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Traffic accident in India in relation with solar and geomagnetic activity parameters and cosmic ray intensity (1989 to 2010)

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We studied the relation between deaths due to traffic accident in India and geomagnetic activity indices: Kp, Ap, Dst and solar activity (SA) parameters, sun spot number, solar flare index (FI), coronal index (CI) and yearly average of cosmic ray intensity, observed during the period of 1989-2011. It is seen that rate of death by traffic accident are well correlated with these parameters. We have found large negative correlation with correlation coefficient of -0.84,-0.79 between rate of death by traffic accident and Kp and Ap indices; large positive correlation with correlation coefficient 0.79 rate of death by traffic accident and Dst index. Further good medium correlation with correlation coefficient of -0.56,-0.60.-0.56 has been found between rate of death by traffic accident and yearly average of sunspot number, solar flare index and coronal index respectively. A positive correlation with correlation coefficient of 0.69 between rate of death by traffic accident and yearly average of cosmic ray intensity was also obtained.

Key words: Sunspot numbers, solar flare index, coronal index, cosmic ray intensity, Ap index, Kp index, Dst index, traffic accident death.

INTRODUCTION

Solar activity (SA), geomagnetic activity (GMA) and cosmic ray activity (CRA), respectively are major constituents of space weather that affects our daily life-navigation (Ptitsyna et al., 1996) as well as human health in space and in the Earth (Breus, 2003). Over the last years, many studies have been carried out concerning the possible effect that solar and geomagnetic activity might have on human physiological state (Stoupel, 2002; Dorman et al., 2001; Cornelissen et al., 2002; Dimitrova et al., 2004). Cosmic ray intensity (CRI) and GMA variations can influence not only the performance and reliability of space-borne or ground-based technological systems, but also human life (Cornelissen et al., 2002;Dzvonik et al., 2006; Stoupel et al., 2007).

These results refer not only to the possible influence of GMA disturbances on the human cardiovascular state through variations of physiological parameters such as heart rate (HR) and arterial diastolic and systolic blood pressure (Dimitrova et al., 2009), but also on the central and vegetative nervous system through changes of the human brain's functional state and the psycho - emotional state (Babayev et al., 2006). Some studies revealed that the most significant effects on myocardial infarctions, brain strokes, and traffic accidents were observed on the days of geomagnetic field disturbances accompanied with Forbush decreases (FDs)

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(Zhadin, 2001; Ptitsyna et al., 1998) and especially during the declining phase of FD (Villoresi et al., 1994; Dorman, 2005). At the same time, it was shown that very low GMA could also adversely affect human cardio-vascular system (Stoupel et al., 2004, 2005, 2007; Stoupel, 2006) and that is why it is suggested that the role of environmental physical factors becoming more active in low GMA, like CR (neutron) activity, should be an object of further studies (Stoupel, 2006).

In the last decades, many scientists have worked on the impact of space weather parameters, through the geomagnetic field, on different diseases (Dorman et al., 2001; Stoupel, 2002; Gmitrov and Ohkubo, 2002; Gmitrov and Gmitrova, 2004; Dimitrova et al., 2004). It has been revealed that cardiovascular, circulatory, nervous and other functional systems react under changes of geophysical factors (Kay, 1994; Watanabe et al., 1994; Persinger and Richards, 1995; Gurfinkel et al., 1995; Cornelissen et al., 2002). It has long been claimed that geomagnetic storms and other electromagnetic variations are associated with changes in the incidence of various diseases, myocardial infractions and strokes (Halberg et al., 2000). Some evidence has also been accumulated on the association between geomagnetic disturbances and increases in work and traffic accidents (Stoupel et al., 2004; Ptitsyna et al., 1996; Dorman, 2005). Others have also been reported on the association between geomagnetic disturbances and increases in number of road traffic and work (industrial) accidents (Stoupel et al., 2004; Srivastava and Saxena, 1980; Ptitsyna et al., 1996; Babayev et al., 2006). These studies were based on the hypothesis that a significant part of traffic accidents could be caused by the incorrect or retarded reaction of drivers to the traffic circumstances, the capability to react correctly being influenced by the changes in the environmental physical activity, particularly, sharp fluctuations of GMF.

