

## Acute coronary syndromes and biometeorological conditions at Crete Island, Greece

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### Abstract

The relationship between the biometeorological conditions with the non fatal Acute Coronary Syndromes (ACS), is examined in the Ierapetra area, with mild climate, in the Southeastern Crete Island, Greece, during the period 2004-2007. Daily ACS counts were acquired from the General Hospital of Ierapetra and corresponding meteorological parameters, such as maximum and minimum air temperature, relative humidity, wind speed and cloudiness, from the meteorological station of Ierapetra (Hellenic National Meteorological Service). Besides, the daily values of the thermal index Physiologically Equivalent Temperature (PET) were evaluated, in order to interpret the grade of the physiological stress.

The find out the possible association between ACS and the meteorological variables we applied on one hand the Pearson's  $\chi^2$  test, the most widely used method of independence control of groups in lines and columns in a table of frequencies. The use of contingency tables instead of Pearson correlation is considered more accurate, because the medical data present large divergence from a Gaussian (regular) distribution. On the other hand, the application of the Generalized Linear Models (GLM) with Poisson distribution resulted in quantitative relationships between the examined parameters.

The ACS syndromes present a multiple variation within the year, with the primary maximum in August and the secondary in May, while relative high ACS frequencies exist in early winter time. The impacts of the weather variability on ACS are not statistically significant (C.L. 95%) and indicate that mild climates without temperature extremes within the year do not appear a clear evidence of influence on ACS.

### 1. Introduction

There is strong evidence, supported by a consensus of world's leading scientists that the earth's climate is changing, causing a harmful impact on human health. It is already recognized that extreme weather events place an extra burden on public health systems. Hippocrates (430 BC) was the first to establish in his treatises that bioclimatic conditions play an important role in the pathogenesis of disease. The last 30 years several studies indicated that climatic indices such as daily temperature (average, minimum, maximum), humidity, wind speed and barometric pressure increase mortality and morbidity rates of ischemic heart disease, especially in the older people (Glantz, 1993; Colwell, 1998; Fish et al., 1985; Rooney et al., 1998). Even more, in January 1985 a smog episode, that took place in parts of West Germany caused many deaths, the majority of them were due to cardiovascular or cardiopulmonary diseases (Wichmann et al., 1989). In a more recent work (Grigoropoulos et al., 2009), it is showed that the ultra

fine particulate matter with diameter less than 1  $\mu\text{m}$  ( $\text{PM}_{10}$ ) is in close relation with sinus arrhythmias registered in the emergency units of the hospitals in Athens.

The exploitation of the effects of the bioclimatic conditions variability and human health is of principal interest and one of the current trends of the related sciences. This acquires more importance, as the climate change influence enforces extreme weather phenomena and increases their frequency of occurrence, driving all the more to a permanent degradation of the bioclimatic conditions.

The objective of this study is a preliminary approach to identify if there is a significant relationship between intra annual weather variability and acute coronary syndromes in the Ierapetra area, in South Eastern part of Crete Island, Greece.

## 2. Data and Analysis

In this study, the daily counts of admissions for non fatal Acute Coronary Syndromes (ACS) - either Acute Myocardial Infarction (AMI) or Unstable Angina (UA) - were obtained from the cardiology emergency department of the General Hospital of Ierapetra, during the period 2004-2007. Acute myocardial infarction (STEMI: ST segment elevation myocardial infarction or NSTEMI: non-ST segment elevation myocardial infarction) is the clinical syndrome that results from an injury to myocardial tissue due to prolonged ischemia. The corresponding meteorological parameters, such as maximum and minimum air temperature, relative humidity, wind speed and cloudiness, were provided from the meteorological station of Ierapetra (Hellenic National Meteorological Service). The geographical position of Ierapetra, Crete Island, appears in Fig. 1.



