

Cosmic Ray and Human Health

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Abstract

In the last years a number of studies were published about Space Weather effects on humans [1-86]. Until the last part of the XX century the studies were limited to Solar (SA) and Geomagnetic (GMA) activities. Only in the last decades of this century began an active interest in Cosmic Rays, describing their role in the form of Neutron Activity (in Impulse/minute) around our Planet [87-91]. The aim of this study summarizes observations in this field.

Keywords: Cosmic Ray; Human Health; Solar (SA); Geomagnetic (GMA)

Introduction and Methodology

Until the final decades of the XX century studies about Space Weather concentrated on Solar Activity (SA) and Geomagnetic Activity (GMA). Both this factors are shields of our Planet from the Cosmic Rays. G Sigl is describing the Cosmic Rays as "one of major unresolved questions in astrophysics.

The limits of energy at our Planet are 10^{19} Electron/Volt. In the last years the source of Cosmic Rays is a Black Hole, close, but outside of our Galactic. This allow to prevent of inclusion in of all our descriptions of energy of this planet the Plank coefficient. Some fractions of Cosmic Rays achieve energies of 10^{21-22} El/V. Under such pressure the Electrons in atoms are pressed into their nuclei and transform to Neutrons. The Neutron activity in Impulses/Minute (Imp/min) around our Planet is a measure of Cosmic Ray activity (CRA). The Cosmic Ray characteristic is as follows: "An extremely Energetic (Relativistic) Charged particle primary originated outside the Earth's magnetosphere".

From year 1968 we started to accumulate data about Space Weather effects on Acute Myocardial Infarction morbidity and mortality. The first presentation was made at the 7th conference of Latvia's Internal Medicine s in Riga, Latvia's capital. The data was from the Vilnius U-ty hospital, Hospital Therapy Department under the chair of my Teacher and Friend professor Liubomiras Laucevichius. The authors were I. Stupelis, (E. Stoupel), J. Jushenaite, J. Labanauskas, N. Stanaityte. The name of our presentation was: "The activity of the Earth's magnetic field, season, and risk of death from myocardial infarction".

Additional presentations were made on the Lithuanian Resort cardiology congress in Druskininkai (1970) and at the II Congress of Cardiology of USSR in Moscow at 1973.

My following activity in this field was in Israel, were I live since 1974. Here I worked in "Hasharon" University hospital (1974), and since 1975 in "Beilinson" Medical Center. The two mentioned hospitals are now united under name "Rabin Medical Center". The work done under professors M. Aygen, J. Agmon, S. Scliarovski, A. Battler and now R. Kornowsky.

Very short about statistics: Pearson correlation coefficients and their probabilities were obtained, in addition to each group average. Probabilities of 95% and higher were described as significant. Those of 94 - 90% as a strong trend to significance. Probabilities lower than 90% were described as Non-Significant (NS).

Results

Presents the Geomagnetic Activity gradation (Figure 1). In our following tables some cardiovascular risk factors were compared in Quiet (I⁰) and Stormy (IV⁰) days of GMA.

Category	"A" index range	Typical "K" values	Amplitude (Nanotesla)
1. Quiet (I ⁰)	0 < A < 8	Usually No. > 3	0 - 20
2. Unsettled (II ⁰)	8 < A < 16	Usually No. > 3	21 - 40
3. Active (III ⁰)	16 < A < 30	Few indices of 4	41 - 70
4. Minor storm (IV ⁰)	30 < A < 50	Mostly 4 & 5	71 - 120
5. Major storm (IV ⁰)	50 < A < 100	Some indices 6	121 - 200
6. Severe storm (IV ⁰)	100 < A	Some indices 7	201 - >550

Figure 1: Geomagnetic activity gradation.

Figure 2 presents the interrelationship between Solar (SA), Geomagnetic (GMA) and Cosmic Ray (CRA) activities. SA and GMA are strong ($r = -0.85$, $p < 0.0001$; $r = -0.66$, $p < 0.0001$) and very significant inverse correlated. SA and GMA are related by $r = 0.5$; $p < 0.0001$.

Figure 3 shows some cardiovascular risk factor dynamics at high (stormy) GMA (left side) and by low GMA and high CRA (Neutron) activity (right side).

Three Space Weather Power Activity Links (240 months, 1990-2009)

