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QUALITY OF LIFE IN THE CONTEXT OF THE DISTANCE FROM THE CITY CENTRE AND ACCESS TO GREEN AREAS, ILLUSTRATED WITH THE CASE OF KRAKÓW DISTRICT

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Summary

The aim of the study was to determine the diversity in the standard of living of the inhabitants across the municipalities that make up the Kraków district (*powiat krakowski*). The study examined the socio-economic conditions and the relationship between the standard of living and the distance from the central city. In their research, the authors also attempted to determine the relationship between the quality of life and the accessibility of green areas. The standard of living and accessibility of green areas were defined as synthetic indicators, using the non-model method. In order to verify the research questions, the Pearson's linear correlation coefficient was applied. The basis for calculating the value of the green areas accessibility index was a network analysis conducted using the QGIS 3.16 software, applied to the CORINE Land Cover 2018 and OpenStreetMap data. The research on the standard of living and quality of life was based on data from public statistics. Ultimately, two classifications were obtained: (1) the standard of living and the quality of life, and (2) the accessibility of green areas. Significant differences in the values of the quality of life and standard of living index were demonstrated. It was concluded that the municipalities of Wielka Wieś, Zabierzów, and Zielonki have the highest standard of living of all the studied area. The best accessibility of green areas is found in the Krzeszowice municipality. In the analysed area, no significant correlation was found between the standard of living and the accessibility of green areas. The results can be applied, among others, in conducting marketing activities of administrative units and as an aid in determining areas requiring the attention of local authorities.

Keywords

network analysis • suburban zone • QGIS • standard of living

1. Introduction

The quality of life and standard of living constitute one of the most important issues of modern science [Roszko-Wójtowicz and Grzelak 2018]. Improving the quality of life is the overarching goal of sustainable development [Kusterka-Jefmańska 2010]. Since the 1980s, there has been a noticeably increasing interest in the subject of the quality

of life [Wnuk et al. 2013], also in Poland due to the Integrated Household Research System conducted by the Central Statistical Office [Piasny 1993]. It is worth noting, however, that despite their interchangeable use in colloquial speech, these terms are not identical. The standard of living is equated with the analysis of the degree of satisfaction of human needs [Garza 2012]. It is a set of objective conditions, which, according to Słaby [2007, p. 104], have the impact in terms of influencing the material condition, safeguarding existential needs, and securing the living environment of individuals. Among the indicators commonly used to measure the standard of living are therefore: economic activity, housing conditions, education of children, using the services of the health care system, pro-environmental activities, etc. [Borys 2008]. Unlike the standard of living, the quality of life is usually characterized by subjective variables [Słaby 1990]. The concept of the quality of life is a multidimensional logical structure referring to the expectations of an individual towards selected aspects of his or her life [Petelewicz 2016]. It is the satisfaction that people get from life and all the elements related to the emotional states they feel, and the value systems that they follow [Szukiełojć-Bieńkuńska 2015].

Nowadays, in the face of intense urbanization changes as well as limitations related to the COVID-19 epidemic, we observe that increasing attention is being paid to the diversity of living standards within given spatial administrative units, as well as the impact of green areas on the quality of life of inhabitants in both urban and suburban areas [Noszczyk et al. 2022]. Greenery is commonly considered to be an important factor influencing the image and the character of any given place [Zachariasz 2016]; also, the presence of greenery displays a positive correlation with the standard of living experienced by residents, particularly in cities [Giannico et al. 2021]. The wide accessibility of open green spaces is perceived on a par with access to basic services. The compilation of these factors translates into a good quality of life [Zachariasz 2006]. It is also factors such as the possibility of communing with nature in the vicinity of one's place of residence that contribute to the overall perception of the quality of life in a given territorial unit [Michniewicz-Ankiersztajn 2014]. Green areas enabling extensive rapport with the natural environment help reduce stress and have a positive effect on the health condition, including mental health [Ryńska 2011]; they give places their unique character and raise the standard of living [Chojecka 2014]. Apart from the improvement of the overall air quality, green areas can positively translate into reducing the urban heat island phenomenon and the negative impact of high temperatures [Ryńska 2011].

