Available online at www.elixirpublishers.com (Elixir International Journal)

Space Science

Elixir Space Sci. 81 (2015) 31488-31492

ISSN: 2229-712X

Suicidal Death in Slovakia Relation with Solar Interplanetary and Geomagnetic Activity Parameters (1986 To 2010)

P. L. Verma

Department of Physics, Government Vivekanand P. G. College, Maihar Satna, M. P., India.

ARTICLE INFO

Article history:

Received: 1 November 2014;

Received in revised form:

15 March 2015;

Accepted: 31 March 2015;

Keywords

Suicide Incidents,
Sunspot Numbers (SSN),
Solar Flare Index (SFI),
Sudden Storm Commencements(SSC),
Geomagnetic Activity Indices.

ABSTRACT

We have studied the relationship between suicide in Slovakia and various Solar, Interplanetary and Geomagnetic Activity parameters, such as Sunspot Numbers (SSN), Solar Flare Index (SFI), Sudden Storm Commencements (SSC), and planetary Ap, Kp and Dst Indices observed during the period of 1986 to 2010. The data shows that the number of deaths due to suicide of males and females is well correlated with the yearly mean of Sunspot Numbers (SSN), Solar Flare Index (SFI), Sudden Storm Commencements (SSC), and planetary Ap, Kp and Dst Indices. We have calculated a large positive correlation, with correlation coefficients of 0.72, 0.64, and 0.62, between the yearly total number of male deaths due to suicide and the Planetary Kp, Ap, and Dst (magnitude) Indices. In addition, we have found a large negative correlation, with correlation coefficients -0.77, -0.68, and -0.60, between the yearly total number of female deaths due to suicide and the Planetary Kp, Ap, and Dst (magnitude) Indices. A large positive correlation, with a correlation coefficient of 0.60, and a good medium positive correlation, with correlation coefficient 0.57, has been found between the yearly total number of male deaths due to suicide and the yearly mean of the SSN and SFI. A good medium negative correlation, with correlation coefficients -0.49 and -0.40, has been found between the yearly total number of female deaths due to suicide and the SSN, SFI. From the statistical analysis of sudden storm commencements (SSC), and death due to suicide, we have obtained a positive correlation, with correlation coefficient of 0.51, between the yearly total number of male deaths due to suicide and Sudden Storm Commencements (SSC), as well as a negative correlation, with a correlation coefficient of -0.38, between the yearly total number of female deaths due to suicide and Sudden Storm Commencements (SSC).

Introduction

The state of the near-Earth space environment is governed by the Sun and is very dynamic on all spatial and temporal scales (Bothmer & Daglis, 2006). The Sun poses a health and safety threat to humans (Palmer et al., 2006) and all kinds of human activities (Jansen et al. 2000). The Geomagnetic Field, which protects the Earth from the Solar Wind and Cosmic rays is also essential to the evolution of life; variations in the Geomagnetic Field can have either direct or indirect effects on human physiology and health, even when the magnitude of the disturbance are small. Over the last two decades, heliobiological studies have been carried out by researchers in many parts of the world. The history of heliobiological studies are well described in (Palmer, 2006; Breus, 2002, 2003; Ragulskaya, 2007) and in reviews such as (Davydo, 1996). The relationship between geophysical factors and the physiological, psychological states of human beings were analyzed in Michael Persinger's review, where more than 95 western authors were taken into consideration (Persinger, 1997). In Zhadin's review, the results of the investigations of about 170 Russian scientists, who have been working in this field of study during the last 20-30 years were presented (Zhadin, 2001). It is inferred from these studies that changes in geomagnetic conditions mostly affect the activity of regulating systems, which are related to higher cortical mechanisms of regulation and the sub-cortical integrative apparatuses, which are responsible for an organism's organization of routine activity, and for adapting to the changes in a physical environment (Babayev & Allahverdiyeva 2005). Other scientists, such as Babayev and Allahverdiyeva, have already studied the effects of geomagnetic activity on human physiological states and revealed that geomagnetic disturbances affect mainly the emotional and vegetative spheres of human beings, while characteristics pertaining to personality traits do not undergo significant change (Babayev & Allahverdiyeva 2007; Babayev et al. 2007). In 2003, Charmaine Gordon and Michael Berk studied the correlation between geomagnetic activity and suicide rates. Gordon and Berk (2003) correlated geomagnetic activity with suicide rates spanning a 13 year period from January 1980 to 1992, and found a significant correlation (r = 0.6964) between the mean total of suicides and the mean average of geomagnetic storm activity. Babayev (2007, 2008) had studied the possible effects of solar, geomagnetic and cosmic ray variability on human physiological and cardiovascular health in the middle latitudes; he concluded that both weak and severe geomagnetic storms affect the functional state of the human brain and amplify the negative emotional background of an individual. Babayev also concluded that heart rate variations in humans are affected by variations in geomagnetic activity and cosmic ray intensity. Different types of geomagnetic storms (i.e. magnetic-cloud origin vs. those caused by high-speed solar wind streams) affect the cardio-vascular system in different ways. Some other investigators have

