

Relationship between solar activity and myocardial infarctions in Mexico City

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RESUMEN

Se llevó a cabo un estudio de la ocurrencia diaria de 2290 infartos al miocardio registrados en la ciudad de México en el Instituto Nacional de Cardiología de 1992 a 1996. El análisis de todo el período 1992-1996 muestra que la periodicidad más prominente en la incidencia de infartos es la de siete días y que hay una tendencia a que aumente dicha incidencia en días de decrementos Forbush por un factor de 1.13, comparado con los días en los cuales no se presenta el fenómeno mencionado.

PALABRAS CLAVE: Relación Sol-Tierra, actividad solar, salud, infartos al miocardio.

ABSTRACT

Daily incidence of 2290 myocardial infarctions in Mexico City at the National Institute of Cardiology from 1992-1996 shows that the most prominent periodicity in the infarction rate is seven days. A tendency is noticed for a higher average infarction rate, by a factor of 1.13, in days of Forbush decreases, compared with the average occurrence in days without Forbush decreases.

KEY WORDS: Sun-Earth relationships, solar activity, health, myocardial infarctions.

INTRODUCTION

In the last few years some solid evidence suggests that solar variability, through geomagnetic activity and cosmic rays, may affect human health. These studies use thousands of cases and present results of statistical significance that relate some pathologies such as myocardial infarctions and brain strokes with cosmic ray flux decreases (Forbush decreases), the persistence of a negative southward interplanetary magnetic field component, or the occurrence of large geomagnetic storms (Hallberg *et al.*, 1991; Dorman *et al.*, 1993; Breus *et al.*, 1994; Villoresi *et al.* (a), (b), 1994; Ptitsyna *et al.*, 1995). From the Medical Emergency Service of Moscow during the period 1979-1981 (around solar maximum), Villoresi *et al.* (1994 a) found that during times of Forbush decreases and geomagnetic index $aa > 60 \gamma$, there was an increase of the infarction and brain stroke rates by a factor of 1.13 and 1.07; and of 1.10 and 1.08 respectively, compared with days without Forbush decreases, or $aa > 60 \gamma$. Villoresi *et al.* (1994 b) performed a similar study for St. Petersburg during January-December 1981, finding an increase of infarction rate during Forbush decreases of 1.14, in agreement with their results in Moscow.

One of the problems with these studies is the identification of the physical mechanism leading to an interaction of solar activity with the biota. Other aspects include the latitudinal dependence of the effects. Moscow and St. Petersburg are at high magnetic latitudes, while Mexico City is at a low magnetic latitude. In this paper we discuss the

proposed relationships between Forbush decreases and intense geomagnetic activity (index $aa > 60 \gamma$), and infarction rate in Mexico City.

DATA AND RESULTS

We use the daily number of myocardial infarctions in Mexico City registered at the National Institute of Cardiology from the 1st of January 1992 to the 31st of December 1996. There are 2290 cases. Figure 1a shows the corresponding time series. Figures 1b and 1c show the power spectra obtained by the Fast Fourier Transform and the Maximum Entropy (MEM) Methods of spectral analysis. MEM gives a better spectral resolution. In Figure 1c we may observe annual (200 days), bimonthly (14.5 and 14 days), and weekly (7 days and its harmonic 3.5 days) peaks. The peaks are correlated with meteorological signals (seasonal variations) or to signals that may be attributed to social organisation (Villoresi *et al.*, 1994 a) or to multiseptan biological rhythms (Breus *et al.*, 1995). Also day-to-day fluctuations of non-periodic origin are evident. They may be related to solar variability, and in order to study them we shall clean up the data by eliminating meteorological and social periodicities.

Figure 2a shows the seasonal weekly behaviour; summer Fridays seem to be slightly more dangerous. Figure 2b shows the bimonthly behaviour. If we relate this behaviour with the fortnightly pay day, on the 15th and the 30th of each month, we find an increase in the infarction rate one week

