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Research of the Changes of Morbidity of Rhinitis Allergica in Hungary between 1999 and 2007 by applying the Regional Inequality Indexes

ABSTRACT

The allergen effect that is due to the quality changes of the atmosphere can locally be observed in the respiratory tracts. The current research is focused on the rhinitis allergica which negatively influences the quality of life of the individual as well as it hinders the school activity and work (SZEINBACH, S.L. et al. 2007 and 2005). The basic problem is that the morbidity of the allergy induced respiratory disease has been growing for almost 50 years in Hungary and, as a consequence, the social economical burden has also been growing.

The areal pattern of the morbidity of rhinitis allergica in Hungary is based on the database of the Korányi Institute of Tuberculosis and Pulmonology. The aim of study is to determine the areal differences of Hungary between 1999 and 2007. The areal difference is examined through regional inequality indices.

Keywords: rhinitis allergica, hay fever, spatial differences

AZ 1997-2007 KÖZÖTTI RHINITIS ALLERGICA MEGBETEGEDÉSEK TERÜLETI KÜLÖNBSÉGEINEK VIZSGÁLATA MAGYARORSZÁGON TERÜLETI EGYENLŐTLENSÉGI INDEXEK ALKALMAZÁSÁVAL

A ma már hazánkban is népbetegségnek számító allergia egyes típusai a levegőminőség változásainak hatására légúti reakciókat váltanak ki. Jelen tanulmányunkban egy ilyenre, a rhinitis allergicára fókuszálunk, amely rontja az életminőséget, negatívan befolyásolja az egyén tanulási-, illetve munkaképességeit (SZEINBACH, S.L. et al. 2007 és 2005). Alapvető jelenség, hogy az elmúlt 50 évben Magyarországon az allergiás megbetegedések okozta légzőszervi problémák előfordulása folyamatosan növekszik, melynek következtében a negatív társadalmi-gazdasági hatások is erősödnek.

A magyarországi rhinitis allergica megbetegedések területi különbségeinek vizsgálatát az Országos Korányi Tbc és Pulmonológiai Intézet adataira alapozva végeztük el. Kutatásunk alapvető célja

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a morbiditás területi különbségeiben meglévő eltérések feltárása volt az 1999-2007 közötti időszakra vonatkozóan, területi egyenlőtlenségi mutatók alkalmazásával.

Kulcsszavak: rhinitis allergica, területi különbségek, szénanátha

1. INTRODUCTION

'We cannot say that an environment is good or bad in general since if I take a fish out of the water and put it on the nicest grass it will not be a good environment for the fish. However, if I put a rabbit into the sea it will not be a good environment for it. There is no good or bad environment, only that is good what we are tailored for.''

(Albert Szent-Györgyi)[2]

From the second part of the 20th century the quality changes of the physical environment deeply influenced both the social and cultural environment of the people, thus affecting their lifestyle as well (Vitrai J. – Vokó Z. 2004). The state of health of the population is primarily determined by the interactions, as a result of which the biological-chemical contents of the environment are changed. The contact with the troposphere plays an outstanding role since the negative effects can be observed mainly in the respiratory tracts. The main forms of incidence of allergic diseases caused by pollens are asthma bronchicale, rhinitis allergica, conjuctivis allergica, dermatitis atopica (Ember I. 2007, PATAKI G. 2003). In case of genetic conditions (the existence of an atopy), after allergen exposure, sensitive reactions develop in the organization, and the symptoms of the allergic illness appear. The pollen induced allergic rhinitis counts as an endemic in the countries of the European Union according to the morbidity data of the institutes of tuberculosis and pulmonology. According to the estimated data of the WHO almost 400 million people struggle against the symptoms of allergic rhinitis which has also been identified as a risk factor of the asthma of allergic origin (Pawankar, R. – Canonica, G. W. – Holgate, S. T. – Lockey, R. F. 2011).

The aim of my study is to research the regional differences of the pollen induced rhinitis allergica. The heterogeneity of the states of illness or health have been characterised by inequality indexes and I have also examined whether the regional differences of the counties as to rhinitis allergica are stationary in time. The basic direction of the changes of time has been stated on national level and I have demonstrated the results with the help of diagrams.