Tele:
E-mail addresses: plverma2010@gmail.com

Table 1. Suicidal Death in Slovakia and Solar, Interplanetary and Geomagnetic Activity Indices during the period of 1986-2010

Years	Male Suicidal Death	Female Suicidal Death	Total Suicidal Death	Yearly Mean of Kp Index	Yearly mean of Magnitude of Dst Index	Yearly Mean of Ap Index	Yearly Mean of Solar Flare Index	Yearly Average of SSN	Yearly Total SSC
1986	514	136	650	657.75	475	380.83	1.13	13.4	21
1987	556	119	675	630.75	358.58	335.1	2.66	29.4	24
1988	538	125	663	666.83	574.33	390.1	8.14	100.2	36
1989	492	107	599	843	905.42	593.83	17.39	157.6	69
1990	582	146	728	775.42	638	496.17	12.2	142.6	43
1991	482	99	581	918.5	932.83	714.75	15.16	154.7	59
1992	434	119	553	787.5	617.75	504.42	7.74	94.3	47
1993	289	69	358	723.1	501.42	459.67	4.23	54.6	27
1994	261	55	316	822.67	629.92	553.13	1.58	29.9	13
1995	344	69	413	657.92	511.67	386.33	0.86	17	23
1996	370	92	462	578.1	331.92	286	0.42	8.6	9
1997	356	105	461	496.42	440.42	257.5	1.01	21	28
1998	371	78	449	613.67	518.67	367	4	64.6	35
1999	397	68	465	665.25	398.17	382.75	6.39	93.3	30
2000	383	76	459	718.42	581.33	460.33	7.61	119.6	45
2001	376	90	466	637.42	539.75	393.67	6.8	111	42
2002	443	71	514	686.33	638.67	400.42	4.56	104	46
2003	447	92	539	870.33	527.25	663.83	3.46	63.7	13
2004	409	78	487	663.33	372.58	409.67	1.6	40.4	28
2005	487	89	576	643.25	480.17	412.1	1.91	29.8	26
2006	59	466	407	490.58	353.1	260	0.54	15.2	20
2007	63	490	427	460.83	250.1	229.25	0.47	7	14
2008	100	631	531	444.1	239.58	213	0.03	2.9	19
2009	75	609	534	274.17	337	120.92	0.02	3.1	21
2010	78	612	534	382	186.92	177.42	0.39	16	15

observed how geomagnetic activity affects arterial blood pressure (ABP), heart rate variability (HRV), the electrical conductivity of biologically active points (Babayev & Allahverdiyeva 2007; Baevsky et al. 1997; Cornelissen 2002; Ghione et al. 1997; Khabarova et al. 2009; Otsuka K et al. 2001), as well as geomagnetic activity effects on cardio-vascular diseases, myocardial infarctions morbidity and mortality, cardiac arrhythmia, brain strokes, and occupational, traffic accidents (Gurfinkel et al. 1998; Oraevskii et al. 1998; Ptitsyna 1998). Recently some researchers have studied suicide incidents, which are related to physiological changes in the human brain, in relation to different Solar and Geomagnetic Activity parameters and have obtained some very interesting results. Verma (2012) has studied the relationship between death due to suicide in India and various Solar Activity (SA) parameters; i.e. Sunspot Numbers (SSN), Solar Flare Index (SFI), Coronal Index (CI) and Cosmic Ray Intensity (CRI) observed during the period of 1989 to 2011. The data shows that the number of Suicide Incidents of male, female, and average is well correlated with yearly averages of the SSN, SFI, and CI; as well as being positively correlated with CRI. Verma (2013) studied Suicide Incidents in relation to the geomagnetic activity parameters, such as the planetary Ap, Kp, and Dst Indices for the period of 1989-2010, and found large negative correlations between Suicide Incidents and the yearly averages of geomagnetic activity parameters: the Kp, Ap, and Dst indices. In this investigation the Suicide Incident in Slovakia is considered for statistical analysis with the Solar, Interplanetary and Geomagnetic Activity parameters for the period of 1986-2010, in order to explore which of the Solar, Interplanetary and Geomagnetic phenomena are responsible for this event.

