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Geomagnetic activity related to acute myocardial infarctions: Relationship in a reduced population and time interval

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RESUMEN

En este trabajo empleamos los datos de infarto agudo al miocardio proporcionados por 5 hospitales en la ciudad de La Habana, que cubren una población estimada de 850 000 habitantes durante los años de 1992 a 1999. Analizamos la ocurrencia de estos infartos en relación con la actividad geomagnética medida a través del índice Ap, considerando un rango de actividad que va del bajo al alto. Encontramos que la distribución de infartos en períodos geomagnéticos tranquilos (Ap<10 g) y perturbados (Ap>50g) es diferente. Empleando el método de épocas superpuestas, observamos un máximo prominente en la distribución de infartos un día después del día del máximo de Ap. Aparentemente la morbilidad por infarto agudo al miocardio responde a un nivel umbral de actividad geomagnética de Ap entre 20- 50 g.

PALABRAS CLAVE: Relaciones Sol-Tierra, relaciones Sol-biosfera, actividad geomagnética, infarto agudo al miocardio.

ABSTRACT

We use medical data of acute myocardial infarctions for 5 hospitals in the city of Havana covering an estimated population of 850 000 inhabitants during the years 1992 to 1999. We analyze the occurrence of infarctions in relation to geomagnetic activity through the Ap index considering low and high activity levels. The distribution of the infarctions in geomagnetically calm (Ap<10 g) and geomagnetically perturbed (Ap >50 g) periods is different. Performing a superposed epoch analysis, we notice a prominent maximum in the distribution of infarctions one day after the Ap maximum. We conclude that the acute myocardial infarctions morbidity seems to be responding to a threshold level of Ap between 20 - 50 g.

KEYWORDS: Sun-Earth relations, Sun-biosphere interaction, geomagnetic activity, acute myocardial infarction.

INTRODUCTION

Few works have been published on the influence of solar activity on biota. Some recent works are the paper of Villoresi *et al*. (1994), Breus *et al*. (1995) and Stoilova and Zdravev (2000) concerning the effect of cosmic ray decreases (Forbush decreases) and geomagnetic activity on myocardial infarctions, brain strokes, sudden death, etc. Preliminary investigations of the influence of the solar and geomagnetic activity on the occurrence of acute myocardial infarction in low geomagnetic latitudes (Mendoza and Díaz-Sandoval, 2000; Mendoza and Díaz-Sandoval, 2003) indicate that there is a statistical response to times of high geomagnetic activity. This work aims to continue the research in this area considering different geographical latitudes and social environments.

MATERIALS AND METHODS

We use the morbidity data for acute myocardial infarction (AMI) at five hospitals of the public health system of Havana City, Cuba (Table 1).The period of study is from 1992 to 1999. The data were extracted from the records of intensive care sections of the hospitals. As only those cases with definitive diagnosis were considered, we have a high degree of reliability for the data. We use the Ap geomagnetic index obtained from the National Geophysical Data Center (http: //www.ngdc.noaa.gov /).

DATA CHARACTERIZATION

Acute Myocardial Infarction (AMI) morbidity

Figure1 shows the trend of the total number of AMI cases. The trend shows a very small yearly increase of ~ 2% in the number of cases. Thus for this study the yearly occurrence of AMI could be considered constant during 1992-1999.

Figure 2 shows the behavior of AMI along the year. The curve shows that the AMI yearly mean value per hospital is lower in summer than in winter. However, taking into

Table 1

Origin of AMI morbidity data used in this paper. Crosses indicate hospitals contributing with AMI data that year. The gaps in "10 de Octubre" hospital relate to modernization of the services and modifications of the buildings.

	Year							
Hospital	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
S. Allende	X	X	X	X	X	X	X	X
10 de Octubre	X	X		X	X		X	X
E. Cabrera		X	X	X	X	X	X	X
J. Albarán					X	X	X	X
C. García					X	X	X	X

account the uncertainties, shown as vertical bars in the figure, it can be considered that the occurrence of AMI is constant (stationary) over the year along the period 1992-1999.

Under the previously described conditions of stationariness within a year, we search for changes in the intensity of the flux of events. We define as flux of events the occurrence of AMI, in number of cases by unit time.

DATA EXPLORATORY PROCEDURE DESCRIPTION AND RESULTS

AMI morbidity in calm days

The search for relationships between the cosmic environment and AMI was carried out by superposition of epochs with a temporal window of 9 days along calm geomagnetic periods centered on the day of the highest Ap value. The calm periods were selected as those days with Ap < 10 g. No window smaller than 9 days was taken. The days in excess that do not reach the number of nine were distributed symmetrically before and after the nearest window if possible. We work with the daily AMI mean per hospital.