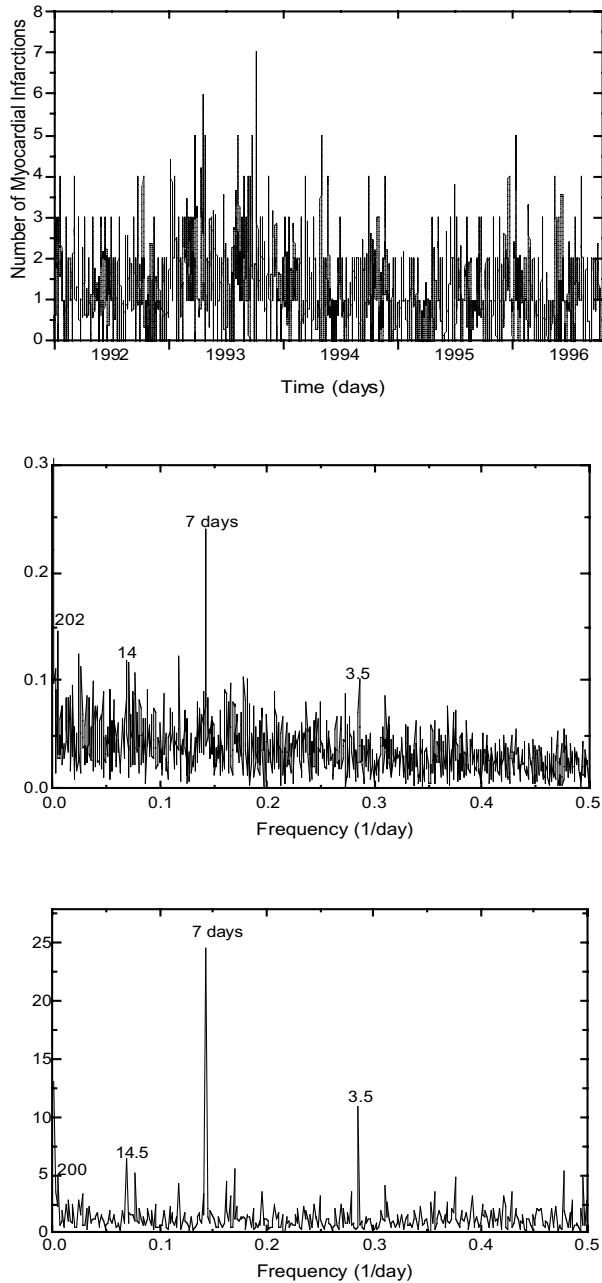


Fig. 1a) Number of daily myocardial infarctions registered in Mexico City at the National Institute of Cardiology. The period goes from the 1st of January 1992 to the 31st of December 1996. 1b) Power spectral analysis of the data using the Fast Fourier Transform Method. 1c) Power spectral analysis of the data using the Maximum Entropy Method.

after a pay day. When annual and bi-monthly behaviour is removed, the superposed epoch analysis in Figure 3a indicates that during weekdays the infarction rate is higher in comparison with weekends by a factor of 1.42. If this situation is due to the social organisation of life we may suggest that a more relaxed routine may diminish infarctions. To test this

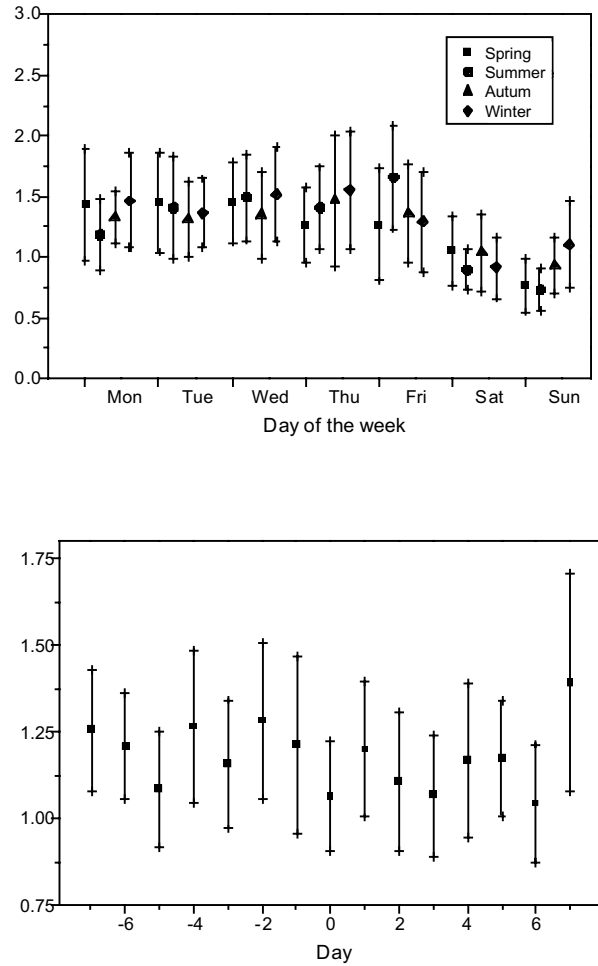


Fig. 2a) Seasonal weekly behaviour of the average number of myocardial infarctions. 2b) Bimonthly behaviour of the average number of myocardial infarctions. The day “0” corresponds to the 15th and the 30th of every month. The vertical lines in both figures indicate a 95% level of confidence.

proposition we plotted the average rate of heart attacks for holidays not coincident with Saturdays and Sundays. The result indicates a slightly higher incidence of infarctions during weekdays compared with holidays by a factor of 1.05, however, the incidence in holidays is higher than during weekends.

