

## **HOSPITAL ADMISSIONS AND WEATHER TYPES IN ATHENS, GREECE**

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### **INTRODUCTION**

In this study we examined the effects of air mass types on Hospital admissions due to respiratory and heart diseases, in a major hospital in Athens Greece for eight years (1992-2000). Air mass types occurring at sea level were objectively classified to 6 types using a combination of Principal Component and Cluster analyses. We used various statistical techniques on hospital admissions data. The introduced air mass classification, seems to explain the hospital admissions variation to a statistically significant degree and will be a useful tool for studying the weather-health associations in a warm Mediterranean Climate situation.

The impact of weather on health has been known for centuries. The occurrence of respiratory and heart diseases is related with both cold and hot weather. Projected global warming and climate change renewed the interest concerning the weather-health association.

A compact index to examine the relationship between weather and health are the synoptic weather systems which are considered to play an important role for human health, over a specific area, through their controlling effect on local meteorological conditions. Some investigators have tried to correlate the prevailing synoptic weather systems occurring in an area with human health. Specifically, Kalkstein (1991) proposed a synoptic weather classification system based on air mass type and evaluated the impact of meteorological conditions on human mortality. McGregor (1999) investigated the relationship between winter ischaemic disease deaths and weather, using a synoptic climatological approach for Birmingham, UK. He found that strong south flow characterizes by high temperatures and humidity coming from Atlantic, combined with rapid changes in temperature, is associated with increased mortality from ischaemic heart episodes during winter. In the Iberian peninsula Garcia et al (2002) ; (2005) examined the health impacts of prevailing synoptic conditions associated with extreme summer temperatures while in Athens Kassomenos et al, 2001 examined the correlation of 8 subjectively predefined synoptic circulation types at 850 hPa (e.g. about 1500-m above the ground), with mortality in Athens, Greece.

In this study we examined the possible associations between hospital admissions due to respiratory and heart diseases and weather types in Athens, Greece.

### **DATA AND METHODOLOGY**

Athens is situated in a small peninsula located in the southeastern edge of the Greek mainland (central Greece). It covers about 450 Km<sup>2</sup> and has about 4,000,000 inhabitants. The built up area is mainly located in a basin, surrounded by tall mountains from three sides and open to

the sea from the south. There are small openings connecting the Metropolitan area of Athens with the rest of Greek mainland to the north, northwest and northeast of the basin. In Athens, more than 2,000,000 cars are registered while industrial activities are mainly located in the west and southwest of the basin.

The climate of the area is Mediterranean with hot, dry summers and moderately wet, mild winters. The mean daily temperature for winter is 10.2°C and the daily minimum temperature drops below 0°C only for a few days every year. In summer, the mean daily air temperature is 26.2°C, and the average daily maximum temperature is higher than 31.0°C. Irradiation is strong with daily values of the order of 22 MJ/m<sup>2</sup> in summer and 8 MJ/m<sup>2</sup> in winter.

We used hourly meteorological data for the National Observatory of Athens, weather station for the period 1992-2000 in order to extract the weather types occurred in the area during hospital admissions. The data used were mean, maximum and minimum air temperature ( $T_{\text{mean}}$ ,  $T_{\text{max}}$ ,  $T_{\text{min}}$ ), diurnal temperature range ( $T_{\text{range}}$ ), total solar radiation (SR), mean relative humidity (RH), mean absolute and specific humidity, mean atmospheric pressure (P), arithmetic mean wind speed (WS) and mean wind velocity components of W-E and S-N directions (u and v respectively).

The analysis was made with the aid for Principal Component and Cluster analyses (Kassomenos et al., 2001). The analysis concluded in 6 weather types in Athens that are associated with hospital admissions due to respiratory, cardiovascular and heart diseases in general.

The Principal component analysis (p-mode) was used the varimax rotation technique, while the cluster analysis was made in the factor scores extracted by the principal component analysis. The hierarchical mode of the cluster analysis was used.

## RESULTS

Table 1 presents the main meteorological characteristics for each air mass type while figure 1 presents the number of hospital admissions per air mass type.

