CORRELATION BETWEEN DEATHS IN GREECE AND EXTREME WEATHER EVENTS

P. Kantartzopoulou[1], T. Kalyvas[1], E. Zervas[1,*]

[1]School of Science and Technology, Hellenic Open University, 26335, Patras, Greece

(panagkantartzopoulou@gmail.com, ekaly@tee.gr, zervas@eap.gr)

ABSTRACT

The objective of this study is to investigate the correlations between the frequency of deaths and the ambient temperature. For this purpose, the data of ambient temperature and deaths in Greece were analyzed for the period 2014 – 2016. The data regarding the number and cause of deaths were obtained from the Hellenic Statistical Authority (ELSTAT). The deaths were classified according to gender and age groups (every five years). Two main categories of diseases were considered as causes of death in this work: heart diseases and respiratory diseases. The temperature data were obtained from the Hellenic National Meteorological Service (HNMS), for the stations Florina, Mikra, Alexandroupoli, Ioannina, Larissa, Mytilini, Araxos, Tripoli and Tatoi, covering the entire Greece. An average daily temperature of these stations were used. The deaths were subsequently correlated with temperature data. For both genders and for all age groups, the total number of deaths in 2014 and 2015 show a U form, with a minimum at about 20-21°C. The same trend is observed in the case of deaths from cardiac of respiratory causes for both men and women.

KEYWORDS

extreme weather events; heart diseases; human health; mortality; respiratory diseases; temperature

1. INTRODUCTION

Climate change may well constitute the biggest global health threat of the 21st century [1]. The weather variability is a risk factor for mortality and many studies have been carried out in order to reveal the relationship between mortality and environmental variables, especially air temperature [2]. In this context, the present study investigates the relationship between the number of deaths in Greece and the air temperature, for a given time period. The findings of this study can be useful for implementing strategies which protect the public health. The data that were collected and analyzed, can serve as a database for future research.

2. METHODOLOGY

Data regarding the number of deaths in Greece in years 2014, 2015 and 2016, were obtained from the Hellenic Statistical Authority (ELSTAT). The deaths were classified according to gender and 5 year age groups: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85+. In particular, 2 main categories of diseases were considered as causes of death, so the deaths were also classified according to them: Heart diseases (heart attacks, diseases of the

circulatory system, ischemic heart diseases and hypertensive diseases) and respiratory diseases (diseases of the respiratory system, diseases of the upper respiratory track and diseases of the pulmonary circulation). The temperature data for the period 2014-2016 were obtained from the Hellenic National Meteorological Service (HNMS), for the meteorological stations Florina (16613), Mikra (16622), Alexandroupoli (16627), Ioannina (16642), Larissa (16648), Mytilini (16667), Araxos (16687), Tripoli (16710) and Tatoi (16715). Based on temperature data, an average daily temperature of 16 °C was determined. In order to find out whether temperature extremes affect human health, the deaths were subsequently correlated with temperature data.

3. RESULTS AND DISCUSSION

The main results concerning the correlation between deaths caused by heart and respiratory diseases and temperature, are presented below.

3.1 Number of deaths and average daily temperature

The total number of deaths in the period 2014 – 2016, increased when temperature was lower than 12 °C or higher than 20 °C (Fig. 1) . A U–shaped relationship between deaths and temperature is observed, indicating that the number of deaths increases when temperatures are extremely high or low.

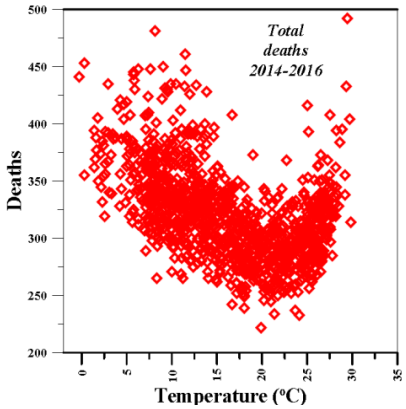

Figure 1. Total number of deaths vs. average daily temperature

Regarding the deaths related to heart diseases, most deaths took place when temperature was lower than 12 °C. These deaths were happened more often when temperature was higher than 18 °C (Fig. 2). A U–shaped relationship between number of deaths and temperature was also ascertained.