In the process of examining the quality of life and the standard of living, the entry stage is the appropriate selection of diagnostic features. Commonly used groups of factors include those related to education [Mazowiecki Ośrodek Badań Regionalnych 2016], health care [Michalska-Żyła 2016], the natural environment [Owsiński and Tarchalski 2008], safety [Central Statistical Office 2017], investment attractiveness [EGO – Evaluation for Government Organizations s.c. 2015], social factors [Sobolewski et al. 2014], the labor market [Michalska-Żyła 2016], and culture [Mazowiecki Ośrodek Badań Regionalnych 2016]. The authors also include here individual indicators

necessary from the point of view of research considerations, that is, those concerning spatial development or attractiveness for housing [EGO – Evaluation for Government Organizations s.c. 2015]. The data of the Central Statistical Office [Piszczek 2013] is a commonly used resource in Poland, when it comes to research on the quality of life. In order to standardize the data in terms of measurement units, normalization formulas are used [Kukuła 2000]. The most frequently recommended standardization method in the literature is the use of the zero unitarization formula [Jarocka 2015]. The index describing the standard of living is usually constructed as a synthetic index. Such a procedure enables the hierarchical classification of administrative units according to the obtained value of the index.

In order to determine the quality of life, researchers also use subjective assessment, for instance, by conducting questionnaire-based surveys [Tijanić 2019], or on the basis of direct field research [Rutkowska 2007], in which subjective perception, evaluation or classifying the reality being described may be featured in addition to an objective inventory of the actual condition.

The majority of the available studies dealing with the subject of access to greenery and its impact on the quality of life focus on the subject of greenery in the context of the quality of life in urban areas [Breuer and Brueser 2013], including the interdependence between urban life and green areas [Krukowski 2018]. Among the generally non-controversial components of the quality of life in the city, correlated with the natural environment, authors indicate the air quality and acoustic climate, as well as the nature of the landscape [Woźniak 2015]. It is worth mentioning, nonetheless, that the concept of including the green factor in research on living standards is not widely used.

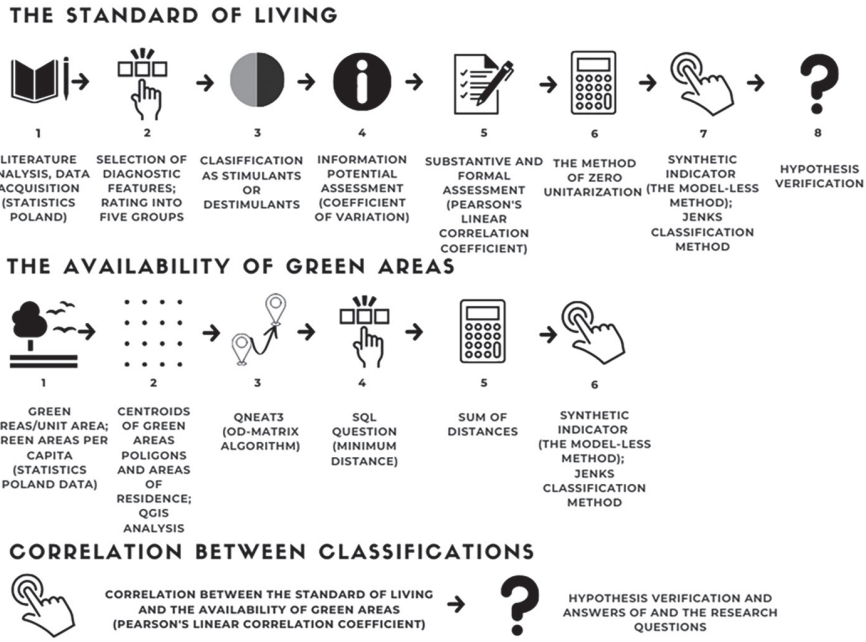
The objective of the present study was to determine the differentiation in the standard of living of the inhabitants across the municipalities of the Kraków district, and to determine the relationship between: (a) the standard of living and the distance to the central city, as well as (b) the standard of living and the accessibility of the inhabitants to green areas.