*Table 1: The main meteorological characteristics of the 6 air masses associated with hospital admissions due to respiratory and heart diseases during 1992-2000 in Athens*

Clusters	%	Mean T (oC)	Absolute Humidity (gr/kg)	Relative Humidity	U (m/s)	V (m/s)	Pressure (mmhg) + 700
Cluster 1	9.4	12.01	11.56	65.48	-3.32	-4.58	55.58
Cluster 2	14.4	14.59	13.07	74.75	-.196	1.54	49.49
Cluster 3	23.8	13.42	12.28	70.60	-.15	-.16	57.43
Cluster 4	14.5	25.59	25.41	47.21	-2.06	-2.51	51.98
Cluster 5	24.6	25.37	24.80	56.08	0.66	0.8	50.55
Cluster 6	13.2	13.45	12.46	57.93	1.29	-.5	51.09

The analysis of the air mass types shows that class 1 is characterised by strong NE winds having the minimum absolute humidity and mean temperature. This mass type is associated with the minimum hospital admissions due to heart problems in KAT. These weather conditions could be characterised as pleasant.

The second healthier category is class 4 characterised by NE winds also but moderate in their strength. The mean temperature is the highest but relative humidity is the lowest. It is probably a summer air mass type presenting pleasant conditions in Athens (etesian winds). The most unhealthy category is class 5 followed by class 3.

Class 5 is characterised by high mean temperature and absolute humidity while the wind regime is from SW (sea breeze). The prevailing weather conditions (high temperatures and moist atmosphere) could be characterised as unhealthy for sensitive groups of the population (ages over 65 y and some detected heart problems in the past).

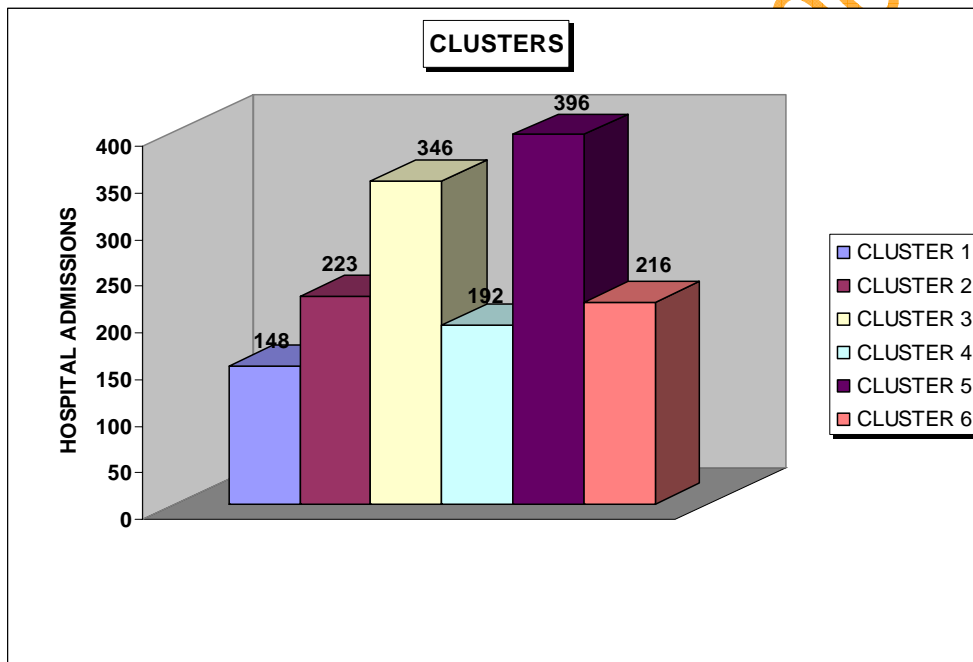


Figure 1. Hospital admissions due to respiratory and heart diseases per air mass type.

Class 3 characterised by low mean temperature and high relative humidity while the wind conditions are nearly a calm regime. The low ventilation and high humidity favours the development of unhealthy conditions over Athens. Due to the low temperature this class is rather a winter one.

It is characteristic that about 50% of the hospital admissions are associated with these two unhealthy weather types.

Finally two weather types with moderate associations with hospital admissions were found (classes 2 and 6).

Class 2 is characterised by SE –S winds presenting a small problem to sensitive groups of population.

