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The possible effects of the solar and geomagnetic activity on multiple sclerosis

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ABSTRACT

Objectives: Increasing observational evidence on the biological effects of Space Weather suggests that geomagnetic disturbances may be an environmental risk factor for multiple sclerosis (MS) relapses. In the present study, we aim to investigate the possible effect of geomagnetic disturbances on MS activity.
Patients and methods: MS patient admittance rates were correlated with the solar and geophysical data covering an eleven-year period (1996–2006, 23rd solar cycle). We also examined the relationship of patterns of the solar flares, the coronal mass ejections (CMEs) and the solar wind with the recorded MS admission numbers.
Results: The rate of MS patient admittance due to acute relapses was found to be associated with the solar and geomagnetic events. There was a “primary” peak in MS admittance rates shortly after intense geomagnetic storms followed by a “secondary” peak 7–8 months later.
Conclusion: We conclude that the geomagnetic and solar activity may represent an environmental health risk factor for multiple sclerosis and we discuss the possible mechanisms underlying this association. More data from larger case series are needed to confirm these preliminary results and to explore the possible influence of Space Weather on the biological and radiological markers of the disease.

1. Introduction

Solar activity collectively represents Sunspots, Flares, Coronal Mass Ejections (CMEs) and assorted solar eruptive events. This activity results in the injection of large amounts of radiation (X-rays, UV radiation, etc), high energy particles (electrons and occasionally protons) and high speed solar plasma (as solar wind) to the interplanetary space. These phenomena affect the Earth’s upper atmosphere, ionosphere and magnetic field [1,2]. The solar activity exhibits an 11-year periodic variation known as a solar cycle which is quantified by the sunspot number. Each cycle is divided into three phases; the rise phase with an increasing range of active phenomena, the maximum phase as the phenomena peak and the decline phase as they gradually decay to the quiet Sun levels.

Earth is protected from the solar activity by its magnetosphere [2]. Yet, under certain conditions solar energy and mass can penetrate the terrestrial environment resulting in magnetospheric disturbances known as geomagnetic activity which includes magnetic storms and substorms. These disturbances are quantified by geomagnetic indices. The DST (Disturbance Storm Index) represents magnetic activity and is derived from a network of near-equatorial geomagnetic observatories measuring the intensity of the globally symmetrical equatorial electrojet (the ring current). It varies, in practice, from +30 nano Tesla (nT) to −200 nT; the range −50 nT to −100 nT characterizes a substorm while values below −100 nT indicate a magnetic storm [2].

A continuously growing body of evidence suggests that the helio-geomagnetic activity may influence various medical conditions and human behaviour (e.g. heart attacks, psychiatric diseases,

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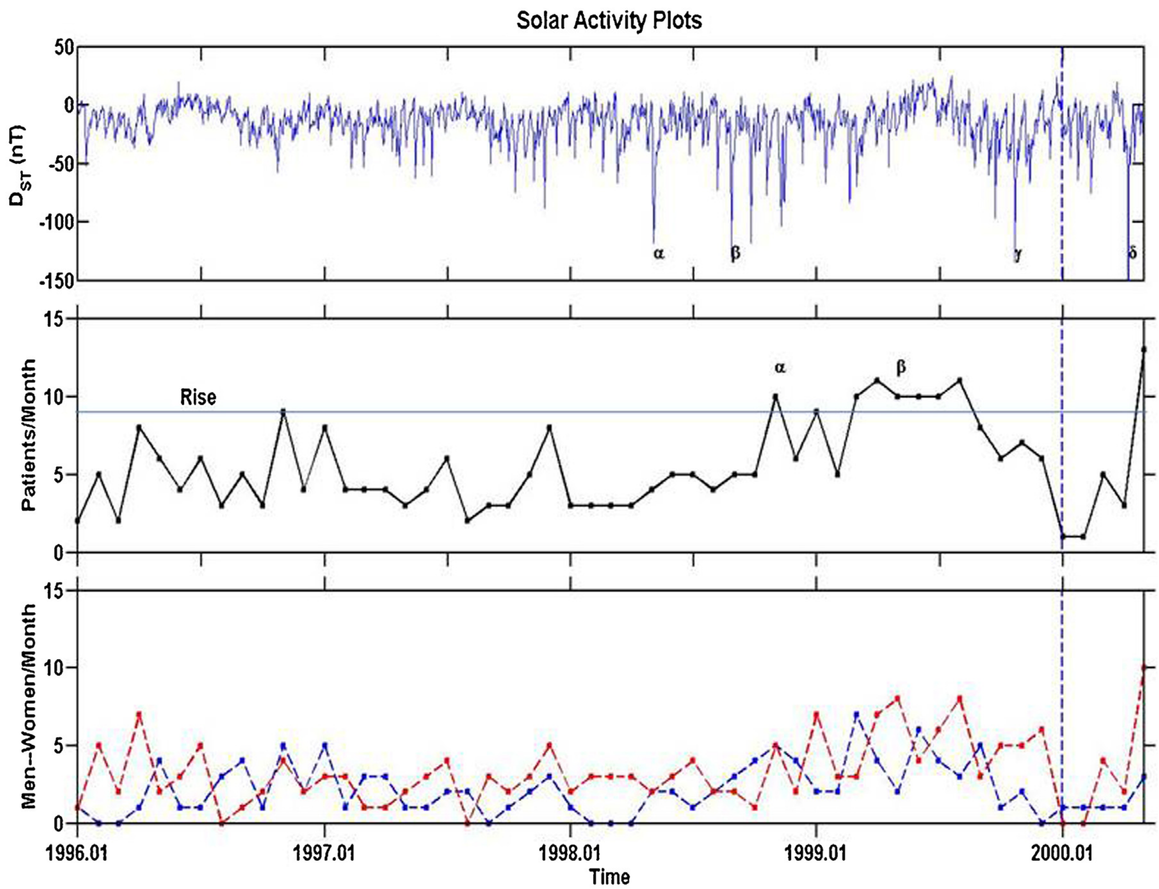