In order to achieve the stated objective, the following research questions were posed: (1) Are the neighbouring municipalities of Kraków characterized by higher values of the living standard index than those not directly adjacent to the city? (2) Is the value of the standard of living index correlated with the type of territorial unit: urban-rural municipality, or rural municipality? (3) Are there any links between the quality of life in municipalities, and the accessibility of green areas to the residents? Moreover, the following research hypothesis was adopted: The municipalities of the Kraków district located in the immediate vicinity of the region's capital city are characterized by a higher standard of living for their inhabitants.

2. Material and methods

The research project on determining the standard of living in the municipalities of the Kraków district (*powiat krakowski*) was divided into three stages. The first stage concerned the determination of the value of the synthetic index of the standard of living

for municipalities included in the Kraków district. The second stage was to calculate the value of the index describing accessibility of green areas. In the third stage, the relationship between the level of quality of life and the accessibility of green areas in individual municipalities of the district was verified. The research stages are shown in Figure 1.



Source: Authors' own study

Fig. 1. Stages of the research project

The selection of diagnostic features was made on the basis of the most common set of variables in the literature, used by researchers to assess the quality of life of the inhabitants of individual units. The data came from the resources of the Local Data Bank of the Central Statistical Office for the municipalities of the Kraków district (*powiat krakowski*). Diagnostic variables were assigned to five main groups of indicators: (1) housing conditions, (2) labour market, (3) health care, (4) social welfare, culture, and education, and (5) natural environment. The selected variables were characterized as stimulants or deterrents, respectively, and then subjected to a substantive and formal assessment of their applicability. The next step, aimed at narrowing down to the most reliable characteristics, assumed the selection due to the variability of the feature in relation to the analysed territorial units, using the relative coefficient $v(x_j)$ described by the formula (1) below:

$$v(x_j) = \frac{s(x_j)}{\overline{x_j}}, j = 1, \ldots, m \tag{1}$$

where:
$s(x_j)$ – standard deviation of the value of the j-th index,
$\overline{x_j}$ – arithmetic mean of the j-th index value.

The $v(x_j) \leq 0.10$ was considered the boundary value, indicating the necessity to discard that particular variable from the set. Indicators that meet the stated correlation have been eliminated, as they do not contribute new information about differentiation in the examined context. An additional assessment of the information potential was made using the Pearson linear correlation coefficient. The borderline value of the data correlation index was set as $r = |0.50|$. Selected partial indices were normalized in the zero unitarization process (MUZ).

Properly formulated partial indices were then used to construct a synthetic index of the standard of living, based on the non-model method, using the arithmetic mean of partial indices. The values of the synthetic index obtained in this way were subdivided, according to the assumptions of the Jenks method [Jenks 1967], into four classes. The municipalities with the highest values of the standard of living index were assigned to class I, while the units with the lowest values were allocated to class IV. The following class ranges were adopted: class I – (0.58–0.69), class II – (0.44–0.58), class III – (0.30–0.44), and class IV – (0, 21–0.30).

In order to verify the research question regarding the impact of the distance from the city Kraków on the standard of living, it was necessary to conduct Pearson's linear correlation analysis. The distance in this study is defined as the distance [in km] between the central city (Kraków) and the centre of each municipality of the Kraków district. The measurement was made with the use of Google Maps, while choosing the optimal route for traveling by car. The linear correlation coefficient was also applied, in considering the statistical significance of individual indicators used to assess the standard of living, as well as the correlation between the quality of life in municipalities and the accessibility of green areas for the inhabitants.

The second stage of the study assumes the analysis of the accessibility of green areas in the area of the municipalities of the Kraków district. The operations were performed using the QGIS software (version 3.16). The data for determining the accessibility indicator for green areas came from performing network analysis for CORINE Land Cover 2018 (CLC) data and the OpenStreetMap road network (OSM).

