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Influence of cosmophysical activity on monthly mortality due to myocardial infarction

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ABSTRACT

Introduction: The role of external triggers in the development of acute cardiovascular events is as important as that of classical risk factors. There is some evidence linking solar and geomagnetic phenomena with cardiovascular events.
Objective: To identify the possible influence of cosmophysical activity on monthly mortality due to acute myocardial infarction (AMI) in patients from Villa Clara.
Method: Analytical observational study of every patient deceased due to AMI (7132) in Villa Clara over 164 months (January 2001 - August 2014). The variables studied were: monthly mortality caused by AMI, solar activity (absolute and smoothed sunspots, and 10.7 cm solar radio flux, absolute and adjusted), geomagnetic (indices: Ap, Cp, Am and aa) and cosmic rays (neutron activity of cosmic rays on the Earth's surface). The Pearson correlation was used for the analysis.
Results: The monthly AMI mortality showed significant correlations, although weak and negative, where the variables of solar activity did not discriminate between sexes. The variables of geomagnetic activity and cosmic rays did not correlate with mortality due to myocardial infarction.
Conclusions: In the patients from Villa Clara, monthly mortality caused by AMI was inversely related to solar activity. However, these results do not allow generalizations that may influence on the medical care for AMI in the territory; so further research is needed on the subject.
Key words: Myocardial infarction, Mortality, Geomagnetic activity, Solar activity, Cosmic radiation, Cuba

Influencia de la actividad cosmofísica en la mortalidad mensual por infarto agudo de miocardio

RESUMEN

Introducción: Los desencadenantes externos de episodios cardiovasculares agudos poseen un rol tan importante en su desarrollo como los conocidos factores de riesgo clásicos. Existen evidencias que relacionan fenómenos solares y geomagnéticos a eventos cardiovasculares.

Objetivo: Identificar la posible influencia de la actividad cosmofísica sobre la mortalidad mensual por infarto agudo de miocardio (IAM) en pacientes villaclareños.
Método: Estudio observacional analítico con todos los pacientes fallecidos (7132) por IAM en Villa Clara durante 164 meses (enero 2001 – agosto 2014). Las variables estudiadas fueron: mortalidad mensual por IAM, actividad solar (manchas solares absolutas y suavizadas, y el flujo de radio solar a 10,7 cm absoluto y ajustado), geomagnética (índices: Ap, Cp, Am y aa) y de rayos cósmicos (actividad de neutrones de rayos cósmicos en la superficie terrestre). Para el análisis se empleó la correlación de Pearson.
Resultados: La mortalidad mensual por IAM mostró correlaciones significativas, aunque débiles y negativas, con las variables de actividad solar sin discernir entre sexos. Las variables de actividad geomagnética y de rayos cósmicos no presentaron correlación con la mortalidad por infarto del miocardio.
Conclusiones: En los pacientes villaclareños, la mortalidad mensual por IAM se relacionó inversamente con la actividad solar; sin embargo, estos resultados no permiten hacer generalizaciones que tengan impacto sobre la atención clínica a esta enfermedad en el territorio, por lo que serían necesarias futuras investigaciones sobre el tema.
Palabras clave: Infarto de miocardio, Mortalidad, Actividad geomagnética, Actividad solar, Radiación cósmica, Cuba

INTRODUCTION

The impact of meteorological, geophysical and solar activity variations on human health is a well-known and discussed fact in scientific literature, resulted in the development of clinical cosmobiology[1].

The Earth and the geospace are very sensitive to changes in solar activity, and this, in turn, modulates the geomagnetic activity and the influence of cosmic rays[2]. Solar and geomagnetic activities correlate directly with each other, but between these and the activity of cosmic rays, the existing correlation is reversed[3].

Considering, definitively, the possibility of the significant influence of solar activity on the Earth's climate took several years to the scientific community[4]; on the other hand, the relationship of solar activity and conditions in the planetary magnetosphere, and its effect on human health, is also a controversial issue which is still in an early stage of exploration despite having been studied extensively since the late last century[2,5].

The human physiology, especially that of the cardiovascular system, is not immune to the environmental effect. It has been elucidated that external triggers of acute cardiovascular events have an important role in the development of these known as classic risk factors of large data[6]. In this way, recently, there is increasing evidence linking cardiovascular effects of solar and geomagnetic phenomena[5].

Cardiovascular diseases are the leading cause of death in Cuba, including acute myocardial infarction (AMI), which represents more than 25% of mortality[7]. The analysis of the impact of Earth's climate in these diseases have been addressed in the country by other authors[8]; despite this fact, research works on the influx of cosmophysical parameters are scarce[9-11].

Villa Clara was the fifth province in the country with the highest mortality due to heart diseases in 2015[7]; hence, it would be useful to identify the possible impact of cosmophysical activity on this phenomenon in the last 14 years.

METHOD

Design and population

An observational analytical study was carried out, which included all the patients who died of AMI in the province of Villa Clara, during 164 months (from January 2001 to August 2014). The population was made up by 7132 patients, of them, 2262 women and 4470 men.

