

ON THE RELATIONSHIP BETWEEN HARD COSMIC RAY FLUX DECREASE AND TRAUMA LEAPS IN 2007–2009 IN VILNIUS CITY

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Abstract. Relationship between hard cosmic ray flux (HCRF) decrease and traumas number leaps in 1 – 3 days is presented. HCRF 105000 measurement results are compared with trauma leaps in Vilnius in 2007 – 2009. It is found that monthly average data of HCRF and trauma numbers have an opposite correlation. To analyse obtained results of HCRF, the criterion of 200 imp/h decrease during 4 h and more was proposed, while increasing the trauma numbers exceeded monthly average values by 10, 15, 20 %. The efficiency of prognosis of trauma leaps in 1 – 2 days is higher, than in 2 – 3 days after HCRF decrease. Efficiency of relationship between HCRF decrease and traumas number leaps in 1 – 2 days was from 64 to 93 % and 2 – 3 days – from 52 to 65 % in 2007 – 2009. Analysing this relationship an influence of human factor was taken into consideration, because trauma maximum values were registered at the weekends.

Keywords: hard cosmic ray flux, traumas, relationship, human factor.

1. Introduction

Physical and chemical processes occurring in the environment, cause corresponding changes in the physico-chemical and physiological functions of a living organism, in particular, is reflected in its cardiovascular, nervous activity and in his mind. So, for example, changes in atmospheric pressure, humidity, temperature, etc., causing fluctuations in many of the functions of the human body and eventually affects human behavior (Bhattacharyya *et al.*2001; Stoupel *et al.*2009; McGregor 2001).

Undoubtedly, the major causative agent of life on Earth is the solar radiation, which is the main source of energy affecting the surface layers of the Earth. The question has place: to what the human activity depends and its focus on variations or changes of cosmic factors, in particular, electromagnetic radiation. The study of external influences can be done in the presence of a large number of statistical data. If a person affected by an external alien factor, then at the same time in different parts of the globe should be observed in approximately the same direction of various phenomena, such as morbidity, mortality, neuro -psychiatric excitations, etc (Chizhevsky 1976).

However, in the present study, the authors are limited to only a number of manifestations of these phenomena in Vilnius, in particular, the leaps of traumatism and

their relation to fluctuations in the geomagnetic field caused by solar activity.

Wrong to suggest that traumas caused only by space and atmospheric phenomena. It is possible to say about the “push” from the previously mentioned external factors that lead to a leap in the number of traumas.

There is a possibility, if the external effects of this nature, in particular, the fluctuations of the geomagnetic field are repeated often, then it can become impaired the body so that few of its action will upset the body (Styra *et al.*2005). On the other hand, the burst of solar activity, suddenly appeared after a long calm period, can increase the number of accidents. However, the frequent repetition of the changes of the geomagnetic effect reduces the number of disorders of the body and, in particular traumas (Styra *et al.*2005; Juozulynas *et al.*1998). Consequently, these moments should be considered when studying the above mentioned problems (Palmer *et al.*2006; Villoresi *et al.*1994; Alania *et al.*2001; Gimitrov 2007; Styra *et al.*2009). Naturally, the investigating biological or physiological effects under the influence of solar and geophysical factors must be taken into consideration together with action of the weather - pressure, temperature, humidity, wind speed, etc. However, meteorological factors independent of the Sun’s activity according to statistics play minor role (Bhattacharyya *et al.*2001).

It is known that the solar phenomena ranging from one to three days of their appearance in the Sun negatively affect primarily the old sick body with pronounced atherosclerosis, the degeneration of the heart (Chizhevsky 1976; Palmer *et al.* 2006, Sirvydas *et al.* 2010).

Fluctuations of solar radiation also affects the vital functions: the nervous system, the centers of respiration and blood circulation, causing the phenomena of strong excitements, parabiosis provided attenuation of the functional activity of the nervous system. This relaxation leads to a change in human behavior, the scattering of his attention, decreased reaction to external stimuli, etc (Chizhevsky 1976), which can lead to undesirable consequences, in particular, to the traumas.

The aim of this work is to study leaps of traumas under the influence of fluctuations of the geomagnetic field, which at the earth's surface are determined by its indirect indicator - variation of hard cosmic rays flux.

2. Material and methods

Data of traumas over a period of 36 months (2007 - 2009) were obtained from the Vilnius ambulance service. During this time there were 45600 traumatism - related ambulance calls. The monitoring of hard cosmic rays flux (HCRF) was carried out by a gama - spectrometer with scintillation detector.