Some studies revealed that the most significant effects of myocardial infarction, brain stroke and traffic accidents were observed on the days of GMF disturbances accompanied with Forbush decreases (Villoresi et al., 1995; Ptitsyna et al., 1998; Dorman, 2005). There are numerous indications that solar activity and solar activity variability-driven time variations of the geomagnetic field can be hazardous in relation to human health state and safety. Some evidence has been reported on the association between geomagnetic disturbances and increases in work and traffic accidents (Ptitsyna et al., 1998). These studies were based on the hypothesis that a significant part of traffic accidents could be caused by the incorrect or retarded reaction of drivers to the traffic circumstances, the capability to react correctly being influenced by the environmental magnetic and electric fields. Reiter (Stoupel et al., 2004) found that work and traffic accidents in Germany were associated with disturbances in atmospheric electricity and in the geomagnetic field (defined by sudden perturbations in radio-wave propagation).

On the basis of 25 reaction tests, it was found also that the human reaction time, during these disturbed periods, was considerably retarded. On the basis of huge statistical data on several millions of medical events in Moscow and in St. Petersburg, there were found sufficient influence of geomagnetic storms accompanied with Cosmic Ray (CR) Forbush-decreases on the frequency of myocardial infarctions, brain strokes and car accident road traumas (Villoresi et al., 1994).

The most remarkable and statistically significant effects have been observed during days of geomagnetic perturbations defined by the days of the declining phase of Forbush decreases in CR intensity. During these days the average numbers of traffic accidents increase by (17.4±3.1%) (Dorman, 2005). Some studies show correlations between high SA and GMA and increased number of traffic accidents (Stoupel et al., 2004).

In the present investigation, an attempt has been made to get possible relationship between solar, geomagnetic and cosmic ray activities with rate of traffic accident death in India. For this study, rate of traffic accident death, solar, geomagnetic and cosmic ray activity parameters for the period of 1989-2010 has been used.

EXPERIMENTAL DATA

In this study, the rate of male and female death by traffic accident in India, yearly average of solar activity parameters sunspot number, solar flare index, coronal index and cosmic ray intensity, geomagnetic activity parameter Kp, Ap and Dst indices for the period 1989-2011, has been taken into consideration. The data of traffic accident has been taken from the National Crime Records Burea (NCRB) 2010 records, ministry of home affairs of India. The data of solar activity parameters, sunspot number, solar flare index and coronal index are taken from the Solar-Terrestrial Physics (STP) solar data (www.ngdc.noaa.gov/stp/solardataservices). The data of cosmic ray intensity yearly average count rates of Oulu super neutron monitor has been used. The data of geomagnetic activity parameters has been taken from Omni web data system (Table 1).

Analysis and results method of analysis and results

In this study, statistical method of correlation has been used. The correlation is one of the most commonly used statistics. A correlation is a single number that describes the degree of relationship between two variables. Correlation coefficient, symbolized as *r*, is a numerical summary of a bivariate relationship and can range from –1.00 to +1.00. Any *r* that is positive indicates a direct or positive relationship between two measured variables. Negative *r* indicates indirect or inverse relationship. The formula for the correlation is:

$$r = \frac{N\sum XY - \left(\sum X\right)\left(\sum Y\right)}{\sqrt{\left[N\sum X^2 - \left(\sum X\right)^2\right]\left[N\sum Y^2 - \left(\sum Y\right)^2\right]}},$$

Where: N=number of pairs of scores, $\sum XY$ =sum of the products of

Table 1. Yearly average of geomagnetic, solar activity parameter, cosmic ray intensity and rate of traffic accident during period of 1989-2010.