Data Sources

Solar Activity (SA) parameters, Sunspot Numbers (SSN), Solar Flare Index (SFI), and interplanetary parameters, such as Sudden Storm Commencement (SSC) are taken from STP Solar Data (http://www.ngdc.noaa.gov/stp/solardataservices).

Data from the Planetary Kp, Ap, and Dst Indices' values have been taken from OMNI Web Data System (http://omniweb.gsfc.nasa.gov). The data of Suicide Incidents in Slovakia has been taken from the National Health Information Center (suicides incidents for the period of 1986-1995 available at http://www.nczisk.sk/Documents/publikacie/2005/zs0605.pdf and for the period of 1996-2011 available at http://www.nczisk.sk/Documents/publikacie/2012/zs1305.pdf).

Methods of Analysis

In this study a statistical method correlation has been used. The correlation is one of the most common, as well as the most useful statistics. A correlation is a single number that describes the degree of relationship between two variables. The 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 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

.8 to 1.0 or -.8 to -1.0 (very large relationship)
.6 to .8 or -.6 to-.8 (large relationship)
.4 to .6 or -.4 to -.6 (good medium relationship)
.2 to .4 or .2 to -.4(weak relationship)
.0 to .2or .0to -.2 (weak or no relationship)

Data Analysis and Results

From the data analysis of Table 1 and Figures 1, 2, 3, 4, 5 and 6 it is inferred that the death due to suicide in Slovakia are related to the yearly average of SSN and SFI. Around Solar Maximum, where the yearly Sunspot Numbers (SSN) and yearly mean of Solar Flare Index (SFI) are at a maximum, the death of males due to suicide has been found to be comparatively high in comparison to corresponding Solar Minimum, where the yearly average of Sunspot Number (SSN) and Solar Flare Index (SFI) are at a minimum. But in the case of female death due to suicide, the results are entirely different. For instance, around Solar Maximum, where the Sunspot Numbers (SSN) and Solar Flare Index (SFI) are at a maximum, the death of females due to suicide have been found to be comparatively low in comparison to corresponding Solar Minimum Figures 4 and 5.

Analysis of the data also shows that death due to suicide is related to Interplanetary and Geomagnetic Activity parameters. The death of males due to suicide are positively correlated with the annual Sudden Storm Commencements (SSC), the yearly mean of Geomagnetic Activity parameters such as the Planetary Kp, Ap, and Dst Indices. The death of females due to suicide are negatively correlated with the annual Sudden Storm Commencements (SSC), the yearly mean of Geomagnetic Activity parameters such as the Planetary Kp, Ap, and Dst Indices. The following main results have been obtain through the statistical analysis of Sunspot Numbers (SSN), Solar Flare Index (SFI), Sudden Storm Commencements (SSC), and Planetary Kp, Ap, and Dst Indices along with the male, female Suicide Incidents:

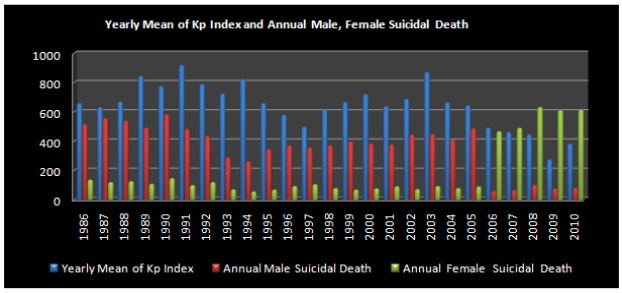

Figure1. Shows yearly mean of the Kp index and male, female suicide incidents in Slovakia for the period of 1986-2010.

