence of healthy lives and well-being (Davis *et al*., 2015; Le Blanc, 2015; Pereira *et al*., 2021), and conversely, without sustainable development humanity will not achieve a favourable state of health (Nunes, Lee & O'Riordan, 2016; Aftab *et al*., 2020). This correlation makes the implementation of SDG3 a major challenge in today's world (Sachs *et al*., 2021; AbuShihab *et al*., 2024).

Assuming that sustainable development is grounded in a moderately anthropocentric value system, its core objective can be understood as the pursuit of enhanced physical, mental, and social well-being for individuals and the global population. This is achieved through the creation of a high quality of life that does not compromise the ability of future generations to meet their own needs (Pluye, Potvin & Denis, 2004; Porritt, 2005). In this perspective, health becomes a specific, aggregate measure of successful sustainable development (Kickbusch, 2013).

The correlation between health and sustainable development is clearly visible in the links between the goals specified in the 2030 Agenda. These links take on particular significance when the goal of *ensuring a healthy life for all at all ages and promoting well-being* (SDG3) is viewed in relation to the other 16 goals of sustainable and harmonised change. There are synergies between SDG3 and the other SDGs (Kickbusch, 2013; Becerra-Posada, 2015). Health conditions the implementation of the overall social, economic and environmental goals. In any case, all of the SDGs are interconnected by the principle of indivisibility – the 17 SDGs are equally important and can only be achieved through their comprehensive implementation (Kostetckaia & Hametner, 2022).

3. Statistical Data and Research Methods

The 17 SDGs elaborated in Agenda 2030 are oriented toward people, the planet, prosperity, peace and partnership (Lipiec, 2019; Adamowicz, 2021; Firlej, 2021; Perkowski, Kosicki & Chrzanowski, 2023). It lists 169 tasks which are measured using 231 indicators, with national governments responsible for observing the progress made on the orders. EU Member States have adopted their own set of

indicators (including a group of measures for SDG3), which are reported by Eurostat (Eurostat, 2021; Szymańska, 2021; Gavurova & Megyesiova, 2022). This study assesses the differentiation and classification of EU countries in terms of the extent to which they have implemented sustainable development in the category of good health and well-being (SDG3). It also identifies the changes that have occurred in this area from 2016 to 2020, the two years under analysis. The following set of 11 indicators, adopted by the EU for monitoring the implementation of SDG3, was used as the basis for formulating value judgments:

- H_1 – healthy life years at birth (years),
- H_2 – share of people with good or very good perceived health (%),
- H_3 – smoking prevalence (%),
- H_4 – standardised death rate due to tuberculosis, HIV and hepatitis (rate),
- H_5 – standardised preventable and treatable mortality (rate),
- H_6 – self-reported unmet need for medical examination and care (%),
- H_7 – obesity rate by body mass index (%),
- H_8 – fatal accidents at work per 100,000 workers,
- H_9 – population living in households reporting suffering from noise (%),
- H_{10} – road traffic deaths per 100,000 persons,
- H_{11} – years of life lost due to PM2.5 exposure (rate).

Statistical information was retrieved from the Eurostat database (sustainability indicators – good health and well-being) (Eurostat, 2023). 2016 and 2020 were chosen for analysis of the implementation of SDG3 in EU countries as data for those years were fully available, thus allowing for a precise and reliable examination of progress and the identification of key trends in SDG3 implementation. It is also an appropriate period for observing changes. The year 2016 is the first full year after the adoption of the 2030 Agenda, making it a crucial starting point. The year 2020 is significant as it represents the point just before the outbreak of the COVID-19 pandemic, allowing for the assessment of progress before the pandemic's impact. Additionally, 2020 is the latest year for which complete data is available for all 11 SDG3 indicators adopted by the EU, enabling a comprehensive and consistent analysis. For 2021, statistical information is not available for three indicators: smoking prevalence (%) (H_3), obesity rate by body mass index (%) (H_7), and population living in households that report suffering from noise (%) (H_9). Finally, observing significant differences in SDG3 implementation levels over the five years is crucial for assessing the effectiveness of actions taken by individual countries.

Choosing different years would likely have yielded different results, especially if years with significant events, such as the COVID-19 pandemic, were included, as these could significantly impact health indicator outcomes. This should be the scope of further research on the degree of SDG3 implementation by EU countries.