Year	Kp index	Dst index	Sunspot numbers	Solar flare index (FI)	Coronal index (CI)	Yearly average of cosmic ray intensity	Rate of death
1989	843	−905.42	157.6	17.39	17.52	5480	20.8
1990	775.42	−638	142.6	12.2	15.99	5416	21.1
1991	918.5	−932.83	145.7	15.16	14.74	5432	22.1
1992	787.5	−617.75	94.3	7.74	10.97	5922	22.5
1993	723.1	−501.42	54.6	4.23	6.88	6203	21.8
1994	822.67	−629.92	29.9	1.58	4.36	6280	21.2
1995	657.92	−511.67	17.5	0.86	2.86	6387	24.3
1996	578.1	−331.92	8.6	0.42	1.98	6503	23.6
1997	496.42	−440.42	21.5	1.01	3.08	6545	24.5
1998	613.67	−518.67	64.3	4	6.35	6399	26.6
1999	665.25	−398.17	93.3	6.39	8.93	6203	27.6
2000	718.42	−581.33	119.6	7.61	9.74	5784	25.5
2001	637.42	−539.75	110.9	6.8	10.53	5889	26.4
2002	686.33	−638.67	104.1	4.56	10.14	5806	24.8
2003	870.33	−527.25	63.56	3.46	6.21	5759	24.3
2004	663.33	−372.58	40.44	1.6	6.4	6093	25.5
2005	643.25	−480.17	29.78	1.91	4.64	6156	26.7
2006	490.58	−353.1	15.18	0.54	4.54	6478	28.1
2007	460.83	−250.1	7.5	0.47	2.11	6632	30
2008	444.1	−239.58	2.86	0.03	1.6	6662	29.7
2009	274.17	−337	3.09	0.02		6804	30.5
2010	382	−186.92	16.5	0.39		6623	32.4

paired scores, $\sum X$ = sum of x scores, $\sum Y$ = sum of y scores, $\sum X^2$ = sum of squared scores, $\sum Y^2$ = sum of squared score.

The scale of correlation coefficient is:

0.8 to 1.0 or -0.8 to -1.0 (very large relationship)
0.6 to 0.8 or -0.6 to-0.8 (large relationship)
0.4 to 0.6 or -0.4 to -0.6 (good medium relationship)
0.2 to 0.4 or 0.2 to -0.4(weak relationship)
0.0 to 0.2or 0.0 to -0.2 (weak or no relationship)

RESULTS

Large negative correlation with correlation coefficient, -0.84 between rate of death by accident and Kp indices. Large negative correlation with correlation coefficient, -0.79 between rate of death by traffic accident and Ap indices.

Large positive correlation with correlation coefficient, 0.79 rate of death by traffic accident and Dst indices. Good medium correlation with correlation coefficient, -0.56 was found between rate of death by traffic accident and yearly average of sunspot number.

Negative correlation with correlation coefficient, -0.60 has been found between rate of death by traffic accident and yearly average of solar flare index.

Negative correlation with correlation coefficient, -0.56 has been found between rate of death by traffic accident and yearly average of coronal index.

Positive correlation with correlation coefficient, 0.69 has been found between rate of death by traffic accident and yearly average of cosmic ray counts rate.

Conclusion

The long term study confirms results of number of previous observations on links between timing of human death and environmental physical factors (Gmitrov and Ohkubo, 2002, Gmitrov and Gmitrova, 2004; Stoupel, 2002, 1999; Stoupel et al., 2004, 2005, 2007). Results of this study also shows that there is strong relationship between death by traffic accident and geomagnetic activity, solar activity parameters (sunspot numbers, solar flare index, coronal index, Kp index, Ap index, Dst index) and cosmic ray activity. The significant correlation with correlation coefficient of -0.84, -0.79, and 0.79

