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SPATIAL DISTRIBUTION OF NON-FINANCIAL HEALTH PROTECTION RESOURCES VERSUS THE STATE OF HEALTH OF THE POPULATION IN POLAND

PRZESTRZENNE ZRÓŻNICOWANIE ZASOBÓW OCHRONY ZDROWIA A STAN ZDROWIA LUDNOŚCI W POLSCE

Summary: The objective of the study is the analysis of the relations between the distribution of non-financial resources of health care protection at a regional level (voivodeships) and the state of health of the female and male population. The study refers, therefore, to a geographical concept, and the potential access to health service benefits. The following research hypotheses were formulated: (H1) non-financial resources are unevenly distributed among the regions; (H2) access to the health care services affects the state of health of females and males; (H3) there are time delays between the observed levels of accessibility and the state of health of the population. Relying on the Perkal method and on the analysis of the correlation between classes of accessibility of services and the state of health of females and males, described by the expected life span at the age of 30, 45 and 60, the truth of the postulated hypotheses was proved.

Keywords: access to health care services, the Perkal method, regional diversity.

Streszczenie: Celem badania jest analiza związku pomiędzy rozmieszczeniem niefinansowych zasobów ochrony zdrowia na poziomie regionalnym (województwa) a stanem zdrowia populacji. Badanie nawiązuje do potencjalnego dostępu do świadczeń. Postawiono następujące hipotezy badawcze: (H1) niefinansowe zasoby ochrony zdrowia są redystrybuowane nierównomiernie pomiędzy regionami; (H2) dostęp do świadczeń wpływa na stan zdrowia kobiet i mężczyzn; (H3) występuje pewne opóźnienie czasowe pomiędzy obserwowanym wskaźnikiem dostępności a stanem zdrowia populacji. Bazując na metodzie Perkala i analizie korelacji pomiędzy klaasami dostępności i stanem zdrowia populacji kobiet i mężczyzn, opisanym dalszą oczekiwaną długością życia w wieku 30, 45 i 60 lat, potwierdzono skonstruowane hipotezy badawcze.

Słowa kluczowe: dostępność usług zdrowotnych, metoda Perkala, regionalne zróżnicowanie.

Nine-tenths of our happiness depends on health alone.

Arthur Schopenhauer

1. Introduction

Equal access to high quality health benefits is one of the priorities of the systems of health protection, manifested in the aspiration to build an effective, complex and, at the same time, a just institutional system, providing the citizens with the possibility to choose health benefits depending on their justified health needs [White 2000; Williams, Torrens 1988]. The key notion is the wording "accessibility" itself, which in the economic literature is usually interpreted as the easiness in spatial interaction. Rigby [1978] and Whitelegg [1982] present the accessibility of hospital services from the point of view of the length of the journey of a patient or the distance covered by the staff of a health care institution. The methods of accessibility are described by, e.g. Nutley [1980], Jordan and Nutley [1993] and Pirie [1979].

A review of literature suggests that fair (equal) access to health benefits can be investigated in multiple aspects [Penchansky, Thomas 1981]. Peters [et al. 2008] lists four dimensions: *geographical accessibility, accessibility as a possibility to benefit from services of a definite type, accessibility in the financial aspect and susceptibility of the system.* Irrespective of the assumed notion, the subject of the analysis can be both the revealed access to health benefits, as the health benefits actually executed (an analysis of quantity, quality and structure of the benefits) or just, corresponding to the justified needs, the distribution of the available resources, which refers more to the notion of potential accessibility [Arredondo, Orozco 2008].

Hence, Guagliardo [2004] suggests a two-stage analysis of accessibility of benefits – first as a potential access to benefits, and in the second stage – as accessibility revealed on the basis of actually "produced" health benefits.

The resources of the health protection system can be broadly divided into financial resources, directly connected with the system of financing the benefits, and non-financial – including material resources (infrastructure, equipment) and personnel resources (doctors, nurses, lower-ranking staff). It seems that the spatial distribution of the non-financial resources is of a primary nature in relation to the non-financial resources, because the financial resources can be transferred solely to the existing medical institutions, employing the minimum number of personnel.

The methodology of the accessibility research includes a number of tools – from the simpler ones, based on rates concerning the number of benefit providers in relation to the size of a population – to more advanced ones based on an analysis of the density of a population [Nutley 1980; Jordan, Nutley 1980; Pirie 1979; Taylor 1999; Fransen et al. 2015; Guagliardo 2004; McGrail, Humphreys 2009; Rosenthal, Zaslavski, Newhouse 2005].

