

Dependency Analysis as the Basis of a Mathematical Model of the Impact Heliogeophysical Factors on Human Health

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Abstract: The article discusses the results of the analysis of the original data to construct a mathematical model of the effect of external factors on human health.

Key words: Heliogeophysical Factors • Human Health • Correlation Analysis • Fourier Analysis • Regression Model • A Piecewise Linear Function

INTRODUCTION

Environmental factors, which have significant influence on living organisms, are divided into 3 groups:

- Galactic and planetary processes that determine solar activity;
- The processes on the Sun and largely determine geophysical phenomena;
- Geophysical factors associated with processes directly on the Earth and near-earth space [1].

Leading signs of the physical state of the atmosphere is air temperature, atmospheric pressure and humidity, the total flux of solar radiation, the partial pressure of oxygen, etc.

According to the views of solar-terrestrial physics, Sun influence the processes occurring near the Earth and its surface by means of electromagnetic radiation emitted by the Sun almost all wavelengths) and corpuscular flows. In natural conditions the body is always subject to the influence of complex dynamic complex of factors. Parameters of solar activity determine the influence of Earth's magnetic field and weather factors [2].

On the development of a person abnormal weather reactions mainly affects the entire atmospheric physical facility (atmospheric pressure, wind speed, air temperature, relative humidity, the partial pressure of oxygen) [1].

The most exposed to the effects of increased solar activity, people with diseases of cardiovascular and Central nervous system. Factors having the greatest "biotropic effects" are solar flares (Wolf number), the intensity of the geomagnetic field (magnetic storms A_p) and the intensity of the stream of radio emission with a wavelength of 10,8 cm (S_{min}) [3-5].

2011-2012 are the years of high solar activity the twenty-fourth 11-year solar activity cycle (Gnevyshev-Ol); analyzed the average monthly values of wolf numbers in the period of 2010-2011, Maxima of solar activity was observed from March to may 2011. A certain period is characterized by instability of weather-climatic conditions [6].

MATERIALS AND METHODS

Thus, the chosen interval of studies (on March 1-may 31, 2011). defined from the point of view of maximum heliogeomagnetic activity and considerable fluctuations of meteorological factors in this period.

For the analysis we used the following statistics:

- Medical data-every day the number of ambulance calls about acute cardiovascular and cerebrovascular pathologies (code diseases according to the International classification of diseases (ICD-9) i00 - i02, i05 - i09, i10 - i25, i42 - i52, i60 - i69, i70, i90, g20 - g26, g40 - g47, g90) in March-may 2011, in Stavropol

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according to the Federal state unitary enterprise "Station of emergency care" (13701 the emergency services); daily mortality for the same reasons, Stavropol (376 cases of death due to cardiovascular and cerebrovascular pathologies);

- Meteorological-daily as at Ben. atmospheric pressure, wind speed, oxygen partial pressure, temperature, humidity in March-may 2011 in Stavropol, provided by weather risks of the Stavropol territory.
- Helio-geophysical - daily values of planetary index of magnetic activity, the intensity of radiation with a wavelength of 10,8 cm (according to the observations of the branch of the Pulkovo Observatory in the village. Cardgames Stavropol territory), the wolf numbers, change the time of day, the change of the gravitational constant (site data <<http://www.wdcb.rssi.ru/data/stp>>, [http:// NASA tecnology.us/](http://NASAtecnology.us/)) in March-may 2011 at the latitude, Stavropol (N45E42) [6].

The choice of the above parameters (factors) environment as its indicators is due to the greatest biotropic effects caused by interaction helio-geomagnetic, gravitational and meteorological fields with the human body according to the analysis of literature [1-4].

In order to evaluate the effects caused directly influence environmental factors on health, it is necessary to clean the ranks of the medical data from the non-random components caused by non-natural (for example, social) factors [7].

Application of dynamical and statistical downscaling models. When selected by Fourier analysis non-random component in the ranks of medical data revealed that in the spectrum of medical data, in accordance with the theory of synchronization of external electromagnetic oscillations of the processes occurring in the human body, there are both variations associated with cycles of solar and geomagnetic activity, the movement of the moon through the geocentric orbit ("tidal" component) (2,24; 3,9; 4,6; 15; 28 days) and harmonica with a period of 3,5 and 7 days, due to the weekly organization of social life.

