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LIFE QUALITY AFFECTED BY GREEN INFRASTRUCTURE – POLISH CITIES' PERSPECTIVE

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Abstract: Article aims to identify significant relations between the green infrastructure and the life quality in large cities. Paper fulfils a gap referring to lack of research on relations between green infrastructure and the life quality which results are applicable to wider populations. Conducted research allowed to recognise green infrastructure as an important factor affecting the life quality by taking into account populations of 28 large cities in Poland. Employed research procedure, involving cluster analysis and regression method, allowed to conclude that green infrastructure provides an explanation for the variation of the life quality of 15% to 25%. On the one hand, significant, positive relations have been confirmed between green spaces and the life quality aspects like physical well-being, psychological well-being, social well-being, and lower life stress. On the other hand, a negative effect of green spaces has been identified, related to conducing to social pathologies.

Keywords: green infrastructure, green spaces, life quality, cities, population

1 INTRODUCTION

Cities as areas of concentrated populations and economic activities are attributed a leading role in affecting economic development. They are growth poles (Friedmann, 1973; Higgins and Savoie, 2017) where welfare processes are most intense and where welfare is most typically defined with respect to the economy. However, the role of cities as engines of economic growth is only one of three major aspects of their functioning distinguished within the concept of sustainable development. The remaining two aspects are related to the natural environment and the society. Cities should be at the frontline of sustainability what was highlighted in United Nations resolution: *Transforming our world: the 2030 Agenda for Sustainable Development*. Document recognize that sustainable urban development is crucial to the life quality by i.e. providing universal access to safe, inclusive and accessible, green and public spaces (UN, 2015). This justifies the need of paying more attention to relations between green infrastructure and life quality.

Green infrastructure comprises of natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales, which provide benefits to human populations (Benedict and McMahon, 2002; Tzoulas et al., 2007) and can be treated as a factor contributing to life quality by providing ecosystem services, e.g. air and water purification, limiting noise, stabilizing the microclimate (Bolund and Hunhammar, 1999; Sodoudi et al., 2018; Dipeolu and Ibem, 2020) and by impacting the social and psychological dimensions of life (Chiesura, 2004; Gilbert, 2016). Direct human contact with nature limits stress (Mennis et al., 2018), encourages reflection (Fuller et al., 2007), is conducive to calm and relaxation (Capaldi et al., 2014), and even speeds up convalescence as confirmed by research carried out by Ulrich (1984), Ulrich et al. (1991), and Velarde et al. (2007). The impact of green infrastructure on the inhabitants' quality of life is one of the contemporary and widely analysed research issues, but there are still some knowledge gaps. The most research papers revolve around the importance of green infrastructure to physical activity and human health (e.g. Maas et al., 2006; Nielsen and Hansen, 2007; D'Alessandro et al., 2015; Gascon et al., 2016; Akpinar, 2016). Not many works focus on relations between green spaces and other important, also included in this paper, aspects creating the life quality like the civilization level, social well-being, psychological well-being or social pathologies (Hand et al., 2017; Younan et al., 2016; Mennis et al., 2018). What is more, "most studies that showed a link between green space and mental health were small, short term and involved groups of similar people (…). It's not clear whether the results are applicable to wider populations" (Gilbert, 2016 p. 56). Within this study, there were used comprehensive, comparable, secondary data referring to populations of 28 large cities (see Materials and Methods) what directly fulfils the gap indicated by Gilbert (2016). Another research gap and the reason for conducting this research was fact, in Central and East Europe there is a lack of studies on direct relations between green infrastructure and life quality. Most of them have been carried out primarily in highly developed countries like the US, Australia, New Zealand or West European countries (e.g. Nielsen and Hansen, 2007; Bancroft et al., 2015; Hand et al., 2017; Völker et al., 2018). Recently there were published research results on green infrastructure importance for socio-economic processes in East part of European Union, but they focus on correlation between green infrastructure and urban resilience (Bănică et al., 2020). Current paper complements state of the art by taking insight into correlation between green infrastructure and life quality in one of the post-communist countries. In Poland the issue of relations between green spaces and the life quality has not been frequently discussed (e.g. Chojecka, 2014; Pielesiak, 2017) and the results of the research are hardly available to international audience.

The article's goal was to identify significant relations between the green infrastructure and the life quality in large cities. Green infrastructure in this paper is understood as an ecological system within urban areas consisted of six categories of green spaces including parks, pocket parks & squares, street greenery, green areas of housing estates, cemeteries, and urban forests (Table 1).

Table 1 Typology of green infrastructure elements

Type	Characteristic
Parks	Green areas with trees, bushes and other plants, covering an area of at least 2 ha, arranged and conserved for inhabitants to relax in, equipped with roads, walks, benches, playgrounds. The surface area of parks includes any water there, for example ponds.
Pocket parks & squares	Areas of greenery smaller than 2 ha, whose main function is to provide relaxation (e.g. there are walks with benches, playgrounds). This category includes green spaces in front of public buildings (as long as they are accessible to the public), statues, as well as boulevards and promenades. Greens often contain a mixture of low levels planting (lawns, flowerbeds) with trees and bushes.
Street greenery	Green areas alongside public transport infrastructure consists of strips of greenery (lawns, bushes, trees) along roads and thoroughfares.
Green areas of housing estates	Areas of greenery accompanying residential buildings. These areas are for relaxation and insulation as well as for aesthetic reasons
Cemeteries	Areas where burials take place (of people or animals), regardless of the legal status, the owner or administrator and the size of the area covered by greenery.
Urban forests	Forests that grow within a city.