2. DATA AND METHODS

2.1. Characteristic Features of the Database

The global database of the health topics at international level is registered by WHO and within this the database of illnesses of allergic origin are concentrated at WAO. Because of the need of the unified data registration the WHO has introduced the system of the International Statistical Classification of Diseases and related Health Problems (BNO), however, even this way the morbidity statistics of allergic diseases are difficult to analyse, since it is not compulsory to report the allergy induced

[2] Szent-Györgyi A. 1975: *Az élet jellege.* Magvető Kiadó, Budapest. p. 71.

illnesses. Due to this fact the result of the estimation of the number of illnesses is uncertain and the value of the hidden morbidity is high.

My research did not aim at examining the hidden morbidity. The analysed data include the number of individuals who are involved in pulmonological treatment, thus they do not reflect the actual morbidity. The rhinitis allergica accompanied by respiratory symptoms as an independent statistical category has been registered in the annual registry of the institutes of pulmonology in Hungary since 1988. The present database of the frequency of rhinitis allergica in Hungary has been co-ordinated by the National 'Korányi' Institute of Pulmonology and Tuberculosis, and the data of morbidity as well as the incidence of the demographical, health informational database of the Central Bureau of Statistics are also based on it (Pataki G –Megyesi Á– Fehér I. 2001, 2002,2003; Jónás J. – Barsiné F. K. 2004, 2005,2006, 2007, 2008).

I started my research with data from 1999 as the uniform health care electronic documentation, i.e. the reliable database has been available since that time. It was necessary to choose 2007 as the closing point for two reasons. On the one hand the patients having respiratory allergic diseases were motivated to attend the dispensary regularly. Due to the examination stated by the professional protocol the allergens causing symptoms could be localised, furthermore the registration and attendance was a pre-requisite of receiving the high level price support of medicines. On the other hand the medicines applied for the group of illness have not been supported and most of the medicines have been available at the pharmacies without a prescription of the doctor. In addition to it patients had to pay for the medical treatment from 15th February, 2007 to 31st March, 2008.

The data have been systematised, processed and statistically analysed by version 15 of statistical software group of SPSS (Statistical Package for Social Sciences) for Windows. I have used the administrative map of Hungary to show the connections through GIS methods which has been presented by module 10 of ArcMap of the ArcGis programme group.

2.2. The Indexes Characterising the Geographical Structure of Rhinitis Allergica

Due to the air pollution of anthropogenic origin regional differences are formed, as a result of this the effect of the changes of the environment influences the health showing a pattern in space (Uzzoli A. 2001, Szauer E. 2005, Vitrai J. 2008, Kajtor E. 2010).

Regression analysis has been applied in order to determine the tendency of time series that are of outstanding importance for the research. The differences of the morbidity of rhinitis allergica, causing respiratory symptoms related to the period of time between 1999 and 2007, which can be observed in space, have been examined through the analysis of the following regional inequality indexes.

Centroid of illnesses

The qualitative description of the examined social phenomenon's structure can be started with determining the *concentration index (K)* that represents simplest the concentration measure of the phenomenon.

$$K = \sum \left(\frac{x_i}{\sum x_i} \right)^2,$$

where x_i is the value of the i^{th} part of area in the formula calculating by the reciprocal of the sample size.

The next territorial inequality index is the centre of mass (centroid) of illnesses. The application of this is favourable because it represents not only the territorial concentration but also the sign of the difference. In order to calculate this, a practically chosen point of reference should be used, where in the course of the research I have chosen the position of our capital, Budapest.

$$S_x = \frac{\sum f_i x_i}{\sum f_i} \qquad S_y = \frac{\sum f_i y_i}{\sum f_i}$$

S_x and S_y in the formula are the coordinates of the centre of mass, x_i and y_i are the coordinates of the basis points and f_i denotes the mass of the basis points (Nemes Nagy J. 2005b). The calculations consist of the absolute volume i.e. the number of all rhinitis allergica illnesses.