The present study used methods of multivariate statistical analysis with particular emphasis on cluster analysis methods, including Ward's method and *k*-means method. More on cluster analysis methods can be found in the work of Ward (1963) and Hartigan (1975). The research was carried out in according to the following procedure.

Step 1. Assess the changes in the indicators used to monitor the implementation of SDG3 in the EU and the diversification of Member States in this respect in 2016 and 2020.

Step 2. Construct matrices that form the basis for classifying the EU countries in terms of the implementation level of SDG3 in 2016 and 2020:

$$\mathbf{X}^t = \left[x_{ij}^t \right]_{(nxm)}, \tag{1}$$

$$\mathbf{Z}^t = \left[z_{ij}^t \right]_{(nxm)}, \tag{2}$$

where:

$\mathbf{X}^t$ – the matrix of values of $H_1 - H_{11}$ indicators monitoring the implementation of SDG3 in *t*-th period,

$\mathbf{Z}^t$ – the matrix of normalised values of $H_1 - H_{11}$ indicators monitoring the implementation of SDG3 in *t*-th period,

$t = 1, 2$ – the number of the analysed period, for 2016 and 2020, respectively,

$i = 1, \ldots, n$ ($n = 27$) – the number of the analysed period (country),

$j = 1, \ldots, m$ ($m = 11$) – the number of the indicator monitoring the implementation of SDG3,

x_{ij}^t – value of *j*-th SDG3 indicator in *i*-th object and *t*-th period,

z_{ij}^t – normalised value of *j*-th SDG3 indicator in *i*-th object and *t*-th period.

Before the classification methods were applied, transformation of the indicators monitoring SDG3 was normalised. The characteristics of the formulas for normalising variables and their properties have been presented elsewhere (Kukuła, 2000; Zeliaś, 2002; Sobczak, 2010).

In the present analysis, the indicators H_1 and H_2 play the role of stimulants, making their high values desirable for the realisation of SDG3. All other indicators monitoring SDG3 are destimulants, but their low values are favourable for achieving SDG3.

Zero unitarisation (Kukuła, 2000) was used to normalise the SGD3 indicators. It is expressed by formula (3) for SDG3 indicators acting as stimulants and formula (4) for destimulants:

$$z_{ij}^t = \frac{x_{ij}^t - \min_i x_{ij}^t}{R_j^t} \qquad \text{for } j = 1, 2, \tag{3}$$

$$z_{ij}^t = \frac{\max_i x_{ij}^t - x_{ij}^t}{R_j^t} \qquad \text{for } j = 3, 4, \ldots, 11, \tag{4}$$

where R_j^t is the range of values of *j*-th indicator monitoring the implementation of SDG3 in *t*-th period.

Step 3. A preliminary classification of EU countries based on their level of SDG3 implementation was conducted using Ward's hierarchical clustering method (Ward, 1963). This analysis, covering 27 EU countries in 2016 and 2020, was guided by a dendrogram of linkages, integration distances, and classification steps. Prior to applying Ward's method, squared Euclidean distances between the countries were calculated based on their SDG3 indicators.

Step 4. The EU countries were grouped into relatively homogeneous classes based on their level of SDG3 implementation in 2016 and 2020 using *k*-means clustering method developed by Dalenius and Gurney (1951).

The Calinski-Harabasz index was used to select the optimal number of classes (Caliński & Harabasz, 1974).

Step 5. A typology and characteristics of the classes of EU countries in terms of their level of SDG3 implementation in 2016 and 2020.

The applied research procedure made it possible to assess the degree of diversification among the EU countries in SDG3 implementation, as well as the changes that occurred between 2016 and 2020.

4. Research Results

The degree and direction of changes occurring in the scale of sustainable development implementation in good health and well-being in the EU were assessed. To this end, the relative changes of indicators monitoring the implementation of SDG3 in 2020 compared to 2016 were used. The coefficients of variation were used to assess the differentiation in the EU countries and the changes which occurred during the period under study. Results of calculations are presented in Table 1 and Figure 1.

