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# In Women Myocardial Infarction Occurrence is Much Stronger Related to Environmental Physical Activity than in Men – a Gender or an Advanced Age Effect?

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**Background:** Despite continuous effect of the recognised risk factors time distribution of acute coronary events differs. Environmental influences are a long time investigated as possible triggers of time related fluctuations. The aim of this study was to check possible links between the monthly numbers of acute myocardial infarction (AMI) (in the pre-troponin era) in general, and in woman and man, with 3 groups of cosmophysical activity indices: solar, geomagnetic (GMA), and cosmic rays (close related to space proton flux at high energy > 90–100 MEV) levels.

**Material and Methods:** The monthly numbers of AMI in the years 1983–1999 (204 consecutive months) from the Kaunas registry were analysed (16,683 patients total; 10,405 ♂, 6,478 ♀). Cosmophysical indices were: solar – sunspot numbers and solar flux at 2,800 MGH, 10.7 cm wavelength, for GMA monthly Ap., Cp., and Am. Indices; for cosmic rays – neutron monitoring data of solar and GMA was obtained from the National Geophysical and Space Service Centers, USA. For cosmic rays activity – from Apatity Neutron Monitor Station of the Russian Academy of Sciences.

**Statistics:** Pearson correlation coefficients (r) and their probabilities (p) were calculated, describing 95 % and higher probabilities as significant and 85–94 % as trends.

**Results:** For the whole group it was a significant inverse correlation with solar and GMA indices and a correlation with cosmic rays activity level. For women, despite the smaller absolute number of AMI, compared with men, the correlation indices were 2–3 times higher, and also the probabilities. The differences can be explained a) by gender differences in reaction to changes in levels of environmental physical activity and/or b) the higher age in general, that women suffer AMI compared to men.

**Conclusion:** The monthly number of acute myocardial infarction correlates with solar, geomagnetic, and cosmic rays activity. This relationship is 2–3 times stronger for women. Gender and/or higher age of suffering myocardial infarction of women can be related to the observed gender differences. *J Clin Basic Cardiol 2005; 8: 59–60.*

**Key words:** myocardial infarction, gender, solar, geomagnetic, cosmic rays, activity

At the beginning of the third millennium acute myocardial infarction (AMI) remains one of the most “popular” diseases in the developed countries, with perspectives to grow in the developing part of the world in the coming decades. The modern cardiology has accepted risk factors for the disease such as hyperlipidaemia, arterial hypertension, smoking, diabetes mellitus, and others [1].

Many studies are considering environmental influences on the pathogenesis and occurrence of acute coronary syndromes (unstable angina pectoris, AMI with and without ST-elevation): time (circadian, circannual aspects) and meteorologic factors [2, 3]. The possibility of space physical activity links with physiologic and pathologic changes, described as clinical cosmobiology, is also a subject for analogic studies. In addition to long time investigation, such as influences of solar and geomagnetic activity, in the last years observations about connection of coronary events, sudden cardiac death (SCD), AMI, cardiac arrhythmias, arterial pressure, and blood coagulation were published [2, 3]. The aim of this study is to compare the monthly numbers of AMI in general as well as for each gender separately with the levels of solar and geomagnetic activity, and with that of another space parameter inversely related to them – cosmic rays activity.

## Material and Methods

16,683 patients (10,405 men and 6,478 women) suffering from AMI were included in this study. The data came from Kaunas, the second largest city in Lithuania. The observation time is 204 consecutive months in the years 1983–1999. The monthly number of AMI at all and for each gender were

compared at 204 and 132 months, respectively (according to available data) with two solar activity indices – sunspot number and solar flux at 2,800 MGH and 10.7 cm wavelength; three geomagnetic activity parameters – Ap., Cp., Am., and cosmic rays activity according to neutron monitoring results at the surface of our planet. All those parameters are widely used describing the level of environmental physical activity [4–6].

## Statistics

Pearson correlation coefficients (r) and their probabilities (p) were obtained for numbers of AMI and each of the mentioned monthly cosmophysical indices. The results were described as significant by probability of 95 % and higher. Results of 85–94 % were characterised as a strong trend to significance. The data for solar and geomagnetic activity was obtained from the NOAA (National Geophysical Data Center and National Space Service Center, USA) [4, 5]. The neutron monitor data for cosmic rays activity came from the Apatity Neutron Monitor Station of the Russian Academy of Sciences [6].