The procedure was based on the following steps:

I. Quantitative analysis, based on the data from the Central Statistical Office:
   a. calculation of the share of green areas in the total area of municipalities,
   b. calculation of the amount of green areas in hectares *per capita*.
II. Spatial accessibility analysis:
   a. Establishing the centroid (geometric centre of the area) for the aggregated layers: green areas – forests, woody and shrub vegetation, meadows and pastures; and residential areas: urban built environment.
   b. Determining the distance measured by the existing road network between the centroids of green areas and residential areas. The spatial accessibility analy-

sis was performed using the QNEAT3 – QGIS 3.16 plug, Network Analysis Toolbox 3. The OD-matrix algorithm was used for centroids of green areas and centroids of residential areas for each municipality. As a result of the described operation, a vector line layer with calculated section costs (total_cost) was created.

c. Selecting the minimum distance between green areas and built areas using an SQL query.
d. Calculating total network distances for each municipality.
e. Obtaining the result; it was assumed that the administrative unit where the total distance necessary to travel to reach green areas is the smallest has the best degree of green areas' accessibility for residents.

For a comprehensive analysis of accessibility of green areas, it was decided that analogous operations should be performed as in the designated indicator of the standard of living. Namely, determination of the synthetic indicator was conducted using the non-model method. The index was constructed on the basis of the data obtained from the network analysis, the share of green areas in the area of municipalities, and the area of green areas per 1,000 inhabitants. It should be emphasized that the green areas' accessibility index was composed taking into account a two-fold approach to the problem of defining green areas. The quantitative analysis uses data from the Central Statistical Authority (GUS), where green areas are defined as landscaped, covered with vegetation, having aesthetic, recreational, health or protective functions, in particular parks, lawns, promenades, boulevards and others [Ustawa 2004]. The Central Statistical Authority data include the indicators, which, in practice, are most commonly used for the objectified evaluation of green resources. However, this is an approach that takes into account only some of the categories of greenery found in urban areas. Especially in the case of areas with a high share of forests or permanent grasslands, the actual share of green areas of natural and social importance may be significantly different from the values provided in the Central Statistical Authority (GUS) reporting [Staszek 2017]. Bearing this in mind, and taking into account the fact that the conducted study does not only concern urban areas, but most of all suburban and rural areas, the components of the green areas accessibility indicator also included data covering forests, meadows, and pastures, based on the data of the CLC project. For all surveyed municipalities, the indicator is based on two data sources, and yet it is structured in the same way, which makes it possible to compare the obtained values. In line with the previous assumptions, the partial indices were standardized and a synthetic index was created based on the arithmetic mean for each territorial unit.

In order to obtain a comprehensive outlook of the impact that green areas exert on the living standards of the inhabitants of individual municipalities, an analysis was made of the degree of correlation between the value of the synthetic index expressing the standard of living, and the synthetic index describing the accessibility of green areas.

3. Results

The synthetic index of the standard of living was calculated using the non-model method based on five groups of indices. The initial database of diagnostic variables, including 14 indicators, has been collated in Table 1.

