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Detection of diseases on example of participation in selected health programmes – spatial approach

Abstract: Health care prophylaxis as an element of health prevention has a major impact on health status of individual unit and consequently on society. In Poland there are significant disparities in health status and quality of life appearing in each region. The main problem in this field is the shortage of the appropriate financial support for combating these disparities, as well as insufficient action of some regions in terms of the promotion of healthy behavior, resulting in, eg. by the lack of suitable mechanisms required for their implementation. The result of the analyses should indicate the similarities and differences that exist in Polish voivodships. These result are from the defining common features in relation to ongoing programmes of health care prevention, detection by their specific disorders, as well as appearing opportunities for further treatment of selected diseases. The study included preventive health programmes implemented at the macro level, although most attention was paid to the Lodz province, due to its unfavourable epidemiological and demographics environment – analysis for the Lodz voivodships will be carried out at the NUTS–4 level. In addition, the article focuses on estimating an unit costs measurement of health programmes implemented in the Lodz region (financed by the Provincial Government of Lodz), in terms of *per capita*, as well as, in incremental values – in this way was possible to identify health programmes that have proved to be the most expensive, as well as identify those that manifested the greatest savings, contributing to the relatively high level of health effects.

Keywords: health care, health care prophylaxis programmes, public health care management, spatial distribution

JEL: I11, I15, I18, H75

1. Introduction. Health programmes in view of health promotion

Inequalities in relation to health care can be understood as differences in various social groups, having a connection with their health. The background of health inequalities are economic factors, as well as social determinants. They are linked with such conditions as the place of birth, growing up, working and ageing. It can be noticed that the high socio-economic status (determined by income and education level), contributes to relatively better quality of life in health, especially in longer living (up to 5–10 years) of people eligible for this group, in comparison with low socio-economic status individuals (Cianciara, 2016: 189).

Inadequate health care defined by the occurrence of "health inequalities" among certain provinces, cannot be reflected by the insufficient implementation of activities in the field of health promotion, including the implementation of health programmes[1]. One of the executive functions of public administration is the providing of services. It indicates for the provision of public services including satisfying health needs of society, e.g. by maintaining hospitals or the implementation of health programmes and policy (Zieliński, 2001: 12–13, 27–42). The implementation of this function is achieved by the performance (in the field of health care) of local government units. Therefore health programmes executed by of the voivodship departments of the National Health Fund (NHS) are addressed to all the inhabitants of the region. The same principles can be introduced while implementing health programmes by the competent entities (*Programy zdrowotne*, 2016). Health programmes can be perceived as tools using to promote health activities.

The goal of public health adopted in most developed countries is to prevent early incidences of diseases, called civilizational. Civilizational diseases threaten the quality of life mostly and cause premature deaths. Among this group, one can enumerate diseases such as: diabetes, cancer, HIV/AIDS, obesity, tuberculosis, changes in the respiratory system, changes in the circulatory system, etc. In the struggle against this type of ailments components of health promotion are used, including health education and health prevention policy (Suchecka, Twardowska, 2016: 120–121).

The duties of health promotion consist mainly of initiating, organising, implementing, coordinating and supervising the activities of health and education aimed at shaping attitudes and health behaviours. The tasks are executed by, for example:

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[1] For the purposes of the article the author uses the term health programmes for the programmes of health policy and health programmes.

1) determining courses to consult citizens with the influence of hazardous factors to their health;
2) popularising the principles of healthy nutrition, hygiene, first aid;
3) popularising citizens' activity for the health benefits;
4) providing information and advices on taking care of the health and preventive health actions;
5) providing information on prevention of infectious diseases;
6) distribution of educational materials;
7) cooperation with media on health promotion;
8) assessing and providing guidelines for entities that operate in the field of health care (Mamos, 2016: 168).