The detector of device, made of crystal NaI(Tl) (6,3 x 6,3 cm) was covered with a lead protection of 12 cm thick to absorb the mild component of cosmic radiation (Styra *et al.* 2005).

The operating stability of this device was controlled by ¹³⁷Cs radionuclide radiation. Measurements were carries out continuously every 15 min.

The experimental error was 1 % at the probability of 95 %. Deviations from the average HCRF value exceeding this error within a 1 h time interval were considered as an external affect on the gamma - spectrometer and were used to analyse the obtained information. Over 105000 HCRF measurement results were analysed. For statistical analysis, the correlation coefficients were calculated. They were used to compare daily HCRF variations and traumas number increase in 1 - 3 days. Results of 65 -75 % were considered as strong trend.

3. Results

The present investigation refers to the local effects of HCRF variation on short - term prediction of trauma number leaps in Vilnius The study of a connection between HCRF decrease and traumas leap after 1 -3 days was carried out. To define a quantitative relationship between these characteristics, specific requirements should be met.

HCRF is a secondary cosmic radiation near the ground surface. To analyse the variation of HCRF to predict the trauma leaps, the optimum criterion of HCRF decrease is necessary. The specific criterion of HCRF decrease for the integral spectrum of 0,3 - 4,0 MeV was proposed. The prognostic effect in trauma leaps of 10, 15, 20 % over the monthly average value was considered.

The processing of experimental data was carried out as follows:

1. The total number of cosmic particles was brought into 1 - h time interval.
2. A decrease in HCRF values (more than 200 impulses) for a 4 - h period during any day was used as the threshold value for selection of analysis.
3. A correlation between HCRF decrease and increase of traumas number after 1 - 3 days was determined.
4. Trauma leaps were assumed to be an increase in their number, exceeding the average monthly value by 10 % and more.
5. Atmospheric pressure situations were taken into consideration.
6. A human factor was analysed.

An example of the monthly average data on HCRF values and traumas cases in 2007 - 2009 is presented in Fig 1. This figure illustrates an opposite course of the curves of above stated parameters. The annual course of HCRF can be explained by the different distance between the Earth and the Sun at different seasons, i. e. the maximum values in winter and minimum in summer time. Such situations have an opposite correlation between HCRF and trauma number with an increase and decrease of the curves course (Fig 1).

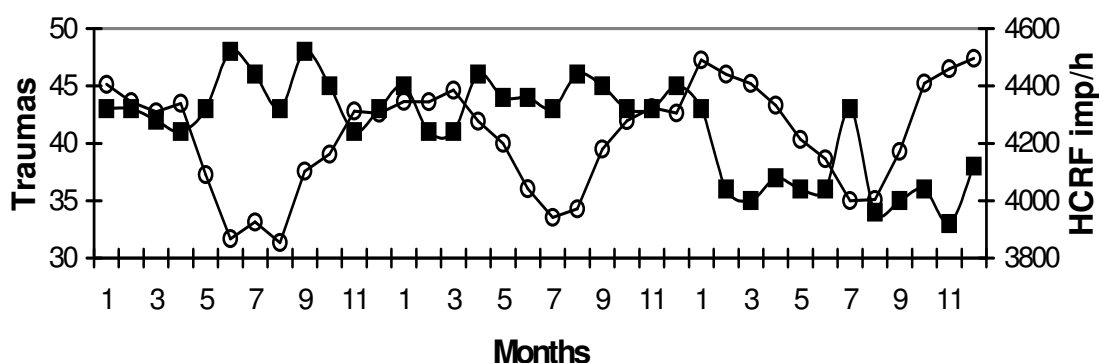


Fig 1. Average monthly values in Vilnius in 2007 - 2009 (o – 1 hard cosmic ray flux, ■ – 2 Traumas)

Thus, it is possible to propose the opposite correlation between the average values of HCRF and trauma numbers with an averaged correlation coefficient of 0,65 for the period 2007 -2009.