The result of the procedure is shown in Figure 3.

The behavior of AMI for calm day periods shows no significant correlation with Ap and their mean values are low, one case every two or three days per hospital.

AMI morbidity in perturbed days

The behavior of AMI during perturbed geomagnetic periods was determined for different levels of geomagnetic

Distribution of the yearly mean number of cases per hospital

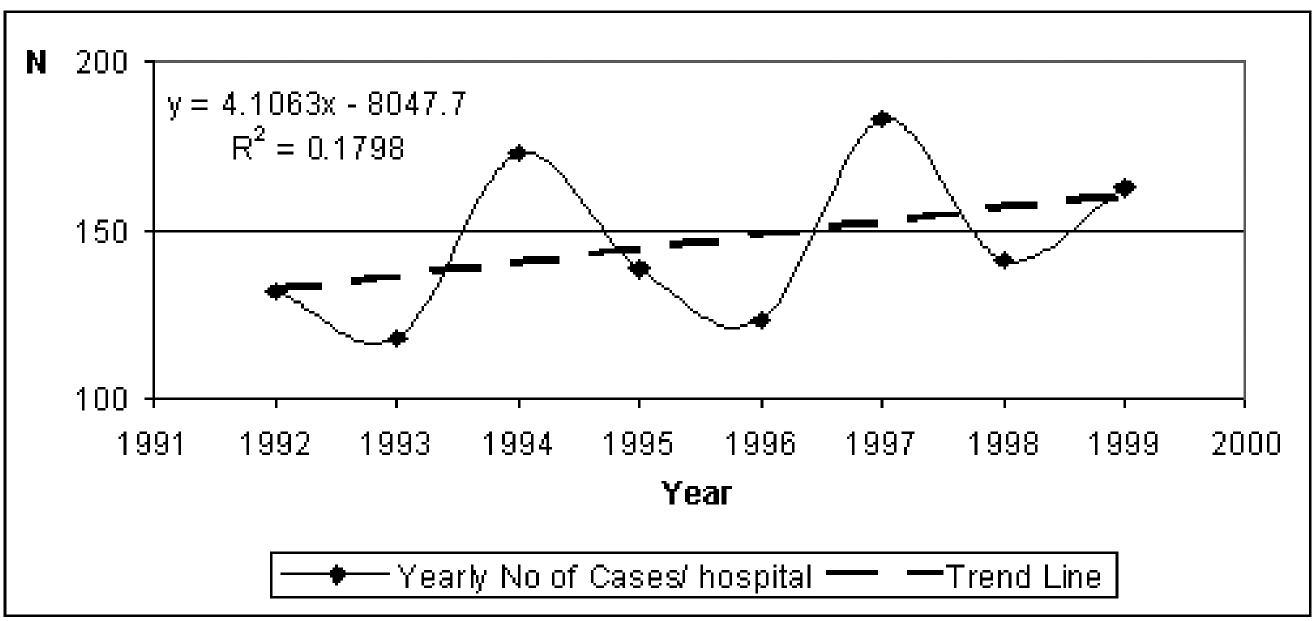

Fig.1. The graph shows the behavior of the yearly mean number of acute myocardial infarction cases per hospital [N] for the whole period. The regression line equation and its regression coefficient are shown at the upper left corner; X, the year and Y the expected yearly mean number of cases per hospital. R is the correlation coefficient.

Yearly behavior of the mean number of acute myocardial infarction cases per day per hospital

