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Influence of heliogeophysical disturbances on cardiac infarction, hypertensic crisis, psychological disturbance and behavioral disorders, bronchial asthma, cerebrovascular accident in Almaty

Abstract. In this work the dependence of frequency of cardiac infarction, hypertensic crisis, psychological disturbance and behavioral disorders, bronchial asthma, cerebrovascular accident in Almaty on solar and magnetic activity at the period 2009-2013 was investigated. During this period there were 694336 cases of calls for emergency help. In order to appreciate the level of solar and geomagnetic activity Wolf number and k-index was used. Data was analysed by statistical method epochs superposition in order to find the correlations between geomagnetic activity and occurrence of listed above diseases. As the result it was established that in the day of magnetic storm and two days after number of patients directed to hospital with psychological disturbance and behavioral disorders increases. Number of patients directed to hospital with cardiac infarction increases the day before and remains some days after. Number of patients directed to hospital with hypertensic crisis increases in the day of magnetic storm. Number of patients directed to hospital with cerebrovascular accident increases a day after magnetic storm. What concerns of bronchial asthma the dependence is not so clear.

Key words: solar activity, geomagnetic activity,cardiac infarction, hypertensic crisis, psychological disturbance and behavioral disorders, bronchial asthma, cerebrovascular accident

Introduction

One of actual problems of heliophysics is investigations on influence of space weather on biosphere. First who shows that the biosphere of our planet influensedby the geomagnetic field variations was Chizhevsky A.L [1,2]. And during almost whole 20th century the discussion among physicists, biologists, physicians and others on this problem carried out [3-6].

Active processes on Sun produces coronal mass ejection and after this plasma could reach Earth within the day. The variation of geomagnetic field caused by changes in current in magnetosphere occurred due to the coronal mass ejection. But there are set of parameters also changes: the intensity of cosmic rays intensity, flux of radioactive gas radon, level of acoustic waves, electromagnetic field and so on. And especially the changes in variations with the frequency near the biologically effective frequencies [7] could affect on human health condition.For nowadays it's obvious that this problem – is multidisciplinary problem and as for as it's rather difficult to distinguish the very influence on health of only space weather as far as there are a complex of other natural and anthropogenic effects on human health. The quantity of investigation made in this field shows the actuality of this problem and this works shows that influence of space weather on biosphere could varied from latitude to latitude, from one region to the other region.That's why it was rather important to study the influence of solar and geomagnetic activity on human health in Almaty, Kazakhstan.

In this work was investigated how the increasing of solar and magnetic activity can correlate with rate of diseases among Almaty population. For this aim was chosen the period 2009-2013 as the phase

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of solar activity increasing and from database of emergency service of Almaty the daily quantity of calls of doctors during these five years with complain for cardiac infarction, hypertensic crisis, psychological disturbanceand behavioral disorders, bronchial asthma, cerebrovascular accident. Taking into account the complexness of factor which could affect on human health we use the method of epochs superposition in order to find the correlations between geomagnetic activity and occurrence of listed above diseases.

Analyzing method description.

The method of epochs superposition is a statistical method using for analyzing causal relations between phenomena. This method referred to the zero data –dates of analyzed phenomenon occurrences.

Let us consider phenomenon S (solar activity or geomagnetic storm) which is realized at time t_0 called key-time or "zero"-time. Assume that another phenomenon D (analyzed disease) observed at key-time and some period before and after – chosen interval in time called epoch. Epoch determined by time of S occurrence t_0 and Δt-temporal resolution: $t_i=t_0+i\Delta t$ and for each time t_0, t_1, t_2,.....t_N taken in correspondence observed value of phenomenon D_0, D_1, D_2,.....D_N.

If phenomenon S occurred M times within the period we want to study the dependence every S phenomena occurrence allows us select the next sets of value D correspondingly to epoch interval and at the end we would have set of values as in Table 1.

Table 1 –Realization of phenomena during analyzed period

Realization No	t_0	t_1	t_2	……	t_N
1	D_0^1	D_1^1	D_2^1	……	D_N^1
2	D_0^2	D_1^2	D_2^2	……	D_N^2
……	……	……	……	……	……
M	D_0^M	D_1^M	D_2^M	……	D_N^M
Colum average	$<D_0>$	$<D_{1>}$	$<D_2>$		$<D_N>$

The average value defined as $\langle D_j\rangle = \frac{1}{M}\sum_{j=1}^{N} D_j^i$. Based on this statistics on M realizations we could analyze the dependence of $\langle D_j\rangle$ on $t_j$and this analyze made clear the question on the dependence between S and D phenomena.