Table 1. Diagnostic variables selected for the study

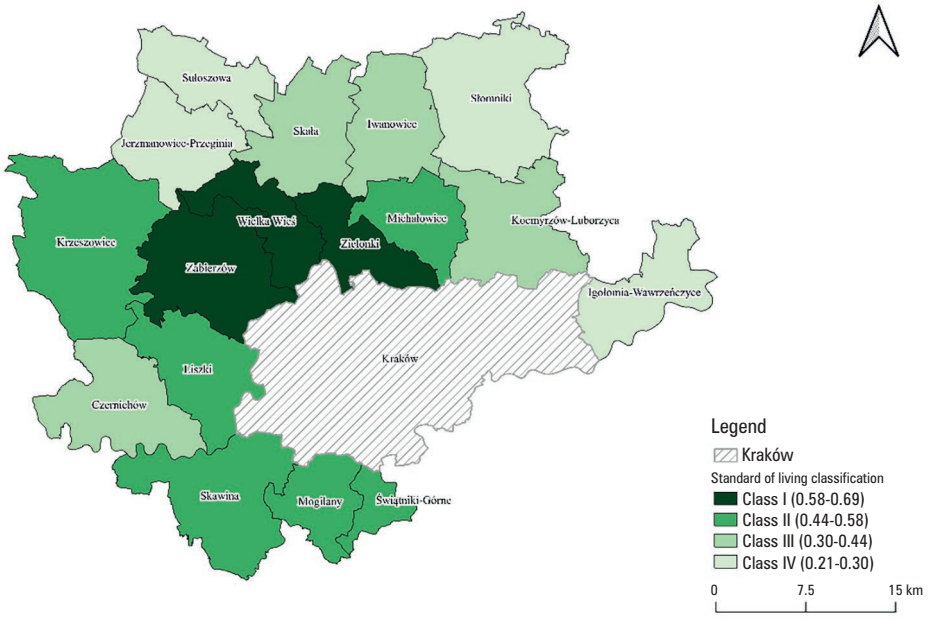
Symbol of the index	Diagnostic variable
I. HOUSING CONDITIONS	
X1	Average usable area of a flat in housing resources, per person
X2	Average usable area of one commissioned apartment
X3	Sewage system network per 100 km^2
II. LABOUR MARKET	
X4	Number of persons working per 1 000 inhabitants
X5	Number of natural persons conducting registered business activity per 1 000 inhabitants
X6	Number of domestic business entities registered in the REGON statistical records per 10 000 inhabitants
III. HEALTH CARE AND SOCIAL WELFARE	
X7	Number of consults per 1 health clinic
X8	Number of pharmacies per 1 km^2
X9	Number of deaths per 1 000 inhabitants
IV. CULTURE AND EDUCATION	
X10	Number of books borrowed from public libraries per 1 reader
X11	Share of children aged 3–5 years in pre-school education
V. NATURAL ENVIRONMENT	
X12	Amount of total mixed waste collected over 1 year per 1 inhabitant
X13	Use of water per 1 inhabitant
X14	Forest cover in %

Source: Authors' own study

Among the listed indices, only one diagnostic variable, that is, X9 – *Number of deaths per 1,000 inhabitants* – was defined as a deterrent. As a result of the substan-

tive and formal assessment, no changes were made to the list of diagnostic variables. The information potential was assessed based on the correlation matrix, assuming the required correlation value of $r \geq |0.50|$. The variable X10 – *Number of books borrowed from public libraries per 1 reader* – was rejected. Each of the selected indicators was subjected to statistical description by determining: arithmetic mean, extreme values, standard deviation, and the coefficient of variation. The diagnostic features indicated for the assessment of the standard of living of the inhabitants were characterized by variability at different levels. The lowest recorded value of the coefficient of variation was 11.32% for the percentage share of pre-school children aged 3–5 (variable X11). The greatest differentiation was found for the variable describing the sewage distribution network per 100 km^2 with the value of the coefficient of variation at the level of 89.83% (variable X3).

Having performed standardization of the partial values of diagnostic variables for each of the municipalities of the Kraków district, a synthetic index of the standard of living was calculated. The spatial distribution of the values of the standard of living index was presented using the visualization made in the QGIS 3.16 program, as shown in Figure 2.



Source: Authors' own study

Fig. 2. Standard of living in the municipalities of Kraków district

Inhabitants of the municipalities of Zielonki, Wielka Wieś, and Zabierzów enjoy the highest standard of living. The municipalities with the lowest indices include: Igołomia-

Wawrzeńczyce, Słomniki, Sułoszowa, and Jerzmanowice-Przeginia. Municipalities in the Class I and II of the inhabitants' standard of living are located mainly in the north-west and south-west parts of the Kraków district. With the exception of the Krzeszowice municipality, these are municipalities directly adjacent to Kraków. Classes III and IV are mostly located in the north-east part of the region.