Table 1. Relative Changes in the Values of Indicators Monitoring Sustainable Development in Terms of SDG3 in the EU in 2020 Compared to 2016

SDG3 Indicator	Preference Direction	Relative Change (%) 2020/2016	Direction of Indicator Change	Coefficient of Variation (%)	
				2016	2020
H_1	S	0.00	no change	8.0	7.3
H_2	S	2.96	positive	14.9	13.8
H_3	D	–7.41	positive	25.2	31.5
H_4	D	–31.54	positive	89.5	92.0
H_5	D	6.28	negative	40.6	43.3
H_6	D	–32.14	positive	120.0	119.7
H_7	D	1.74	negative	9.5	9.0

Table 1 cnt'd

SDG3 Indicator	Preference Direction	Relative Change (%) 2020/2016	Direction of Indicator Change	Coefficient of Variation (%)	
				2016	2020
H_8	D	−3.80	positive	54.8	50.0
H_9	D	−2.76	positive	31.0	35.8
H_{10}	D	−20.75	positive	31.6	34.9
H_{11}	D	−25.34	positive	69.3	76.0

Notes: S – stimulant, D – destimulant.

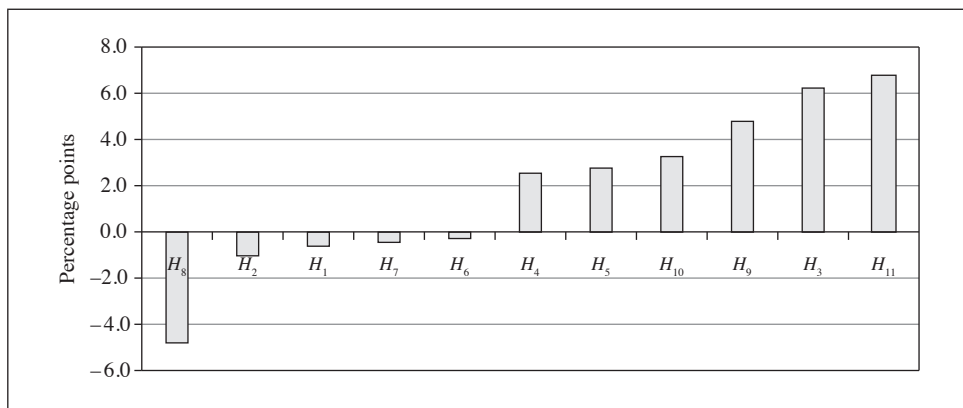Source: the authors, based on Eurostat database.

Fig. 1. Absolute Changes in the Coefficients of Variation for the Indicators Monitoring the Implementation of SDG3 in the EU in 2020 Compared to 2016 (Percentage Points) Arranged in Ascending Order

Source: the authors, based on Eurostat database.

Analysis of Table 1 and Figure 1 shows that both the dispersion of the EU countries in terms of their level of SDG3 implementation and the changes that occurred to that level in 2020 varied significantly from that observed in 2016 for the individual monitoring indicators.