The prognosis of trauma leaps is considered within 2 days simultaneously with the information on ambulance calls which often arrive about midnight or right after it and this complicates the dating. Measurement results of HCRF decrease and trauma leaps within 1 - 2 and 2 - 3 days in 2007 - 2009 are illustrated in Tables 1 - 3, The data in these tables show the highest connection between

HCRF decrease and trauma leaps within 1 - 2 days. In all cases (Tables 1 - 3) the maximum correlation between above stated parameters change was in 2007. The minimum difference of the occurrence of compared results in three years period was from 71 to 84 %, when the trauma leaps exceeded the monthly average value by 20 % (Table 3). Most efficient result - 93 % was obtained in 2007, when the trauma leaps exceeded the monthly average value by 15 % (Table 2).

Table 1. Traumas number exceeding the monthly average values by 10 % and the number of occurrence of this increase according to decrease in HCRF of > 200 impulses in Vilnius city in 2007 – 2009

Months	Traumas number			Number of occurrences					
	2007	2008	2009	Within 1 -2 days interval			Within 2 - 3 days interval		
				2007	2008	2009	10%	15%	20%
January	8	6	3	4	4	2	3	3	1
February	6	11	9	5	5	4	5	3	3
March	8	8	6	5	4	4	6	4	2
April	9	8	12	9	7	9	6	6	6
May	11	6	9	9	5	5	5	4	3
June	8	9	10	5	7	5	5	5	7
July	9	9	7	4	7	3	6	4	4
August	13	8	7	13	7	3	10	3	4
September	5	12	10	5	9	5	3	8	5
October	9	6	9	7	2	8	4	4	7
November	8	6	9	7	6	8	1	1	5
December	8	10	9	8	9	8	6	7	8
Total	92	99	100	81	72	64	60	52	55
Total, %				88	73	64	65	52	55

Table 2. Traumas number exceeding the monthly average values by 15 % and the number of occurrence of this increase according to decrease in HCRF of > 200 impulses in Vilnius city in 2007 2009

Months	Traumas number			Number of occurrences					
	2007	2008	2009	Within 1 -2 days interval			Within 2 - 3 days interval		
				2007	2008	2009	10%	15%	20%
January	5	5	3	2	3	3	2	3	2
February	6	9	6	5	4	2	5	1	1
March	5	6	6	3	2	4	5	3	2
April	8	7	7	8	6	6	5	6	4
May	8	6	5	7	5	3	4	4	2
June	5	7	7	4	6	6	4	4	4
July	9	5	7	4	4	3	6	2	4
August	10	4	6	10	4	3	3	2	3
September	5	10	3	5	8	5	3	7	5
October	3	4	8	6	1	7	4	3	6
November	7	5	7	6	5	7	1	1	3
December	8	9	6	8	8	5	6	6	5
Total	84	77	76	78	56	56	53	42	41
Total, %				93	73	74	63	54	54

Table 3. Traumas number exceeding the monthly average values by 20 % and the number of occurrence of this increase according to decrease in HCRF of > 200 impulses in Vilnius city in 2007-2009

Months	Traumas number			Number of occurrences					
	2007	2008	2009	Within 1 -2 days interval			Within 2 - 3 days interval		
				2007	2008	2009	10%	15%	20%
January	3	5	3	2	3	3	1	3	1
February	5	6	6	5	4	2	4	1	1
March	4	3	5	2	0	3	4	1	2
April	7	4	6	7	4	5	4	3	4
May	7	4	5	6	3	3	4	3	2
June	4	6	3	3	5	3	3	3	3
July	5	4	7	3	3	3	4	2	4
August	5	2	5	5	2	3	3	1	2
September	3	6	8	3	6	5	3	6	5
October	6	3	8	4	1	7	2	2	6
November	6	3	5	5	3	5	0	0	2
December	8	6	4	8	6	4	6	3	4
Total	63	52	65	53	40	46	38	28	36
Total, %				84	77	71	60	54	55

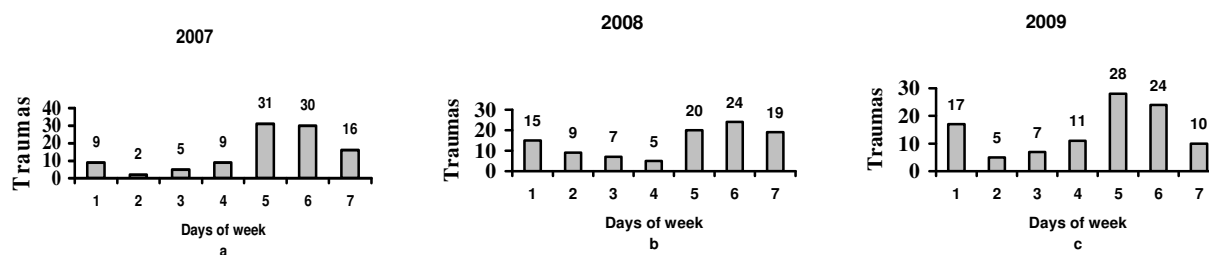


Fig 2. Dependence of trauma numbers exceeding the monthly average values by 10 % on days of the week in 2007 – 2009: a – 2007; b – 2008; c – 2009