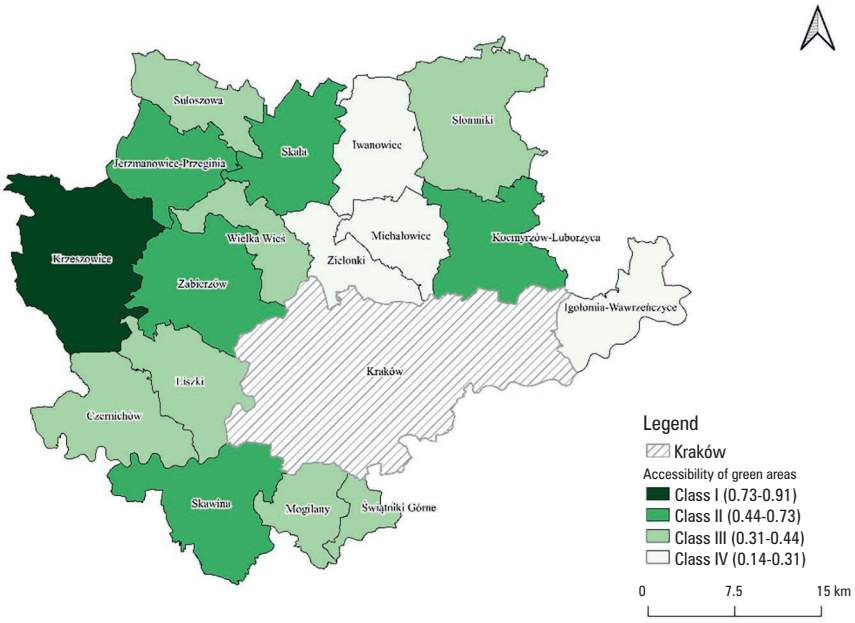
The verification of the hypothesis was based on the Pearson linear correlation coefficient between the synthetic index of the standard of living, and the distance from the city. Pearson's correlation coefficient was calculated as –0.75. The obtained value should be seen as the proof of a strong correlation between the index of the standard of living, and the distance from the central city. A negative value determines the direction of the impact, such that: the greater the distance from Kraków, the lower the value of the synthetic index (i.e. the lower standard of living of the inhabitants). Therefore, the adopted research hypothesis was deemed to be correct.

Considerations regarding the standard of living of the inhabitants were extended to include the analysis of green areas accessibility. The highest share of green areas in the total area of the municipality was recorded for the municipality of Krzeszowice, at the level of 23.85%. Skawina (22.15%) and Zabierzów (19.28%) are characterized by the second and third highest degree of green areas of all municipalities. The lowest share of green areas in all of the analysed units was found in the municipalities of Igołomia-Wawrzeńczyce (5.55%), Sułoszowa (7.41%), and Świątniki Górne (7.43%).

The maximum value of green areas per capita recorded in the Kraków district was recorded at 0.10 ha/person in the Krzeszowice municipality (similar to the share of green areas within the municipality's area). The highest values were successively recorded in the following municipalities: Skawina and Skała (0.90 ha/person), as well as Iwanowice, Jerzmanowice-Przeginia and Kocmyrzów-Luborzyca (0.80 ha/person). The lowest values were recorded in the following municipalities: Świątniki Górne (0.01 ha/person), Zielonki (0.02 ha/person) and Mogilany (0.03 ha/person).

For aggregated layers of green spaces (CLC data) and residential areas, travel costs were calculated for all combinations of points representing area centroids (total_cost). After applying the SQL – select min (total-cost) query – the minimum values of travel between green areas and built-up areas were obtained. Subsequently, the minimum values obtained for each of the units were added up. This particular variable is a deterrent. The highest value of the sum of distances for the analysed pairs was obtained for the municipality of Iwanowice (969,911.09 m). The lowest value has been recorded in the Sułoszowa municipality, amounting to 59,103.94 m.

Based on the totals of the distances, the share of green areas within the given municipality, and green areas per 1,000 inhabitants, the value of the synthetic indicator of green areas' accessibility was determined for each municipality (Fig. 3). Class I municipality with the highest value of the synthetic index was Krzeszowice. By contrast, the administrative units with the lowest values of the index of green areas' accessibility (class IV) are: Igołomia-Wawrzeńczyce, Zielonki, Michałowice, and Iwanowice.