One of the instruments that are used to implement the tasks in the field of promotion and disease prevention programmes are health programmes. Until January 1st 2015 the definitions of health programme and programme of health policy were synonymous. According to the amendment of the Act from August 27th 2004 on Health Care Services Financed from Public Funds (Ustawa z dnia 27 sierpnia 2004 r. o świadczeniach opieki zdrowotnej finansowanych ze środków publicznych), some changes on development, implementation, execution and financing were introduced. Since January 1st 2015, health programmes are developed, implemented, operated and funded by NHS, whereas health policy programmes can be developed, implemented, operated and funded by the ministers and local government entities. However, the definition of both notions is quite the same and sounds as follows: "health programmes (policy) are planned and intended actions in the field of health care. They detect and implement specific health needs, with the aim of improving the health of a specific group of beneficiaries. Health programmes are financed from public funds" (Suchecka, Twardowska, 2016: 122).

Scope of the study of programmes is divided into 3 categories, each dedicated to the health prevention. The primary category should be understood as prevention at the emergence of the disease, or changes in behaviour relating to the health or the social environment, which may have a negative impact on health. The secondary category focuses on stopping the disease by diagnosis and early intervention, while the third degree category concentrates on the prevention of recurrence of disease, disability and quality of life improvement through treatment (Panasiuk, 2011).

2. Health programmes carried out in Poland

Within the main axiom of health policy on public health a National Health Programme (NHP) was established, which is formed in every 5 years. The basic condition for achieving goals of the NHP is an active contribution of different authorities, such as: government, non-governmental organisations, local governments,

local communities, as well as the citizens. The current guidelines for public health policy are included in the National Health Programme perspective for 2016–2020. The strategic goal established in the perspective concerns: extension of healthy life of Poles, the health related quality of life and the reduction of society's health inequalities. As the operational objectives, the NHP 2016–2020 introduced:

1) improving diet, nutritional status and physical activity of the society,
2) prevention and solving problems related to addiction to psychoactive substances and behavioural addictions,
3) improving the mental welfare of society,
4) improving procreative health,
5) reduction of health risks resulting from the physical, chemical and biological properties in the environment, the workplace, housing, recreation and learning,
6) the promotion of healthy and active ageing (*Narodowy Program Zdrowia 2016–2020*, 2016).

These aims are achieved through of health programmes. However, these goals are the objectives set by the Ministry of Health and concern citizens of all voivodships. Ministry of Health manages and administrates on a national scale the 14 programmes listed in table below, such as:

Table 1. Health programmes administrated by Ministry of Health

List of health programmes	
– Depressive disorder prevention programme for children and adolescents aged 11–13 years; – The programme of prevention and early detection of type 2 diabetes (those aged 45–64); – The health programme for early detection of dementia or other cognitive disorders; – The health programme for early detection of colorectal cancer; – The health programme of early detection of neoplastic lesions of the upper respiratory tract for people aged 45–65 years; – Programme of prevention of amblyopia – early detection of vision and strabismus in children aged 4 and 5 years; – Preventive action for early detection of glaucoma;	– Preventive action for healthy woman – breast cancer prevention; – The programme of early detection and prevention of posture defects among children of school age; – The screening programme for allergies for school-age children; – The screening programme for hearing for school-age children 6–12; – The programme for early detection of infection with human papilloma virus HPV for women aged 30–65 years; – The programme for early detection of lung cancer for people aged 50–74 years; – The programme for early detection and prevention of cardiovascular disease for people aged 30–55 years.

Source: *Wykaz programów*, 2016

Currently in Poland, carrying out health programmes is based on article 48 of the Act of August 27th 2004 on Health Care Services Financed from Public

Funds. There are only two exceptions from that rule and these programmes a characterised by the long-term perspective:

1) National Programme for the Development of Transplantation Medicine, which is a multiannual programme for the period 2011–2020, based on Resolution No. 164/2010 of the Council of Ministers from October 12th 2010;

2) National Programme Against Cancer, which would be implemented under the Resolution No. 208 of the Council of Ministers from November 3rd 2015 on establishing a multiannual programme for the years from 2016 to 2024 (*Akty prawne*, 2016).