Finally, the myocardial infarction data cleaned of annual, bimonthly and weekly effects can be analysed in relation with geomagnetic phenomena. We study two kinds of events (Villoresi *et al.*, 1994 a): (1) geomagnetic activity defined by the *aa* index, specifically when $aa > 60 \gamma$; and (2) Forbush decreases with a decrease of $> 1.5\%$, as observed at the Neutron Monitor Station in Mexico City. Further we studied: (2a) Forbush with sudden start and smooth start (FD), and (2b) Forbush with a sudden start only (the decrease from the normal level of cosmic ray flux occurs in less than

24 hrs). We compared the average rate of infarctions for the days characterised by the phenomena mentioned above with the rate for days excluded by the criterion of selection. Figure 3b shows the average results for the years 1992-1996. We observe that for cases (1) and (2a) the effect is small, but for case (2b), i.e., days with Forbush decreases with a sudden start, the infarction rate increased by a factor of 1.13, compared with days without Forbush.

Figures 2 and 3 are plotted with uncertainties corresponding to a 95% of confidence level.

DISCUSSION AND CONCLUSIONS

The most prominent periodicities found in the present study correspond to seven days and its harmonic, 3.5 days.

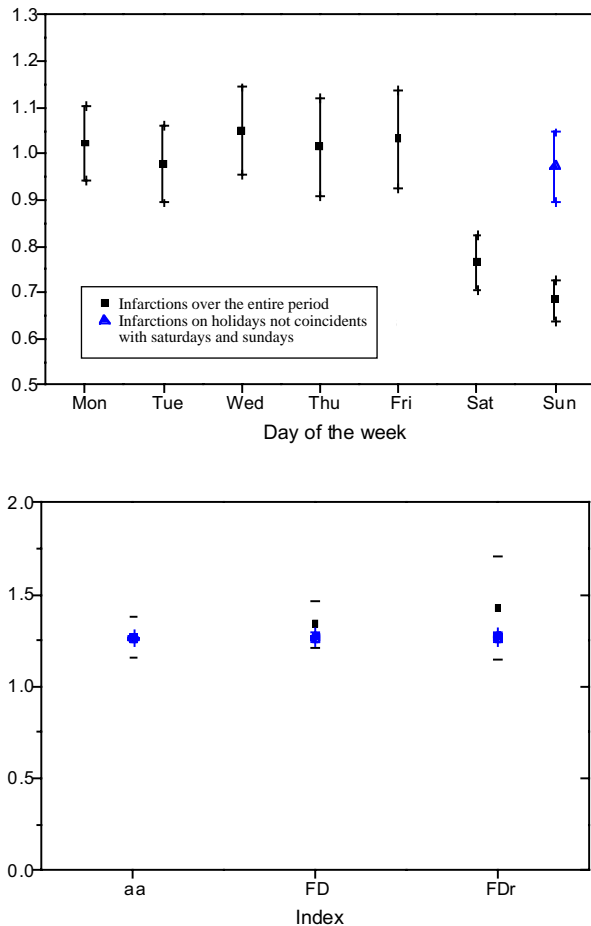


Fig. 3a) Weekly behaviour of the average number of myocardial infarctions. The vertical lines indicate a 95% level of confidence. 3b) Average number of myocardial infarctions. The squares correspond to days with Forbush decreases (FD and FDR) or $aa > 60 \gamma$, the circles correspond to days without the geomagnetic phenomena. The horizontal marks indicate a 95% level of confidence.

One interpretation is to attribute this signal to the social organisation of life; i.e. the weekly periodicity of work and rest (Villoresi *et al.*, 1994 a). However, Breus *et al.* (1995) propose that this signal may reflect the circaseptan biological rhythms, which are a general characteristic of life at the unicellular level as well as in humans even when living in social isolation (Halberg *et al.*, 1991).

During days of Forbush decreases with a sudden start, i.e. those Forbush decreases associated with an interplanetary shock wave, there is an increase of myocardial infarctions by a factor of 1.13. Our results for the period 1992-1996 support the studies of Villoresi *et al.* (1994a). However, due to the relatively small number of cases the uncertainties are large and the results should be interpreted as a tendency. More cases must be analysed in order to establish firmer conclusion about the effect of solar activity and myocardial infarctions. Also, year by year analysis of our results shall be carried out in a future study.

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