Source: Authors' own study

Fig. 3. Accessibility of green areas

The obtained value of the Pearson linear correlation index for the standard of living and access to green areas was less than 0.20.

To offer a summary and to answer the research questions, it was found that: (1) except for the Igołomia-Wawrzeńczyce municipality, the neighbouring municipalities of Kraków are characterized by higher values of the standard of living index than municipalities not directly adjacent to the city; (2) the value of the standard of living index is not correlated with the type of territorial unit: urban-rural municipality, or rural municipality; (3) no strong correlation was observed between the quality of life in municipalities and the accessibility of green areas for their inhabitants.

4. Discussion

The quality of life in a given area may be influenced by the proximity of a large urban centre such as Kraków. Municipalities of the Kraków district located in the immediate vicinity of the region's capital city enjoy a higher standard of living of their inhabitants. Similar results were reported in the *Analiza poziomu życia w miastach województwa mazowieckiego* [Analysis of the standard of living in the cities of Mazowsze region in 2014, Mazowiecki Ośrodek Badań Regionalnych 2016]. Also, with the distance from

the capital increasing, a decrease in the value of the synthetic index of the standard of living was observed. The results of the present research prove that in the Kraków district, there is a spatial differentiation in the value of the standard of living.

In the analysed area, no significant correlation was found between the standard of living and the accessibility of green areas. On the other hand, a strong correlation was shown between the total value of the standard of living index and certain variables, namely, business entities entered in the REGON records per 10,000 people, natural persons running a business per 1,000 population, and water consumption per capita. This may indicate that in the analysed area, the greatest impact on the quality of life is still exerted by socio-economic issues. The positive nature of the coefficient determining the correlation between the quality of life in the municipalities of the Kraków district and access to green areas could indicate that with the increase in access to green areas, the standard of living of the inhabitants also increases. However, the level of the correlation coefficient determines a negligible correlation between the aforementioned features. These results may indicate the subjective nature of green areas' accessibility. In her research, Pielesiak [2017] postulated that green areas are an important factor in the quality of life of inhabitants in both rural and urban-rural municipalities. However, it is worth returning to the concept of Rogola [2009], who noticed that the quality of life is influenced by both the measurable and non-measurable factors. In this latter concept, green areas can be perceived in a subjective way, and they may be interpreted, inter alia, thanks to the conducted surveys. Hence, in the opinion of the authors, the gap regarding the impact of greenery on the quality of life of inhabitants of rural areas needs to be filled. However, the research method should be adapted so that the accessibility of green areas, especially in non-urban areas, is perceived not as influencing the living standards of the population in the strictest sense, but as translating into an improvement in the mental and physical condition of the inhabitants [Chojecka 2014].

5. Conclusions and summary

The assessment of the quality of life and standard of living is a complex research task that requires a multifaceted approach, which is informed by the necessity to know the statistics and the tools for analysing spatial data, as well as the ability to build synthetic measures based on data of various types, coming from dispersed sources. The selection of parameters and indicators for testing the quality of life depends on the research objective, stated research problems, scale and scope of the study, as well as on the available and obtainable data. So far, the research into the quality of life and standard of living of the inhabitants was typically based on the data of social statistics. However, it would be worthwhile to supplement the quality of life research with analyses based on spatial data, especially those derived from free and commonly available sources. The present study uses data from the Central Statistical Authority (GUS), as well as commonly available data from the CLC project, OSM and Google Maps data. This allowed the researchers to confirm the correlation between the quality of life level and the distance from the central city, which is also present in the studies of other authors.

At the same time, no correlation of the quality of life with the access of residents to green areas has been demonstrated. Having said that, the authors predict that in the future, as the social awareness of the beneficial impact of green areas on human life and health develops, this correlation may become noticeable and have a greater impact on the value of the calculated indicators of the quality of life.

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