Apart from mentioned above two long-term programmes, the Polish Health Ministry provides services within programmes financed from public funds, in activities relating to the promotion and health prevention, such as:

1) prevention of tobacco-related diseases including chronic obstructive pulmonary disease (POCHP),

2) treatment of children in coma,

3) prenatal tests,

4) prevention of cervical cancer,

5) prevention of breast cancer,

6) orthodontic care for children with congenital craniofacial (Rozporządzenie Ministra Zdrowia z dnia 6 listopada 2013 r.).

Community campaigns on the health of the inhabitants of certain regions, as well as health policy programmes executed by the voivodships, counties and municipalities authorities are diverse from each another. Every entity has dedicated programmes, which in some regions have similar main objectives.

3. Health policy programmes realised in the Lodz region

The municipality, poviat and voivodship are combined by the tasks described in the Act from August 27th 2004 on Health Care Services Financed from Public Funds. The rules implies that the responsibilities of local government units (see: Ustawa z dnia 8 marca 1990 r. o samorządzie gminnym, Ustawa z dnia 5 czerwca 1998 r. o samorządzie powiatowym, Ustawa z dnia 5 czerwca 1998 r. o samorządzie województwa) include: development, implementation and evaluation of the effects of health programmes resulting from the identified health needs and the health of citizens. Estimating the level of effectiveness is one of the last stages for monitoring of the implementation of the health programmes. Therefore, it is very important to select an appropriate tools and measures for verification of health care programmes already at the design stage.

However, when local governments design a cost-effective programme of preventive health care, they face other problems. It is the overall financial situation resulting from insufficient and inadequate level of resources especially income. This makes any decision on funding a health programme difficult, forcing local governments to enter into partnerships, and thus implies co-operation between districts located within a voivodship. Poviats – the local government entities, experience discrimination (especially at the level of sharing expenses) by coercion of passive participation in creating health programmes (programmes with ended implementation period), which is in fact due to inadequate efficiency of more expensive health programmes (Kłosowska et al., 2013: 4). An example of such a partnership for the implementation of health care programmes is Lodzkie Voivodship.

4. Aim of the research. Methodology and methods

The main purpose of the presented analysis focus on the establishing of similarities and differences that exist in Polish voivodships by their ability to identify common features in relation to the ongoing programmes of health care prevention, detection by specific disorders, as well as opportunities for further treatment of selected diseases. The study included preventive health programmes implemented at the macro level, although as it was already mentioned, most attention was paid to the Lodzkie province, due to its unfavourable epidemiological and demographics environment. Detailed analysis Lodzkie voivodships was carried out at the NUTS-4 level. Moreover, a secondary objectives of the paper focus on estimating the unit costs measures of health programmes implemented in the Lodz region (and financed by the Provincial Government of Lodz), in terms of *per capita*, as well as, in incremental approach. This combinations of research directions allowed firstly to indicate similarities/dissimilarities in spatial distribution of health care programmes performances, and secondly to assess the cost-effectiveness of selected initiatives. As a result it was possible to indicate the health programmes that proved to be the most expensive, and the most economical (that generates a relatively high level of health effects).

4.1. Methodology and methods

For similarity diagnosis at the NUTS-2 aggregation level, agglomerations methods were used. Most frequently used techniques of multivariate statistics analysis concerns the cluster analysis, which combines multi-dimensional objects. It is a tool for exploratory data analysis that aims to arrange objects in homogenous

groups, in such a way that the degree of association of objects within a cluster is the largest, and the objects from other clusters as small as possible (*Analiza skupień*, 2011). In other words, cluster analysis or clustering is a technique that allows dividing a set of objects into groups, forming clusters in such a way that objects assigned to the same cluster are more alike than those in other subgroups (see: Stanisz, 2007). The cluster analysis is based on distance function; most often in the analysis of similarity the Euclidean approach. Euclidean distance is a geometric distance function attributed to the multidimensional space. It is calculated according to formula:

$$d(o_i, o_j) = \sqrt{\sum_{k=1}^{m}(x_{ik} - x_{jk})^2} . \tag{1}$$

On the basis of the distance functions values, it is possible to group objects into homogenous clusters and for that purpose a several techniques can be used, for instance: single, full or Ward's binding. Ward's method is most commonly used in regional analysis and allows estimating the distance between clusters basing on the variance values. It intends to minimise the sum of squared deviations of any two clusters that can be formed at any stage. This method is considered as very effective, but tends to form clusters of small size (*Metoda Warda*, 2011).