Experiment and discussion of Results

As it was mentioned above the period 2009-2013 on the phase of solar activity increasing was chosen as analyzed period.During this period there were 694336 cases of calls for emergency help forcardiac infarction, hypertensic crisis, psychological disturbance and behavioral disorders, bronchial asthma, cerebrovascular accident, per year shown in Figure 1. In order to appreciate the level of solar and geomagnetic activity next parameters was used:

- Wolf number - sunspot number of sunspots per year,

- k-index – quantifies disturbances in the horizontal component of earth's magnetic field

The information on geoheliophysical factors for analyzed period was obtained from bulletin of Solar Geophysical Data NoAA USA (http//spidrngdcnoaa-gov) and Ionosphere institute Geomagnetic observatory "Alma-Ata" (www.ionos.kz)

The detail analysis of total calls shows that not all the previous diagnosis was confirmed and only part of patient was directed to hospital. The number of patients directed to hospital for cardiac infarction, hypertensic crisis, psychological disturbance and behavioral disorders, bronchial asthma, cerebrovascular accident during 2009-2013 per year shown in Figure 2.

There we can see that with the increasing of solar activity the number of patients directed to hospital for each of analyzing diseases also increases. In order to search it in detail we use the method of epoch superposition.

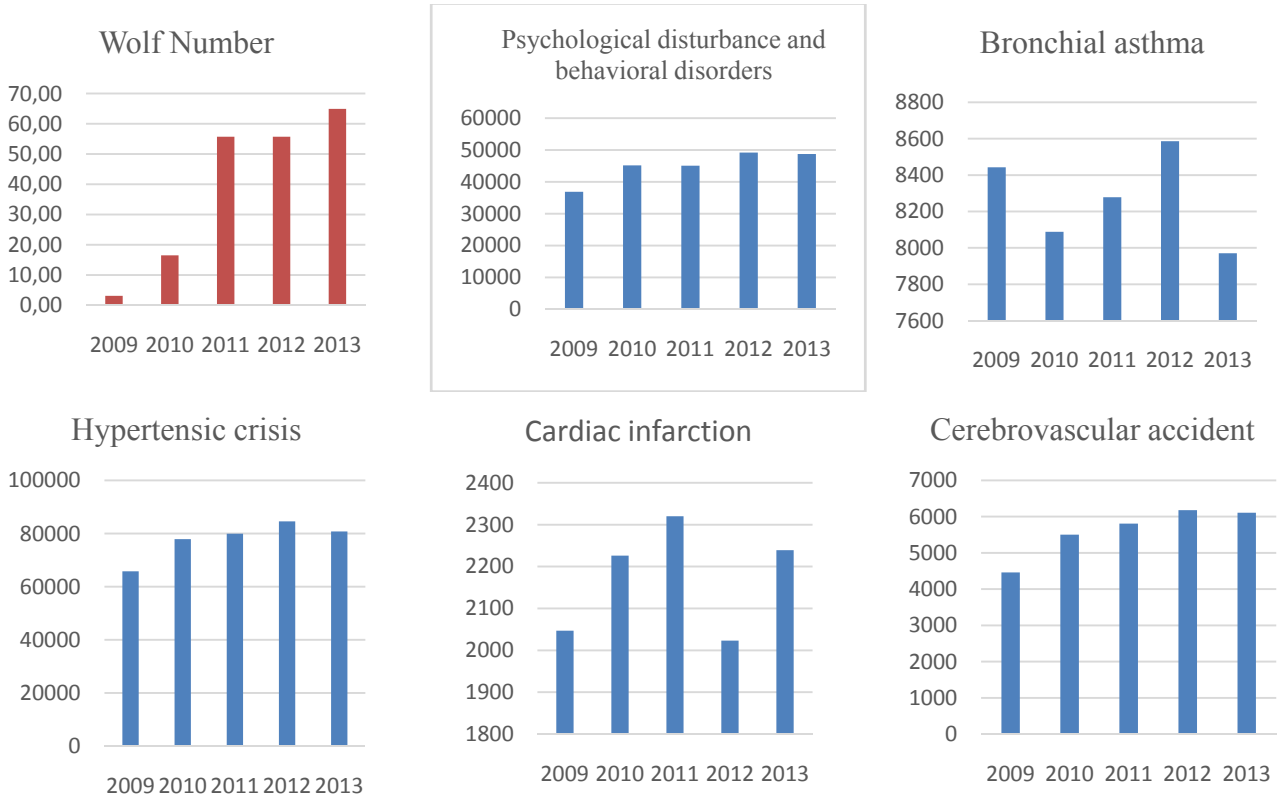

Figure 1 – Wolf number and quantity of calls for emergency help for cardiac infarction, hypertensic crisis, psychological disturbance and behavioral disorders, bronchial asthma, cerebrovascular accident per year during 2009 – 2013

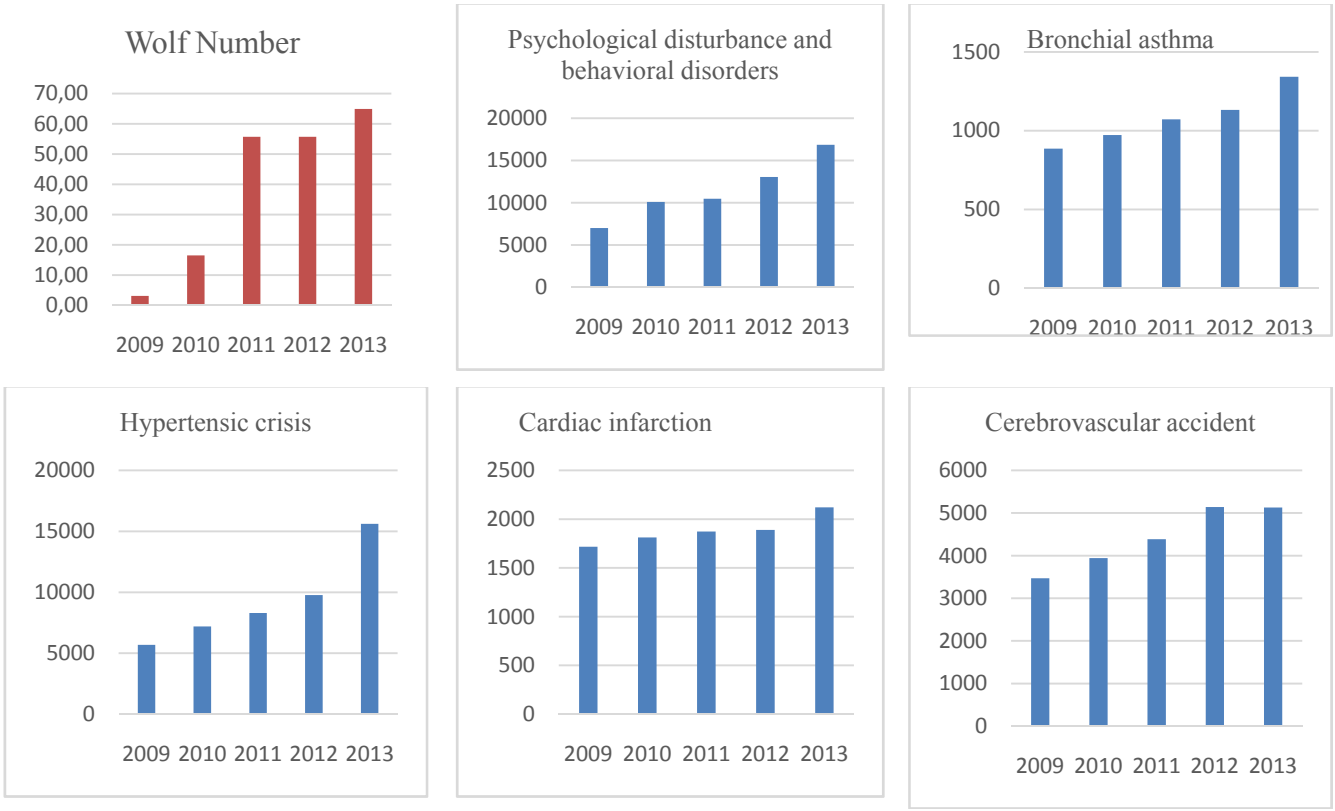

Figure 2 – Wolf number and the number of patients directed to hospital for cardiac infarction, hypertensic crisis, psychological disturbance and behavioral disorders, bronchial asthma, cerebrovascular accident during 2009-2013 per year shown

During this period the 82 magnetic storms with k-index more than 5 and occurred apart for several days from other magnetic storm was chosen. The list of magnetic storms shows in table 2. This table defined us the key data for 82 realizations.