Hoover index

The Hoover index is usually used in current area researches that ensure the mutual comparison of the territorial distribution of social phenomena and the population. If the calculation of the Hoover index is for more dates then the calculated values of the index show whether the regional difference of the examined process increases or it moves on equalization.

$$H = \frac{1}{2} \sum \left| x_i - y_i \right|$$

The applied notations in the formula: x_i is the percentage of the i^{th} part of area out of the volume of rhinitis allergica and y_i is the percentage of the i^{th} part of area out of the number of population.

Standard distance

Determining the centre of mass with time series is well usable at the analysis of territorial ratio shifts. At the same time if a structural inversion occurs because of the course of phenomenon, its summation shift cannot be detected at determining the centre of mass due to the symmetric change. The analysis of standard deviation is suited for further tests in case of such a growth. By calculating the index the smaller deviation of distance of basic points from the centre of mass the more characteristic it is that the phenomenon is concentrated around the centre of mass.

$$D = \frac{\sqrt{\sum f_i \left((x_i - x)^2 + (y_i - y)^2 \right)}}{\sum f_i}$$

Where x_i and y_i are the coordinates of the points of reference, x and y are the coordinates of the centroids and f_i denotes the weights of the single points (Nemes Nagy J. 2005b).

Weighted deviation and weighted relative deviation

The index is applicable to characterize the change in time of spatial inequalities of a social-economical phenomenon by calculating the average of the squares of differences between the single values and the weighted average.

$\sigma = \sqrt{\frac{\sum_{i=1}^{n} f_i (y_i - \bar{y})^2}{\sum f_i}}$, where $y_i = \frac{x_i}{f_i}$ is the value of the specific index in the i^{th} territory unit and $\bar{y} = y_i$ is the weighted average.

The weighted relative deviation shows the deviation of the data compared to the weighted average of the examined data.

$V = 100\left[\frac{1}{\bar{y}}\right]\sqrt{\frac{\sum (y_i - \bar{y})^2 f_i}{\sum f_i}}$, where $y_i = \frac{x_i}{f_i}$ is the value of specific index in the i^{th} territory unit and $\bar{y} = y_i$ is the weighted average.

Territorial autocorrelation

The observation unit is the complex of elements related to towns and counties the data of which are aggregated and have been produced as by-products of administrative processes. The Moran index shows whether the examined unit's value is similar or different from the neighbouring area.

$I = \frac{N}{\sum_{i=1}^{N}\sum_{j=1}^{N} D_{ij}} \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} (x_i - \bar{x})(x_j - \bar{x}) D_{ij}}{\sum_{i=1}^{N} (x_i - \bar{x})^2}$, where $(x_i - x)(x_j - x)$ is the product of the differences between the area units and the averages, D_{ij} is the general element of the neighbourhood matrix and N is the number of area units.

If the values are close to zero, it shows uniform spaces, so the distribution of the examined phenomenon does not depend on the territory and neighbourhood. The minimum of the autocorrelation is always higher than -1 and its maximum is always lower than +1. If $I > -1/N-1$, the positive areal autocorrelation, and in case of $I < -1/N-1$ negative areal autocorrelation is observable. In case of division into regions of Hungary, the value of 0.2 shows strong neighbourhood effect.

The local Moran index (I_i) characterizes the relationship between the examined area and its neighbours by assigning a factual number to each area unit.

$$I_i = N \frac{(x_i - \bar{x}) \sum_{j=1}^{N} D_{ij} (x_j - \bar{x})}{\sum_{j=1}^{N} (x_j - \bar{x})^2}$$

Where N is the number of the examined area units, D_{ij} is the element of the i^{th} row and j^{th} column of the neighbourhood matrix and $(x_i - x)(x_j - x)$ is the product of the differences between area units' values and averages.