Fig. 1: Crete Island, Greece. Ierapetra city is indicated by a rectangular frame

The relationship between ACS/STEMI and the aforementioned meteorological parameters was calculated by the application of: a) Pearson  $\chi^2$  test, the most widely used method of independence control of groups in lines and columns in a table of frequencies and b) Generalized Linear Models with Poisson distribution (McCullagh and Nelder, 1997), a method of analysis, which has been performed satisfactorily in previous studies (Nastos and Matzarakis, 2006; Nastos et al., 2008). The values of each meteorological parameter and ACS/STEMI, were grouped in four quartiles, so that the first quartile contain the lowest 25% and the fourth quartile the highest 25% of the values. In the

process, the number of days for the quartiles of ACS/STEMI was calculated for each quartile of the parameters and then a contingency table was constructed for every parameter. Besides, the bioclimatic conditions expressed by the Physiologically Equivalent Temperature (PET), based on the energy balance models of the human body, are analyzed (Matzarakis et al., 1999).

### 3. Results and Discussion

Ierapetra is Europe's southernmost town, characterized by very mild climate and mean air temperature rarely drops below 12°C in the winter. The temperate climate of Ierapetra is of typical Mediterranean type, defined by cold and rain period (October–March) and warm and dry period (April–September). The mean maximum air temperature is 31.8 °C in July and August and the mean minimum air temperature is 8.7 °C, in February. The mean annual rainfall is 494 mm and is rare during the summer months. The mean annual number of sunshine hours is 3066 while the prevailing wind direction is of the North sector and the mean wind speed ranges from 7.1 kts in May to 12.4 kts in July.

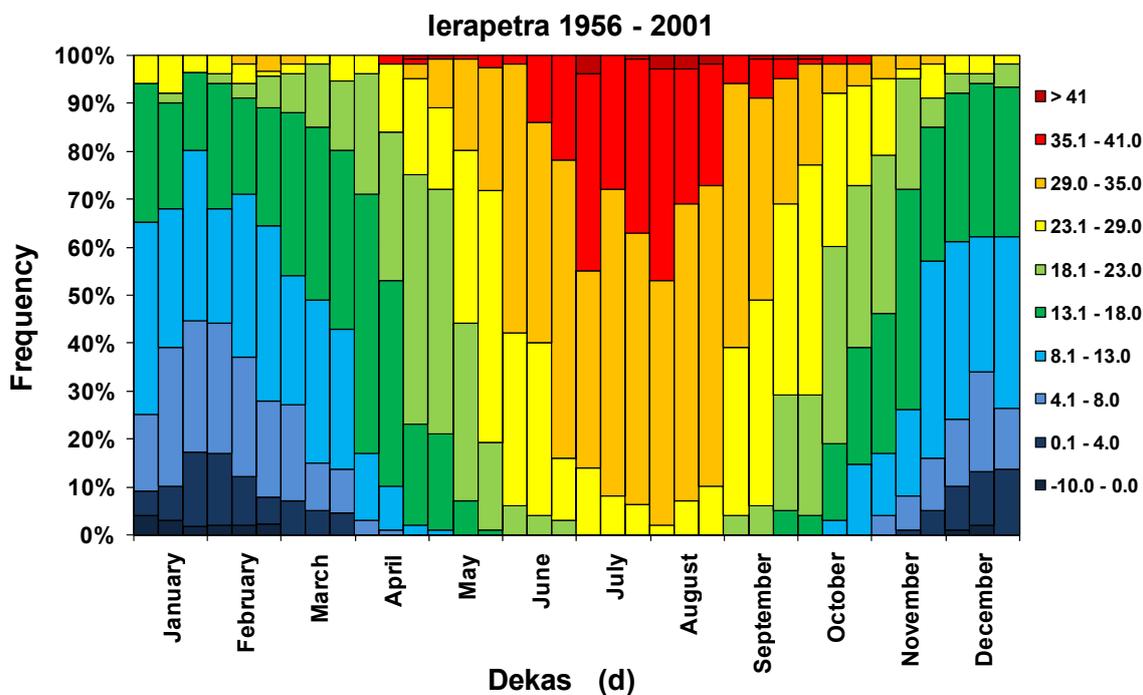


Fig. 2: Bioclimatic diagram with respect to PET classes per ten days interval, for Ierapetra, Crete Island, Greece, during the period 1956-2001