Source: author's own work based on Szymańska et al. (2015) and Statistics Poland (http://stat.gov.pl/en/)

The life quality is defined as an individual's subjective assessment of his/her satisfaction with life which includes two aspects: individual ('the way how I feel') and social ('how I operate in the environment') (Panek, 2015). In this paper, the life quality is considered in the system of eight dimensions defined by Czapiński and Panek (2015) and including social capital, psychological well-being, physical well-being, social well-being, level of civilization, material well-being, life stress, and pathologies (Table 2).

Table 2 Quality of life dimensions

Dimension	Charactersitic
social capital	It includes inhabitant activity for the benefit of the local community, participation in local and parliamentary elections and the EU referendum, and participation in non-mandatory meetings. Social capital is also linked to opinion that most people can be trusted, positive attitude towards democracy, membership in organizations and performing functions there.
psychological well-being	Compilation of sense of happiness, evaluation of one's life to date, and evaluation of the past year as well as worsening symptoms of depression.
physical well-being	It refers to intensification of somatic symptoms, a serious illness in the past year, degree of disability, and increasing health-related stress.
social well-being	It concerns no sense of loneliness, a feeling of being loved and respected, and refers to the number of friends.
level of civilization	It is described by level of education, ownership of modern communication devices and handling them, active command of foreign languages, and possessing a driver's license.
material well-being	It includes a household income per equivalent unit and number of goods and devices in the household (except for devices included into the level of civilization).
life stress	Sum of six categories of stress measured by experiences with respect to finance, work, contacts with public offices, bringing up children, marital relations and ecology.
pathologies	It refers to alcohol abuse and drugs use, smoking, visiting a psychiatrist or a psychologist, and being of perpetrator or victim of law-breaking (burglaries, assaults, thefts).

Source: author's own work based on Czapiński and Panek (2015)

2 MATERIALS AND METHODS

The spatial scope included twenty eight large Polish cities from approximately 100 thousand to more than 1.7 million inhabitants (Figure 1). The cities selection was determined by the fact that a detailed diagnosis of the life quality level was carried out there (Czapiński and Panek, 2015). Its results constitute a set of valuable data meeting the requirement of representativeness and being suitable for use in statistical analysis. Another reason why Polish cities are an appropriate research area is lack of their differentiation in terms of inhabitants accessibility to green infrastructure (Zwierzchowska and Mizgajski, 2019).

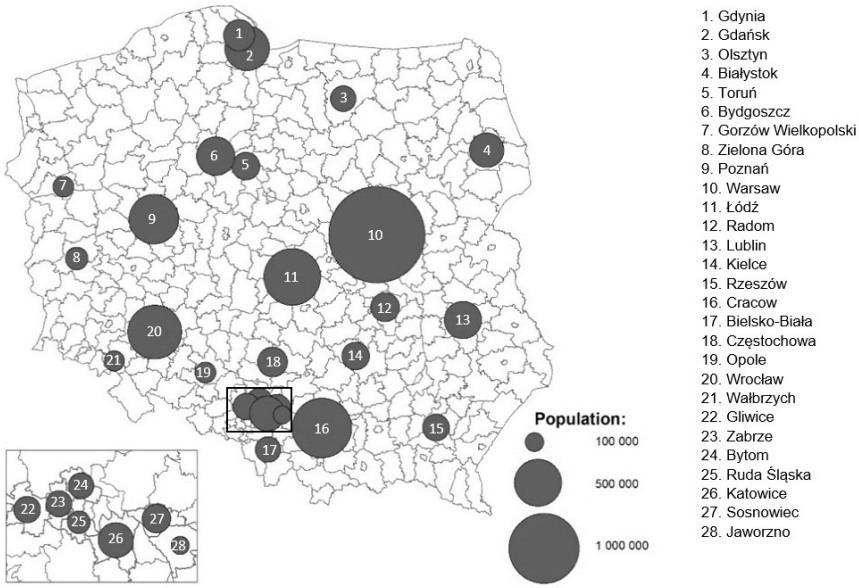

Figure 1 Polish cities taken into consideration in the research and their populations in 2015

The first major category of source materials consisted of data describing the area of green infrastructure, and provided by the Statistics Poland. Relativization thereof led to developing fourteen indicators of intensity and structure (Table 3) presenting the area of each type of green infrastructure per inhabitant and its share in the city's total area.

Second category of source materials pertained to the quality of life. The data came from the most up-to-date national survey: *Social Diagnosis 2015 – objective and subjective quality of life in Poland*, carried out under supervision of Czapiński and Panek (2015). It is a diagnosis of the conditions and quality of life of the Poles

as they report it. Authors investigated households and their occupants aged 16 and above using two separate questionnaires. Detailed characteristic of research methodology and way of data gathering is available at www.diagnoza.com. Its results included a ranking of analysed cities (Figure 1) with respect to the inhabitants' life quality. It was characterised by data published in form of synthetic indicators based on standardised values of the component variables (Table 4) each of the latter measured on a different scale. These indicators were relative in nature and showed the position of particular cities in relation to the average of the sample.

Table 3 Categories of green infrastructure and the attributed indicators

Category	Indicator code	Indicator
parks	01	share of parks in city's total area [%]
	02	parks area per inhabitant [m^2 per capita]
pocket parks & squares	03	share of pocket parks & squares in city's total area [%]
	04	pocket parks & squares area per inhabitant [m^2 per capita]
street greenery	05	share of street greenery in city's total area [%]
	06	street greenery per inhabitant [m^2 per capita]
green areas of housing estates	07	share of housing estate greenery in city's total area [%]
	08	green areas of housing estates per inhabitant [m^2 per capita]
cemeteries	09	share of cemeteries in city's total area [%]
	10	area of cemeteries per inhabitant [m^2 per capita]
urban forests	11	share of forests in city's total area [%]
	12	area of forests per inhabitant [m^2 per capita]
total green spaces	13	share of total green spaces in city's total area [%]
	14	total area of green spaces per inhabitant [m^2 per capita]

Source: author's own work

The research procedure consisted of three major stages (Figure 2) which embraced characteristic of green infrastructure intensity and structure, determining the level of life quality in cities, and identification of significant relations between these two elements.