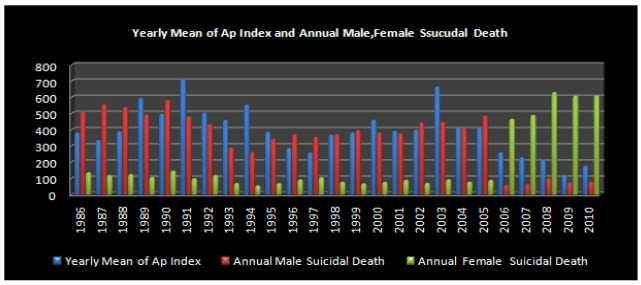

Figure 2. Shows yearly mean of the Ap index and male, female suicide incidents in Slovakia for the period of 1986-2010.

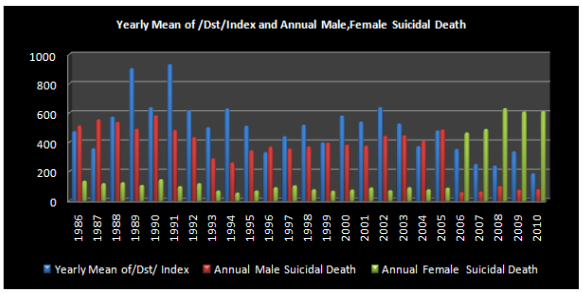

Figure 3. Shows yearly mean of the Dst index and male, female suicide incidents in Slovakia for the period of 1986-2010

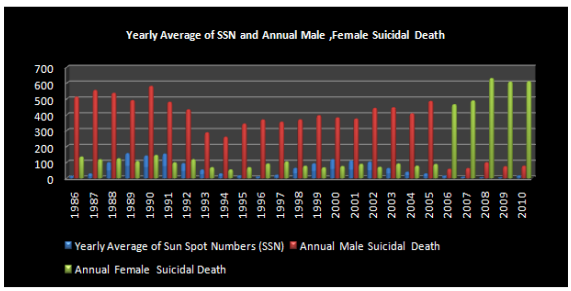

Figure 4. Shows yearly average of Sunspot Numbers (SSN) and male, female suicide incidents in Slovakia for the period of 1986-2010

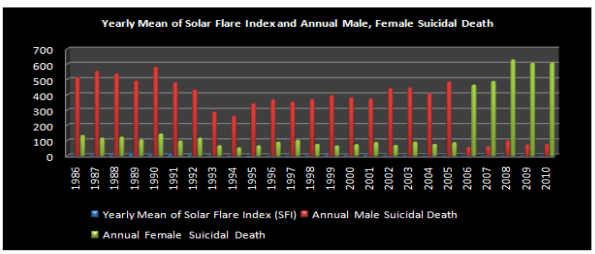

Figure 5. Shows yearly average of Solar Flare Index (SFI) and male, female suicide incidents in Slovakia for the period of 1986-2010

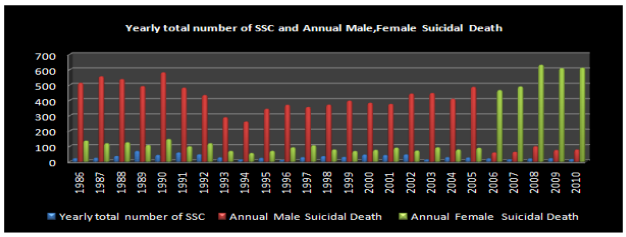

Figure 6. Shows annual Sudden Storm Commencements (SSC) and male, female suicide incidents in Slovakia for the period of 1986-2010

Main Results

(a) - Large positive correlation, with a correlation coefficient of 0.72, has been found between the yearly mean of Kp index and the yearly total number of male deaths due to suicide.

(b) - Large negative correlation, with a correlation coefficient of -0.77, has been found between the yearly mean of Kp index and the yearly total number of female deaths due to suicide.

(c) - Large positive correlation, with a correlation coefficient of 0.64, has been found between the yearly mean of Ap index and the yearly total number of male deaths due to suicide.

(d) - Large negative correlation, with a correlation coefficient of -0.68, has been found between the yearly mean of Ap index and the yearly total number of female deaths due to suicide.

(e) - Large positive correlation, with a correlation coefficient of 0.62, has been found between the magnitude of yearly mean of Dst index and the yearly total number of male deaths due to suicide.