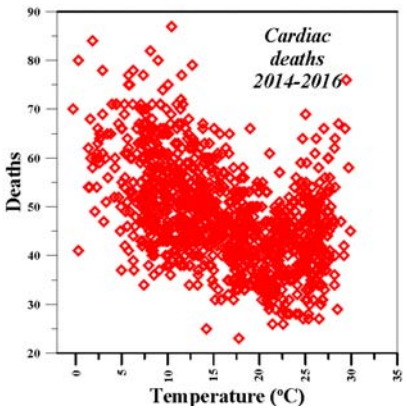

Figure 2. Number of cardiac deaths vs. average daily temperature

The number of deaths related to respiratory diseases, increased when temperature was lower than 15 °C or higher than 25 °C (Fig. 3). A U–shaped relationship was also found in this case.

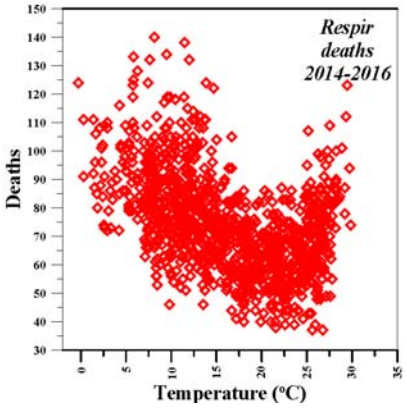

Figure 3. Number of respiratory deaths vs. average daily temperature

Regarding deaths caused by heart diseases, there are more men's deaths than women's. The opposite is true, concerning deaths caused by respiratory diseases. Overall, men's deaths are more than women's. It is noteworthy that while the ischemic heart disease is the leading cause of death in Greece, the deaths from respiratory diseases exceed those from heart diseases, when temperature is taken into account (Fig. 4).

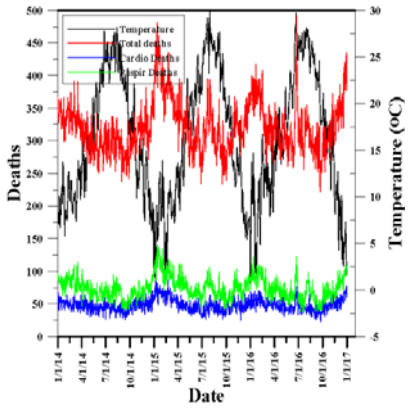

Figure 4. Number of Total deaths, Cardiac deaths and Respiratory deaths, in relation with the average daily temperature for the period 2014 - 2016

3.2 Male - female deaths and average daily temperature

The total number of deaths by gender, is shown in Figure 5. It appears that temperature affects both genders, though men's deaths are more than women's.

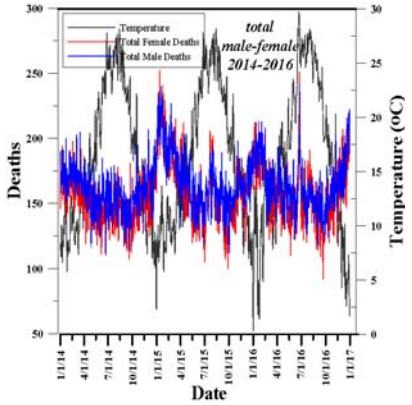

Figure 5. Total number of male and female deaths, in relation with average daily temperature for the period 2014 - 2016

The deaths caused by heart diseases are shown in Figure 6. Men's deaths are more than women's during the whole period. The number of deaths increases in summer and winter. Especially in winter of 2015, the number of deaths increases significantly. A rapid increase in number of deaths also occurred in June and July of 2016.

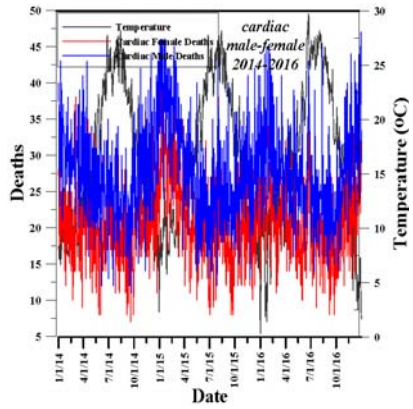

Figure 6. Number of male and female cardiac deaths, in relation with average daily temperature for the period 2014 - 2016

The deaths caused by respiratory diseases are shown in Figure 7. Women's deaths are evidently more than men's. Most respiratory deaths occurred in 2015, when the winter temperatures were the lowest compared to the other years. September is the month with the fewer cardiac and respiratory deaths, for all years.