Ward's method was used to determine a preliminary proposal for dividing the EU countries into relatively homogeneous classes based on the level of SDG3 implementation. Figure 2 shows the steps of hierarchical classification in the form of a dendrogram of connections and node distances in 2016 and 2020. Based on these, a variant division of the EU27 countries, using *k*-means method, into two and three classes for both years, was proposed. In order to select the optimal number of classes, Calinski-Harabasz quality index of classification results CH(*k*)*t* was
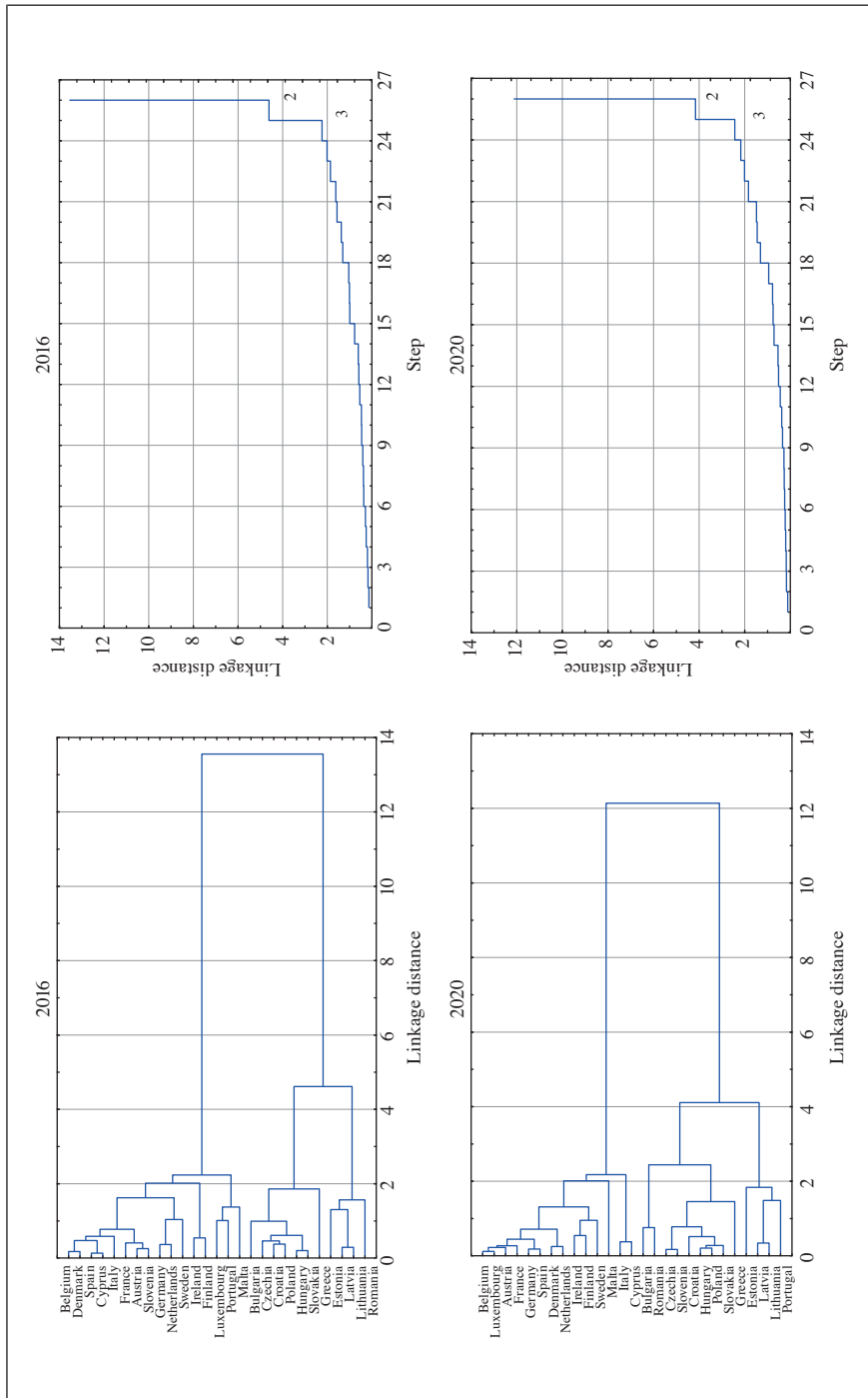
Fig. 2. Dendrogram of Connections Using Ward's Method, Node Distances and Classification Steps of 27 EU Countries in 2016 and 2020

used (where: k – number of classes, $t = 1, 2$ for 2016 and 2020, respectively), which took the following values: $CH(2)_1 = 13.41$, $CH(3)_1 = 10.56$, $CH(2)_2 = 14.61$, $CH(3)_2 = 10.34$. More favourable, maximum values of the quality index for the classification results were obtained when the EU countries were divided into two relatively diverse classes in 2016 and 2020.

Classification results of the EU countries for implementation level of SDG3 (good health and well-being) in 2016 and 2020 are summarised in Table 2.

Table 2. Classification Results of the EU Countries into Relatively Uniform Classes in Terms of SDG3 Implementation Level in 2016 and 2020 Using k-means Method

Class Number	Class Name	Class Composition (Distance from the Middle of the Class)	Class Size	Average Distance from the Middle of the Class
2016				
1	Lower level of SDG3 implementation	Bulgaria (0.24), Czechia (0.20), Estonia (0.30), Greece (0.30), Croatia (0.15), Latvia (0.28), Lithuania (0.22), Hungary (0.15), Poland (0.13), Romania (0.24), Slovakia (0.18)	11	0.22
2	Higher level of SDG3 implementation	Belgium (0.11), Denmark (0.11), Germany (0.16), Ireland (0.24), Spain (0.09), France (0.17), Italy (0.19), Cyprus (0.13), Luxembourg (0.24), Malta (0.27), Netherlands (0.20), Austria (0.13), Portugal (0.25), Slovenia (0.17), Finland (0.23), Sweden (0.26)	16	0.18
2020				
1	Lower level of SDG3 implementation	Bulgaria (0.24), Czechia (0.17), Estonia (0.32), Croatia (0.16), Latvia (0.26), Lithuania (0.20), Hungary (0.14), Poland (0.13), Romania (0.23), Slovakia (0.15)	10	0.20
2	Higher level of SDG3 implementation	Belgium (0.10), Denmark (0.14), Germany (0.12), Ireland (0.17), Greece (0.27), Spain (0.08), France (0.13), Italy (0.22), Cyprus (0.23), Luxembourg (0.10), Malta (0.29), Netherlands (0.20), Austria (0.11), Portugal (0.25), Slovenia (0.13), Finland (0.21), Sweden (0.24)	17	0.18