The mild climatic conditions at Ierapetra are depicted in the more descriptive bioclimatic diagram concerning PET classes per ten days interval, during the period 1956-2001 (Fig. 2). The PET values, estimated from RayMan model (Matzarakis et al., 2007), give evidence of strong heat stress for approximately 20% -30% of the days within the period from July to August. The temperate climatic regime of Ierapetra, as described before, brings difficulties in the evaluation of the impact of heat in human health, which

particularly appear in regions with mild climate, without temperature extremes (Gnecchi Ruscone et al., 1985; Ku et al., 1998).

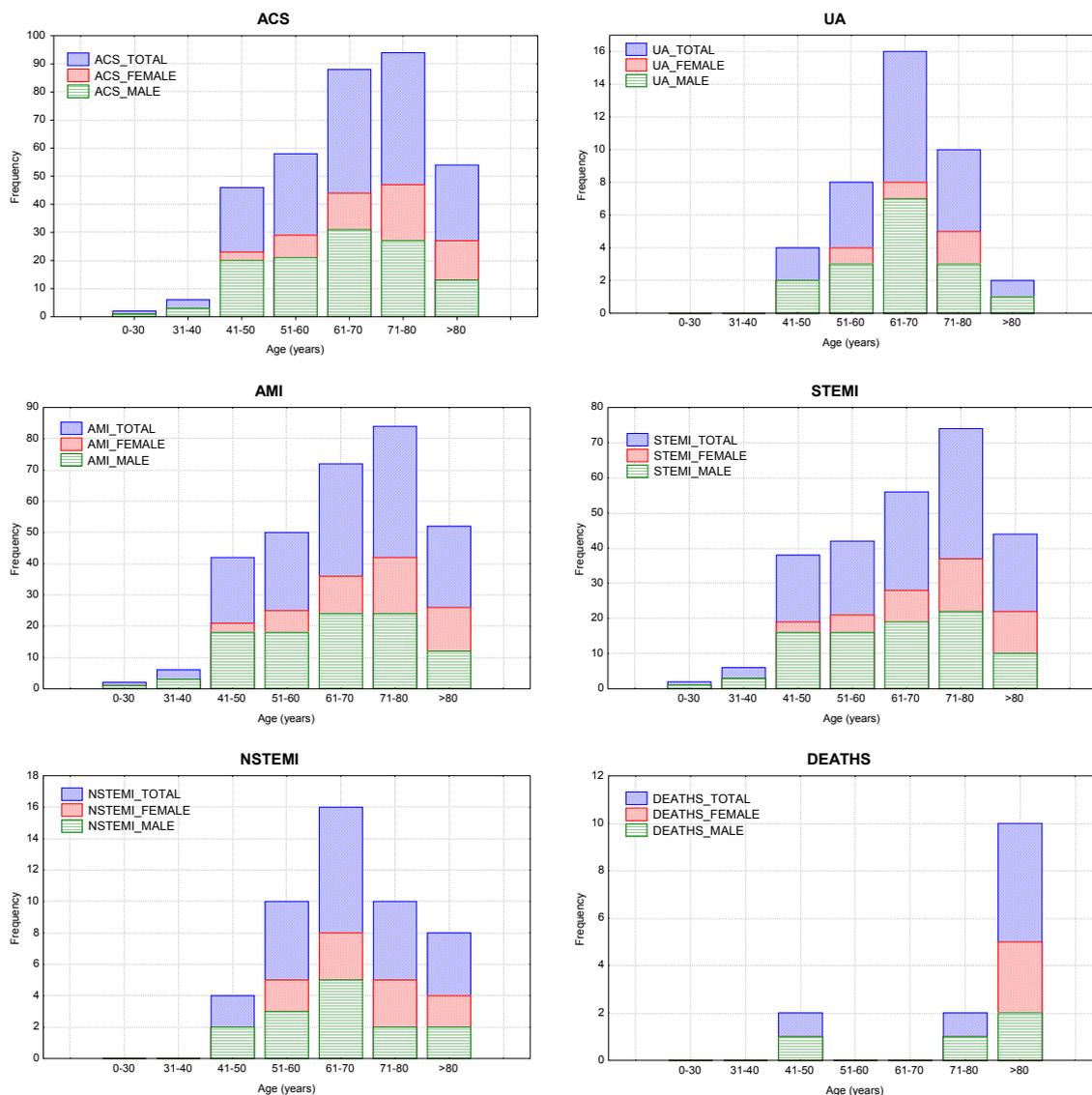


Fig. 3: Stacked graphs with respect to male, female and total counts for ACS, UA, AMI, STEMI, NSTEMI and Deaths, for different classes of age, in Ierapetra area, Crete Island, for the period 2004-2007

As far as the cardiovascular diseases depend on sex and age, Fig. 3 depicts the frequency of each examined cardiovascular syndrome per sex and age classes. It is crystal clear that males appear higher frequency than females for all the syndromes. Regarding only deaths, females predominate within the age class greater than 80 yrs. Moreover, females with age greater than 70 yrs seem to be a little more vulnerable than males in NSTEMI syndromes. These findings are in agreement with the results of an analysis concerning the projected prevalence of the cardiovascular syndromes in the Americans with age greater than 20 years old (American Heart Association, 2003).

The frequencies of the ACS or STEMI admissions within the quartiles of the examined meteorological parameters (contingency tables) were tested by the application of the Pearson  $\chi^2$  test (not shown). The results revealed that the null hypothesis is fulfilled;

namely the meteorological parameters examined are not associated with the emergence of the cardiovascular syndromes. Notwithstanding the results are not statistically significant (C.L. 95%), ACS and particularly STEMI syndromes seem to be influenced by high maximum and minimum air temperature (the highest 25% quartile).

Table 1: Results of the application of Generalized Linear Models (GLM) with Poisson distribution, (dependent variable is the ACS/STEMI admissions, while independent covariates are the aforementioned meteorological parameters)