If I_i is significantly different from zero ($p<0,05$), then we can identify following interpretations:

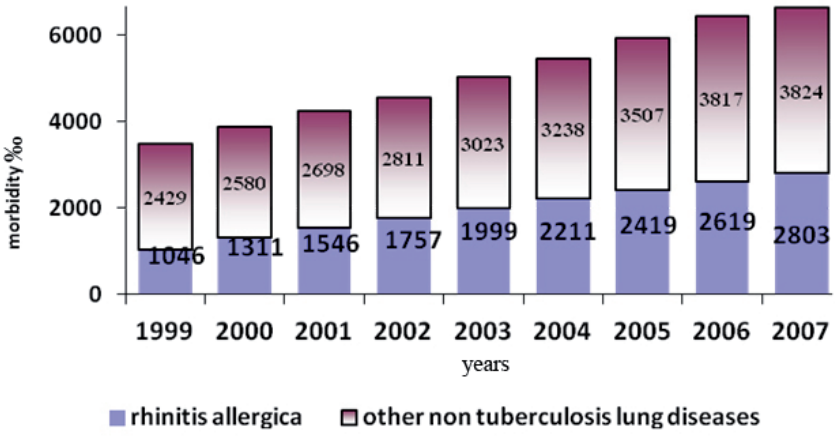
- Hot spot (HH): the phenomenon is more concentrated on the examined area unit and in its region.
- Cold spot (LL): the phenomenon is less concentrated on the examined area unit and in its region.
- High-Low (HL): the phenomenon is more concentrated on the examined area unit and less concentrated in its region.
- Low-High (LH): the phenomenon is less concentrated on the examined area unit and more concentrated in its region.

3. EXAMINATION OF THE MORBIDITY OF RHINITIS ALLERGICA IN HUNGARY BETWEEN 1999 AND 2007

3.1. Change in morbidity rate of rhinitis allergica between 1999 and 2007

According to the statistical data of the National Korányi Tuberculosis and Pulmonological Institute the morbidity of those who were registered with non-tuberculosis respiratory diseases showed a monotone increasing value that became almost twice as high as at the beginning (from 3476 to 6627 for 1000 people). Due to the rhinitis allergica the medical attendance became 2.7 times higher in 9 years. The chart shows (*Figure 1*) the monotone increase of morbidity. During the same period of time the proportion of the pollen induced hay fever grew from 30.10 % to 42.29 % compared to the frequency of the total number of non-tuberculosis respiratory diseases. From the economic point of view it is of major importance that the people most affected by the rhinitis allergica belong to the active age. For this reason I examined the size of the patient population belonging to the age group between 15 and 60 years compared to the total number of patients. In 1999 87% of the patients belonged to the active age group, while in 2007 it was 84% due to a slight decrease.

Figure 1: Change of the proportion of the morbidity of rhinitis allergica in relation to non-tuberculosis lung diseases in Hungary between 1999 and 2007



Source: Figure created by the author based on data of National Korányi Institute of Pulmonology

Through regression analysis I drew the conclusion that the morbidity of the hay fever showed a 214.35‰ growth among the population of Hungary.

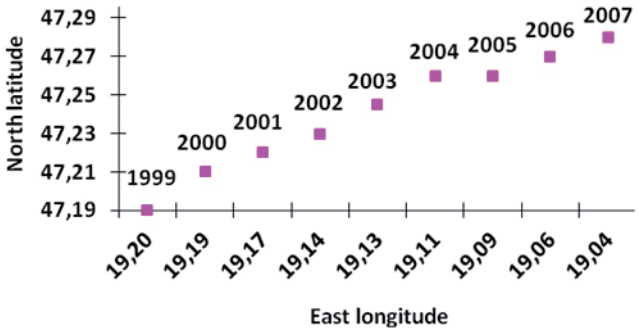
3.2. Examination of the morbidity of rhinitis allergica using inequality indexes

The spatial analysis started by determining the centroid of illness and then followed the characterization of the territorial differences of rhinitis allergica caused by pollen .

Centroid of illness

I examined the position of county seats compared to Budapest as a reference locus. I defined the sign of the coordinates of the town positive if it was located northwards or eastwards compared to Budapest. The calculations consist of the absolute volume i.e. the number of all rhinitis allergica illnesses. At the same time, the number of the registered population was used as the value of the function i.e. used as weight. In 1999 the centroid of the illness LAT 47°11'N., LONG. 19°11'E. was located nearby Kiskunlacháza (*Figure 2*).