Source: the authors (using Statistica 13.3 software), based on Eurostat database.

Figure 3 shows average values of the normalised SDG3 indicators in separated classes of EU countries in 2016 and 2020.

Table 3 lists the profiles of the separated classes of the EU countries in 2016 and 2020, providing the basis for detailed characterisation and assessment of the differences existing between them in the implementation of SDG3.
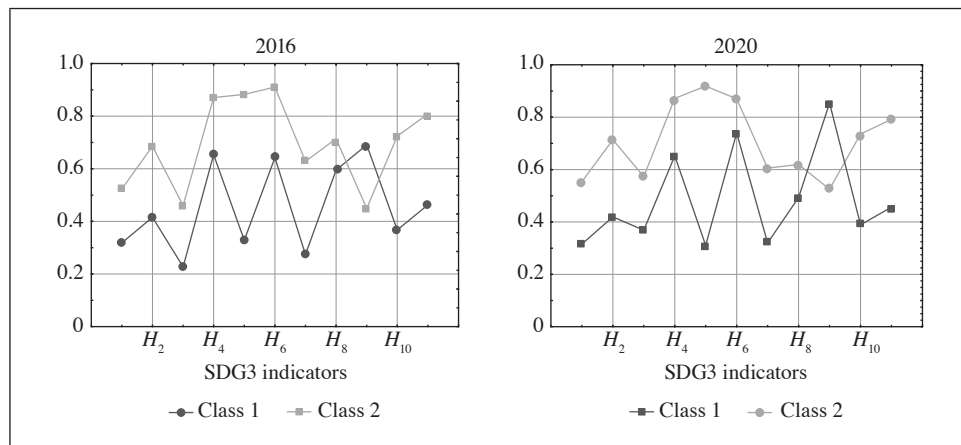
Fig. 3. Mean Values of the Normalised SDG3 Indicators in the EU Countries in 2016 and 2020

Source: the authors (using Statistica 13.3 software), based on Eurostat database.

Table 3. Mean Values of Indicators Monitoring the Implementation of SDG3 for the Identified Types of Classes of the EU Countries in 2016 and 2020

Indicators Monitoring SDG3	Mean Value of the Indicator			
	2016		2020	
	Class 1	Class 2	Class 1	Class 2
H_1 – healthy life years at birth (years) – S	59.84	63.84	59.49	64.08
H_2 – share of people with good or very good perceived health (%) – S	59.82	70.48	60.82	72.43
H_3 – smoking prevalence (%) – D	30.18	23.19	29.10	21.94
H_4 – standardised death rate due to tuberculosis, HIV and hepatitis by type of disease (rate) – D	4.11	1.97	3.02	1.38
H_5 – standardised preventable and treatable mortality (rate) – D	419.94	214.66	465.62	216.00
H_6 – self-reported unmet need for medical examination and care (%) – D	5.60	1.55	3.38	1.69
H_7 – obesity rate by body mass index (%) – D	58.08	51.84	58.69	53.23
H_8 – fatal accidents at work per 100,000 workers – D	2.86	2.16	2.40	1.88
H_9 – population living in households that report suffering from noise (%) – D	13.42	17.89	11.33	18.82
H_{10} – road traffic deaths per 100,000 persons – D	7.25	4.69	5.97	3.72
H_{11} – years of life lost due to PM2.5 exposure (rate) – D	1,109.45	424.5	850.2	333.24

Notes: S – stimulant, D – destimulant.

Source: the authors, based on Eurostat database.

The research results allow for a detailed assessment of the differentiation level among the EU countries regarding their implementation of the SDG3 and the changes which occurred in 2020 compared to 2016.