First stage included an analysis of structural indicators describing the types of green infrastructure and the total area of green infrastructure per inhabitant. Analysed cities were clustered into 3 groups of large, average, and small intensity of green infrastructure. To this end, standardised values of indicator of green spaces per inhabitant were used (no 14 in Table 3). A similar classification was made with respect to the life quality; it resulted in three groups of cities with a high, average, and low quality of life. To this end, the standardised indices describing the eight dimensions of the life quality (Table 4) were averaged. In both cases, the classification procedure was based on clustering analysis in accordance with the k-means algorithm (k=3).

Table 4 Dimensions of the life quality and indicated phenomena taken into account

Dimension	Synthetic indicator code	Indicated phenomena (component variables)
social capital	A	activity for the benefit of the local community; participation in local and parliamentary elections and the EU referendum; participation in non-mandatory meetings; a positive attitude towards democracy; membership in organizations and performing functions there; opinion that most people can be trusted;
psychological well-being	B	a sense of happiness; an evaluation of one's life to date, worsening symptoms of depression; evaluation of the past year
physical well-being	C	intensification of somatic symptoms; a serious illness in the past year; degree of disability; increasing health-related stress
social well-being	D	no sense of loneliness; a sense of being loved and respected; the number of friends
level of civilization	E	level of education; ownership of modern communication devices and handling them; active command of foreign languages; a driver's license
material well-being	F	household income per equivalent unit; number of goods and devices in the household (except for devices included into the level of civilization)
life stress	G	sum of six categories of stress measured by experiences with respect to finance, work, contacts with public offices, bringing up children, marital relations and ecology
pathologies	H	alcohol abuse and drugs use; smoking; visiting a psychiatrist or a psychologist; perpetrator or victim of law-breaking (burglaries, assaults, thefts)

Source: author's own work based on Czapiński and Panek (2015)

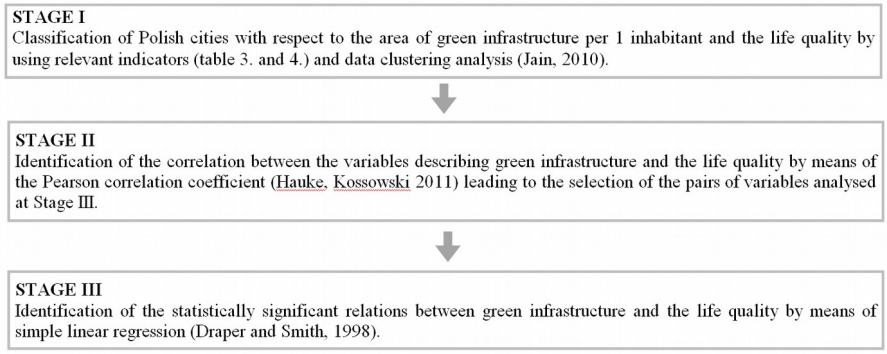

Figure 2 The algorithm of the research procedure. Source: author's own work

At second stage, checking the linearity of the analysed relations (analysis of dispersion diagrams) was followed by an identification of the correlations between the variables describing green infrastructure (Table 3) and the variables related to the life quality (Table 4) based on the values of Pearson's correlations (r). This allowed to indicate pairs of variables with statistically significant relations ($p \leq 0.05$) which

was a prerequisite for qualifying these variables for further analysis. The set of independent variables was also limited when the correlation between them exceed r=0.8, which meant that they may have similar information charges. In the case of two possible independent variables describing the same type of green areas in the context of the affecting the same life quality dimension, only one of them was selected for further research. The criterion of such a selection was a higher level of correlation with dependent variable.

Third stage of the research procedure was based on an analysis of linear regression with a single independent variable. The simple regression method is widely applied in the i.e. social sciences, medical research, economics, agriculture, biology, and meteorology (von Eye and Schuster, 1998; Fox, 2016; Toutakhane, 2018) and is dedicated to examining the relationship between quantitative dependent variable (Y) and one explanatory variable (X). Using simple linear regression resulted from an informal postulate to abstain from introducing too many independent variables to the regression models in the case of a small set of analysed units (N=28). This could artificially increase the coefficient of determination R^2 (Ratajczak, 2002). Standardised values of indicators describing types of green infrastructure (Table 3) were treated as independent variables and on the other hand the values of indicators referring to life quality dimensions (Table 4) were used as dependent variables. The results of a regression analysis were the basis for conclusions related to the significance of green infrastructure in affecting the life quality in cities. All statistical operations were carried out by means of Statistica 13.1. software.

3 RESULTS

The analysed cities were varied with respect to the share of green spaces in the total city's area. The biggest share, exceeding 12%, was identified in three cities characterised by high level of forestation: Olsztyn, Poznań, and Łódź. Green spaces were of least importance to the spatial structure in Kielce, Ruda Śląska, Rzeszów, Jaworzno, Częstochowa, and Zielona Góra (Figure 3). In the terms of area covered the dominating types of green infrastructure were forests (in eleven cities) and green areas of housing estates (in ten cities). On the other hand, pocket parks & squares were the smallest part of the spatial urban structure and they did not exceed 0.5% of a city's total area in nineteen cases. (Figure 3).

