Proceedings of ICRC 2001: 3527 © Copernicus Gesellschaft 2001

ICRC 2001

Relationship between Forbush decreases and myocardial infarctions in Mexico

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Abstract. We study the daily incidence of myocardial infarctions in Mexico working with 129 917 cases of myocardial infarction deaths from 1996 to 1999. We found that higher average of infarction death rates occur in days of Forbush decreases, compared with the average incidence in days of no Forbush. Also there is a lower incidence of myocardial infarction deaths during geomagnetically perturbed days (*aa* > 60γ) compared with geomagnetically quiet days. Furthermore, the most important periodicity at higher frequencies in myocardial infacrtion death occurrences is that of seven days. However, during solar minimum times the circaseptan signal is not present, while during solar maximum it does appear.

1. Introduction

In the last few years an increasing number of solid evidences have appeared indicating that solar variability through geomagnetic activity and cosmic rays may affect human health. These studies present results of statistical significance that relate some pathologies such as myocardial infarctions and brain strokes, with Forbush decreases, the persistence of a negative southward interplanetary magnetic field component, or the occurrence of large geomagnetic storms (Dorman et al., 1993; Breus et al., 1994; Villorsi et al, 1994; Villoresi et al, 1994; Ptytsina et al, 1995; Mendoza an Diaz-Sandoval, 2000).

The purpose of the present paper is to assess the proposed relationships between Forbush decreases and intense geomagnetic activity (index *aa* > 60γ), and myocardial infarction death occurence in Mexico, taking into account the phases of the solar cycle.

2. Data and Results

We use the daily number of myocardial infarction deaths (MID) registered in Mexico at the General Direction of Epidemiology which depends on the Ministry of Health (SSA), from 1st January 1996 to 31st December, 1999. There are 129 917 cases. The time covered by our study comprises the minimum phase (1996) of solar cycle 23 up to near its maximum (1998-1999).

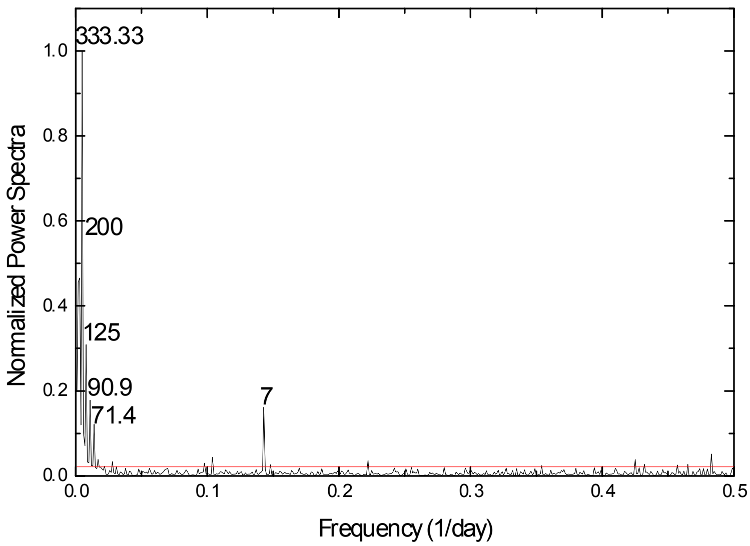
In Fig. 1 we show the power spectra of MID obtained by the Maximum Entropy Method (MEM) of spectral analysis (Burg, 1972). Fig. 1a for the whole period presents the prominent periodicities at ~ 333, 200, 125, 91 and 71 days, at higher frequencies the most important peak is at 7 days. In Fig. 1b appear the results for 1998-1999; the important peaks at lower and higher frequencies are: 333 and 7 days, respectively. Fig.1c has the results for 1996; there is only one important peak at 250 days.

We study two kinds of solar and geomagnetic phenomena that seem relevant in this context (Villoresi et al., 1994; Mendoza and Diaz-Sandoval, 2000) : 1) geomagnetic activity, in particular we choose intense geomagnetically perturbed days as those with *aa* > 60 γ ; and 2) Forbush decreases, with a decrease of > 1.5% observed in the Neutron Monitor Station in Mexico City (Hurtado et al., 1996-1999). We calculated both, the average value of MID for the days characterized by the phenomena mentioned above, and the average number of MID over the days without such phenomena. During minimum no Forbush or high geomagnetic activity was observed in Mexico, therefore our results concern only the near maximum phase. In Fig. 2 we observe that for days with Forbush decreases or *aa* ≤ 60γ the MID occurrence increased by 1.02 and 1.04 respectively, compared with days without Forbush or with *aa* > 60γ. Both results are significant at the 99% of confidence under a *student* test.