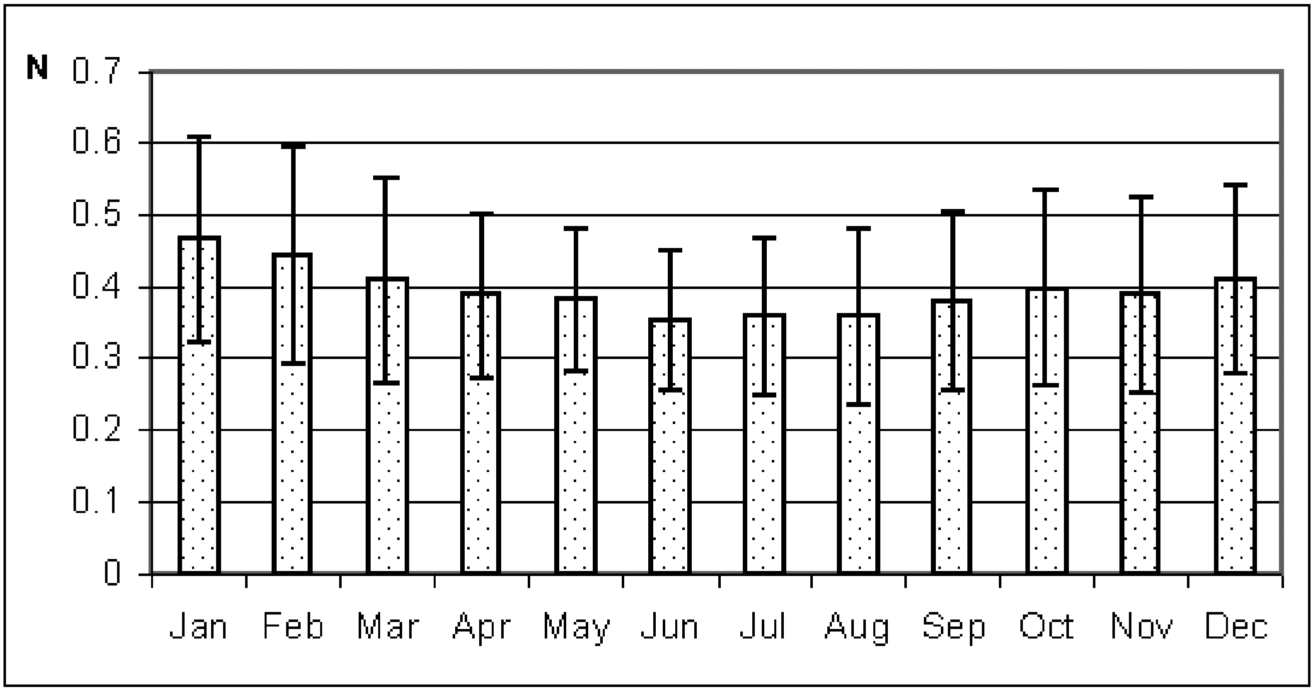

Fig. 2. Behavior of the mean number of cases per day per hospital of acute myocardial infarction [N] over the year for the whole period. The curve seems to present a seasonal behavior, but the variance allows us to consider AMI approximately stationary (constant) over the year.