Spatial distribution can be also tested for spatial autocorrelation. In case of determining the structure of the area and studying its development and growth it must be remembered that areas depend on the spatial interactions between neighbouring objects. Here a problem arises, related to the problem of multi-directional spatial relationships, which can be solved using a spatial weights matrix **W** that describes the connection scheme between locations. Properly identified the degree of contiguity or the scheme of adjacent (e.g. queen, bishop, rook, *k*-nearest neighbours) affects the reliability of the results. The most commonly used approach for constructing the spatial weight matrix **W** is based on 1st order queen contiguity matrix (Suchecki, 2010: 105), although, as literature indicates, there is no one competent approach towards the construction of spatial relation. For measurement of spatial autocorrelation, two types of information are compared: the similarity of observation (as to the value) and the similarity of location – these characteristics reveal the differences between clustering and spatial autocorrelation approaches.

The results of spatial autocorrelations analyses are summarised by the global and local values of Moran's *I* statistics. Having estimated the statistics for significance of global pattern of autocorrelation, it is possible to investigate further the inner association between analysed regions/locations, using local indicators of spatial association (LISA) (see: Anselin, 1995). For global autocorrelation a Moran's *I* statistics is calculated, according to formula:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} = \frac{\mathbf{z}^{\mathrm{T}}\mathbf{W}\mathbf{z}}{\mathbf{z}^{\mathrm{T}}\mathbf{z}}. \tag{2}$$

Variants of spatial autocorrelation (positive or negative values of Moran's *I* statistics) give a certain answer concerning clustering of similar or quite opposite values of analysed variables, within assumed scheme of adjacency (defined by the spatial weight matrix). This approach differs from agglomeration clustering, which indeed indicates similar/opposite object (not necessary located in geographical space). For global and local spatial autocorrelation, the most important factor that allows for forming clusters is the neighbouring effect which in accordance with the Tobler's law (Tobler, 1970: 234–240) assumes that everything is linked together, but closer objects are more dependent on each other than the distant ones.

4.2. Estimating the cost-efficiency of health programmes

There can be many methods for estimating cost-efficiency of a health initiative listed (see: Suchecka, 2016) that can be used in assessment of health programme. Depending on the measuring scale of inputs and outputs described by the programme, on can distinguish methods focusing on one hand on health benefits, utility or effectiveness. The most popularly applicable variation of the assessment techniques is the Cost-Benefit Analysis (CBA), which takes into account so-called external costs. CBA is a method evaluating the effectiveness of projects and investments including the total expected costs and achieved benefits, both expressed in monetary units. This analysis responds to a question about the relevance of incurred expenses, in order to obtain appropriate net benefits, thus contributes to making decisions about allocating resources needed to implement the health program. The result indicates the net benefits – a difference between total benefits and total costs, as follows:

$$\underset{\text{(net benefits)}}{CBA} = \underset{\text{(total benefits)}}{\sum B} - \underset{\text{(total cost)}}{\sum C}. \tag{3}$$

or in incremental approach (Suchecka, Twardowska, 2016: 139):

$$CBR\ INC = \frac{\Delta C}{\Delta B} = \frac{C_A - C_B}{B_A - B_B}. \tag{4}$$

5. Data bank and results of the analyses

The data sample consisted of information received from data banks of Ministry of Health, National Health Fund and local government of Lodzkie province for years 2010–2015. For the multidimensional analysis the data were restated for comparability purposes using the procedure of standardisation. For the agglomeration techniques and clustering the Euclidean distance were used, followed by the Ward's binding method – it was assumed that the biding distance amounted to 20% of the total distance between clusters.