3. Discussion and Conclusions

We found that during days of Forbush decreases there is an increase of MID by a factor of 1.02. Our test of significance allow us to be confident that there is a small but real higher incidence of MID at Forbush times. This result supports previous studies (Villoresi et al., 1994), although in our case the effect of Forbush decreases on MID is smaller, as those results report a factor of 1.13 and we find a factor of 1.02. Due to the inhibitory effect of the geomagnetic field, in Mexico we have fewer days of Forbush decreases compared with the number of days at higher geomagnetic latitudes. If we assume that Forbush decreases may affect MID incidence, then we may expect a lower occurrence of MID in Mexico compared with higher geomagnetic latitudes. We also found a decrease of MID by a factor of 1.04 during geomagnetically perturbed days in comparison with days of no perturbation. In contrast it has been found (Villoresi et al., 1994) an increase of MID on geomagnetically perturbed days by a similar factor (1.07); we suggest that the difference might reflect a geomagnetic latitudinal effect, but we cannot see how this happens.

The most important signal found at higher frequencies in the present study is the one corresponding to seven days. One approach is to attribute this signal to the social organization of life: the weekly period of work and rest (Villoresi et al., 1994). However, it has been also proposed that this period reflects the circaseptan biological rhythms (Halberg et al., 1991; Breus et al., 1995). We found that the circaseptan period is absent during solar minimum, in agrement with results of MID data in Tbilisi, Republic of Georgia, from 1980 to 1992 (Khomeriki et al., 1998).



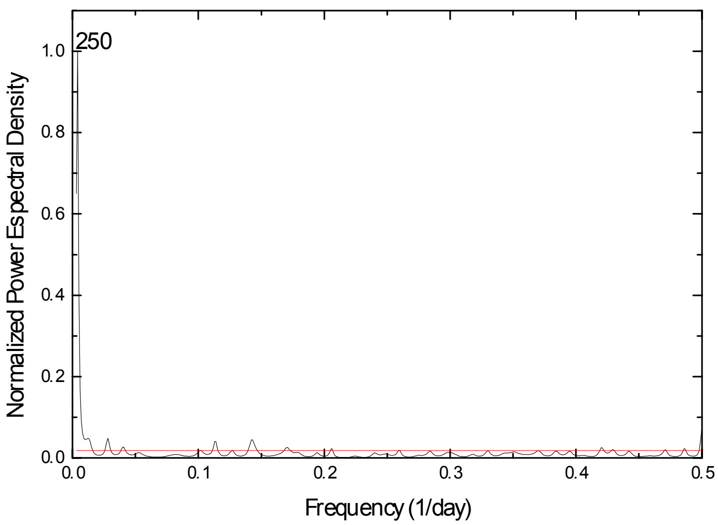


Fig. 1. **(a)** Power spectral analysis using the MEM for the number of daily MID registered in Mexico (1996-1999). **(b)** The same as (a) but for solar maximum times (1998-1999). The horizontal lines in the figure indicate the 95% level of confidence and we consider only peaks above it.

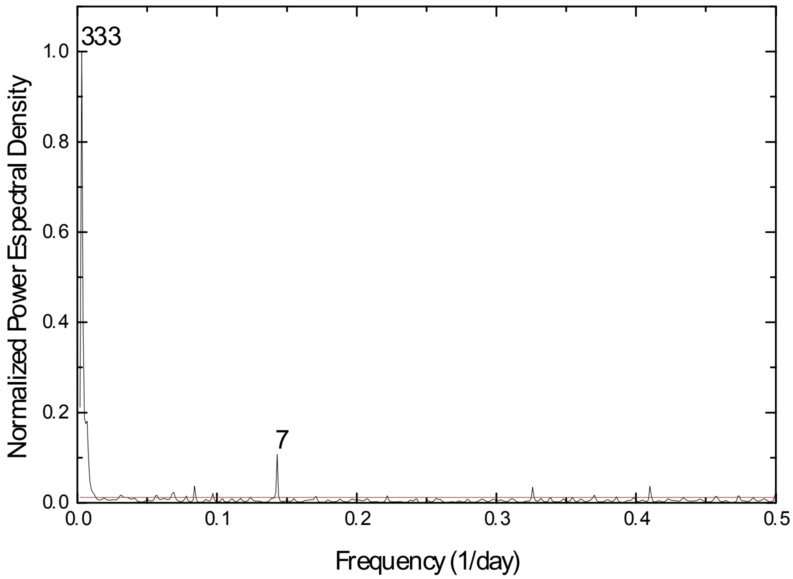


Fig. 1(c) The same as Fig 1(a) but for solar minimum (1996). The horizontal lines in the figure indicate the 95% level of confidence and we consider only peaks above it.