5. Discussion and Conclusions of the Research

Research on the implementation of sustainable development goals has focused on a wide range of issues, including:

– monitoring the achievement of SDGs (Hametner & Kostetckaia, 2020; Lafortune *et al*., 2020; Sachs *et al*., 2021),

– seeking harmony (synergies) or conflict (trade-offs) between the Agenda 2030 goals (Hickel & Kallis, 2020; Linnerud, Holden & Simonsen, 2021; Warchold, Pradhan & Kropp, 2021),

– integrating these research areas (Biggeri *et al*., 2019; Hametner & Kostetckaia, 2020).

Monitoring the achievement of SDGs usually involves constructing aggregate indices based on normalised values of selected indicators. Studying the relationships between the goals (harmony, conflict), on the other hand, typically relies on analysing the correlations between the variables (e.g., using Spearman's rank correlation method). The literature does not report on attempts to assess the degree of implementation of individual sustainable development goals or to classify countries in this regard.

The study has analysed the values of 11 indicators monitoring the implementation of SDG3 in the countries of the EU in two years, 2016 and 2020. In 2020, only healthy life years at birth (H_1) remained unchanged, and in both years the average score for the EU was 64 years of age. Standardised preventable and treatable mortality deteriorated (H_5) – the value increased by 6.28%, while the obesity rate by body mass index (H_7) increased by 1.73%. In 2016, 51.80% of the EU population was overweight, a share that had risen to 52.70% by 2020. A positive direction of change was observed for the remaining eight SDG3 indicators all improved from 2016 to 2020. The most favourable changes in SDG3 occurred for self-reported unmet need for medical examination and care (H_6) – a decrease of 32.14%, and standardised death rate due to tuberculosis, HIV and hepatitis (H_4) – a decline of 31.54%. Significant improvement was also recorded for the years of life lost due to PM2.5 exposure (H_{11}) – down by 25.34% and the rate for road traffic deaths (H_{10}) – lower by 20.75%.

The differentiation levels among EU countries in 2016 and 2020, based on individual indicators monitoring SDG3 implementation, varied considerably. The coefficient of variation ranged from 7.30% in 2020 for H_1 indicator (healthy life years) to 120.00% in 2016 for the H_6 indicator (self-reported unmet need for medical examination and care).

In both 2016 and 2020, EU countries exhibited very high – though slightly decreasing – levels of disparity for the H_6 indicator, which showed by far the greatest variation. The coefficient of variation amounted to 120.00% in 2016 and dropped slightly to 119.70% in 2020. It is worth noting that this indicator showed the greatest improvement during the analysed period.

EU Member States varied little (the coefficient of variation was lower than 15.00%) with regard to three goals: the share of people with good or very good perceived health (H_2), obesity rate by body mass index (H_7) and healthy life years at birth (H_1), all of which decreased from 2016 to 2020.

The variation among the EU countries declined for 5 of the 11 SDG3 indicators (healthy life years at birth, share of people with good or very good perceived health, self-reported unmet need for medical examination and care, obesity rate by body mass index and fatal accidents at work – H_1, H_2, H_6, H_7, H_8). But it was higher for the other indicators. While the variation among EU countries for indicators including H_4 – standardised death rate due to tuberculosis and HIV and hepatitis and H_{11} – years of life lost due to PM2.5 exposure was very high in 2016 (with coefficient values reaching 89.50% and 69.30%, respectively), it had worryingly increased even further by 2020 – to 92.00% and 76.00%, respectively.

Dividing the EU countries by their level of SDG3 implementation into two relatively homogeneous classes was optimal for both years. In both years the first class, comprising the countries characterised by lower levels of SDG3 implementation (11 and 10 countries, respectively), was less numerous. In 2016, the first class included the 11 countries: Bulgaria, Czechia, Estonia, Greece, Croatia, Latvia, Lithuania, Hungary, Poland, Romania and Slovakia. The second class (for which SDG3 implementation was higher) included the other 16 countries. The division of countries into homogeneous groups in 2016 and 2020 turned out to be relatively stable. The only change in the composition of the classes concerned Greece, which in 2020 was characterised by a higher level of SDG3 implementation. In 2016 and 2020, only three countries of the "new EU enlargement" (Cyprus, Malta and Slovenia) were listed in the class 2 grouping (those countries with higher SDG3 implementation). All countries of the "post-socialist block," with the exception of Slovenia, had significantly worse health and well-being.