In Poland, monographs on the subject were published by Lijewski [1967], Dzieciuchowicz [1979], Namysłowski [1980], Kitowski [1988] and Gawryszewski [1989], Taylor [1999]. However, they were focused, first of all, on the analysis of accessibility as a spatial classification of the diversification of commuting to satisfy the social and living needs.

Independently of the assumed methodology, the key task in the research on accessibility is the identification of the regions which should be provided with more benefits (allocate larger amounts of the resources) and the ones in which increased accessibility will not be translated into an improvement of the state of health of a given population [Fransen et al. 2015]. Possibilities of implementation of corrective activities usually depend on the health protection system functioning in a given country – it seems that, in this respect, the budgetary system creates the greatest possibilities, through direct influence exerted on the institutions providing the health benefits.

The authors of the study set themselves two objectives:

1) the analysis of the geographic distribution of non-financial health protection resources, including the infrastructure and human resources on a regional (voivodeship) level;

2) the analysis of the relation between the existing non-financial health protection resources and the state of health of the population, also on a regional (voivodeship) level.

Therefore the study refers to the geographic conception of the potential accessibility to the benefits. It is assumed in this paper that the voivodeships of relatively higher material and human resources provide a better potential access to medical benefits. This was used as the basis for the following research hypotheses:

H1: the non-financial resources are unequally distributed among the regions;

H2: accessibility to health care benefits affects the state of health of females and males;

H3: there are time delays between the observed level of accessibility and the state of health of a given population.

The H1 hypothesis assumes that the non-financial health protection resources in Poland are unequally distributed – there are regions where the non-financial resources are poorer and regions well equipped in infrastructure, diagnostic tools and medical staff. This hypothesis is based on, among other things, the observations of Golinowska [2012], which emphasize that the geographic distribution of health protection units, especially hospitals, is unequal and historically conditioned and, most importantly, it does not reflect the health needs of the population. Verification of the H1 hypothesis allows to determine the regions characterized by the relatively worst and best access to health care benefits.

The H2 hypothesis assumes that there is a statistically significant linear relation between the state of health of females and males of 30, 45 and 60 years of age, measured with the expected lifespan rate and access to the health care benefits.

The relation was analysed in a regional (voivodeship) layout. The assumed research supposition that in those better equipped with the non-financial resources the state of health of the population is better as a result of the better access to the health care benefits.

The H3 hypothesis is a continuation of the H2 hypothesis and assumes that there occurs a time delay between the potential accessibility to health care benefits and the state of health of a given population. This means that the results of an improvement or deterioration of the accessibility to the healthcare benefits become apparent with a certain time delay. The data referring to the non-financial health care resources and the expected lifespan were analysed in the territorial perspective, corresponding to the NTS2 level (according to the CSO terminology). The data covering the years 2008-2013 were obtained from the Health Protection Information Systems Centre.

2. Methodology of research

The research hypotheses were verified with the use of the synthetic index method, one of the multidimensional comparative methods (MCM), allowing the linear ordering of objects. Introducing MCM into economic studies resulted in many different variants of synthetic indexes, such as the taxonomic development meter [Hellwig 1968], the Quality-of-Life Index [Strahl 2006] and the Quality-of-Life Meter [Zeliaś 2000], (comp. [Pociecha 1988]). Synthetic meters are the function aggregating partial information contained in individual meters of assessment, which allows the general assessment of the level of development of the examined phenomenon [Kuciński 2013].

In the presented study, a synthetic index was built with the use of the Perkal method. Despite the fact that the author himself focused on applying his method in his research on natural history, especially in anthropological research [Perkal 1953; Perkal 1960], later on it was also applied in the research on the classification of regions, or individual units on the basis of the criterion of the level of their development [Ilnicki 2009; Gierańczyk 2009; Namyślak 2007; Malkowski 2007; Karmowska 2011; Radwan & Paluch 2011; Malkowska 2015].

A synthetic meter of health care accessibility as a sum of standardized indexes, describing health care material and personnel resources was constructed in the discussed study. Diagnostic variables, characterizing availability of infrastructure, diagnostic equipment and medical personnel were selected:

X1 – number of physicians in hospitals;
X2 – number of specialist physicians (ambulatory patient care);
X3 – number of nurses in hospitals;
X4 – number of midwives in hospitals;
X5 – number of direct contact physicians;
X6 – number of nurses in ambulatory patient care;
X7 – number of hospital beds;

X8 – number of operating theatres;
X9 – number of echocardiograph units;
X10 – number of X-ray units;
X11 – number of USG units;
X12 – number of Pet scanning units;
X13 – number of CTG units;
X14 – number of MR units.