Class 6 is associated with NW flow during winter. This weather type is associated with dry conditions and good ventilation

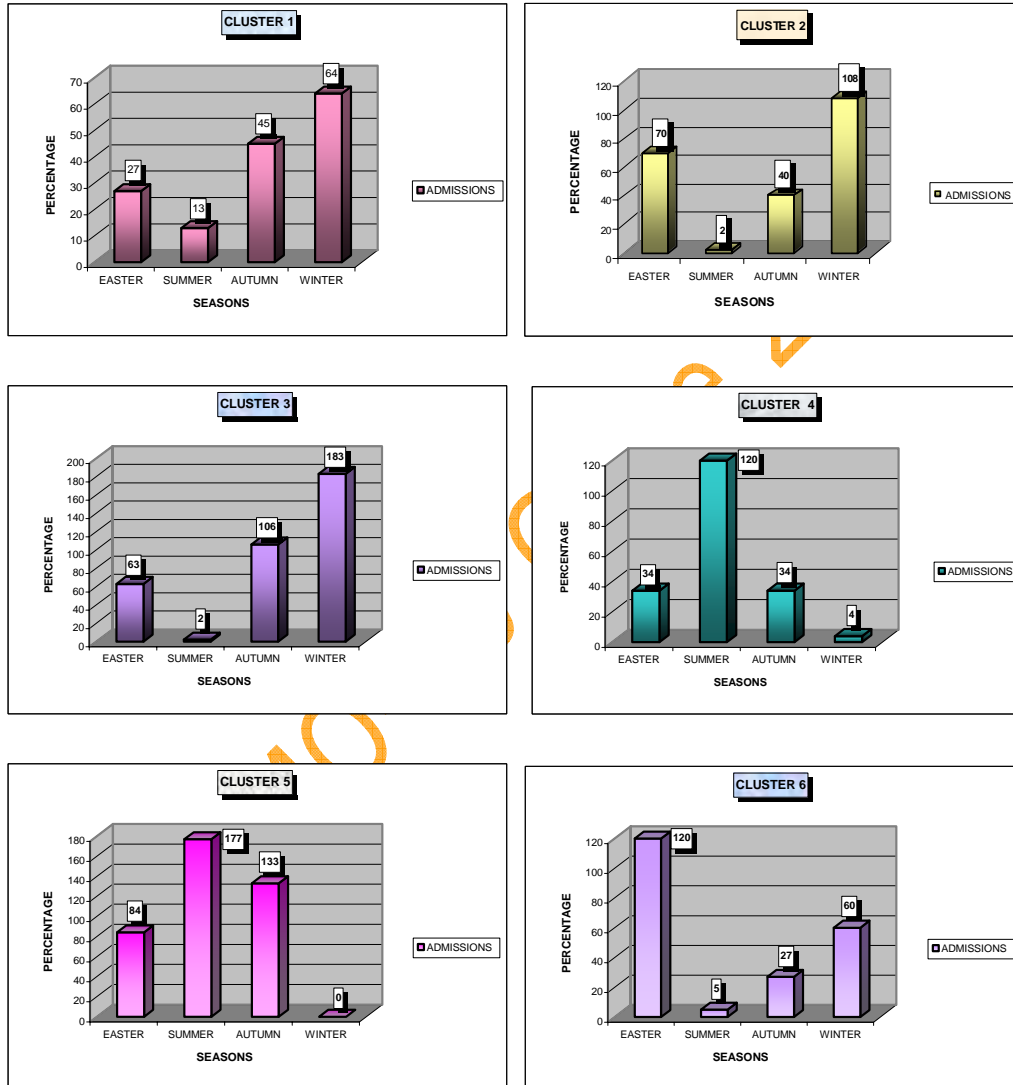


Figure 2. Hospital admissions in percentage per weather type.

Figure 2 shows the hospital admissions per synoptic type. It is obvious that during days belonging to types 2, 3 and 6 the summer admissions are very limited. The same was found for clusters 4 and 5 but for winter.

## **CONCLUSIONS**

In this work an attempt has been made in order to find possible associations between weather types and hospital admissions due to respiratory and heart problems of sensitive groups of the population in Athens Greece.

It is found that south winds combined with high temperature and moisture shape unhealthy conditions over Athens. Also unhealthy conditions are associated with very poor ventilation and moisture environment during winter.

Healthy conditions in Athens are associated with NE winds during all the seasons of the year, good ventilation and low moisture.

There is a great seasonal variability on the hospital admissions for each weather type.

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