Intensity of green infrastructure expressed by their area per inhabitant oscillated between slightly more than 20 m^2 in Bytom and more than 100 m^2 in Olsztyn (Figure 4).

Naturally cities with relatively large shares of forests tended to have more green spaces per capita (e.g. Olsztyn, Poznań, Jaworzno). Cities devoid of forests, typically the most populated and polluted ones had the smallest area of green spaces. Such a cases were represented by i.e. Warsaw which is the capital city, and also Bytom and Ruda Śląska which are a mining cities situated in the Upper Silesia (largest conurbation in Poland) (Figure 4).

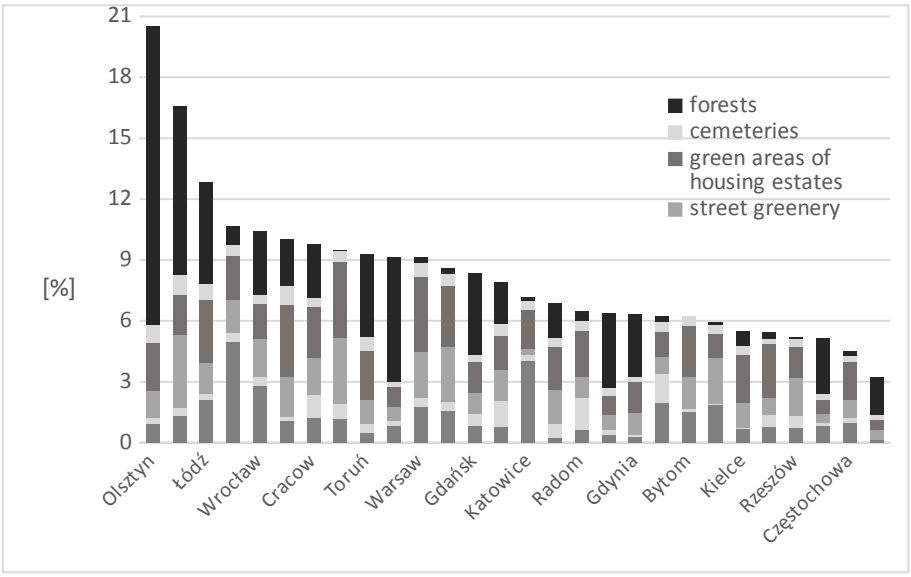

Figure 3 Share of green spaces in the total area of the analysed cities in 2015

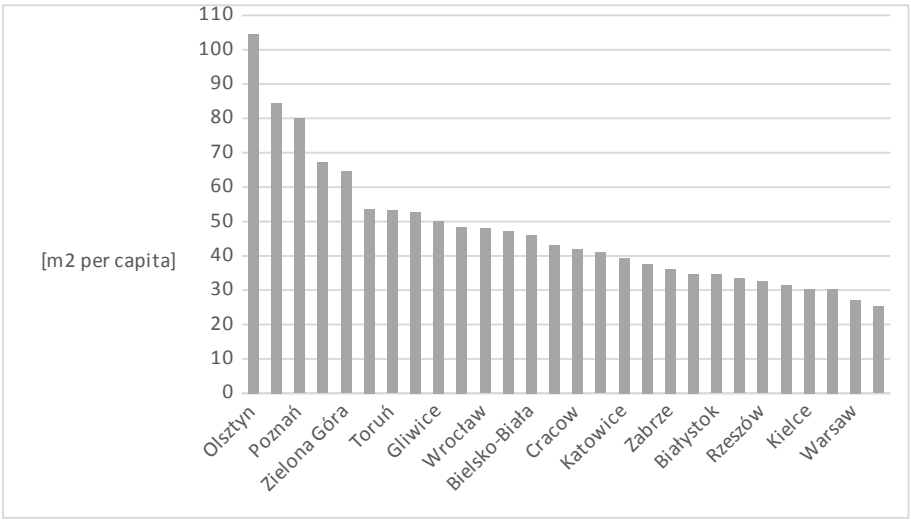

Figure 4 Total area of green spaces per inhabitant in the analysed cities in 2015

An analysis of the life quality was based on data published in the form of standardised values describing following dimensions: social capital, psychological well-being, physical well-being, social well-being, level of civilization, material well-being, life stress and pathologies (Table 2). Assuming that these dimensions are of the same importance to the general quality of life, their values were averaged to obtain a synthetic coefficient. Among the analysed cities, the highest quality of life was noticed in large and dynamically developing cities like Poznań, Cracow and Warsaw (Figure 5). The situation was average in Bielsko-Biała, Łódź and Lublin: cities negatively affected by the social and economic transformation after 1989 (Węcławowicz, 2016). Cities located in the poorly developed eastern part of Poland (Białystok, Kielce, Radom) as well as cities in the strongly polluted south of Poland (Ruda Śląska, Opole) offered a relatively lowest standard of living (Figure 5).