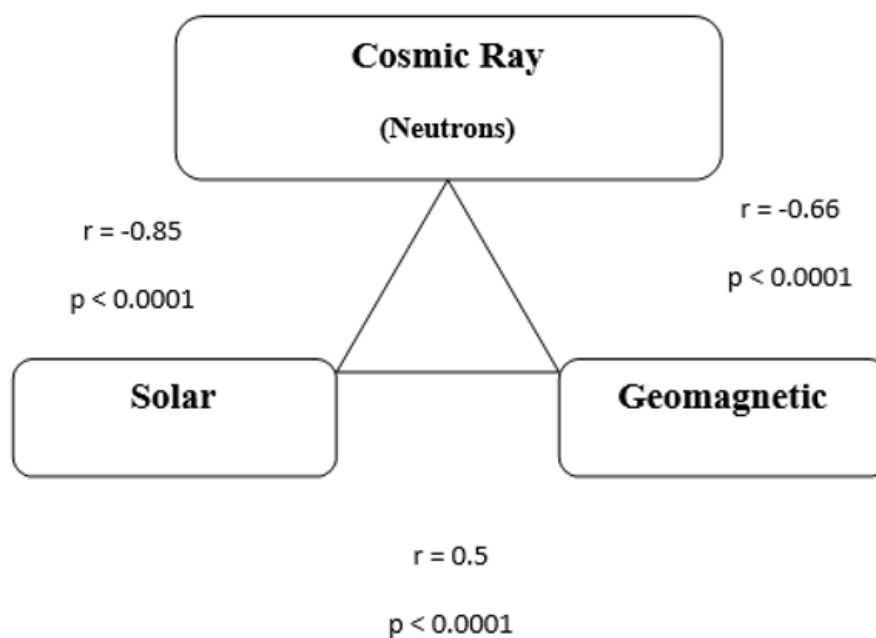


Figure 2

In high GMA such cardiovascular Risk Factors like Blood Coagulation, arterial blood pressure, Inflammation parameters (C-Reactive Protein (CRP) are rising. In high CRA (Neutron) activity cardiac arrhythmia components are rising, including Supraventricular and ventricular extrasystoles, Ventricular Tachycardia (VT), Ventricular Fibrillation (VF) predictors of Sudden Cardiac Death (SCD). Much more AMI patients suffer Cardiac Arrhythmia. Life Threatening Cardiac Arrhythmias demanding Implantable Cardioverter-Defibrillator Discharges much and significantly more in high CRA and less at higher GMA (Mayo Clinic data) [92]. The discharges took place in higher CRA (Neutron) activity [92]. Additional events at this Space Weather situation includes Acute Myocardial Infarction (AMI), Left Anterior Descending Coronary Artery as the culprit artery in AMI. The possible explanation of this effects can be the special links between the human Atheroma in the arteries with Neutron activity, stimulating such changes like Atheroma fissuring and/or disruption playing an important role in the natural history of Acute Coronary Events [93,94].

And, finally, the cardiovascular pathology that is close to take the place of Coronary Heart Disease-Cerebral Stroke (CVA) is killing his victims much more in high CRA (Neutron) activity days. With correlation coefficient $r = 0.41$ in I^0/IV^0 GMA levels comparison, much higher

Some Cardiovascular Disease Risk Factors in Extreme High/Low Daily Space Weather Conditions

GMA Stormy Days	Low GMA / High CRA – Neutron Activity (imp./min)
Blood coagulation: Prothrombin time - INR - ↑11.8%, p=0.007 Platelets count - ↑24.33%, p=0.02 Fibrinogen - ↑11.18%, p=0.02 Platelets activity - ↑8.63%, p=0.09 Basophils - ↓63.3%, p=0.03	Electric Heart Instability (imp./min): APB - ↑31.57%, VPB - ↑25%, I ⁰ /IV ⁰ GMA VT, VF - ↑, r=0.9, p=0.02, I ⁰ /IV ⁰ GMA PAF, AMI, SCD - ↑
Inflammation: C-Reactive Protein (IV ⁰ /I ⁰ GMA) - ↑, r=0.096 Immunoglobulins M, G - ↑, p=0.039 Anticardiolipin Syndrome - ↑	Cardiac Arrhythmia (AMI pts) - ↑14.1%, r=0.96, p=0.01, I⁰/IV⁰ GMA Implantable Cardioverter Defibrillator (ICD) discharges for VT, VF at 9246±299 imp./min, Daily average (1995 – 2005yy) 8865±411 imp./min, r=0.96, p=0.01, I⁰/IV⁰ GMA
Arterial Blood Pressure: Systolic pressure - ↑ 14.6 mmHg Diastolic pressure - ↑ 2.25 mmHg Maximum daily Systolic pressure - ↑ 5.56 mmHg Maximum daily Diastolic pressure - ↑ 6.04 mmHg	Stroke (CVA) mortality – Neutron Activity, r=0.41, p<0.0001 (n=132,000)

Figure 3

in quiet (low) GMA/higher Neutron activity, as it show the data of 132.120 CVA death's in Kaunas, Lithuania, and also in Israel. In addition, we must mention that many other acute medical events are related to Space Weather dynamics: pregnancy natural history. Intraocular pressure changes, migraine attacks, immunology and endocrinology effects, Such changes in human behavior like suicide and homicide also are in this group.

Discussion

Long time considering Space Weather effects on Human Health most attention was put to SA and GMA. In the last decades of the XX Century some studies appeared also to high energy Protons and Cosmic Rays. In year 2002 we published in *Journal of Basic and Clinical Physiology and Pharmacology* a paper "Cosmic Rays Activity and monthly Number of Deaths. A correlative Study". In year 2007 we published a paper named "Clinical Cosmobiology: Distribution of deaths during 180 months and Cosmophysical Activity. "The Lithuanian study, 1990-2004.The role of cosmic rays". *Journal "Medicina" 42, 218-241.* The Cosmic ray data helped to achieve a known astrophysicist Dr. P. Israelevich, who was one of coauthors. It was a beginning to give the Clinical Comobiology issue a new way, including also the cosmic rays as one of the major factors in the problem of Space Weather action on human health.

An additional question was the origin of Cosmic Rays: if they are from our Galactic, and we accept that 10^{19} electron/volt is the energy limit on this Planet, so taking in account energies of 10^{21-22} measured in some fractions of cosmic ray's, Plank coefficient must be included in the energy equations. $E = mc^2$ must be replaced in A. Einstein's equation by $E = mc^2/1+mc^2/E_p$.

But it was not done, because some studies show that cosmic rays are coming from a Black Hole, close to our Galactics, but outside. Anyway, this questions are a source for intensive discussions in the leading scientific Journals.

Conclusion

1. Cosmic Ray are inverse related to Solar (SA) and Geomagnetic Activities (GMA).
2. A number of Cardiovascular Disease risk factors are rising by high SA and GMA. But a similar picture with other risk factors is seen in High CRA and low SA and GMA, resulting in higher mortality from Acute Cardiovascular Events on High CRA (Neutron) activity.
3. Preventive measures are recommended in both Extreme Space Weather situations
4. GMA can be a defense factor again some Life Threatening Cardiac Arrhythmias in high CRA (Neutron) activity.

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