## Results

Table 1 presents the comparative results between the monthly numbers of AMI and three groups of cosmophysical activity for all patients and, separately, for men and women. We can see, that the monthly number of AMI was significantly correlated with all three physical parameters. For solar and geomagnetic activity the relationship was inverse, for cosmic rays positive. Despite much higher num-

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**Table 1.** Monthly number of acute myocardial infarction (Kaunas data) – Pearson correlation coefficients (r) and their probabilities (p) with monthly solar, geomagnetic and cosmic rays activity indices

Categories (cosmophysical activity indices)		Acute myocardial infarction	Male	Female
Number	n	16,683	10,405	6,478
Month	N	204	204	204
Sunspot no°	r	-0.289	-0.164	-0.35
	P	0.0001	0.019	0.0001
	N	204	204	204
Solar flux 2800 MGH, 10.7 cm	r	-0.219	-0.317	-0.55
	P	0.0017	0.0004	0.0001
	N	204	204	204
GMA – a. Ap.	r	-0.293	-0.141	-0.37
	P	0.0007	0.1	0.0001
	N	132	132	132
GMA – b. Cp.	r	-0.341	-0.18	-0.41
	P	0.0001	0.09	0.0001
	N	132	132	132
GMA – c. Am.	r	-0.269	-0.123	-0.347
	P	0.0018	0.1	0.0001
	N	132	132	132
Cosmic rays	r	0.28	0.124	0.367
	P	0.0001	0.07	0.0001
	N	167	167	167

bers of AMI in men, (10,405 vs. 6,478), the significance and correlation coefficients for women are 2–3 times higher than for men. The mean age for women in this study was 70.7 years, and 60.9 for men. 14.2 % of the men were older than 74 years and 39.5 % of the women ( $p < 0.0001$ ).

## Discussion

Gender differences in acute coronary syndromes, atherogenesis, concomitant pathologies, like diastolic heart failure, hypertension, diabetes, heart rupture, outcomes in coronary revascularisation are widely discussed [7–12]. Unfortunately women show higher risk in revascularisation procedures, more heart failure, and higher mortality in acute coronary syndromes [10, 11]. We know that atherogenesis in women is postponed, compared with men, and acute myocardial infarction in women is generally occurring 5–10 years later [7–11].

The results of many studies consider the female gender as an independent risk factor affecting prognosis. A selective group in this study where AMI was accompanied by rhythm disturbances consisted of men with mean age of 60.1 years and 11.8 % older than 74. The same parameters for women were mean age 70.0 and 28.8 % older than 74 years. We have shown in our previous observations that at age  $> 74$  the links of mortality with cosmophysical activity are changing. It can be connected with drop in reserves to compensate the observed changes in many cardiovascular risk factors observed in different daily and monthly estimations of cosmophysical parameters. It is remarkable, that considering daily changes in geomagnetic activity many risk factors like blood coagulation, arterial pressure and others show a significant rise at extreme levels of GMA and also clinical data of less favourable natural history of many cardiovascular events [2, 3]. But such days of stormy GMA are relatively rare 3–6 % yearly (5.6 % in 1974–2003 according to our calculation in the middle latitude). When we take the monthly (not daily) event rate we found that the relationship between AMI and solar and GMA is inverse, and new “players” like high energy proton flux [2, 3, 13], and the closely related cosmic rays activity [14] (both

inversely related to solar and GMA) show positive relationship with AMI and other “emergencies”.

It is remarkable that all three groups of physical parameters in this study are, in general, significantly correlated with monthly numbers of AMI, but in women those links are much stronger. So, we must presume, like in many other fields, the older woman is more susceptible to environmental physical activity comparing with younger man with the same pathology. Its not clear how such accompanying factors like diabetes, hypertension, obesity – more often in female coronary patients – are involved in the higher relationship to environmental physical activity of women. While data related to solar and GMA is relatively extensive, observations on high energy proton flux and cosmic rays are only beginning to emerge [13, 14]. More observations on possible biologic effects and mechanisms of action of those influences might explain the positive links of them with coronary events like in this study, strong links also with noncardiovascular death, for example cardiopulmonary arrest in oncologic patients [15].

One of the limitations of this study is that it is provided on data previous to the new criteria for AMI diagnosis [8], when most of non-ST elevation AMI are recognised using the troponin laboratory test. The accumulation of this data in the next years will give opportunity to analyse each form of acute coronary syndromes: STEMI, NSTEMI and unstable angina pectoris.

## Conclusion

- The monthly number of acute myocardial infarction is significantly related to solar, geomagnetic and cosmic rays activity.
- This relationship is much stronger in women than in men.
- Gender specificity and older age of women suffering myocardial infarction can be related to those differences between sexes.

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