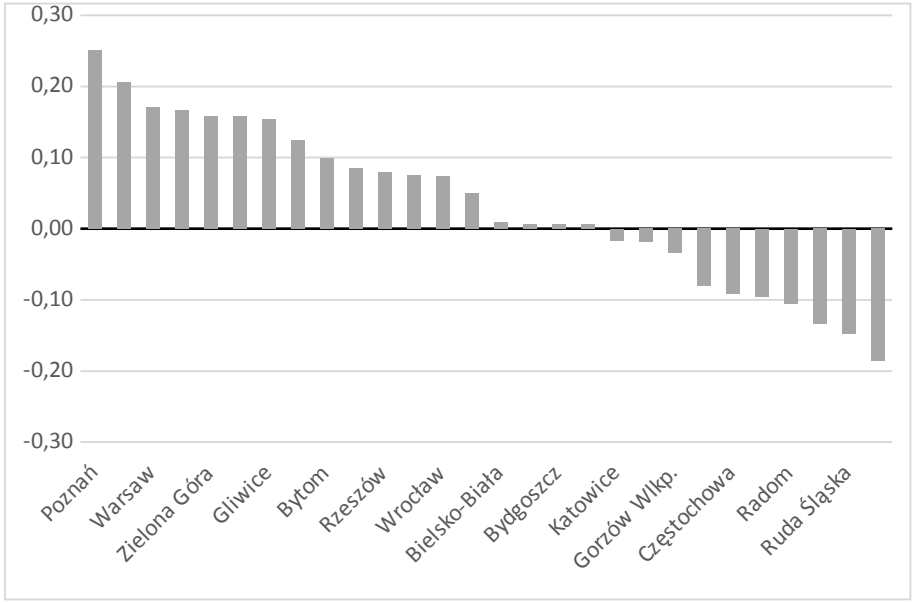

Figure 5 Life quality in the analysed cities in 2015

Taking above results regarding green infrastructure intensity and the life quality level into account, someone can assume tentatively that the green infrastructure may to some extent affect the life quality. This relation is further corroborated by results of clustering analysis which resulted in dividing the set of cities into three classes with respect to the intensity of green infrastructure and the life quality (Table 5).

In the case of thirteen cities, there was full conformity between the levels of the analysed phenomena. Only in two cities (Cracow, Warsaw) the situation seemed to contradict the assumption of a positive correlation between the life quality and green infrastructure. These discrepancies resulted from the fact that Warsaw and Krakow,

Polish most populated cities, have small area of green infrastructure per inhabitant. Notably, there was not a single case within analysed group of cities where large area of green spaces per capita would be accompanied by a low life quality (Table 5).

Table 5 Green infrastructure intensity and the life quality in Polish cities

		Life quality		
		high	average	low
green infrastructure intensity	high	Poznań, Jaworzno, Olsztyn		
	average	Toruń, Zielona Góra, Gliwice	Gdańsk, Wrocław, Bielsko-Biała, Łódź, Bydgoszcz	Wałbrzych, Opole
	small	Cracow, Warsaw	Bytom, Gdynia, Lublin, Rzeszów, Zabrze, Katowice, Sosnowiec, Gorzów Wielkopolski	Częstochowa, Białystok, Radom, Ruda Śląska, Kielce

Source: author's own work

The above results led to a subsequent analysis where Pearson's r-correlation was used to define the power of the analysed dependencies and provide more details on them. Only in the case of two of the analysed life quality's dimensions: social capital (A) and material well-being (B), the results did not confirm any relation with green infrastructure (Table 6). The strength of relations between green infrastructure and the remaining dimensions of the life quality, expressed by absolute values of the r-coefficient revolving between 0.383 and 0.501, could have been deemed as moderate. It was noticed that physical well-being (C) was relatively most frequently correlated with green spaces; it has a relevant relation with the area of total green infrastructure (11 and 12) and the area of forests (13 and 14) (Table 6).

There was also a significant correlation between psychological well-being (B) and the area of forests (12) and between social well-being (D) and the general area of green spaces (13). Interestingly, clear relations were also identified between the area of street greenery (06) and the level of civilization (E) and life stress (G). Finally, relatively weakest relations were noted between social pathologies (H) and the area of cemeteries (10) and total green spaces (14) (Table 6). Identification of the indicated relations served as a basis for subsequent studies on defining the nature and level of green spaces' impact on the quality of life.

Eight pairs of variables were subjected to regression analysis, describing selected dimensions of the life's quality and the types of green infrastructure for which the highest values of correlation were identified (Figure 6).

Results showed that green spaces were not the prevailing factor affecting the quality of life in Polish cities. It was corroborated by the determination coefficients (R^2) which oscillated between 0.147 and 0.251 (Table 7). This meant that generally the green spaces explained the variation of the specific aspects of the quality of life from around 15 to 25%.

Table 6 Matrix of correlations between variables characterizing the quality of life and green spaces

variables (codes)		green spaces													
		01	02	03	04	05	06	07	08	09	10	11	12	13	14
quality of life	A	0.052	0.105	0.101	0.316	0.250	0.291	0.026	0.095	0.151	0.246	-0.044	-0.060	0.059	0.076
	B	-0.080	-0.155	-0.091	0.134	0.008	0.028	-0.175	-0.226	0.101	0.253	0.374	**0.420**	0.257	0.340
	C	-0.328	-0.366	-0.095	0.097	0.210	0.187	0.040	0.031	0.330	0.347	**0.492**	**0.501**	**0.393**	**0.426**
	D	0.262	0.213	-0.154	0.084	0.247	0.293	-0.141	-0.246	0.258	0.286	0.329	0.259	**0.384**	0.334
	E	-0.003	-0.030	-0.078	0.307	0.334	**0.407**	-0.032	-0.091	0.040	0.139	0.049	0.066	0.102	0.126
	F	-0.205	-0.235	0.015	0.371	0.119	0.059	-0.006	-0.138	0.077	0.089	0.158	0.200	0.107	0.124
	G	-0.067	-0.131	0.063	-0.023	-0.287	**-0.406**	-0.049	-0.037	-0.011	0.056	0.098	0.181	-0.004	0.062
	H	0.050	0.081	0.192	0.143	0.092	0.104	-0.035	0.104	0.224	**0.383**	0.205	0.292	0.241	**0.398**

statistically significant correlation coefficients ($p < 0.05$) were **bolded**

B – psychological well-being
C – physical well-being
D – social well-being
E – level of civilization
G – life stress
H – pathologies

06 – street greenery per inhabitant [m^2 per capita]
10 – area of cemeteries per inhabitant [m^2 per capita]
11 – share of forests in city's total area [%]
12 – area of forests per inhabitant [m^2 per capita]
13 – share of total green spaces in city's total area [%]
14 – total area of green spaces per inhabitant [m^2 per capita]

see tables 1 and 2 for the other variables' definitions.