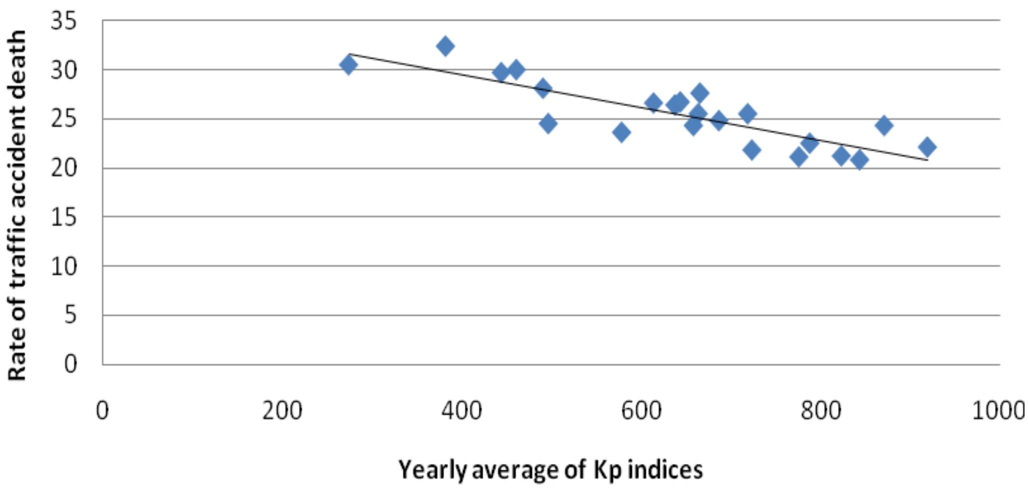

Figure 1. Scatter plot between yearly average of Kp indices and rate of death by traffic accident during period of 1989-2010 showing negative correlation with correlation coefficient -0.84.

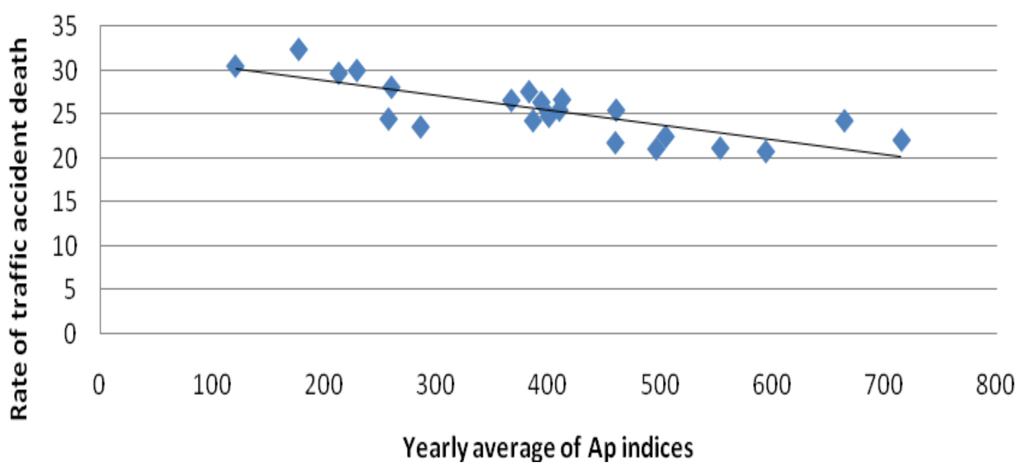

Figure 2. Scatter plot between yearly average of Ap indices and rate of death by traffic accident during period of 1989-2010 showing negative correlation with correlation coefficient -0.79.

between yearly average of Kp, Ap, Dst index and rate of death by traffic accident shown in Figures 1, 2, 3 and -0.56, -0.60, -0.56 between yearly average of sunspot number, solar flare index ,coronal index and death by traffic accident shown in Figures 4, 5 and 6 and 0.6, between yearly average of cosmic ray count rate and death by traffic accident shown in Figure 7; confirms the relationship of solar, geomagnetic activity parameter, cosmic ray activity and rate of death by traffic accident.

Although, there are several factors of traffic accident like medical-biological; social; sleeping while driving, etc; as well as terrestrial weather changes – meteorological conditions. Nevertheless, alongside with aforementioned medical-biological, meteorological, social and other affecting factors, disturbances and variations in space weather (geophysical and cosmic ray activity) can also play a significant role in traffic accidents as a trigger factor, increasing the risk of traffic accidents.