The differences in the degree of SDG3 implementation in the identified classes of EU countries can be caused by a variety of factors, including (Küfeoğlu, 2022):

– lifestyle,
– dietary habits and access to healthy food,
– healthcare systems and expenditures on health services,
– state of the natural environment,
– historical neglect in public health in former Eastern Bloc countries.

Identifying the causes of the observed differences in the degree of SDG3 implementation in EU countries is a significant research challenge, as the conclusions drawn can serve as a basis for addressing these disparities.

The countries presenting higher levels of SDG3 implementation were characterised by a greater clustering around the centre of gravity. In class 1, average distances from the centres of gravity in 2016 and 2020 were 0.22 and 0.20, while in class 2 they were 0.18 and 0.18, respectively. In class 1, Estonia and Greece were the most distant from the centre of class gravity in 2016, as were Estonia and Latvia in 2020, while in class 2 Malta and Portugal were the furthest from the centre in 2016, as were Malta and Greece in 2020.

In both years, the first class, which grouped the EU countries characterised by a lower level of SDG3 implementation, showed significantly more favourable values for the H_9 indicator (population living in households reporting suffering from noise). In 2016 in the first class, 13.42% of the population reported being exposed to noise at home, while in 2020 the number fell to 11.33%. In the second class, the H_9 indicator reached 17.89% in 2016 and increased to 18.82% in 2020.

In both 2016 and 2020, the second class of countries was characterised by greater SDG3 implementation for the other 10 indicators. At the same time, the EU countries differed the most for the H_5 indicator (standardised preventable and treatable mortality). In 2020, it deteriorated in both classes of countries, largely due to the COVID-19 pandemic. However, the increase in the rate of standardised preventable and treatable mortality was much higher in the class of countries featuring a lower level of SDG3 implementation. Without diminishing the importance of the other indicators monitoring public health and well-being, it should be noted that preventable mortality is among the most severe impacts, requiring urgent and prioritised action by the governments of the EU Member States classified in class 1.

The changes in disparities between the identified classes in the years under study are also noteworthy. In 2020, the disproportions increased over 2016 levels for the following indicators: H_1, H_2, H_5, H_8, H_9, while decreasing for: $H_3, H_6, H_7, H_{10}, H_{11}$. Only for one indicator, H_4, did no change occur.

A detailed comparative analysis between classes of countries with different levels of SDG3 implementation makes it possible to evaluate the effectiveness of actions taken within each group of countries. Countries with lower SDG3 implementation levels exhibit higher preventable and treatable mortality rates (H_5), suggesting significant gaps in their healthcare systems. Large investments are necessary in health infrastructure, medical personnel training, and improving the accessibility and quality of healthcare services. The lower percentage of individuals reporting good or very good health (H_2) indicates a need for intensive educational campaigns promoting a healthy lifestyle and health prevention measures. The high percentage of smokers (H_3) in this group highlights the need for intensified anti-

smoking efforts, including educational campaigns, stricter regulations on the sale and consumption of tobacco products, increased tobacco taxes, and support for smoking cessation programmes. The higher rate of road traffic deaths (H_{10}) suggests the need for modernising road infrastructure, redoubling efforts to improve road safety, and conducting educational campaigns on road safety. The high percentage of individuals reporting unmet health needs (H_6) indicates problems with access to healthcare. Improving the accessibility and quality of healthcare services are urgently needed, and could be achieved by developing a network of medical facilities and implementing innovative solutions such as telemedicine. The high number of years of life lost due to PM2.5 exposure (H_{11}) suggests the need to improve air quality. Reducing pollutant emissions and promoting clean energy sources would be advisable steps forward.

