

CORRELATION OF TWO LEVELS OF SPACE PROTON FLUX WITH MONTHLY DISTRIBUTION OF DEATHS FROM CARDIOVASCULAR DISEASE AND SUICIDE

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ABSTRACT

In our previous studies /1-3/ we described some significant links between monthly number of deaths due to cardiovascular disease and suicide and space proton flux >90 MeV. The aims of the present study were to compare the relationship of some solar and geomagnetic parameters with space proton fluxes of >60 and >90 MeV; to examine the monthly correlation of these two proton groups with the monthly death distribution in two countries, Israel and Lithuania. Physical data were obtained from the National Geophysical Data Center and the SESC in Boulder, CO; NSSDC in Goddard Space Flight Center, USA, and the Izmiran Institute of the Academy of Sciences in Russia. Pearson correlation coefficients and probabilities were compared for 56-180 consecutive months. Proton flux of >60 MeV significantly correlated with three of the four studied monthly geomagnetic activity indices (Ap, Am, Dst), but not with such solar activity markers as sunspot number and solar flux (2800 MGH, 10.6 cm). There was no significant relationship between proton flux of >60 MeV and monthly

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number of deaths from cardiovascular diseases and suicide, in contrast to the results for >90 MeV. From the data available during the 36 months (1986-1988), there was no correlation between monthly levels of >60 to >90 MeV. In conclusion, a monthly space proton flux of >60 MeV is not significantly correlated with the monthly death distribution from cardiovascular disease and suicide and some solar activity indices, such as proton flux of >90 MeV. It is possible that the 60-90 MeV fraction in the >60 MeV proton flux "blunts" the cosmobiological relationship between proton flux of >90 MeV and monthly death number.

INTRODUCTION

Earlier studies by our group have indicated the existence of correlative links between fluctuations in proton flux, a component of cosmic rays and solar wind, and other cosmophysical events (solar activity, geomagnetic activity) and the temporal distribution of some biological-medical phenomena /1-3/. These studies involved the comparison of only one energy level of proton flux, >90 MeV. The aim of the present study was to correlate the same monthly cosmophysical and biological parameters with a second energy level of proton flux, >60 MeV, and to determine whether there are differences in the physical and biological relationships of the >60 MeV and >90 MeV fractions.

METHODS

The cosmophysical parameters examined were sunspot number, solar radioflux (2800 MGH, 10.6 cm, wavelength), geomagnetic activity (Ap, Am, Cp, Kp), radiowave propagation (Fof2), minimum and maximum (+ and -) ionosphere ionization in early morning and noon, and sudden magnetic disturbances of the ionosphere (the last 3 parameters up to 1989 only) /4/. These data were obtained for various periods between 1983 and 1997 from the National Geophysical Data Center in Boulder, Colorado /5,6/, the National Space Service Center in Boulder, Colorado /7/, the Goddard National Space Flight Center in Greenbelt, MD, USA /8/, and the Izmiran Institute of the Academy of Sciences of the former USSR (up to 1989 only) /9/. For the present

study, the monthly levels of proton flux >90 MeV and >60 MeV were compared for 36 months (1986-1988).

Data on the monthly distributions of deaths from acute myocardial infarction, ischemic heart disease, stroke and suicide, among the leading causes of death in developed countries, were collected during various periods between 1983 and 1997 at two major medical centers located in geographically distinct regions (Rabin Medical Center, Israel and Kaunas Medical University, Lithuania). Specifically, the monthly distribution of deaths from acute myocardial infarction was correlated with fluctuations in proton flux >90 MeV over a 228-month period (1,892 deaths) and with >60 MeV over a 56-month period (353 deaths) at Rabin Medical Center. The distribution of deaths from ischemic heart disease was correlated with proton flux >90 MeV over two 107-month periods (2,992 and 1,465 deaths; age group 35-64 year only) and with proton flux >60 MeV over a 96-month period (129,913 deaths) at Kaunas Medical University (Lithuanian national data). The monthly distribution of deaths from stroke was correlated with proton flux >90 MeV over a 107-month period (1,287 deaths) and with >60 MeV over a 56-month period (295 deaths) at Rabin Medical Center, and for 107 months (949 deaths) and 96 months (39,919 deaths) in Lithuania. The monthly distribution of deaths from suicide was correlated with proton flux >90 MeV over 107 months (2,539 deaths) in Israel and with proton flux >60 MeV over 96 months (11,704 deaths) in Lithuania.