5.1. Spatial distribution analysis

On the basis of conducted analysis, it was possible to indicate similarities between provinces in Poland for two randomly selected health programmes in 2015 (mammography and cytology health care programmes), taking into account determinants of the programmes such as: diagnosis methods, severity level of symptoms, and number of cases.
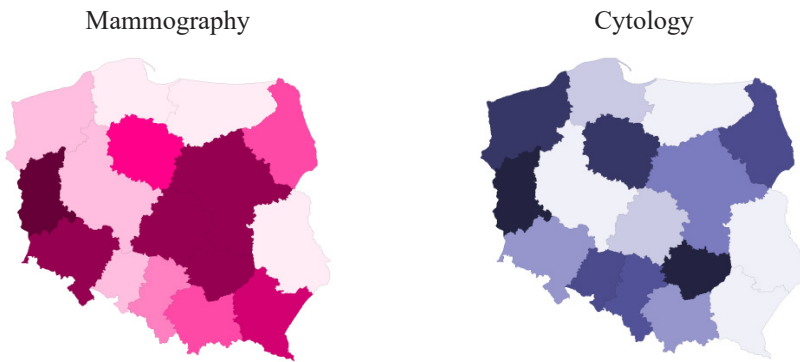
Legend: colours indicate a group of similarity.

Figure 1. Similarities between voivodships for two selected health care programmes in 2015

Source: own elaboration based on Ministry of Health database

In 2015, as far as the mammography programme is concerned the Lodzkie voivodship was performing similarly as Mazowieckie, Malopolskie and Dolno-slaskie. Looking at the other widely applicable health programme: cytology; here the Lodzkie did not performed alike Mazowieckie – the estimates indicated similarity with Pomorskie. What should be also noted is the fact that the regions located in the Eastern part of Poland did not formulated homogenous clusters, and

in some cases, location generally recognised as "poor" performed different as it was expected.

Next, the attention was paid on coverage of population (in %) with programmes for breast cancer and cervical carcinoma in Lodzkie voivodship in 2015. For this purpose quantile maps were generated and existence of spatial autocorrelation was verified. Although, spatial distribution maps indicated possible dependency, the result of Moran's *I* statistics, unfortunately, did not confirm the presumptions (both calculated global statistics demonstrated lack of significance).
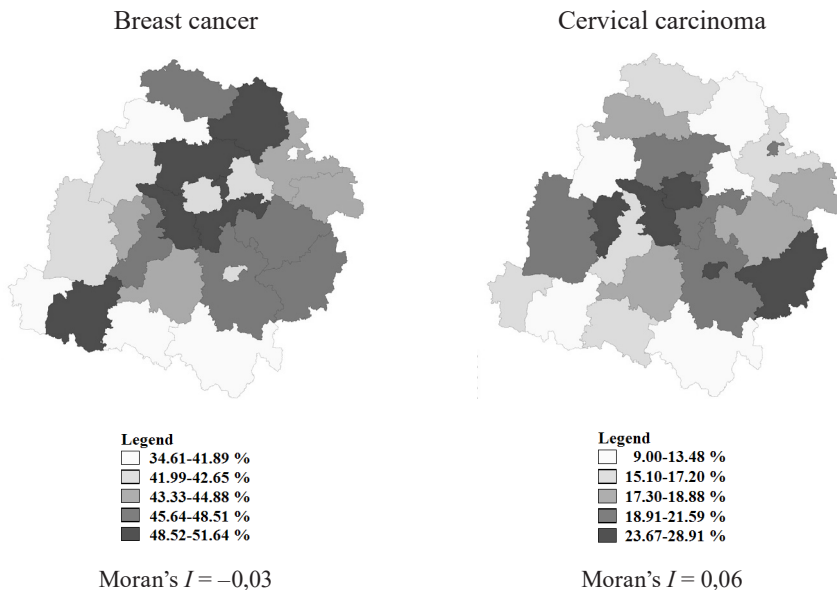