Fig. 1. Geomagnetic activity plots for the Rise Phase. Upper panel: The daily values of the geomagnetic index DST during 1996–1999 (Rise Phase). Middle panel: The admittances per month of MS patients during 1996–1999 (Rise Phase); the confidence level marked by the horizontal line was set at 5 + 2.7 (mean plus standard deviation of the sample). Bottom panel: Monthly distribution of males (blue line) and females (red line) MS patients during 1996–1999 (Rise Phase). In the upper and middle panels the significant peaks in the patient admissions were annotated with Greek letters (see text for details). DST: Disturbance Storm Index; MS: multiple sclerosis. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

myocardial infractions, stroke, epilepsy, suicides, and traffic accidents) [3]. The underlying mechanisms (e.g. melatonin suppression [4,5], Schumann resonances [6], etc), however, remain speculative.

Multiple sclerosis (MS) is a chronic, inflammatory, demyelinating disease of the central nervous system (CNS) which affects mainly young adults. Attempts have been made to link a number of external stimuli to the pathogenesis of MS including viral and bacterial infections, exposure to sunlight, shifts in environmental temperature, ionizing and non-ionizing radiation, nutrition, hormonal changes, etc., with conflicting results [7,8].

Previous studies on the possible association between the solar and geomagnetic factors with multiple sclerosis indicate that the geographic distribution of MS appears to be better related to the geomagnetic than the geographic latitude [9,10]. The prevalence of MS is lower in equatorial regions, and increases rapidly as we move towards the north and the south, until it peaks at about 60° [11]. Herein, we study the hypothesis that the geomagnetic activity and the associated solar drivers affect MS activity and we present data from the patient records of the Department of Neurology, University Hospital of Patras, Greece within the 23rd solar cycle (1996–2006).

2. Materials and methods

The data for the solar activity and the geomagnetic index DST were obtained from

the OMNI database [12] for the number of sunspots and the near-Earth solar wind speed, the GOES satellite database [13] for the number of flares, the SOHO/LASCO satellite database for the number of CMEs, and the Kyoto Observatory [14] for the daily values of the DST index.

Cases of MS covering a 23 year period (1984–2006) had been already identified during an epidemiological survey [15]. In this study we included all cases of MS patients who were admitted to the Department of Neurology of the University Hospital of Patras due to an acute episode from 1996 until 2006. These included both the newly diagnosed patients and those with a known history of relapsing-remitting MS (RRMS). The data were collected using the Clinic's admittance records and the patient files.

We used two common statistical tools [16]:

1. The Pearson's Product Moment Correlation Coefficient, $r(X, Y)s$: It gives an indication on the strength of the linear relationship between two random variables X(t) and Y(t):

$$r(X,Y) = \left(\frac{1}{n-1}\right)\sum_i \left(\frac{X_i-\mu_X}{\sigma_X}\right)\left(\frac{Y_i-\mu_Y}{\sigma_Y}\right)$$

where $(X_i-\mu_X)/\sigma_X$, μ_X, and σ_X are the standard score, sample mean, and sample standard deviation for the random variable X; the same holds for $(Y_i-\mu_Y)/\sigma_Y$, μ_Y, and σ_Y respectively. If r(X,Y) = 0, then X and Y are said to be uncorrelated (or linearly independent as a special case). The closer the value of r(X,Y) is to 1, the stronger the correlation between the two variables.