Source: the author's own work

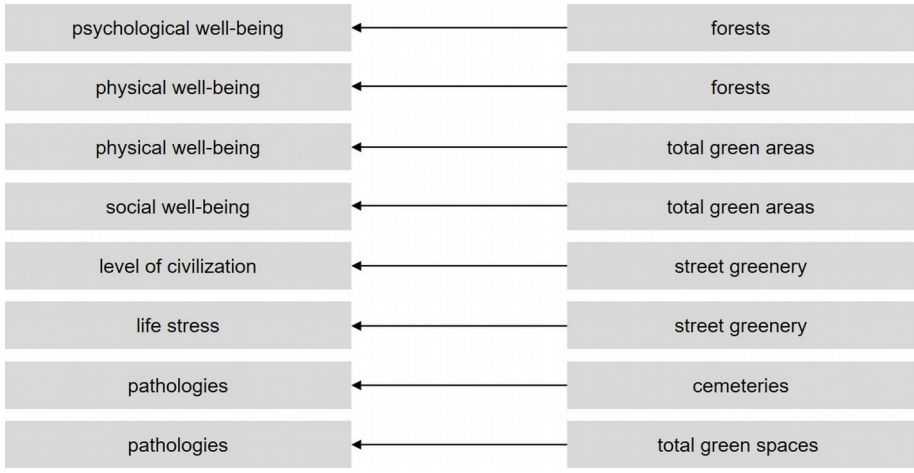

Figure 6 The assumed impact of green spaces on the quality of life in Polish cities

Special attention should be paid to the relative significance of forests which tend to affect most both the psychological and physical well-being. A positive impact of green spaces has also been identified with respect to social well-being, stemming from lack of sense of loneliness and from establishing social relations. The re-

search indicated also a rather surprising relation between street greenery and the level of civilization identified inter alia, on the basis of possessing a driving license (Table 2). The situation seems to be an example of feints which may result from some statistical effect, namely street greenery is strongly correlated to a city's length of road network which, in turn, is most probably correlated to the number of people with driving licenses. At the same time, street greenery is conducive for reducing life stress as certified by the negative value of coefficient β (Table 7). Pathologies were the last dimension of the quality of life in a city which proved to some extent related to green spaces. It was identified that a larger number of green spaces, including cemeteries, was accompanied by a higher level of social pathologies.

Table 7 Impact of green spaces on the quality of life

dependent variables (y)		independent variables (x)		coefficient of determination (R^2)	significance level (p)	beta coefficient (β)
quality of life	code	green spaces	code			
Psychological well-being	B	forests	12	0.176	0.026	0.420
physical well-being	C	forests	12	0.251	0.007	0.501
		total	13	0.154	0.039	0.393
social well-being	D	total	13	0.147	0.044	0.384
level of civilisation	E	street greenery	06	0.166	0.031	0.407
life stress	G	street greenery	06	0.165	0.032	-0.406
pathologies	H	cemeteries	10	0.147	0.044	0.383
		total	14	0.159	0.036	0.398

Source: author's own work

4 DISCUSSION

The obtained results illustrated the diversity of the analysed cities in terms of the intensity of green infrastructure per inhabitant. Most cities confirmed the relation indicated by Fuller and Gaston (2009) between the size of a city and the area of green infrastructure per capita: the bigger the city, the poorer the availability of green infrastructure. Two cities contradicted this thesis: Poznań and Łódź, which are among top 5 the most populated cities in Poland, and at the same time they are characterised by relatively large green infrastructure area per capita in comparison with much smaller cities (Figure 4). It resulted directly from the green areas structure of these cities, which was shaped by urban forests to a large extent (Figure 3). Therefore, it can be assumed that the preservation of a large area of forests in a large city is crucial for ensuring the higher accessibility to green areas. Thus, it allows for deviations from the rule indicated by Fuller and Gaston (2009) in rare cases.

Results allowed to state that the intensity of green infrastructure usually goes hand in hand with life quality increase (Table 5). It is worthy to emphasize that it was not fully confirmed in the case of cities with extraordinary positive socio-economic situation (i.e. Warsaw and Cracow), where the life quality was shaped primarily by material well-being and the level of civilization (Czapiński and Panek, 2015). These dimensions depend much more on economic and infrastructural factors than on opportunities to make use of green infrastructure, what was also confirmed to some extent by Uršič and Tamano (2019). Correlation analysis between particular life quality dimension and green infrastructure type (Table 6) did not confirmed any statistical relations only in case of social capital and material well-being. This is understandable because social capital consists mainly of certain features of social organization like trust, norms and interaction networks (Putnam, 1993). What is more, social capital depends on more economic factors including a fair distribution of income or activity on the labour market (Ferragina, 2013). In the case of material well-being, it is also hard to expect its relationship with green infrastructure because it results mainly from the household income and ownership of various goods and devices.