Previous investigators have determined that human brain activity is influenced by geomagnetic activity (Babayev and Allahverdiyeva, 2007; Allahverdiyev et al., 2001). Disturbances of geomagnetic conditions causes negative influence, seriously disintegrate brain's functionality, activate braking processes and amplify the negative emotional background of an individual. It is also shown that geomagnetic disturbances affect mainly emotional and vegetative spheres of humans. A human being's physiological state and brain's bioelectrical activity, affected by geomagnetic activity negatively, may result in inadequate reaction and its retardation in relation

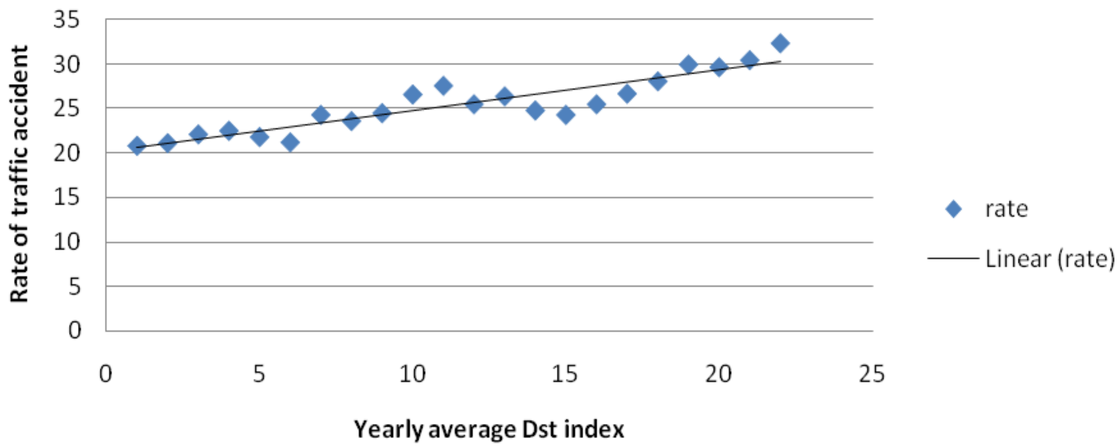

Figure 3. Scatter plot between yearly average of Dst indices and rate of death by traffic accident during period of 1989-2010 showing positive correlation with correlation coefficient .079.

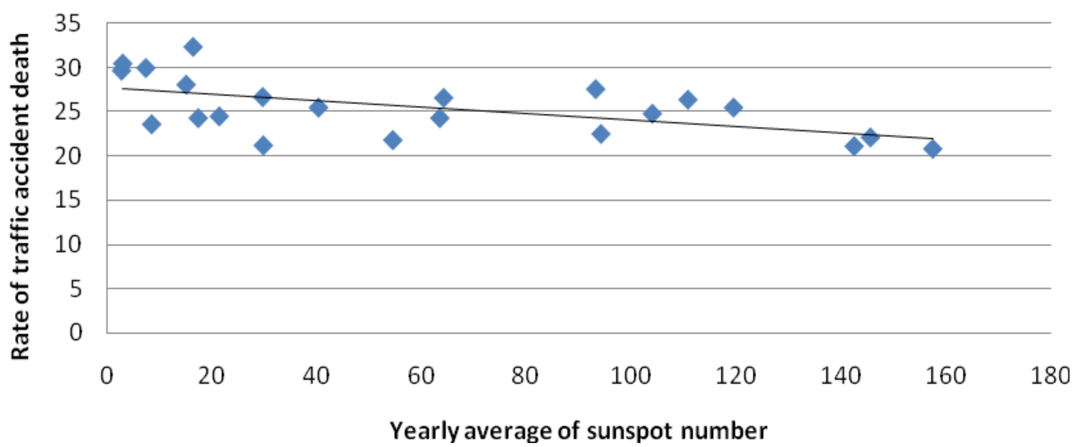

Figure 4. Scatter plot between yearly average of sun spot number and rate of death by traffic accident during period of 1989-2010 showing negative correlation with correlation coefficient -0.56.