Since the harmonics with the period of 3,5 and 7 days from the original data should be deleted, introduced an amendment to the data on average seven-day signal and then determined the distribution law and carried out the spectral analysis of the corrected data. To avoid fluctuations of the filter is applied Mas.

At the next stage of research of influence of natural factors on human health, a study was conducted correlation dependences between geophysical and meteorological data and health data [8].

When assessing the tightness of the linear Association helio-geophysical and medical time-series showed that a linear relationship between medical data and air temperature, the partial pressure of oxygen and the index of magnetic activity average ($r > 0,251$), with the other indicators is weak ($r \leq 0,250$). It is assumed that such small values of the correlation coefficients can be caused by the presence of temporary shifts-delay or advance-reactions of the organism to the action of external factors that does not contradict the theoretical information, or the existence of purely functional relationship between the analyzed variables. The statistical link between the solar-geophysical, meteorological factors and the number of insurance cases authentic [6].

When correlated time series there is a possibility of a temporary shift, i.e. the influence of one phenomenon to another is performed with some delay, or the response of the system to influence ahead of the effect [6].

Detection time offset and length of time lag occurs by calculating a linear correlation coefficient $r(L)$ by the well-known formula Pearson, so that the number of $x(t)$ is shifted in relation to the number of $y(t)$ L units of time. The range $r(L)$ is a tabular set lystrosaurus correlation function. The presence of peaks in the function $r(L)$ says about lag [8].

In the study on the extremum of a function of the correlation coefficient was found timing reactions factors. Basically (in the case of atmospheric pressure, wind speed and wolf numbers) the body's response to perturbations acting factors is delayed or is in phase. The translation of correlation coefficients between the influencing factors and "retarded" medical data revealed that the strength of links has increased from weak to moderate.

Estimates of the magnitude of the correlation relationship with the assumption nonlinear relationship between medical and helio-geophysical, meteorological factors produced the following results. Considering adopted in the analysis of heliometeotropic reactions scale the degree of tightness of the connection (weak- $0,000 \pm 0,250$; middle - $0,251 \pm 0,500$; close - $0,501 \pm 0,750$; very close - $0,751 \pm 1,000$), the nonlinear relationship between the indicators and human health: humidity and duration of the day is weak; pressure, temperature, wind speed, partial pressure of oxygen and the flow rate of the radio-medium; communication with the wolf numbers, the index of

magnetic activity and the change of the gravitational constant is close. Comparing values of correlation coefficients and the correlations leads to the conclusion about the existence of functional links between medical data and environmental factors.

Due to the simultaneous influence of factors not considered in the analyzed variable may be distorted the true meaning of relationships between variables. This makes necessary the introduction of a measure of the statistical relationship, "purified" from the indirect effects of other variables [9].

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Models Evaluation: The results of calculation of private pairwise correlation coefficients between the influencing factors of different groups, suggest that there is a very close linear relation between pressure, temperature, wind speed, partial pressure of oxygen, the intensity of a stream of radio emission with a wavelength of 10,8 cm, the change of the gravitational constant and the index of magnetic activity. *i.e.* the analyzed set of features is characterized by interdependence of these features among themselves-multicollinearity. This creates serious difficulties to obtain valid estimates of the impact of individual characteristic to the indicator as at its formation and for model-building of its forecast. When building regression models correlation of characteristics predictors leads to an incorrect evaluation of the contribution of the characteristics of the predictors in the variation of the target attribute (the model describes the dependence of the target attribute of predictors) [9].

Because the multicollinearity is associated with a high degree of linear correlation between the initial signs are invited to circumvent this difficulty, using as new variables some linear combinations of the original variables, chosen so that the correlation between them were small or absent. In this case, the correlation matrix between the estimates of the parameters relatively new variables will be close to diagonal, which will significantly simplify the interpretation of results.

Thus, the multiple correlation coefficient is a measure of the closeness of the statistical relationship between the result indicator and a set of explanatory variables and calculated for the new characteristics of groups of factors and medical data indicates a medium of communication between the data above [10].

Concluding Remarks: When constructing mathematical models for the class of admissible solutions of the mathematical tasks can be accepted the class of linear functions. Best to restore the health of data on complex geophysical and meteorological parameters from the point of view of the accuracy of approximation is piecewise linear function with a single break point. The choice of the class of linear functions as a class of feasible solutions is not contrary to the experimental data with significance level [6].

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