(f) -Large negative correlation, with a correlation coefficient of -0.61, has been found between the magnitude of yearly mean of Dst index and the yearly total number of female deaths due to suicide.

(g) -Large positive correlation, with a correlation coefficient of 0.60, has been found between the yearly average of the Sunspot Numbers (SSN) and the yearly total number of male deaths due to suicide.

(h) -Good medium negative correlation, with a correlation coefficient of -0.49, has been found between the yearly average of Sunspot Numbers (SSN) and the yearly total number of female deaths due to suicide.

(i) -Good medium positive correlation, with a correlation coefficient of 0.57, has been found between the yearly mean of the Solar Flare Index (SFI) and the yearly total number of male deaths due to suicide.

(j) -Good medium negative correlation, with correlation coefficient of -0.40, has been found between the yearly mean of the Solar Flare Index (SFI) and the yearly total number of female deaths due to suicide.

(k) -Positive correlation, with correlation a coefficient of 0.51, has been found between yearly total number of Sudden Storm Commencements (SSC) and the yearly total number of male deaths due to suicide.

(l) - Negative correlation, with a correlation coefficient of -0.38, has been found between yearly total number of Sudden Storm Commencements (SSC) and the yearly total number of female deaths due to suicide.

Discussion and Conclusion

In this study, the significant correlations between the yearly number of male, female deaths due to suicide and Solar, Interplanetary, and Geomagnetic Activity parameters lead to the conclusion that variations in Solar, Interplanetary and Geomagnetic Field can directly or indirectly affect the human organism, mainly through the impact on the functional activity of the brain by changing its background state and infringing on the adequacy of reacting (responding) during transition from test phase to "normal" activity. These external perturbations particularly infringe on the balance of synchronic and non-synchronic systems, ergo (activating) - and trophotrophic (braking) the episegmentary vegetative centers. These changes are most likely connected to the dysfunction of central integrative brain apparatus accompanied by the strengthening of activating systems and through insufficiency (deficit) of inhibiting mechanisms. Dysfunction affects, in turn, the episegmentary vegetative centers, which are followed by the non-adequacy of vegetative securing of routine activity. Some scientists have studied Solar and Geomagnetic Activity in relation to the human physiological state and have concluded that there is a positive relation between the level of aggression in rats and Geomagnetic Activity (Persinger, 1997), as well as an connection between the increase of anxiety, aggression and Geomagnetic Activity, Interplanetary Magnetic Field (Grigoryev 2008). Although there is currently no known geophysical mechanism to explain this phenomena, it is expected that particular changes in the ambient electromagnetic and acoustical signals caused by Heliogeophysical factors could promote the exacerbation of the mental state and even act as a trigger of the suicidal behavior. However, the clarification of the mechanisms behind the impact of Solar, Interplanetary and Geophysical factors on humans requires more detailed studies.

References

Bothmer, V. & Daglis, I.A. 2006. 'Space Weather: Physics and Effects.' Springer Praxis Books, Environmental Sciences.

Breus TK, Chibisov SM., Baevsky RM., Schebzuhov KV., 2002. 'The chronostructure of heart biorhythms under effects of external environment factors.' Moscow: Russian University of People's Friendship, Polygraph Service; 231.

Breus, T.K. & Rapoport S.I., 2003. 'Magnetic Storms: Medical-Biological and Geophysical Aspects.' Moscow, "Sovetskii Sport" Press (In Russian).

Babayev, E.S. & Allahverdiyeva, A.A., 2007. 'Effect of Geomagnetic activity variations on the physiological state healthy humans: some results of Azerbajanian studies of functionally.' Adv. Sp. Res., 40, 1941.

Babayev, E.S., Mustafa, F.R., Shustarev, P.N., 2007. J. Beekeeping, Moscow, 1, 12.

Babayev, E.S., 2007. 'Recent Advances in Space Technologies.' (RAST-07), Proc .3rd Int. Conf. 14-16.

Babayev, E.S., & Allahverdiyeva, A.A., 2005. 'Revista CENIC: Ciencias Biologicas.' Numero Especial in CD, La Habana, Cuba, 36, 7.