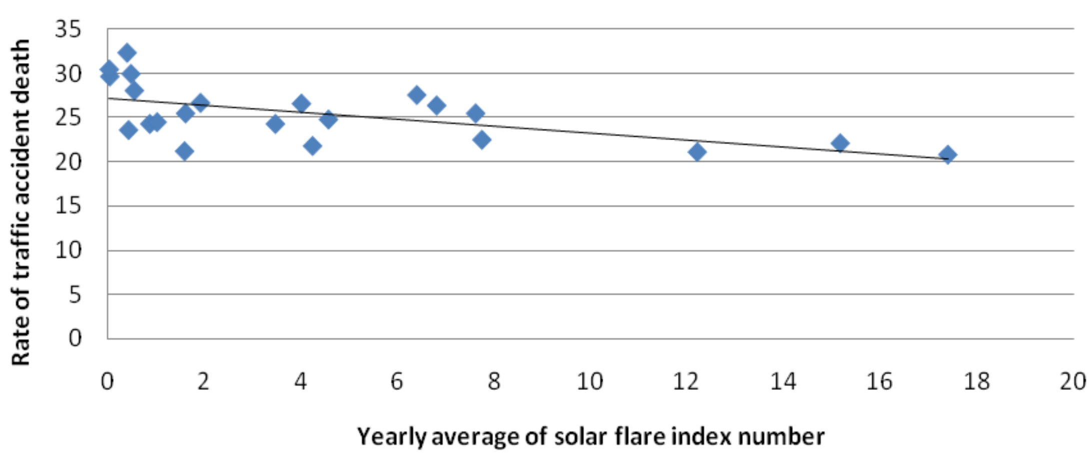

Figure 5. Scatter plot between yearly average of solar flare index and rate of death by traffic accident during period of 1989-2010 2010 showing negative correlation with correlation coefficient -0.60.

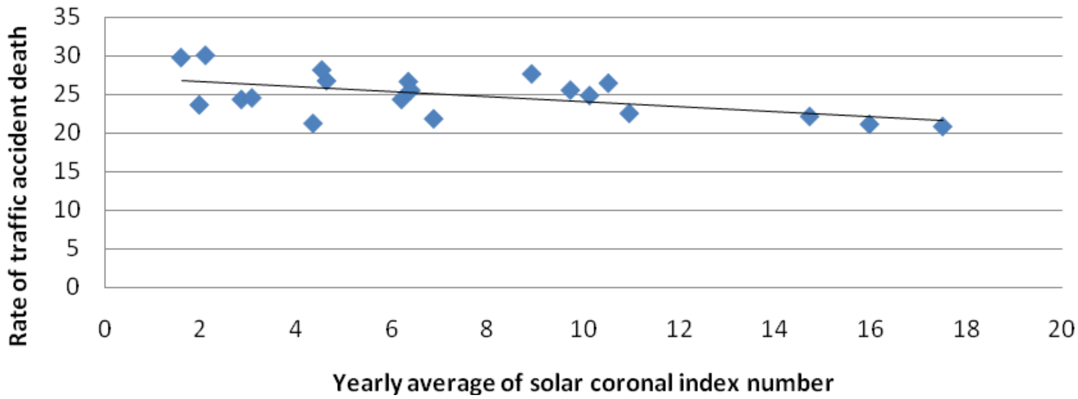

Figure 6. Scatter plot between yearly average of solar flare index and rate of death by traffic accident during period of 1989-2010 showing negative correlation with correlation coefficient -0.56.