The above variables were selected using the expert method, though the accessibility criterion had also been taken into account. Based on the tools of descriptive statistics (Table 1) the set of potential diagnostic variables was verified in terms of their changeability and the degree of correlation in order to eliminate the ones in which the discriminatory abilities are unsatisfactory. Eventually, there were twelve variables selected for constructing the synthetic index.

Construction of a synthetic index with the Perkal method involves two stages:

1) standardization, as a result of which values of the variables are expressed in comparable units, which allows aggregation;

2) calculation of synthetic indexes, which can assume values from –3 to 3, whereas the relatively developed regions have an index value higher than 0, medium-developed – close to 0, and the regions relatively the least developed – lower than 0.

On the basis of the selected indexes, a matrix of observations was formed, describing each one of the 16 voivodeships (regions) with twelve selected indexes. The variables were analysed from a relative perspective, in order to eliminate the effect of the size of a voivodeship.

All variables are stimulants and the values of the indexes were standardized according to the formula [Malkowski 2007; Bem et al. 2016]:

$$p_{ik} = \frac{x_{ik} - \bar{x}}{S_k}, \tag{1}$$

where: $\bar{x}$ – average for the k-th variable; S_k – standard deviation of the k-th variable.

As a result of standardization, the indexes expressed with standardized units become comparable and can be aggregated. On the basis of the standardized units, the Perkal synthetic index W_p characterizing the level of accessibility of health care was calculated according to the formula:

$$W_P = \frac{1}{n} \sum_{i=1}^{k} p_{ik}, \tag{2}$$

where p_{ik} – standardized value of the j-th trait of the i-th object.

Categories of accessibility to health care were determined on the basis of the deviation of the results from the arithmetic average.

In the following stage of the research, an analysis of correlation, measured with the Pearson linear correlation coefficient between the values of the created synthetic index of health care accessibility and the expected further lifespan was carried out; separately for the female and male populations at 30, 45 and 60 years of age. Younger age groups were deliberately not taken into consideration, because the state of health of younger people is to a lesser extent connected with making use and accessibility of health benefits.

3. Results and discussion

Values of the Perkal index (W_p) for individual voivodeships were determined with the use of twelve selected diagnostic variables describing potential accessibility to health benefits. On this basis, making use of the determined divisions of changeability, categories of access to health care benefits in the system of voivodeships were determined. When interpreting the obtained results, one should remember that the values of a synthetic index measure the relative diversification in the access of individual voivodeships to non-material health care provision and cannot be interpreted as absolute values. Low W_p values only show that a given voivodeship has less than average resources at its disposal. Similarly, high values do not inform us about a very high level of development, but only about the fact that the potential access to benefits is significantly higher than in other voivodeships.

When analysing the categories of accessibility in the years 2008-2010, one can observe that accessibility to health care benefits (in 2010) was inadequate or adequate in comparison to the average values, in nine voivodeships; in four voivodeships it was assessed to be inadequate. In three voivodeships access to health care benefits is carried out at a higher level than the average and was assessed as good or very good (Table 1).

Analogical analysis was carried out for the data from the years 2011-2013 and it was observed that in 2013, though the number of voivodeships offering significantly lower (inadequate) access to the health care benefits decreased from four to three, at the same time the number of voivodeships characterized by a very good access to the benefits in comparison to the average, decreased (Table 2).

The results quoted above support the H1 hypothesis which emphasizes the unequal distribution of the non-financial resources. The research revealed that although there were inequalities in the potential access to health protection benefits during the examined period, distribution of those inequalities has quite a dynamic nature – in some regions the access to the benefits improved, whereas in a few others it deteriorated. When comparing the years 2008 and 2013, it is possible to observe that in five voivodeships the accessibility did not change, whereas if in the Mazowieckie and Podkarpackie voivodeships such stability can be recognised as positive, because of their very good or good level of access in comparison with other voivodeships, in other voivodeships – Dolnośląskie, Lubelskie and Śląskie – it means a lack of

Table 1. Perkal indexes and categories of availability of health benefits in individual voivodeships, 2008-2010.