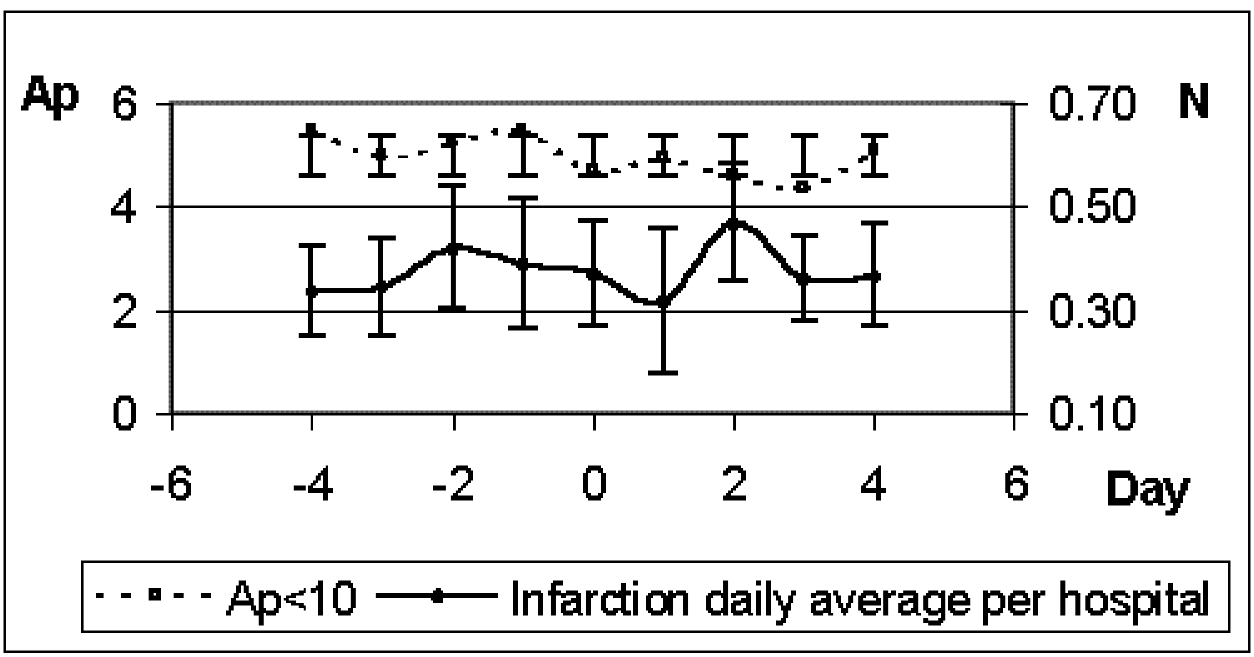

Fig. 3. Behavior of the acute myocardial infarction daily average occurrence by hospital [N] and Ap average index during "calm periods" ($Ap<10$, 49 cases) in a 9 days window. Zero refers to the center of the 9 days window. Variance shows by error bars for infarction and 1 standard deviation for Ap mean value.

activity. Periods with Ap greater than a given activity level were determined. The method of superposition of epochs with a 9 days temporal window was applied to these intervals, centered in the maximum Ap value of the window. For two consecutive maxima whose windows were overlapped only one maximum was taken, the first one.

Figure 4 shows activity levels of Ap between 10 and 100 g. For Ap 20 g there is no significant change in the profile of the distribution of AMI. A change in the profile of the distribution is evident for activity levels about 50 g: a maximum one-day after the center of the temporal windows is developed. The maximum is more noticeable for Ap > 80g. Higher activity levels do not produce higher peaks.

AMI morbidity in relation to gender

To explore differences in the behavior of AMI in relation to gender, we apply the same method of superposition of epochs separating the data by sex. Figure 5 indicates that no difference between sexes is evident.

DISCUSSION

Figure 4 indicates a peak of AMI three days before the peaks of Ap>50g and Ap>80g . We have two possibilities to explain this peak: We can consider this peak as the result of geomagnetic activity with a level inferior to the considered one, but of importance to the phenomenon. On the other hand, high geomagnetic activity is mostly the result of the arrival to the earth of solar coronal mass ejections. These ejections are frequently accompained by solar flares.The flare products, high energy particles and short wavelength radiation, reach the earth hours or even days before the coronal mass ejection, ionizing the high atmosphere; this is another possible source of the AMI peak. An exploration of this hypothesis was not considered in this paper. Perhaps the behavior of the Flare Index on Solar Activity could be explored in a future work.

The contrast of the AMI distributions for Ap<10g and Ap>50g activity levels over a 9 days windows shows that they are significantly different (level of significance [a] = 0.01). Assuming the AMI peaks are associated to geomagnetic activity, the time of action of the interplanetary disturbances on the cardiovascular system has a delay of one day.

The presence of an important AMI maximum one day after the occurrence of Ap>50 g and its disappearance for Ap>20 g, indicates that the AMI morbidity is responding to a threshold level of geomagnetic activity. The threshold is between 20 and 50 g. If the AMI peak appearing three