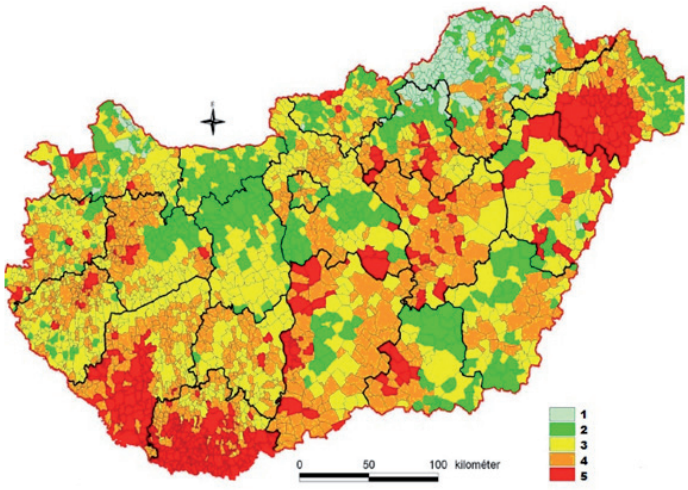
Figure 2: The trend information about change of the midpoint of rhinitis allergica in Hungary between 1999 and 2007



Source: Figure created by the author

The direction of the shift shows the bigger number of presence and registration in the capital, in its agglomeration and in the north-east part of the country. Due to this, the midpoint was replaced to the area of LAT. 47°16' N., LONG.19°02' E. (Dunavarsány). The result shows that the areal concentration of rhinitis allergica is on places with common ragweed (*Figure 3*).

Figure 3: Map of the presence of Common Ragweed potential in 2005



Legend: 1-absent, 2- rarely, 3-low, 4- medium, 5- high
Source: *http://www.fvm.gov.hu/doc/upload/200707/parlagfu_6.pdf* (2007. 10.23.)

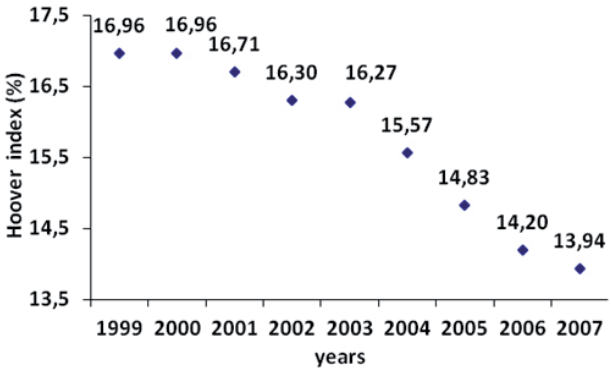
By analysing the time series, the change in the value of the concentration index shows a slight decreasing tendency in concentration of respiratory allergic diseases.

The next step was to determine the centroid of the population. The comparison of the two centrums shows eastward orientation of centroid of illnesses.

Hoover index

According to the results the largest areal inequality was between 1999 and 2000 during this period of investigation (*Figure 4*). Currently, the appearance frequency of hay fever tends to equalization in the counties.

Figure 4: The Hoover index of rhinitis allergica in Hungary between 1999 and 2007



Source: Figure created by the author

The difference of the attendance of dispensaries may influence indirectly the number of registered rhinitis allergica diseases, so it can contribute to the previous inequality result. Due to this, I examined the tendency of the inequality because of the attendance of dispensaries. It can be stated that the value of the Hoover index increased from 6.5% (1999) to 8.7% (2007). Therefore, the changing tendency in number of diseases is the main reason of the equalization process of spatial distribution of rhinitis allergica. For a detailed explanation the value of the weighted relative deviation is needed.

Standard deviation

The coordinates of Budapest as the point of reference were (x_i, y_i), x and y the coordinates of the county seats and the weight was the number of rhinitis allergica registered population of the given county. I summarized the values of standard deviation (D) during the period of investigation.

Table 1: Standard deviation (D) of rhinitis allergi

years	1999	2000	2001	2002	2003	2004	2005	2006	2007
D	0,0042	0,0038	0,0035	0,0032	0,0028	0,0030	0,0028	0,0027	0,0026

The low value of the deviation proves that the concentration of rhinitis allergica is around the centroid.