Table 2 – List of chosen magnetic storms

Start of the storm (LT)	End of the storm (LT)	Duration	k-index
14.02.09from 09h	15.02 to 00h	15h	5
24.06.09from 03h	25.06 to 06h	27h	5
28.06.09from 21h	29.06 to 12h	15h	5
22.07.09from 06h	22.07 to 18h	12h	5
11.10.09from 09h	11.10 to 15h	6h	5
20.01.10from 18h	21.01 to 06h	12h	5
15.02.10from 21h	16.02 to 09h	12h	5
04.04.10from 18h	08.04 to 09h	87h	7
11.04.10from 18h	12.04 to 09h	15h	5
02.05.10from 15h	04.05 to 06h	39h	5
30.05.10from 12h	01.06 to 09h	45h	5
03.08.10from 23h42м	05.08 to 09from	27h18m	7
24.09.10from 18h	25.09 to 06h	12h	5
28.09.10from 13h34м	28.09 to 21h	7h26m	5
11.10.10from 12h	12.10 to 03h	15h	5
23.10.10from 12h	25.10 to 03h	39h	5
11.11.10from 15h	13.11 to 00h	33h	5
27.11.10from 21h	28.11 to 12h	15h	5
14.12.10from 15h	15.12 to 03h	12h	5
28.12.10from 18h	29.12 to 03h	9h	5
04.02.11from22h10м	05.02 to 12h	13h50m	6
14.02.11from 21h57м	15.02 to 06h	8h43m	6
18.02.11from 07h30м	19.02 to 00h	16h30m	5
01.03.11from 09h	03.03 to06h	45h	5
11.03.11from 21h	12.03 to 09h	12h	6
01.04.11from 15h	04.04 to 12h	63h	5
06.04.11from 15h35м	07.04 to 06h	15h	6
11.04.11from 18h	13.04 to 00h	30h	5
20.04.11from 03h15м	20.04 to 21h	17h45m	5
29.04.11from 21h	02.05 to 03h	53h	6
27.05.11from 18h	30.05 to 03h	57h	6
05.06.11from 02h45м	05.06 to 21h	18h15m	6
11.07.11from 14h55м	12.07 to 03h	12h05m	5
19.07.11from 12h	21.07 to 06h	42h	4
05.08.11from 04h56м	05.08 to 09h	4h 4m	4
05.08.11from 23h50м	07.08 to 00h	25h10h	7
09.09.11from 18h43м	11.09 to 06h	25h17m	6
12.09.11from 09h	13.09 to21h	36h	5
26.09.11from 18h32м	29.09 to00h	54h	7