Baevsky R.M., Petrov V.M., Cornelissen G., Orth-Gomer K., Akerstedt T., Otsuka K., Breus T., Siegelova J., Fiser J. 1997. 'Metaanalyzed Heart Rate Variability, Exposure to Geomagnetic Storms, and the Risk of Ischemic Heart Disease.' Scripta Med., 70, .199.

Cornelissen G., Halberg F., Breus T. et al., 2002. 'Non-photic Solar Associations of Heart Rate Variability and Myocardial Infarction.' J. Atm. Solar-Terr. Phys., 64,.707.

Davydov, B.I., Tikhonchuk, V.S., Strzhizhovskiy, A.D., 1996. 'Space Biology & Medicine, Vol. III: Humans in Spaceflight, Book 2: Effects of Other Spaceflight Factors.' Chapter 18: Nonionizing Radiation, AIAA, Moscow, "Nauka" Press.

Elchin S. Babayev., 2008. 'Solar and Geomagnetic Activities and Related Effects on the Human physiological and Cardio-Health State: Some Results of Azerbaijani and Collaborative StudiesFirst Middle East and Africa.' IAU-Regional Meeting Proceedings MEARIM No. 1, 235.

Ghione S., Mezzasalma L., Del. Seppia C., Papi F., 1998. 'Do Geomagnetic Disturbances of Solar Origin Affect ArterialBlood Pressure.' J. Hum. Hypertens., 12,749.

Gurfinkel' Iu.I., Gurfinkel' Iu.I., Kuleshova V.P., Oraevskii V.N. 1998. 'Assessment of the Effect of a Geomagnetic Storm on theFrequency of Appearance of Acute Cardiovascular Pathology.' Biofizika,.43, No.4,.654.

Khabarova O.,2009. 'Change of Geomagnetic Oscillatory Regimeis a Possible Cause of Human Sensitivity to CosmicSun and Geosphere.' 4(2): 79 .

Otsuka K.,Cornelissen G., Weydahl A. et al., 2001. 'Geomagnetic Disturbance Associated with Decrease in Heart RateVariability in a Subarctic Area.' Biomedicine Pharmacother., 55 (Suppl. 1), 51.

Oraevskii V.N., Kuleshova V.P., Gurfinkel' Iu.F., GusevaA.V., Rapoport S.I., 1998. 'Medico-biological Effect of NaturalElectromagnetic Variations.' Biofizika, 43, No.5, 844.

Palmer, S.J., Rycroft MJ, Cermack M., 2006. 'Solar and geomagnetic activity, extremely low frequency magnetic and electric fields and human health at the Earth's surface.' Surv. Geophys. 27:557.

Jansen, F., Pirjola, R.,& Favre, R. 2000. 'Space Weather Hazard to the Earth?' Swiss Re Publishing.

Persinger, M.A. 1987. 'Geophysical variable and human behavior Experiential.' 43(1), 92.

Ptitsyna N.G., G. Villoresi , L.I. Dorman , N. Iucci , M.I. Tyasto 1998. 'Natural and Man-made Low-frequency Magnetic Fieldsas a Potential Health Hazard.' UFN (Uspekhi PhysicheskikhNauk), 168(7),767.

Persinger, M.A., 1997. 'Geomagnetic variables and behavior: LXXXIII. Increased geomagnetic activity and group aggression in chronic limbic epileptic male rats, Percept.' Mot. Skills, 85 (3 Pt 2), 1376.

Pavel Grigoryev1, et al., 2007. 'Natural Cataclysms and Global Problems of the Modern Civilization.' Special edition of Transactions of the International Academy of Science “Health & Ecology”, ICSD/IAS, Baku-Innsbruck, 729.

Stoupel E., Wittenberg, J., Zabludowski, G., Boner, 1995. 'Ambulatory Blood Pressure Monitoring in Patients with Hypertension on Days of High and Low Geomagnetic Activity.' J. Hum. Hypertens. 9,.293.

Verma, P.L., 2012. 'Suicide incidents in India in relation with solar activity parameters and cosmic ray intensity (1989 to 2011).' International Journal of Physical Sciences, 7(49), 6240.

Verma, P.L., 2013. 'Suicide Incident in India in Relation with Geomagnetic Activity Parameters During the Period of 1989-2010.' IJAR, 3(6) 464.

Zhadin, M.N., 2001. 'Review of russian literature on biological action of DC and low-frequency AC magnetic fields Bioelectromagnetics.' 22(1), 27.