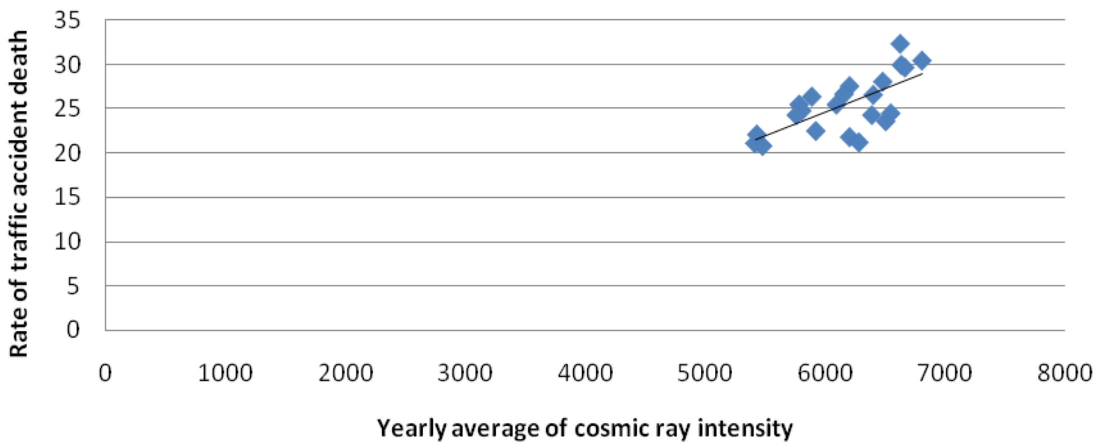

Figure 7. Scatter plot between yearly average of cosmic ray count rate and rate of death by traffic accident during period of 1989-2010 showing positive correlation with correlation coefficient 0.69.

to the situation leading to the relatively increased number of traffic accidents. In this study, the phenomena with solar, geomagnetic and cosmic ray activity in relation to India and obtained significant correlation. For general picture of the phenomena, further study is needed for different latitude and longitude.

REFERENCES

Allahverdiyev AA, Babayev ES, Khalilov EN, Gahramanova NN (2001). Possible space weather influence on the functional state of the human brain. Proceedings of the ESA Space Weather Workshop "Looking Towards a European Space Weather Programme". P. 17.

Babayev ES, Allahverdiyeva AA (2007). Effects of geomagnetic activity variations on the physiological and psychological state of functionally healthy humans: Some results of Azerbaijani studies. Adv. Space Res. 40:1941.

Babayev ES, Hashimov AM, Yusifbeyli NA, Rasulov ZG, Asgarov AB (2006). Geomagnetic storm risks to electric power distribution and supply systems at mid-latitude locations and their vulnerability from space weather. Technical and Physical Problems in Power Engineering" (Proc. 3rd Int. Conf. TPE-2006, Turkey, 29-31 May 2006), Gazi University, Ankara, 1097.

Cornelissen G, Halberg F, Breus Tk, Syutkina EV, Baevskii RM, Weydahl A, Watanabe Y, Otsuka K, Siegelova J, Fiser B, Bakken E (2002). Non-photic Solar Associations of Heart Rate Variability and Myocardial Infarction." J. Atm. Solar-Terr. Phys. 64:707.

Dimitrova S, Mustafa FR, Stoilova I, Babayev ES, Kazimov EA (2009). Possible influence of solar extreme events and related geomagnetic disturbances on human cardio-vascular state: results of collaborative Bulgarian-Azerbaijani studies. Adv. Space Res. 43:641.

Dimitrova S, Stoilova I, Cholakov I (2004). Influence of local geomagnetic storms on arterial blood pressure. Bioelectromagnetics 25:408.

Dorman LI (2005). Space Weather and Dangerous Phenomena on the Earth: Principles of Great Geomagnetic Storms Forecasting by Online Cosmic Ray Data. Ann. Geophys. 23:2997.

Dorman LI, Iucci N, Ptitsyna NG, Villoresi G (2001). Cosmic ray as indicator of space weather influence on frequency of infracts myocardial, brain strokes, car and train accidents, in: Proc. 27th ICRC (Hamburg). P. 3511.