The identified, statistically significant relationships regarding the influence of green infrastructure on other quality of life's dimensions (Table 7) can be explained logically. It allows to consider green infrastructure as one of many important factors determining the life quality in the city (Węziak-Białowolska, 2016). The positive influence of forests on psychological well-being can be attributed to the fact that contact with nature is conducive for limiting psychological fatigue as confirmed by Beyer et al. (2014) and to an intensified sense of happiness (Capaldi et al., 2014). The importance of green infrastructure, especially forests, for physical well-being manifests itself in the fact that this space are chosen by inhabitants for physical activity what results in a better state of general health (D'Alessandro et al., 2015; Foo, 2016). The relation between forests and physical well-being also stems from the fact that in urbanised areas, forests are most efficient in providing ecosystem services of key importance to human health, i.e.: air purification, micro-climate regulation, and noise limitation (Bolund and Hunhammar, 1999; Livesley et al., 2016). The urban forests – least affected by humans and the biggest natural complexes among all types of green infrastructure analysed – had the strongest influence on life quality. For this reason, urban forests should be protected from the progressing urbanization and attempts should be made at increasing their areas by creating solid greenery systems (Zhang et al., 2007). A positive impact of green spaces has also been identified with respect to social well-being described by lack of sense of loneliness and by social relations' establishing. These results are further corroborated by research carried out by Kazmierczak and James (2007). They proved that greenery could improve a sense of social inclusion and be conducive to the integration of local communities by analysing four mechanisms of green infrastructure' impact on the communities of UK cities. Another identified function of green areas was limiting the level of life stress. Stress suffered by inhabitants due to noisy and intense traffic may be limited by means of a desirable use of the street space, taking into ac-

count mostly presence of greenery. It was confirmed by studies carried out by Błaszczyk and Kosmala (2008) who suggest that inhabitants of big Polish cities had very positive attitudes towards street greenery which, as an element of the urban green infrastructure system, may decrease the level of stress (Ulrich et al., 1991; Nielsen and Hansen, 2007). Obtained results confirmed also the need for designing city streets as green spaces encouraging relaxation rather than dehumanized urban canyons pointed by Ali-Toudert and Mayer (2006). There was identified one negative relation either. A larger area of green infrastructure, especially cemeteries, was accompanied by a higher level of social pathologies. The result seemed astonishing, especially in the light of studies of Maas et al. (2009) who indicated a positive relation between green infrastructure and a sense of safety. Perhaps this is an element which distinguishes inhabitants of Western Europe from people in Poland where parks, especially after dark, are not regarded safe (Bogacka, 2017). On the other hand, cemeteries are conducive to certain sorts of pathologies. This is confirmed by Mozgawa-Saj (2018) who noted that in Poland, desecration and grave robbing are fairly common phenomena. What is more, police statistics suggest that drug-related crimes are committed relatively frequently in cemeteries (Police Statistics, 2018). It should be emphasized such a situation does not result in any way from the cemeteries functions but from lack in basic equipment like sufficient lighting and monitoring. Despite the fact that negative relations between green infrastructure and social pathologies were relatively weak, they should not be disregarded. Of importance is also regular care of green spaces; neglect thereof should be prevented because the inhabitants might think of them as too dangerous (Jorgensen et al., 2002).

It is necessary to point out limitations of obtained results. They prove only a statistical correlation and correspondence between green infrastructure and life quality, and do not present the "cause-and-effect" relations which are by its nature impossible to observe (Hume, 1978). On the other hand identified correlation can be logically explained by results of in-depth, qualitative, and space-limited analyses, which dominate in current state of the art on linkeages between green infrastructure and life quality (e.g. Chiesura, 2004; Beyer et al., 2014; Carrus et al., 2015; Akpinar, 2016; Mennis et al., 2018). Obtained results are supportive for these case-studies and complementary to the state of the art by filling the research gap noticed by Glibert (2016) who pointed out that until recently, most studies were small, short term and involved groups of similar people, and it's not clear whether the results are applicable to wider populations. Solution of such weakness was to use a set of representative secondary data describing populations of 28 large cities.

5 CONCLUSIONS

The article's goal was to identify significant relations between the green infrastructure and the life quality in large cities. The main conclusion was drawn that green infrastructure provide an explanation for the variation of the quality of life of 15% to 25%. Thus, the strength of the relationship between the considered pheno-

mena was demonstrated, and thus it was proven that green infrastructure can be treated as one of the significant factors shaping life quality in the city.

Another important and more specific finding can be formulated either. First one refers to positive influence of green infrastructure which has been identified in the case of four out of eight dimensions of life quality, viewed in this article: psychological well-being, physical well-being, social well-being, and life stress. The second finding concerns negative relations identified between the green spaces, especially cemeteries, and the social pathologies what should be explained, not by their main function, but by its insufficient management.

Article fulfils three research gaps pointed out in the introduction section. First one concerns the consideration of a wider set of life quality dimensions, not only physical activity and human health, which are most often considered in research so far. Second one refers to fact the obtained results are also applicable to wider populations, what was achieved as a consequence of regression method application and by including variables described by secondary data from representative samples of 28 large cities populations. Third one refers to taking part in covering the deficit of scientific studies on the significance of green infrastructure for the life quality in Central and East European countries.

Paper constitute a general background and inspiration for future in-depth and qualitative research, which should be focused on the verification and in-detailed determination of nature of the identified relationships between a specific green infrastructure type and a given life quality dimension.