Breast cancer

Cervical carcinoma

Legend
☐ 34.61-41.89 %
☐ 41.99-42.65 %
▨ 43.33-44.88 %
▩ 45.64-48.51 %
■ 48.52-51.64 %

Legend
☐ 9.00-13.48 %
☐ 15.10-17.20 %
▨ 17.30-18.88 %
▩ 18.91-21.59 %
■ 23.67-28.91 %

Moran's $I = -0{,}03$

Moran's $I = 0{,}06$

Figure 2. Spatial distribution of coverage of population [in %] in 2015 in Lodzkie

Note: Moran's global autocorrelations were insignificant for p-sign = 0.05.

Source: own elaboration based on Ministry of Health database

5.2. Financial analysis

Lodzkie province supports many health programmes (table below). It was possible to indicate which of them were relatively affordable or expensive (*per capita* values) and comparing year to year (for incremental levels) to point out the cost of including next patient in the programme.

The cost *per capita* indicated that in the period of analysis the most expensive programme was a one for early detection of colorectal cancer – a unit cost of a benefit amounted above 300 PLN per patient.

Table 2. Health programmes conducted in Lodz province in years 2010–2014 – cost of a benefit *per capita* and incremental values (in PLN)

Programme	Levels of cost								
	per capita					Incremental			
	2010	2011	2012	2013	2014	2011/10	2012/11	2013/12	2014/13
Depressive disorder prevention programme for children and adolescents aged 11–13 years	133.87	147.54	124.86	129.20	123.63	228.00	570.95	1 830.00	115.47
The programme of prevention and early detection of type 2 diabetes (those aged 45–64)	88.14	77.12	34.81	51.65	N/D	163.16	–28.57	2.31	51.65
The health programme for early detection of dementia or other cognitive disorders	193.95	256.59	246.66	N/D	N/D	1 634.50	297.40	246.66	N/D
The health programme for early detection of colorectal cancer	350.00	350.00	N/D	N/D	313.86	350.00	350.00	N/D	313.86
The health programme of early detection of neoplastic lesions of the upper respiratory tract for people aged 45–65 years	45.00	45.00	43.89	N/D	N/D	N/D	46.14	43.89	N/D
Programme of prevention of amblyopia – early detection of vision and strabismus in children aged 4 and 5 years	28.02	54.55	51.80	49.24	49.83	459.13	61.36	N/D	57.24
Preventive action for early detection of glaucoma	68.18	79.37	82.04	N/D	N/D	87.41	58.92	82.04	N/D
Preventive action for healthy woman – breast cancer prevention	64.71	91.69	70.94	N/D	N/D	113.73	–84.68	70.94	N/D
The programme of early detection and prevention of posture defects among children of school age	N/D	N/D	238.33	N/D	N/D	N/D	N/D	238.33	N/D
The screening programme for allergies for school-age children	N/D	N/D	82.09	N/D	N/D	N/D	N/D	82.09	N/D
The screening programme for hearing for school-age children 6–12	N/D	N/D	53.89	40.03	39.82	N/D	N/D	38.95	39.20
The programme for early detection of infection with human papilloma virus HPV for women aged 30–65 years	N/D	N/D	N/D	157.15	150.67	N/D	N/D	N/D	142.15

Programme	Levels of cost								
	per capita					Incremental			
	2010	2011	2012	2013	2014	2011/10	2012/11	2013/12	2014/13
The programme for early detection of lung cancer for people aged 50–74 years	N/D	N/D	N/D	N/D	289.44	N/D	N/D	N/D	N/D
The programme for early detection and prevention of cardiovascular disease for people aged 30–55 years	N/D	N/D	N/D	N/D	145.46	N/D	N/D	N/D	N/D