It is necessary to point out, that HCRF decrease according to the chosen criterion appears two times (in average) per month when the traumata leaps do not observe. In these cases trauma leaps often don't mount to 10 % over monthly average value of traumas number. It is necessary to add another important factor of trauma leaps - human factor, provoking leaps in traumas (Fig 2.).

4. Discussion

The spectrum of μ - meson and γ - quanta is formed by the interaction of secondary cosmic radiation with NaI(Tl) crystal of the detector while passing through the lead protection of 12 cm thick. Therefore, the analysis of the obtained data refers to the hard cosmic component only. Hence, HCRF variations indirectly describe the geomagnetic field instability.

The influence of geomagnetic field intensity change on the human body is most pronounced in some situations. For example, it occurs when geomagnetic field variations appear after a long period of stability. Human organism doesn't respond immediately, but in some days (Styra *et al.*2005; Styra *et al.*2010). Hence, an indirect indicator - HCRF of geomagnetic field variations may be

predictive of trauma leaps (Juozulynas *et al.*1998). After the other HCRF decrease during some days the number of trauma leaps decrease because an organism adapts to external influences.

The instability of the geomagnetic field is often accompanied by the change of the weather. So, the atmospheric pressure change, temperature, humidity, wind's velocity have to be taken in to consideration together with geomagnetic field variation to predict the trauma leaps. In present study the obtained results in trauma leaps are limited by geomagnetic affect only. Therefore prognostic efficiency of trauma leaps in 1 - 3 days sometimes is low in many cases.

It is necessary to point out an important human factor, provoking leaps in traumas (Fig 2).

The data in Fig 2 illustrate the fact, that the main part of traumas number belong to the second part of the week, i. e. to weekend. The maximum traumas number was in Fridays and Saturdays in 2007 - 2009. This fact has place because of increased activity of people at weekend, when the car accident numbers are increased too. In this case it is problematic to take into consideration the geomagnetic affect on people, which often takes place. That is why geomagnetic field variations have a little additional part to the human factor in traumas leap at weekend.

It is known that variations of trauma numbers frequency depend on population ageing, health care system and etc. It means that geomagnetic variations exert only an extra effect. However, increase in trauma numbers by 10 - 20 % above the average monthly level sometimes took place in the absence of the corresponding HCRF criterion within previous 1 - 3 days. This phenomenon is possible because of incorrect data on the time of ambulance calls. Thunderstorm activity increases the secondary cosmic radiation near the ground surface (Styro 1984) leading to the registration error of HCRF. Cyclones and anticyclones also influences the results of HCRF measurement (Styro *et al.*2008; Styro *et al.*2010). Tectonic processes influence the flux of cosmic particles too (Styro 1996). The accuracy of trauma leaps prognosis by HCRF decrease also depends on the human factor.

These phenomena can change the course of HCRF values at any moment, and simultaneously decrease the reliability of the prediction of an increase in the incidence of traumatism. This may explain why there were situations when no increase in the number of cases of traumas occurred despite the presence of the appropriate HCRF criteria (Tables 1 - 3). Obviously, situations are possible when other factors influencing the incidence of traumas are not essential and the additional effect of the geomagnetic field become negligible too. Thus, to predict a correlation between these characteristics with accuracy close to 100 % is practically impossible.

5. Conclusions

The obtained results confirm the occurrence of a prognostic connection between HCRF decrease and trauma leaps within 1 - 3 days. To describe this fact the criterion of HCRF decrease by 200 impulses and more over 4 - hours period and more for the available measurement installation is found. The efficiency of prognosis of the number of traumas leap exceeding the monthly average value is higher in 1 - 2 days, that in 2 - 3 days after HCRF decrease in 2007 -2009. The maximum result of 93 % of prognostic efficiency is registered in 2007. Evidently, variations in the geomagnetic field make a perceptible contribution to the other effect that evoke traumatism.

Finally, these results must be regarded as preliminary.

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