Scope of the study

The study area included the province of Villa Clara, located in the central region of Cuba, between 22°16', 23°09' north latitude and 80 80°02', 80°25' west longitude, and it covers an area of 8413.13 km^2. Its geographical limits are the Atlantic Ocean, to the north; the province of Sancti Spiritus, to the south

and east, and the provinces of Matanzas and Cienfuegos, to the west[12].

Variables

The number of patients dying due to AMI (I21-I22), by months, was obtained from the mortality database of the Provincial Statistical Center of the Provincial Health Board of Villa Clara.

The solar activity was evaluated by the monthly average of the variables: sunspots (absolute and smoothed) and the solar radio flux with a wavelength of 10.7 cm at 2800 MHz frequency (absolute and adjusted). The geomagnetic activity was studied through the monthly average of the indices: Ap, Cp, Am and aa. The values were obtained from databases of the National Oceanic and Atmospheric Administration, Space Environment Center[13,14].

The activity of cosmic rays was evaluated by means of the monthly average of the activity of neutrons in the terrestrial surface (imp/min), data obtained from the Neutron Monitoring Data center, University of Oulu, Finland[15].

Statistical analysis

The data were stored and processed in SPSS, version 21.0 for Windows. The statistical analysis was carried out through the Pearson's correlation due to the compliance of the normality assumption of the study variables. The reliability was of 95%. The graph was made in the Microsoft Excel 2013 program.

Ethical aspects

The research was approved by the Ethics Committee of the University of Medical Sciences of Villa Clara. The approval of the Provincial Board of Public Health of Villa Clara was obtained for the use of the provincial mortality database. No identity data of the patients involved were revealed and the information was only used for research purposes.

RESULTS

In general, without discerning sex, the monthly mortality due to AMI showed significant correlations, although weak, with the solar variables. It is important to point out that these were negative, which means that as the values of the solar variables decreased, mortality due to AMI increased, and vice versa. Taking sex into account, there was no correlation with the female, while the male correlated significantly, although weak and negative. The geomagnetic and cosmic ray activity variables did not correlate with mortality due to AMI (**Table**).

Table. Relationship of cosmophysical parameters and monthly mortality due to acute myocardial infarction.

Variables of cosmophysical activity	Mortality		
	Total	Female Sex	Male Sex
Solar activity			
- Sunspots	-0.204 (0.009)	-0.099 (0.207)	-0.207 (0.008)
- Smoothed sunspots	-0.210 (0.007)	-0.128 (0.102)	-0.193 (0.013)
- Solar radio flux 2800 MHz	-0.200 (0.010)	-0.090 (0.250)	-0.208 (0.008)
- Adjusted solar radio flux 2800 MHz	-0.201 (0.010)	-0.097 (0.219)	-0.204 (0.009)
Geomagnetic activity			
- Ap	0.008 (0.919)	0.034 (0.668)	-0.014 (0.858)
- Cp	0.040 (0.613)	0.074 (0.348)	0.000 (0.998)
- Am	0.046 (0.559)	0.057 (0.469)	0.021 (0.791)
- aa	0.043 (0.581)	0.051 (0.513)	0.021 (0.786)
Cosmic ray activity			
- Cosmic ray activity (imp/min)	0.065 (0.407)	0.006 (0.936)	0.085 (0.280)

The data express Pearson's correlation (significance).