Dzvonik O, Stetiarova J, Kudela K, Daxner P (2006). A monitoring of space weather effects on some parameters of mental performance

and health in aviation personnel. Stud. Psychol. 48:273.
Gmitrov J, Gmitrova A (2004). Geomagnetic field effect on cardiovascular regulation. Bioelectromagnetics 25:92.
Gmitrov J, Ohkubo C (2002). Artificial static and geomagnetic field interrelated impact on cardiovascular regulation. Bioelectromagnetics 23:329.
Gurfinkel Iu I, Liubimov VV, Oraevskii VN, Parfenova LM, Iur'ev A (1995). The effect of geomagnetic disturbances in capillary blood flow in ischemic heart disease patients. Biofizika 40:793.
Halberg F, Cornelissen G, Otsuka K, Watanabe Y, Katinas GS, Burioka N (2000). Cross-spectrally coherent 10.5 and 21-year biological and physical cycles, magnetic storms and myocardial infarctions. Neuroendocrinol. Lett. 21:233.
Kay RW (1994). Geomagnetic storms: association with incidence of depression as measured by hospital admission. Br. J. Psychiatry 164(3):403.
Persinger MA, Richards PM (1995). Vestibular experiences of humans during brief periods of partial sensory deprivation are enhanced when daily geomagnetic activity exceeds 15–20 nT. Neurosci. Lett. 194(1-2):69.
Ptitsyna NG, Villoresi G, Dorman LI, Iucci N, Tyasto MI (1998). Natural and man-made low-frequency magnetic fields as a potential health hazard. UFN (Uspekhi Physicheskikh Nauk). 168(7):767.
Ptitsyna NG, Villoresi G, Kopytenko YA, Kudrin VA, Tyasto MI, Kopytenko EA, Iucci N, Voronov PM, Zaitsev DB (1996). Coronary heart diseases: an assessment of risk associated with workexposure to ultra low frequency magnetic fields." Bioelectromagnetics 17:436.
Srivastava BJ, Saxena S (1980). Geomagnetic –biological correlations –Some new results. Indian J. Radio Space Phys. 9:121.
Stoupel E (1999). Effect of geomagnetic activity on cardiovascular parameters. J. Clin. Basic Cardiol. 2:34.
Stoupel E (2002). The effect of geomagnetic activity on cardiovascular parameters. Biomed. Pharmacother. 56:247.
Stoupel E (2006). Cardiac arrhythmia and geomagnetic activity. Indian Pacing Electrophysiol. J. 6:49.
Stoupel E, Babayev ES, Mustafa FR, Abramson EP, Israelevich P (2007). Acute myocardial infarction (AMI) occurrence – environmental links. Baku 2003–2005 data. Medical science monitor. Int. Med. J. Exp. Clin. Res. P. 175.
Stoupel E, Domarkiene S, Radishauskas R, Israclcvich P, Abramson E, Sulkes J (2005). In women myocardial infarction occurrence is much stronger related to environmental physical activity than in men-a gender or an advanced age effect? J. Clin. Basic Cardiol. 8:59.
Stoupel E, Kalediene R, Petrauskiene J, Domarkiene S, Radishauskas R, Abramson E, Israelevich P, Sulkes J (2004). Three Kinds of Cosmophysical Activity: Links to Temporal Distribution of Deaths and Occurrence of Acute Myocardial Infarction. Med. Sci. Monit. 10:80.
Villoresi G, Breus TK, Dorman LI, Iucci N, Rapoport SI (1994). The influence of geophysical and social effects on the incidences of clinically important pathologies (Moscow 1979–1981). Phys. Med. 10(3):79-91.
Villoresi GL. Dorman I, Ptitsyna NG, Iucci N, Tiasto MI (1995). Forbush decreases as indicators of health - hazardous geomagnetic storms", Proc. 24th Intern. Cosmic Ray Conf. Rome. 4:1106-1109.
Watanabe Y, Hillman DC, Otsuka K, Bingham C, Breus TK, Cornelissen G, Halberg F (1994). Cross-spectral coherence between geomagnetic disturbance and human cardiovascular variables at non-societal frequencies. Chronobiologia 21(3-4):265.
Zhadin MN (2001). Review of Russian literature on biological action of DC and low frequency AC magnetic fields. Bioelectromagnetics 22:27.