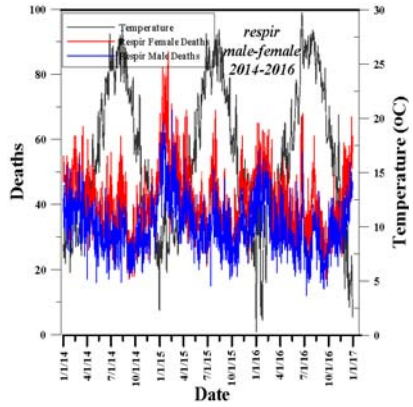

Figure 7. Number of male and female respiratory deaths, in relation with average daily temperature for the period 2014 - 2016

3.3. Daily deaths and average daily temperature, in the 0-29 age group

The number of daily deaths in the 0 – 29 age group is shown in Figure 8. The deaths in this age group account for only 1% of the total number of deaths.

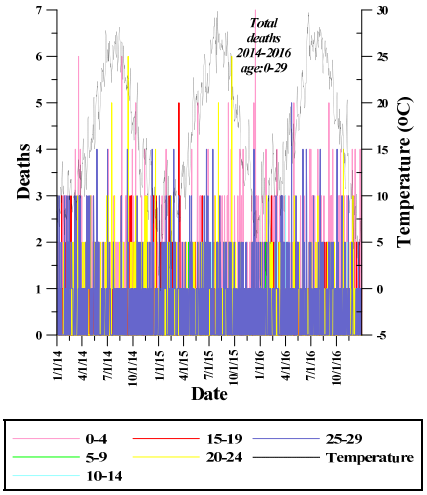

Figure 8. Number of total daily deaths in the 0-29 age group, in relation with the average daily temperature for the period 2014 – 2016

3.4. Daily deaths and average daily temperature, in the 30-59 age group

The number of daily deaths increases in the 30 – 59 age group (Fig. 9). Mortality increases with age.

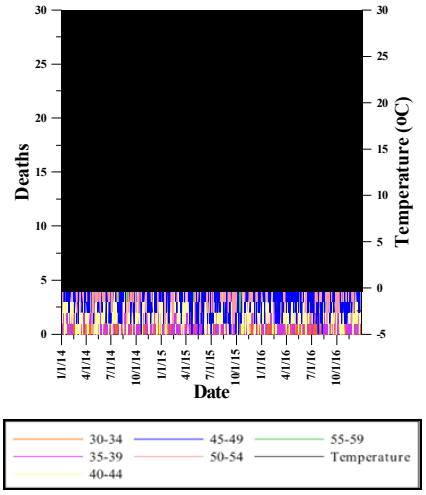

Figure 9. Number of total daily deaths in the 30-59 age group, in relation with the average daily temperature for the period 2014 – 2016

As in the case of total deaths, cardiac deaths in the 30 – 59 age group increase with age (Fig. 10). In the 50 - 59 age group, cardiac deaths are double that of the 40 – 44 age group and 7 times more than the 30 – 34 age group. Male cardiac deaths are 6 times more than female, in each age group.

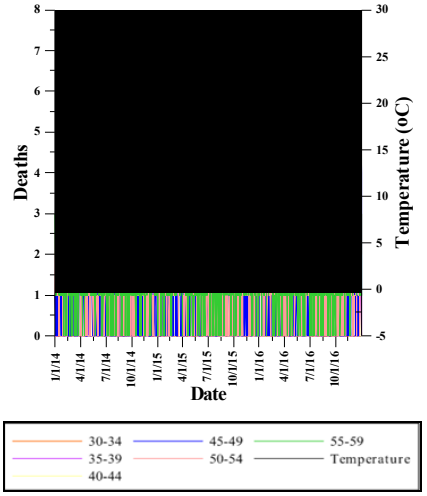

Figure 10. Number of total daily cardiac deaths in the 30-59 age group, in relation with the average daily temperature for the period 2014 – 2016

The number of respiratory deaths in the 30 – 59 age group, is shown In Figure 11. The deaths in the 50 – 59 age group are many more than in the younger age groups.