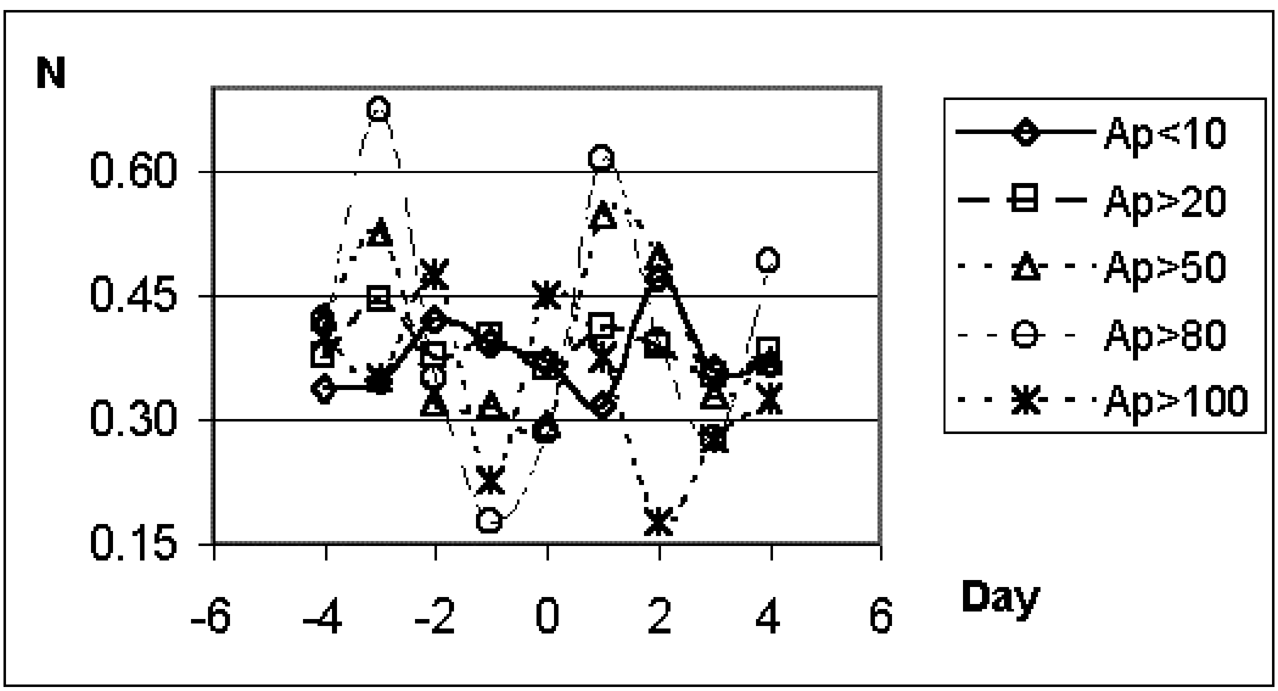

Fig. 4. AMI morbidity per hospital per day [N] during periods of different Ap activity level. Notice a clear modulation of the values. A maximum, one day after the center of the temporal window is developed for Ap>50. Higher activity levels do not produce significant changes in the distribution profile.

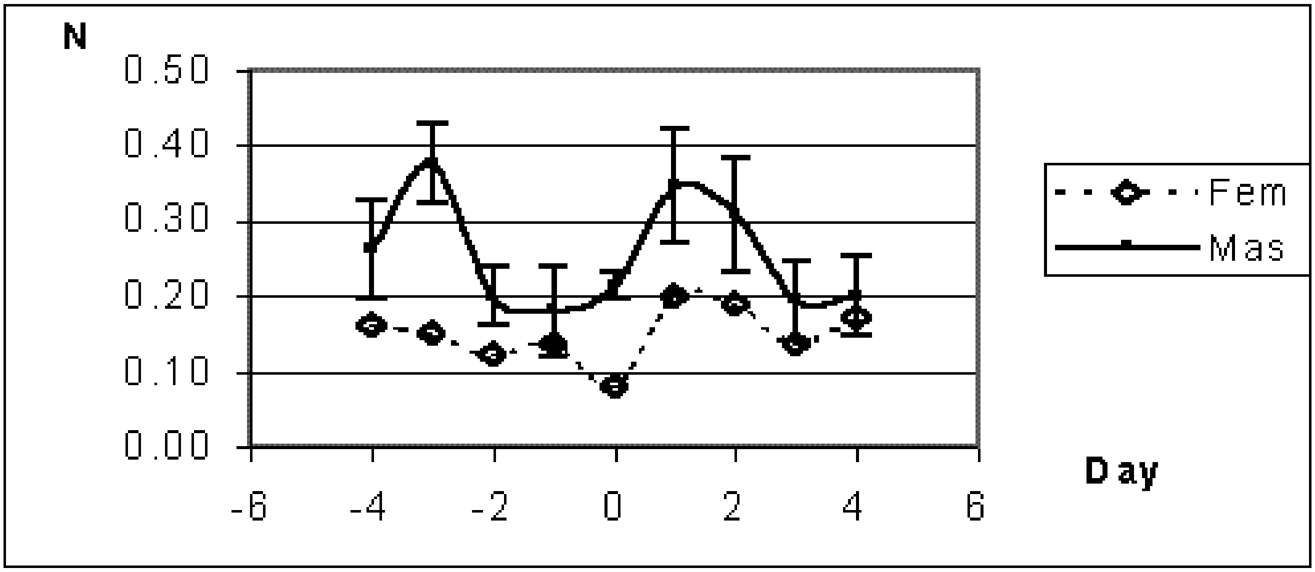

Fig. 5. AMI considering gender during perturbed periods with Ap >50 (axis units as in previous figure). No significant behavioral difference was noticed. Variance shown by error bars for male cases.

days before Ap>50 g is related to previous geomagnetic activity, then the triggering effect of geomagnetic activity has a relaxation time of about three days. Thus we should not expect a significant increase of AMI morbidity in less than three days between periods of high geomagnetic activity.

These results may have a practical use for epidemiological studies of AMI and related illnessess. They suggest the existence of a relationship between the state of the cosmic weather and AMI.

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