Voivodeships	W_{P2008}	Category	W_{P2009}	Category	W_{P2010}	Category
Dolnośląskie	–1.5	adequate	1.13	good	–0.09	adequate
Kujawsko-pomorskie	–2.01	adequate	–0.77	adequate	–2.78	inadequate
Lubelskie	–0.24	adequate	1.45	good	2.15	very good
Lubuskie	–2.16	adequate	–1.78	adequate	–3.93	inadequate
Łódzkie	0.24	good	–0.69	adequate	0.7	good
Małopolskie	5.08	very good	1.35	good	4.15	very good
Mazowieckie	4.51	very good	6.75	very good	4.73	very good
Opolskie	–1.94	adequate	–2.83	inadequate	–1.86	adequate
Podkarpackie	2.22	good	–3.59	niedostateczny	0.35	good
Podlaskie	–0.41	adequate	3.71	very good	–1.15	adequate
Pomorskie	3.64	very good	1.47	good	1.71	good
Śląskie	–0.57	adequate	–1.00	very good	–2.7	inadequate
Świętokrzyskie	–1.84	adequate	0.98	good	–0.02	adequate
Warmińsko-mazurskie	–4.72	inadequate	–4.54	inadequate	–1.76	adequate
Wielkopolskie	2.62	good	1.21	good	3.32	very good
Zachodniopomorskie	–2.93	inadequate	–2.84	adequate	–2.88	inadequate

$W_{P2008} \geq 2.74$ – very good; $–0.01 < W_{p2008} < 2.74$ – good; $–2.76 < W_{p2008} < –0.01$– adequate; $W_{P2008} < –2.76$;
$W_{P2009} \geq 2.78$ – very good; $0.00 < W_{p2009} < 2.78$ – good; $–2.78 < W_{p2009} < 0$ – adequate; $W_{P2009} < –2.78$;
$W_{P2010} \geq 2.56$ – very good; $–0.003 < W_{p2010} < 2.56$ – good; $–2.57 < W_{p2010} < –0.03$ – adequate; $W_{P2010} < –2.57$.

Source: author's own study.

Table 2. Perkal indexes and categories of availability of health benefits in individual voivodeships, 2011-2013

Voivodeships	WP_{2011}	Category	WP_{2012}	Category	WP_{2013}	Category
1	2	3	4	5	6	7
Dolnośląskie	–0.06	adequate	–0.33	adequate	–1.46	adequate
Kujawsko-pomorskie	–3.62	inadequate	–2.95	adequate	–4.18	inadequate
Lubelskie	–0.25	adequate	1.38	good	–0.10	adequate
Lubuskie	–5.69	inadequate	–2.32	adequate	–3.35	inadequate
Łódzkie	2.96	good	–3.03	adequate	–5.01	inadequate
Małopolskie	2.88	good	2.70	good	–0.09	adequate
Mazowieckie	4.38	very good	7.48	very good	4.00	very good
Opolskie	–0.64	adequate	–2.44	adequate	2.05	good

Table 2, cont.

1	2	3	4	5	6	7
Podkarpackie	−1.03	adequate	2.58	good	2.75	good
Podlaskie	5.81	very good	−2.88	adequate	0.50	good
Pomorskie	4.91	very good	5.20	very good	0.75	good
Śląskie	2.47	good	2.54	good	−1.94	adequate
Świętokrzyskie	−2.64	adequate	1.22	good	4.46	very good
Warmińsko-mazurskie	0.02	good	−3.85	inadequate	4.19	very good
Wielkopolskie	−4.69	inadequate	−4.39	inadequate	−1.53	adequate
Zachodniopomorskie	−4.78	inadequate	−0.90	adequate	−1.05	adequate

$W_{P2011} \geq 3.53$ – very good; $0.02 < W_{p2011} < 3.53$ – good; $-3.53 < W_{p2011} < 0.02$ – adequate; $W_{P2011} < -3.53$;
$W_{p2012} \geq 3.35$ – very good; $0.02 < W_{p2012} < 3.35$ – good; $-3.35 < W_{p2012} < 0.02$ – adequate; $W_{p2012} < -3.35$;
$W_{p2013} \geq 2.84$ – very good; $-0.02 < W_{p2013} < 2.84$ – good; $-2.84 < W_{p2013} < 0.02$ – adequate; $W_{p2013} < -2.84$.

Source: author's own study.

upturn in those areas. In six voivodeships the access to benefits deteriorated. In three of them it had an inadequate level (Kujawsko-Pomorskie, Lubuskie and Łódzkie), and in three others it improved, in two of them to a very good level. Such deterioration can only be interpreted in relation to other units, hence either the amount of resources definitely diminished, or the non-financial resources in other voivodeships increased.

In the second stage of the research, the strength and the direction of the linear relationship was determined with the use of the Pearson linear correlation coefficient for the units creating the statistical community, described with the use of the Perkal indexes (in the years 2008-2013) and the rates of the further life expectancy of females (LEF) and males (LEM) in 2013.