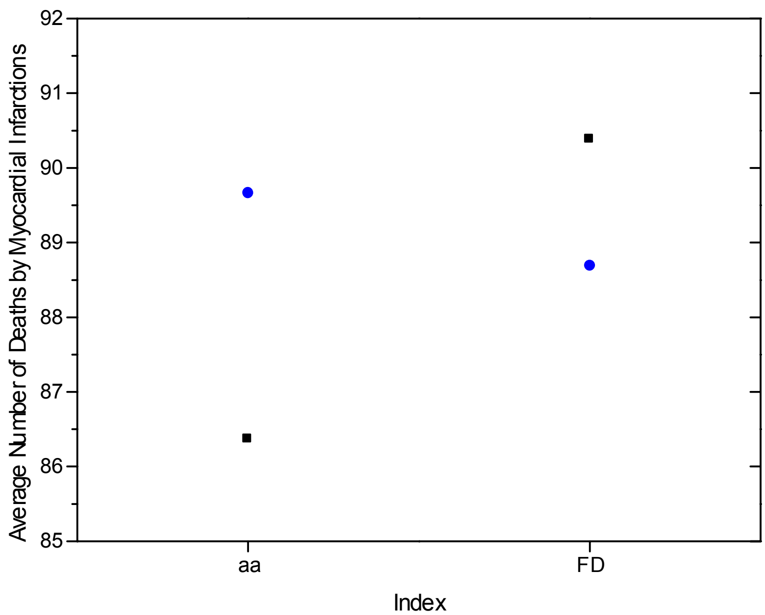


Fig. 2. Average number of MID as described in Fig. 1(b). The squares correspond to days with Forbush decreases (FD) or *aa* > 60 γ, the circles correspond to days without the solar or geomagnetic phenomena considered.

Acknowledgements. We thank Dr. Luis Anaya and Dr. Pablo Kuri for providing us with the National Direction of Epidemiology MID data. Also to DGAPA (UNAM) grant IN 115998 and CONACyT grant 33057-T.

4. References

Breus, T. K, Golyshev, S. A., Ivanova, S. I., Levitin, A. E., Oraevsky, V. N., and Papitashvili, V. O. 1994. In: D. N. Baker, V. O. Papitashvili, and M. J. Teague eds. *Cospar Coll. Series 5*. Oxford: Pergamon Press,

Breus, T. K. , Cornelissen, G., Halberg, F., and Levitin, E. 1995. *Ann Geophys 13*, 1211.

Burg, J. P. 1972. *Geophysics 37*, 375.

Dorman, L. .I, Iucci, N., and Villoresi, G. 1993. *Astrophys and Space Sci 208*, 55.

Halberg, F., Breus, T. K., Cornelissen, G., Bingham. C., Hillman, D. C., Rigatuso, J., Delmore, P., and Bakken, E. 1991. *Chronobiology in space*. Minnesota: Univ. of Minessota / Medtronic Chronobiology Seminar Series *1*.

Hurtado A, Valdes-Galicia JF, Musalem O. Neutron Monitor Technical Reports. Mexico 1996-1999. *Instituto de Geofisica UNAM*.

Khomeriki, O., Paatashvili, T., Gheonjian, L., and Kapanadze, N. 1998. *Bull. Georgian Acad. Sci.*, *158*, 123.

Mendoza, B. and Díaz-Sandoval, R. 2000. *Geofísica Internacional 39*, 53.

Ptitsyna, N. G., Villoresi, G., Tyasto, M. I., Iucci, N., and Dorman, L. I. 1995. *Physica Medica 11*, 38.

Villoresi, G., Breus, T. K., Iucci, N., Dorman, L. I., and Rapaport, S. I. 1994. *Physica Medica 10* (3), 79.

Villoresi, G., Kopytenko, Y. A., Ptitsyna, N. G., Tyasto, M. I., Kopytenko, E. A., Iucci, N., and Voronov, P. M. 1994. *Physica Medica 10* (4), 107.