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Kvalita života ovplyvnená zelenou infraštruktúrou – perspektíva poľských miest

Súhrn

Mestám ako oblastiam koncentrovaného sústredenia obyvateľstva a ekonomických aktivít sa pripisuje vedúca úloha pri ovplyvňovaní ekonomického a regionálneho rozvoja štátu. Sú to póly rastu (Friedmann, 1973; Higgins a Savoie, 2017), kde sú procesy rastu blahobytu najintenzívnejšie a kde blahobyt je najčastejšie vysvetľovaný vo vzťahu s rastom ekonomiky. Úloha miest ako „motorov" hospodárskeho rastu je však iba jedným z troch hlavných aspektov ich fungovania, ktoré sa premietajú do koncepcie trvalo udržateľného rozvoja mesta. Zvyšné dva aspekty súvisia s prírodným prostredím a sociálnym životom obyvateľov.

Cieľom predloženého článku bolo zistiť významné vzťahy medzi zelenou infraštruktúrou a kvalitou života vo veľkých mestách. Zelená infraštruktúra sa v tomto príspevku chápe ako ekologický systém v mestských oblastiach pozostávajúci zo šiestich základných kategórií zelených plôch, konkrétne parkov (i), malých parčíkov parkov a námestí so zeleňou (ii), pouličnej zelene (iii), zelených plôch sídlisk (iv), cintorínov (v) a mestských lesov (vi).

Kvalita života je definovaná ako subjektívne hodnotenie jednotlivca jeho spokojnosti so životom, ktoré zahŕňa dva aspekty: individuálny a sociálny. V tomto príspevku sa kvalita života venuje systému ôsmich dimenzií, ktoré definovali Czapiński a Panek (2015). Zahŕňa sociálny kapitál, psychickú pohodu, fyzickú pohodu, sociálnu pohodu, úroveň civilizácie, hmotnú pohodu, životný stres a patológie.

Postup výskumu pozostával z troch hlavných etáp, ktoré obsahovali charakteristiku intenzity a štruktúry zelenej infraštruktúry v mestách, stanovenie úrovne kvality života v mestách a identifikáciu významných vzťahov medzi týmito dvoma prvkami. Na tento účel sa použila klastrová analýza a regresná metóda. Získané výsledky ukázali, že zelené plochy boli jedným z významných, ale nie prevládajúcim faktorom ovplyvňujúcim kvalitu života v poľských mestách. Potvrdili to determinačné koeficienty (R^2), ktoré oscilovali medzi 0,147 a 0,251. To znamenalo, že zelené plochy všeobecne vysvetľovali odchýlky konkrétnych aspektov kvality života od približne 15 do 25 %. Výsledky umožňovali konštatovať, že intenzita zelenej infraštruktúry zvyčajne ide ruka v ruke so zvyšovaním kvality života. Takto sa preukázala sila vzťahu medzi uvažovanými javmi a dokázalo sa, že zelenú infraštruktúru možno považovať za jeden z významných faktorov formujúcich kvalitu života v meste.

Analyzované mestá variovali s ohľadom na podiel zelených plôch na celkovej ploche mesta. Najväčší podiel, presahujúci 12 % plochy mesta, bol zistený v troch mestách charakterizovaných vysokou úrovňou zalesnenia, v Olsztyne, Poznani a Lodži. Zelené priestory zaberali najmenšie podiely z rozlohy a mali aj najmenší význam pre priestorovú štruktúru v Kielciach, Rude Śląskej, Rzeszówe, Jaworzne, Čenstochovej a Zielonej Góre. Z hľadiska územia pokrytého zeleňou dominovali medzi typmi zelenej infraštruktúry mestské lesy (v 11 mestách) a zelené plochy sídlisk (v 10 mestách). Na druhej strane boli male parčíky a zeleň námestí najmenšou časťou, mali najmenší podiel spomedzi kategórií zelených plôch, priestorovej štruktúry miest a v 19 prípadoch nepresiahli 0,5 % z celkovej rozlohy mesta.

Na základe získaných výsledkov možno formulovať aj ďalšie dôležité a konkrétnejšie zistenia. Prvé z nich sa týka pozitívneho vplyvu zelenej infraštruktúry, ktorý bol identifikovaný v prípade štyroch z ôsmich dimenzií kvality života, ktoré sú analyzované v predloženom príspevku, konkrétne v dimenziách psychická pohoda, fyzická pohoda, sociálna pohoda a životný stres. Druhé zistenie sa týka negatívnych vzťahov identifikovaných medzi zelenými plochami, najmä cintorínmi na jednej strane a sociálnymi patologickými javmi na strane druhej, čo je možné vysvetliť ani nie tak hlavnou funkciou týchto druhov zelených plôch, ale skôr ich nie najvhodnejším manažovaním v kontexte ich zakomponovania na priestorovej štruktúry mesta.

Článok sa pokúša vyplniť tri medzery vo výskume miest uvedené v úvodnej časti. Prvá sa týka zváženia širšieho súboru dimenzií kvality života, nielen fyzickej aktivity a ľudského zdravia, ktoré sú doteraz pri výskume mesta najčastejšie zvažované a hodnotené. Druhá sa týka skutočnosti, že získané výsledky sú použiteľné aj pre širšiu vzorku populácie, čo sa dosiahlo ako výsledok aplikácie regresnej metódy hodnotenia, pri zahrnutí premenných opísaných priamymi i nepriamymi dátami z reprezentatívnych vzoriek obyvateľstva 28 rôzne veľkých miest. Tretia „medzera“ sa týka účasti na vyplnení deficitu vedeckých štúdií zameraných na výskum významu zelenej infraštruktúry pre kvalitu života v mestách krajín strednej a východnej Európy.

Príspevok predstavuje všeobecnú bázu a inšpiráciu pre budúci hĺbkový kvantitatívny a kvalitatívny výskum, ktorý by sa mal zamerať na overenie a podrobné stanovenie povahy identifikovaných vzťahov medzi konkrétnym typom zelenej infraštruktúry a daným rozmerom kvality života.