ACS			STEMI		
variable	b coefficient $\pm$ standard error	significance level p	variable	b coefficient $\pm$ standard error	significance level p
T <sub>max</sub> (°C)	0.0180 $\pm$ 0.0129	0.163061	T <sub>max</sub> (°C)	0.0217 $\pm$ 0.0147	0.140714
T <sub>min</sub> (°C)	0.0192 $\pm$ 0.0142	0.179036	T <sub>min</sub> (°C)	0.0209 $\pm$ 0.0162	0.196644
RH (%)	-0.0041 $\pm$ 0.0093	0.657128	RH (%)	-0.0078 $\pm$ 0.0107	0.467654
WS (m/s)	-0.0019 $\pm$ 0.0301	0.950132	WS (m/s)	-0.0155 $\pm$ 0.0348	0.656980

Because the medical data do not follow normal but Poisson distribution, the application of Generalized Linear Models with Poisson distribution is considered the most appropriate method of checking the impact of weather on cardiovascular syndromes. The results of this analysis are presented in Table 1, where an insignificant correlation between ACS/STEMI and meteorological variables exist (C.L. 95%). The insignificance of the results could be attributed to several factors. The predominant factor is the temperate climate without extremes, while the employment of the population in the greenhouses seems to be beneficial. Another reason of local interest that might be mentioned is the regulated climatic conditions inside the many greenhouses in the region, which protect the health of the people working in there against the cold weather conditions, which is responsible for the acute coronary syndromes exacerbation.

#### 4. Conclusions

In this study, the impact of weather variability on non fatal Acute Coronary Syndromes (ACS), obtained from the cardiology emergency department of the General Hospital of Ierapetra, Crete Island, Greece, during the period 2004-2007, was examined. The results from the performed analysis showed that there was not any statistically significant relationship (C.L. 95%) between ACS and weather parameters. This could be attributed to the temperate climate of Ierapetra, supporting the assumption that mild climates without temperature extremes have minor impacts on ACS incidence. Further research is needed in order to confirm our findings and understand better the involved pathophysiological mechanisms.

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