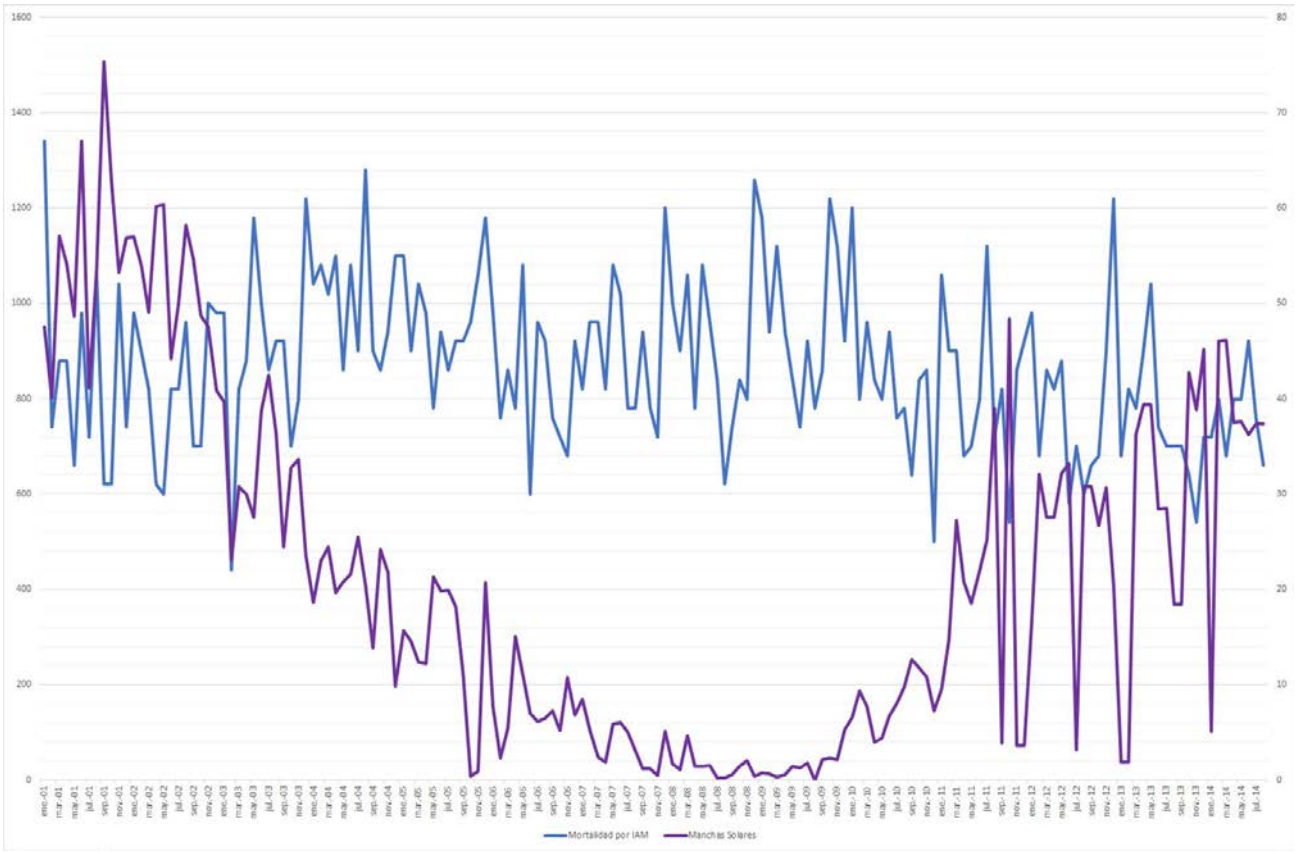

Figure. Temporal distribution of the monthly average of sunspots and monthly mortality due to acute myocardial infarction.

The **figure** shows the inverse relationship between the extreme values of monthly AMI mortality and sunspots.

DISCUSSION

The results of this research support observations on the influence of spatial climatic conditions on monthly mortality due to AMI. Several studies have shown an inverse correlation between monthly morbidity and mortality due to cardiovascular causes in relation to solar and geomagnetic activity, while the cosmic ray activity has been directly correlated[3,16-20]. Our results indicate an inverse correlation between monthly deaths due to AMI in relation to solar activity; however, no correlation was shown with geomagnetic activity or with cosmic rays.

Therefore, it is suggested that high geomagnetic activity and geomagnetic storms are relatively rare phenomena[21,22]; in past decades, days with these events did not exceed 6%[3,23]. Human beings live most of the times under calm geomagnetic activity accompanied by high cosmic rays activity[14,15]. This explains the fact that in the monthly analysis of these variables over the years, an inverse correlation is evidenced due to the low frequency in days per year of these phenomena.

The mortality due to AMI increases in the extreme days of geomagnetic (low/high) and solar activity. In the case that concerns us, the fact that the days of low solar and geomagnetic activity is accompanied by high activity of cosmic rays could explain the results of the present study. Stoupel[24] states that the greatest transformation of neutrons into protons in the human body, with high affinity for the fatty tissues (atheromatous plaque), could be involved in the rupture processes or cracked atheroma, prelude to this atherothrombotic accident in coronary arteries and alterations in the heart's electrical conduction. The role of cardiac arrhythmias with danger to life has also been shown by other

studies and correlated directly with the high cosmic ray activity, and inversely, with solar and geomagnetic activity[25,26].

Only two recently published Cuban studies discussed the subject. Rodríguez Taboada *et al.*[10] reported that the admission of patients for AMI in the period of geomagnetic storms was significantly higher; meanwhile, Montero Vega *et al.*[11] found a relationship between the increased of geomagnetic activity and the frequency of AMI mortality. Although these works represent a precedent in the study of the clinical cosmobiology in Cuba, they perform an analysis different from ours, in terms of the variables studied, i.e., no direct comparisons can be made regarding the results.

This research has as limitations, the fact of having a relatively small sample because it is the experience of a single province; however, it provides the first data on the influence of spatial factors on monthly mortality due to AMI in Cuban patients. Future research involving a larger sample, with national and international collaboration, is necessary in order to obtain more solid results that can help to better understanding such a complex issue.

CONCLUSIONS

In the patients from Villa Clara, monthly mortality due to myocardial infarction was inversely related to solar activity; nonetheless, these results do not allow generalizations that have an impact on the clinical care to this disease in the territory, thus, future research works on the subject are necessary.

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