On the basis of the correlation analysis it was observed that the access to health care is correlated with the life expectancy of females and males at the age of 30,45 and 60. The strength of the correlation is weak in the case of women, or medium for the male population. The study also revealed that the life expectancy in 2013 is the most strongly correlated – in the case of men – with the annual level of accessibility in the same year (2013), whereas in the case of males – with the accessibility observed in 2008 (the correlations are also statistically significant). The direction of the relation is clear – better provision with the non-financial resources, interpreted as a better access to health care benefits is correlated with longer life expectancy, which is one of the measures of the general health of the population. The strength of the correlation increases, for men and women, along with ageing (Table 4). *The above statements justify the assumption of the H2 hypothesis stating the existence of a linear relation between the state of health of the population and the level of accessibility to the health care benefits.*

Table 3. Correlations between the level of accessibility and life expectancy of females and males in the years 2011-2013

	LEM30	LEM45	LEM60	LEF30	LEF45	LEF60
W_{P2008}	0.610	0.668	0.792	0.416	0.411	0.441
t	2.881	3.356	4.850	1.714	1.687	1.839
p	0.012**	0.005***	0.000***	0.109	0.114	0.087*
W_{P2009}	0.195	0.253	0.447	0.347	0.375	0.429
t	0.744	0.976	1.872	1.382	1.513	1.776
p	0.469	0.345	0.082*	0.189	0.152	0.098*
W_{P2010}	0.417	0.469	0.597	0.459	0.448	0.452
t	1.718	1.987	2.786	1.931	1.876	1.897
p	0.108	0.067*	0.015**	0.074*	0.082*	0.079*
W_{P2011}	0.144	0.207	0.410	0.368	0.362	0.408
t	0.546	0.792	1.683	1.482	1.453	1.673
p	0.594	0.442	0.115	0.160	0.168	0.117
W_{P2012}	0.476	0.515	0.631	0.387	0.405	0.457
t	2.028	2.249	3.046	1.572	1.656	1.921
p	0.062*	0.041**	0.009***	0.138	0.120	0.075*
W_{P2013}	0.419	0.415	0.402	0.598	0.594	0.545
t	1.724	1.706	1.643	2.794	2.761	2.432
p	**0.107**	**0.110**	**0.123**	**0.014****	**0.015****	**0.029****

* Significance level α = 0.1, ** significance level α = 0.05, *** significance level α = 0.01.

Source: author's own study.

In reference to the H3 hypothesis, it is possible to say that the strength of this relationship is growing – along with the growth of the interval of time between the observed level of access and lifespan expectancy. However, this refers mainly to the male population. In the case of women, a similar relationship can be observed only if the year 2013 is excluded from the analysis – for the years 2008-2012 the correlation rates increase with the growing time span (Table 4). *The above observations allow for accepting the H3 hypothesis.*

4. Conclusion

In the presented study, distribution of the non-financial healthcare resources were analysed in terms of voivodeships. The formulated hypothesis concerning the unequal development of infrastructure, diagnostic equipment and personnel, interpreted as the potential access to healthcare benefits, have been confirmed. Moreover, although certain changes had been made in the level of accessibility during the analysed time span, they did not result in the compensation of the existing inequalities.

The analysis also confirmed that the state of health of a population, both female and male, is connected with the level of access to the healthcare benefits. The authors do realize that the potential access to healthcare benefits is only one and by no means the most important factor determining the state of health. Yet, the study confirmed that, along with ageing, the strength of the linear relation between accessibility of the benefit providers and the lifespan expectancy keeps increasing – particularly in the case of the male population.

The objective of the studies on the inequalities in healthcare is not only diagnosing the existing inequalities, but also promoting mechanisms of the allocation of the resources, taking into account the justified health needs of the local communities, which is one of the factors of a harmonious socio-economic development.

Further studies of the authors will include a widened presentation of the problem. It seems that an extended analysis should include control variables describing the socio-economic and demographic situation of individual voivodeships. The voivodeships of less favourable demographic structure are certainly characterized by higher healthcare needs, whereas a less advantageous economic situation may be a source of barriers in the access to financial benefits. Another stage of the research should also include an analysis of the revealed accessibility, or the real use of the benefits by patients in individual voivodeships. The results of the conducted research will allow a complex assessment of the effectiveness of the healthcare system and, potentially, the development of a proposition of mechanisms of allocation promoting equal access to the healthcare benefits.

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