Countries with higher SDG3 implementation levels have lower preventable mortality rates (H_5), reflecting the efficiency of their healthcare systems. They should continue investing in medical innovations and further improve their healthcare systems. The higher percentage of individuals reporting good or very good health (H_2) may result from better access to healthcare, effective health campaigns, and strong awareness of public health issues. These countries should continue educational and preventive campaigns to promote healthy lifestyles and increase public health awareness. Lower smoking rates (H_3) suggest the effectiveness of anti-smoking measures such as strict regulations on smoking in public places, educational campaigns, and support for the cessation of smoking. These countries should maintain strict smoking regulations and support smoking cessation programmes. Lower road traffic death rates (H_{10}) indicate the effectiveness of road safety improvement measures, such as modernising road infrastructure, strengthening regulations, and public education on road safety, and the need for their continuation. A low percentage of individuals reporting unmet health needs (H_6) reflects good accessibility and quality of healthcare services, resulting from effective health policies and investments in the health sector. These countries should continue their current actions and support and develop innovative solutions. Fewer years of life lost due to PM2.5 exposure (H_{11}) suggests that environmental protection measures and air quality improvements are effective. Countries with higher SDG3 implementation levels should continue promoting clean energy sources and reducing pollutant emissions.

In conclusion, the detailed analysis presented here shows that EU countries have had varying degrees of success in implementing SDG3 measures. Countries with lower SDG3 implementation levels require intensified actions in many areas, while countries with higher levels should continue their effective strategies while introducing innovations and further improvements.

The research has three main limitations:

1. The study was based on 11 health and well-being indicators adopted by the EU. While these indicators are crucial, they may not reflect the full picture of public health and quality of life. There are many other aspects of health and well-being that were not included.

2. The research was conducted for the years 2016 and 2020, which may not fully capture long-term trends and changes. Analysing data over a longer period could provide a more comprehensive view of SDG3 implementation.

3. The research was based on quantitative data, which limits the understanding of the context and qualitative aspects of SDG3 implementation. Qualitative data could provide valuable insights into the causes and effects of the phenomena observed.

These limitations suggest the results should be interpreted cautiously and that there is a need to consider these limitations when formulating conclusions and policy recommendations. The limitations form the basis for determining the further research perspective, primarily focused on expanding the subject and temporal scope of the research and undertaking qualitative studies.

Based on the foregoing research, the following general conclusions can be formulated:

1. From 2016 to 2020, the countries of the European Union (EU27) showed progress in implementing SDG3 goals. Progress was recorded for 8 of the 11 indicators analysed, suggesting that activities taken by the EU and its Member States improved public health and well-being. Further efforts should be focused on improving preventable mortality, reducing obesity, and extending health. This will primarily require promoting a healthy lifestyle, including physical activity and a proper diet, as well as expanding preventive health screenings and improving the quality of medical care. These goals can be achieved by increasing spending on comprehensive health protection for residents, as well as enhancing the organisa-tion of the healthcare system. It also seems important to intensify efforts in imple-menting other SDGs that are highly correlated with health security, such as poverty eradication, green energy, and improving the state of the natural environment.

2. A significant increase in the value of the standardised preventable and treat-able mortality indicator should be considered alarming. Its source certainly lies in the effects of the COVID-19 pandemic, but it also points to unhealthy lifestyle practices and deficiencies in the public health system. This only further suggests the need to promote healthy lifestyles and increase investment in the healthcare system.

3. The countries of the European Union, in 2016 and 2020, varied significantly in their SDG3 implementation levels. The largest variation occurred for self--reported unmet need for medical examination and care (H_6) and standardised death rate due to tuberculosis, HIV and hepatitis (H_4). Changes in the degree of variation among EU countries were bidirectional: dispersion increased for six indicators and

decreased for five. Addressing these disparities should be a priority for EU policy and the actions of Member States governments.

4. In both years, two classes of the EU countries emerged, one consisting of older EU Member States, which had a higher level of public health and well--being (Greece, which in 2016 was classified among the lower-rated countries, was an exception). Then there were Cyprus, Malta and Slovenia from among the countries of the so-called new enlargement. As can be seen, the former Eastern Bloc countries (except Slovenia) require special support from the EU and the intensification of national efforts to implement SDG3.

5. SDG3 indicators should be constantly monitored so changes in the implementation of SDG3 can be identified and assessed, solutions improved, and actions developed to bring about better public health and well-being.

Further research should examine drivers and inhibitors of progress in SDG3 implementation, model solutions, and methods to improve the effectiveness of measures taken by both the EU and the individual Member States. Incorporating a temporal perspective in further research will allow for a better understanding of the changes and the effectiveness of actions taken, which is crucial for achieving long-term health goals and quality of life across the entire EU.

Authors' Contribution

The authors' individual contribution is as follows: Each contributed 50%.

Conflict of Interest

The authors declare no conflict of interest.

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