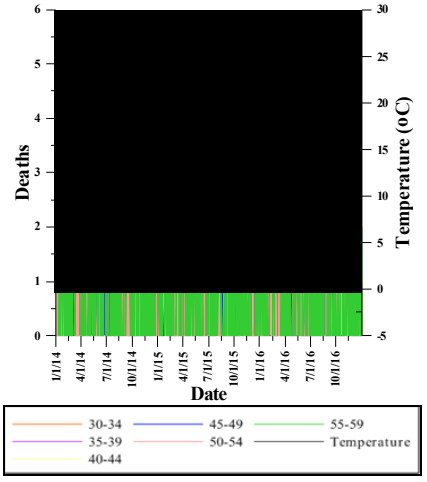

Figure 11. Number of total daily respiratory deaths in the 30-59 age group, in relation with the average daily temperature for the period 2014 – 2016

3.5. Daily deaths and average daily temperature, in the 60-85+ age group

The total daily deaths in the 60-85+ age group are shown in Figure 12. The number of deaths is significantly increased, compared to the younger age groups. Total male deaths are double that of female, until the age of 79 years. In the 80 - 84 age group the number of female deaths is slightly more than the number of male deaths, while in ages of 85 years and over, the female deaths are many more than male. It was found that both genders are affected by lower than 12°C and higher than

25°C temperatures.

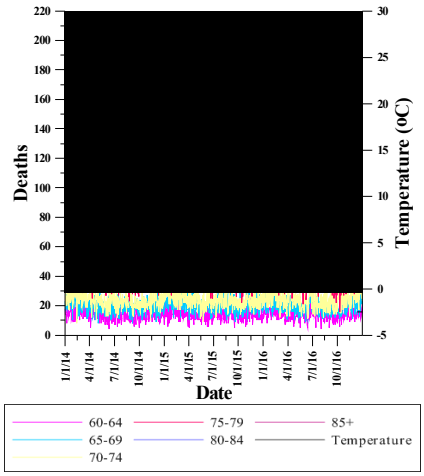

Figure 12. Number of total daily deaths in the 60 – 85+ age group, in relation with the average daily temperature for the period 2014 – 2016

Cardiac deaths are increased significantly over the age of 75 years for both genders (Fig. 13). As in the case of the total deaths, in ages of 85 years and over, the female cardiac deaths are many more than male.

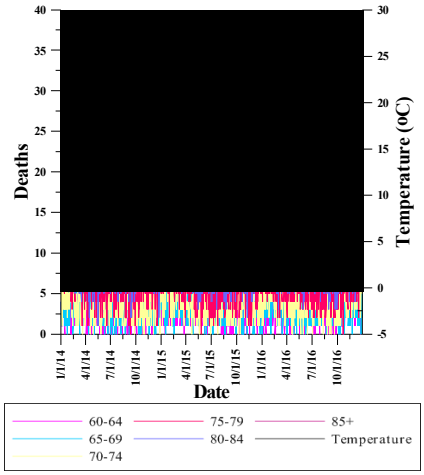

Figure 13. Number of total daily cardiac deaths in the 60-85+ age group, in relation with the average daily temperature for the period 2014 – 2016

The number of respiratory deaths is shown in Figure 14. There is a significant increase in the number of deaths, in the older age groups. In the 60 – 75 age group, the number of men's respiratory deaths is double that of women's. Over the age of 75, women's deaths increase and exceed men's, as in the case of total and cardiac deaths.

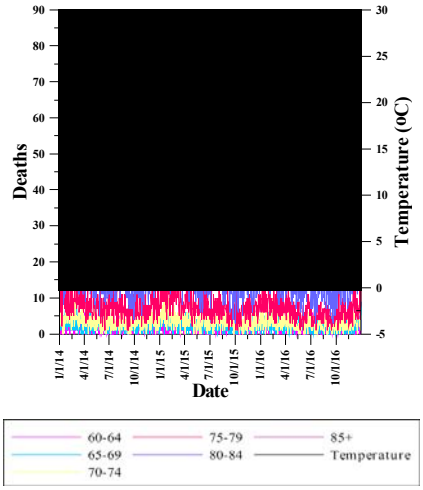

Figure 14. Number of total daily respiratory deaths in the 60-85+ age group, in relation with the average daily temperature for the period 2014 – 2016

4. CONCLUSIONS

It emerged that low and high temperatures affect human health regardless of gender, because of an important increase of number of deaths. This trend was mainly noticed when there were extended warm or cold periods, or when a rapid change of temperature had occurred. The relationship between number of deaths and temperature is a U-shaped curve, showing that extreme temperatures justify the increase of mortality. The elderly people (70–85+) are the most vulnerable. A significant increase of deaths was noticed in late December and in early January. Despite the prevailing low temperatures, this trend could be mostly attributed to the Christmas period, when some people tend to overindulge

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