Continuation of table 2

Start of the storm (LT)	End of the storm (LT)	Duration	k-index
29.09.11from 06h	30.09 to 03h	21h	5
02.10.11from 09h	03.10 to 00h	15h	5
05.10.11from 12h	04.10 to 03h	15h	5
25.10.11from00h32м	25.10 to 15h	15h	6
31.10.11from 18h	02.11 to06h	36h	5
22.01.12from 12h	23.01 to 12h	24h	5
25.01.12from 09h	26.01 to 00h	15h	5
07.02.12from 15h	08.02 to 09h	18h	5
15.02.12from 00h	15.02 to 12h	12h	5
27.02.12from 18h	28.02 to 18h	24h	5
01.03.12from 09h	02.03 to 07h	22h	5
06.03.12from 18h	08.03 to 06h	36h	6
08.03.12from 17h02м	10.03 to 03h	34h	7
12.03.12from 12h	13.03 to 06h	18h	6
15.03.12from 19h04м	18.03 to 09h	44h	7
12.04 from 21h	13.04 to 18h	21h	6
23.04.12from 09h21м	24.03 to 15h	28h39m	5
24.04.12from 21h	26.04 to 21h	48h	5
22.05.12from 02h30м	23.05 to 18h	38h30m	5
03.06.12from 15h	04.06 to 03h	12h	5
04.06.12from 12h	05.06 to 00h	12h	5
16.06.12from 15h52м	18.06 to 18h	50h8m	7
05.07.12from 16h58м	06.07 to 03h	10h02м	5
08.07.12from 09h	08.07 to 21h	12h	5
09.07.12from 03h	10.07 to 06h	27h	5
15.07.12from00h10м	16.07 to 21h	43h50m	6
30.07.12from 18h	31.07 to 03h	9h	5
02.08.12from 15h	03.08 to 06h	15h	6
03.09.12from 01h	03.09 to 06h	5h	5
03.09.12from 15h	04.09 to 09h	18h	6
05.09.12from 03h	05.09 to 21h	18h	5
19.09.12from 21h	20.09 to 06h	9h	5
01.10.12c 03h	01.10 to 15h	12h	5
13.10.12from 09h	15.10 to 09h	48h	5
13.11.12from 05h15м	14.11 to 18h	36h45h	5
24.11.12from 00h	24.11 to 00h	24h	5
17.01.13from 00h	18.01 to 03h	27h	5
18.01.13from 15h	19.01 to 09h	18h	5
25.01.13from 21h	27.01 to 09h	36h	5
13.02.13from 21h	14.02 to 21h	24h	5
16.02.13from 18h	17.02 to 03h	9h	5
01.03.13from 00h	02.03 to 09h	33h	5
17.03.13from 12h	18.03 to 09h	21h	6

The results of analysis of 82 realization for each diseases shown in figures3-7 where 0 – fit with key data, -1 – day before key data, 1 – day after key data and so on. As the results we find that in the day of magnetic storm and two days after number of patients directed to hospital with psychological disturbanceand behavioral disorders increases. Number of patients directed to hospital with cardiac infarction increases the day before and remains some days after.

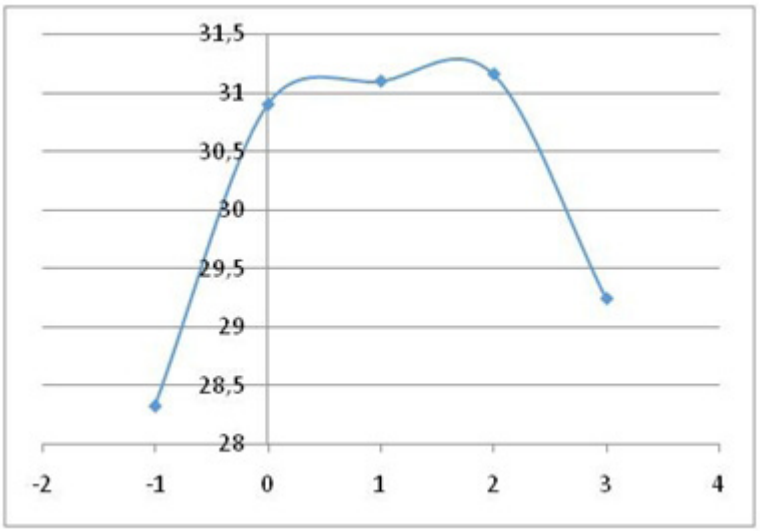

Figure 3 – Results of statistical analysis by epoch superposition for psychological disturbanceand behavioral disorders