Statistical analysis

Pearson correlation coefficients (r) and their probabilities (p) were calculated for monthly proton flux >90 and >60 MeV and the other cosmophysical parameters and the biological parameters, and for measurements of proton flux of >90 MeV and >60 MeV (36-month period). Probabilities of 95% were considered significant and 90-94% as strong trends.

RESULTS

Figures 1 and 2 show some of the cosmophysical relationships for proton flux >90 MeV and >60 MeV, respectively. Proton flux >60 MeV was significantly correlated only with geomagnetic activity

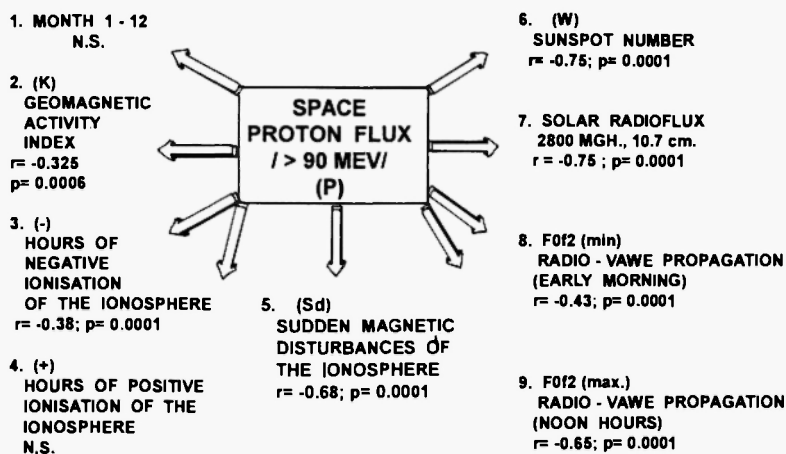


Fig. 1: Cosmophysical interrelationship for month by levels of space proton flux >90 MeV. ©Springer-Verlag; reprinted with permission from [3].

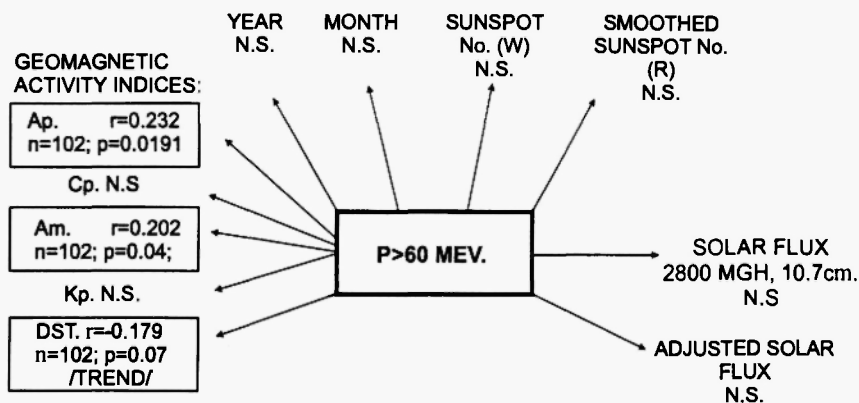


Fig. 2: Cosmophysical interrelationship for monthly levels of space proton flux >60 MeV.

whereas proton flux >90 MeV was correlated also with solar activity and other related parameters. Tables 1 and 2 show the correlation between protons of both energy levels with the monthly deaths from cardiovascular disease and suicide, respectively. In contrast to the significant correlation of the medical data with proton flux >90 MeV,

TABLE 1

Monthly (n) space proton flux and cardiovascular deaths (N) distribution

Proton flux >90 MeV	Proton flux >60 MeV
1. Myocardial infarction	
Rabin Medical Center, Israel	
n = 228; N = 1892	n = 56; N = 383
r = 0.405; p = 0.0001	N.S.
2. Ischemic heart disease	
Kaunas, Lithuania (35-64 yr)	Lithuania
n = 107; N = 2,992	n = 96; N = 129,913
r = 0.314; p = 0.001	N.S.
3. Chronic ischemic heart disease	
Kaunas, Lithuania (35-64 yr)	
n = 107; N = 1,465	
r = -0.36; p = 0.0002	
4. Stroke	
Rabin Medical Center, Israel	
n = 107; N = 1,287	n = 56; N = 295
r = -0.221; p = 0.02	N.S.
5. Stroke	
Kaunas, Lithuania (35-64 yr)	Lithuania
n = 107; N = 949	n = 96; N = 39,919
r = -0.25; p = 0.01	N.S.