Weighted deviation and weighted relative deviation

The weighted deviation is suited to characterize the timely change in areal inequalities of rhinitis allergica. The values of the weighted deviation (σ) were determined, they can be found in *Table 2*. The

value of deviation shows increasing tendency. One of the causes of the change can be the increase in differences between the numbers of registered diseases referred to population in the counties.

At the same time, the tendency of the process is the same if the relative positions of investigational units i.e. the counties do not change; only the absolute number of patients increases. Therefore I determined also the value of relative deviation that is more suited to investigate the change of relative disease position; this can be found in *Table 2*. Determining the relative deviation I compared the deviation to the average of the data. Due to this, the index measures the differences among the counties. According to the results the values of relative deviation have a decreasing tendency. At the same time, the data are extreme, because the variation coefficient exceeds 30%. Therefore the convergent index does not mean improvement. All the more it means that the counties in better positions did not improve, which can be characterized with lower number of diseases, results in convergence. At the same time, the result of the calculation is that the country average does not present well our data.

Table 2: Weighted deviation and weighted relative deviation of rhinitis allergica

year	Weighted deviation	Weighted relative deviation
1999	0,0053	48,13
2000	0,0065	47,14
2001	0,0073	46,86
2002	0,0076	41,76
2003	0,0089	43,22
2004	0,0095	41,71
2005	0,0100	40,02
2006	0,0107	38,90
2007	0,0109	38,14

Areal autocorrelation

The disease position of a county can be characterized by the number of allergic diseases per 100 000 persons. Using spatial autocorrelation I determined how the counties form separated groups. I modelled the data of the neighbourhood matrix, which is required for the calculation, like 'bastion' neighbourhood based on its areal position. In this case, the counties were concentrated in neighbourhood groups, in which the values of morbidity of rhinitis allergica are almost the same during the period of investigation. However, the tendency is that the clustering becomes weaker (*Table 3*).

Table 3: The Moran Index

Years	2007	2006	2005	2004	2003	2002	2001	2000	1999
Global Moran Index	0,247	0,297	0,317	0,369	0,385	0,430	0,426	0,427	0,401
z value z_k(1,96-2,58)	2,046	2,39	2,53	2,89	3,00	3,29	3,32	3,35	3,24

Using local indices the counties were determined which influence principally the value of the global Moran index.

The analysis using the local Moran index (I_i) showed that two out of the four possible significant outputs appeared in Hungary during the period of investigation. The county of Hajdú-Bihar can be characterized with the largest spatial autocorrelation where the value of the local Moran index was between 1.34 and 1.65. Furthermore it can be stated that the county of Hajdú-Bihar and Jász-

Nagykun-Szolnok form cold-spot clusters all the time because there are low values of morbidity in the participant counties. The county of Borsod-Abaúj-Zemplén was also part of this cluster between 1999 and 2004 and the county of Békés joined in 2007. The county of Veszprém is a hot spot and the county of Zala was also a hot spot until 2002 that shows a high neighbourhood effect. The spatial differences among the morbidities of rhinitis allergica in the counties proved to be stationary in time.

4. SUMMARY

I have examined a 9 year period of the problem of rhinitis allergica affecting over 300 000 registered patients living in Hungary at the moment.

When analysing the data it becomes clear that rhinitis allergica appears in an always growing extent from the illnesses of non-tuberculosis origin among the Hungarian population. The growth of those struggling against rhinitis allergica is especially remarkable in the case of counties where the ratio of illnesses is at a lower level. It affects mostly the active aged population so the economic effect of the pollens can be foreseen.

When revealing the morbidity inequalities of Hungary we can draw the conclusion that the areal difference among the counties have proved to be stationary in time. At the same time the relative deviation of the frequency of rhinitis allergica reflects the worsening situation of the counties that were earlier characterised by lower frequency. The clusters, that can be characterised either with higher or lower morbidity during the time of the examination, have been identified.

The part of my research described in this study has helped to achieve a more complex knowledge of the regional system of connections of rhinitis allergica. Besides the spread of the pollens it is a further task to examine the additive contribution of the factors of the lifestyle in the process of sensitivisation that can be based on the comparative analysis of the regional pattern of the allergic adult and young population. The results can be integrated in teaching and health-educational activities and can be the basis of the co-ordination of programmes with preventive goals.

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