Source: own elaboration based on Ministry of Health database

Trying to establish the most affordable health programme administrated by the local governments would be hard in terms of *per capita* values. That is the reason why in health care programmes effectiveness assessment an incremental approach is necessary. The estimates present clearly, which programmes generate lesser or higher cost when extending the list of patients. For instance, looking at the comparison of the years 2012 and 2013 another patient added into programme for depressive disorder prevention programme for children and adolescents aged 11–13 years would consume a volume of cost in an amount of 1830 PLN. On the other hand taking into account the health programmes for prevention and early detection of type 2 diabetes (those aged 45–64) and preventive actions for healthy woman – breast cancer prevention in years 2011 and 2012, adding another patient on the list resulted in lowering the amounts of cost by 28.57 for the first, and by 84.68 for the second mentioned. The incremental analysis supports in many cases the decision-making better, however its construction requires at least operating of a programme in two periods of time. The *per capita* turned to be bereft of this limitation.

6. Conclusions and final remarks

For considered and investigated randomly programmes it was possible to indicate the similarities in the level of detection of diseases – this allowed taking the analysis further, and for the NUTS 2 level to conduct the multivariate analysis, which result could be observed on the clusters maps. At the same time, investigating deeply it was not possible to identify any spatial autocorrelations pattern – for NUTS-4 level in Lodzkie province. The rates of coverage were diverse among poviats in Lodzkie voivodships, what further could influence the rate of diseases detection.

Incremental values were seldom much higher than *per capita* costs of a programme; that could indicate the shadow price of the programme. The Cost-Benefit

Analysis and incremental CBA arguments for the use of quantitative analysis in health care sector.

In 2017 the financing scheme is about to be changed, due to possibilities of refund for financing of health care programmes, which could encourage local authorities to expand the range and variety of offered benefits. Undoubtedly, the conclusion from the analysis supports the use of the variety of quantitative methods in supporting decision-making from the regional and structural perspective.

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Wykrywalność chorób na przykładzie uczestnictwa w wybranych programach zdrowotnych – analizy przestrzenno-czasowe

Streszczenie: Profilaktyka opieki zdrowotnej, wchodząca w skład prewencji zdrowotnej, ma bardzo znaczący wpływ na stan zdrowia jednostek, a w konsekwencji na społeczeństwo jako całość. W Polsce zauważa się znaczne różnice w stanie zdrowia i jakości życia w poszczególnych regionach. Głównym problemem jest niedobór właściwego wsparcia finansowego w niwelowaniu różnic, jak również niewystarczające działania niektórych regionów pod względem wspierania zachowań prozdrowotnych, np. brak odpowiednich mechanizmów przeznaczonych do realizacji zakładanych celów. Analizy wskazują na podobieństwa i różnice, które można zaobserwować w poszczególnych województwach w Polsce. Wynikają one z określenia wspólnych cech w odniesieniu do aktualnie realizowanych programów profilaktyki opieki zdrowotnej, wykrywania specyficznych symptomów chorób, a także pojawiających się szans w ich dalszym leczeniu. Badaniem objęto profilaktyczne programy zdrowotne realizowane na poziomie makro, jednakże najwięcej uwagi poświęcono województwu łódzkiemu, ze względu na niekorzystne środowisko epidemiologiczne i demograficzne – analizy dla województwa łódzkiego zostały przeprowadzone na poziomie NUTS–4. Ponadto artykuł skupia się na szacowaniu jednostkowych kosztów pomiaru programów zdrowotnych realizowanych w regionie łódzkim (finansowanych przez samorząd wojewódzkiego łódzkiego) w kategoriach *per capita*, a także w wartościach pierwotnych. Dzięki temu możliwe było wskazanie programów zdrowotnych, które okazały się najbardziej kosztowne, jak również tych, które cechowały się największą oszczędnością, przyczyniając się do stosunkowo wysokiego poziomu efektów zdrowotnych.

Słowa kluczowe: opieka zdrowotna, programy profilaktyki zdrowotnej, zarządzanie w publicznej opiece zdrowia, zróżnicowanie przestrzenne

JEL: I11, I15, I18, H75