r = Pearson correlation coefficient; p = probability; N.S. = non significant

TABLE 2

Monthly (n) space proton flux and suicide (N) distribution

Proton flux >90 MeV	Proton flux >60 MeV
1. Suicide (fatal)	
Israel	
n = 107; N = 2,359	
r = 0.418; p = 0.0001	
2. Suicide (fatal)	
Lithuania	
n = 96; N = 11,704	
N.S.	
3. Suicide (attempts)	
Israel	
n = 107; N = 7,234	
r = 0.425; p = 0.0001	
4. Suicide and trauma	
Kaunas, Lithuania (35-64 yr)	
n = 107; N = 3,523	
r = -0.49; p = 0.0001	

r = Pearson correlation coefficient; p = probability; N.S. = non significant

no significant correlations were noted for proton flux >60 MeV. Interestingly, this holds true also when suicide attempts were taken into consideration: 83 month data, n=7,234, Israel. The measurements of proton flux at both energy levels over a 36-month period are shown in Figure 3. The mean monthly values were 2.25 ± 0.275 and $0.231 \pm 0.108 \text{ P.cm}^{-2}.\text{s}^{-1}.\text{sr}^{-1}$ for >60 and >90 MeV, respectively. There was no correlation between the two ($r = 0.095$).

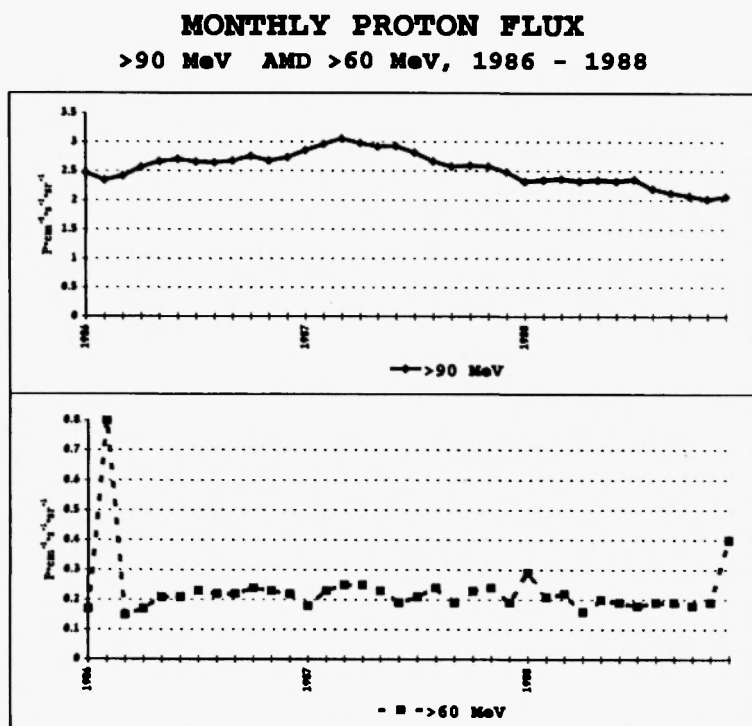


Fig. 3: Thirty-six months' (1986-1988) levels of space proton flux >90 and >60 MeV.

DISCUSSION

Our earlier studies indicated a close adverse relationship between proton flux >90 MeV and other cosmophysical factors and the monthly distribution of deaths from cardiovascular disease and suicide /1-3/. These findings were not observed here for proton flux >60 MeV. We speculate that the 60-90 MeV fraction of the >60 MeV proton flux may be derived from sources not closely linked to cosmophysical influences or that it has a different distribution by time. As a result, it "blunts" the previously documented cosmobiological impact of the >90 MeV fraction. This assumption is supported by data showing that low-energy proton flux is generated by smaller "proton events" /10/ and it has a weaker relationship to cosmic rays of solar and astro-

physical origin /10,11/. High-energy proton flux, however, as shown here, is significantly related, positively or adversely, to solar activity and ionospheric physical parameters, and these apparently act together to affect the temporal distribution of terrestrial biological events. In our previous studies, such links were demonstrated for human genetic, immunological and anatomic parameters, the coagulation system, blood pressure, electrical heart instability, hormone activity and related clinical consequences /1,2,12-16/.

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