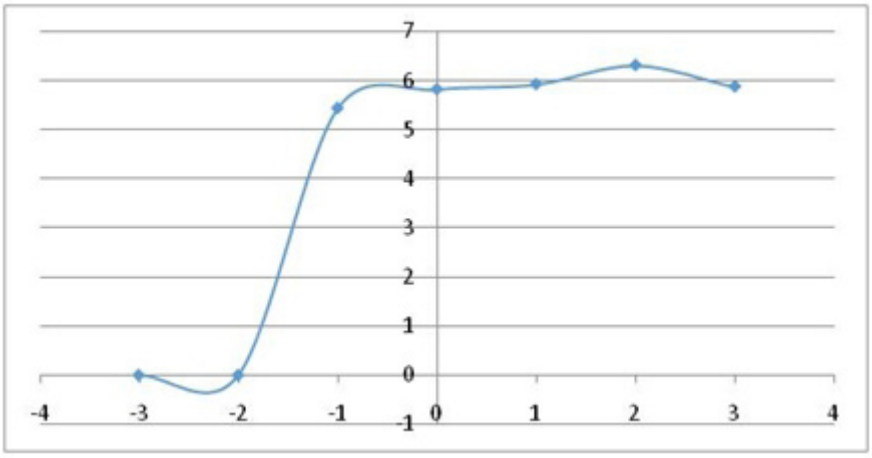

Figure 4– Results of statistical analysis by epoch superpositionfor cardiac infarction

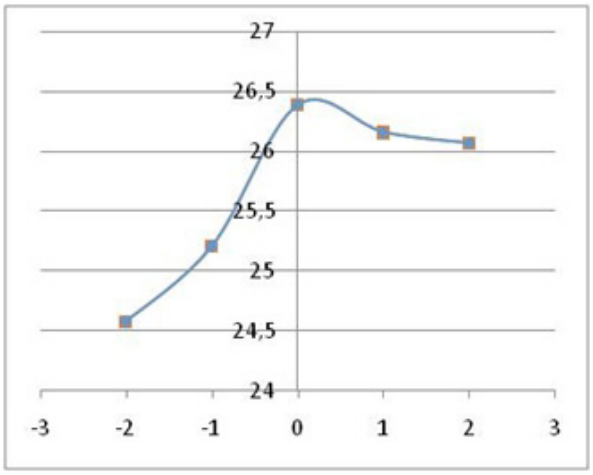

Figure 5– Results of statistical analysis by epoch superpositionfor hypertensic crisis

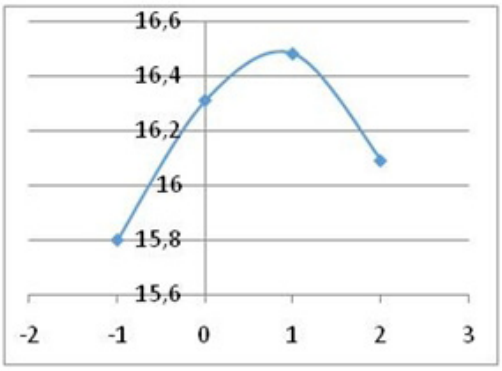

Figure 6– Results of statistical analysis by epoch superpositionfor cerebrovascular accident

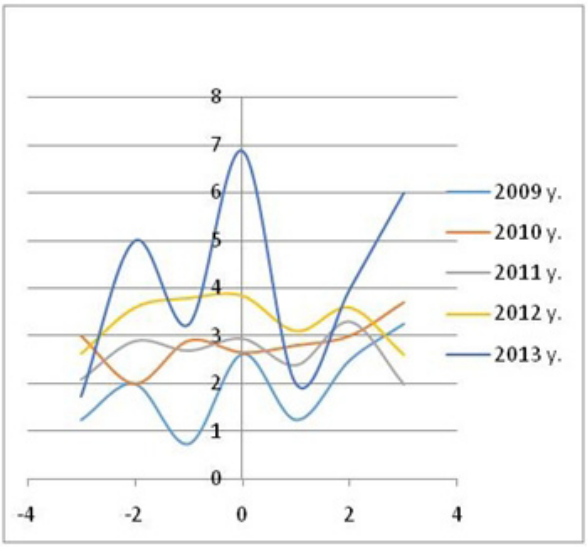

Figure 7– Results of statistical analysis by epoch superpositionfor bronchial asthma

Conclusion

As the results we find that in the day of magnetic storm and two days after number of patients directed to hospital with psychological disturbanceand behavioral disorders increases. Number of patients directed to hospital with cardiac infarction increases the day before and remains some days after. Number of patients directed to hospital with hypertensic crisis increasesin the day of magnetic storm.Number of patients directed to hospital with cerebrovascular accidentincreases a day after magnetic storm. What concerns of bronchial asthma the dependence is not so clear and we attribute this to seasonal dependence of bronchial asthma and its dependence on space weather should be analyzed in detail by other parameter and other method.

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