THE IMPACT OF HOT WEATHER CONDITIONS ON TOURISM IN FLORENCE, ITALY: THE SUMMERS 2002 - 2003 EXPERIENCE

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ABSTRACT

The Italian summers of 2002 and 2003 showed differing weather conditions: the former was very hot only in June, while the latter was very hot quite consistently. In fact, during the summer of 2003, in the month of August, there was a catastrophic heat-wave, and Italy was the second most affected country in Europe after France. For this reason, Florence, an important Italian city for tourism, was chosen to study the influence of weather conditions on tourists, in particular on emergency room admissions. Admission data were provided by the hospital located in the historical centre of Florence. The sample was divided into four groups according to nationality and residency. A biometeorological index based on the human energy balance, the Physiological Equivalent Temperature (PET), was calculated. Daily minimum, maximum and average PET values were considered with the aim of evaluating the thermo-physiological discomfort of tourists during hot weather conditions in the Mediterranean area. The percentages of variation in event rates, according to PET modifications in both summer 2002 and 2003, were derived from their relative risks by using a regression model. PET values showed very different patterns, and summer 2003 always showed higher daily maximum, minimum and average PET values than 2002, except for the third week of June 2002. The results of this study showed a highly significant linear increase in event rates of tourists coming from high northern latitudes in Europe and America, especially when the daily minimum PET was increased. The study of the impact of these weather conditions could represent the first step towards the development of an operative watch/warning system calibrated for tourists.

KEYWORDS: *Tourism, PET, Biometeorology, Discomfort, Summer*

INTRODUCTION

Although weather and climate are widely recognised as vitally important for tourism, relative little is known about their effects (1). For many regions, such as Italy, tourism is a very important source of income. Since about 40% of tourists come to Italy during summer, the hot weather can play a very important role in determining the quality of a vacation. Furthermore, the extreme hot conditions may represent a risk factor to tourists, increasing emergency room visits, expecially among the elderly and those who are affected by chronic diseases. The Italian summers of 2002 and 2003 showed very different weather conditions: the former was very hot only in June, while during the latter, very hot conditions frequently occurred. In fact, during August of 2003 there was a catastrophic heat-wave throughout Europe, and Italy was the second most affected country after France (2).

Florence is one of the most important cities in Italy from the point of view of tourism: in 2002 2,450,736 tourists visited the city, dropping only slightly to 2,368,044 in 2003. The days spent by tourists in the city were 6,314,508 in 2002 and 6,049,123 in 2003 (3). Tourists especially come from Germany, France, United Kingdom and Austria (4).

The aim of this study was to evaluate, from a biometeorological point of view, the impact of hot weather conditions on emergency room admissions among tourists to the hospital located in the historical centre of Florence. This impact was evaluated by the integration of physical factors influencing the body-atmosphere thermal state by using a thermal index based on the energy balance model for humans. These kinds of indices are reliable indicators of on-site thermal conditions (5). The difference in the susceptibility of people coming from countries located at different latitudes were also studied. The identification of thresholds of risk leading to emergency room admissions could be used to implement a watch/warning system for tourists. This information could also be used for business planning and decision-making in the field of recreation (1). In these ways tour operators could change sightseeing plans when extreme weather conditions were forecast (for example, indoor instead of outdoor activities).

METHODS

Study site

Florence is an Italian city located in the Region of Tuscany ($\lambda = 11°11'$ E; $\Phi = 43°47'$ N). The city is 50 m a.s.l. in a closed valley bottom at the foot of the Apennines, and extends along the plain in a SE-NW direction. The surface area is about 100 km^2, is crossed by the river Arno, and is surrounded by hills to the South and mountains to the North, which rise to almost 1000 m.

The city has a climate which can be defined as Mediterranean semi-continental, with cold winters and hot summers. The coldest month is January, with an average temperature of about 6°C. The warmest months are July and August, with an average temperature of 24°C.

Hospital admissions

Data on daily hospital admissions of tourists into the emergency room were provided by the administration of Santa Maria Nuova Hospital (Azienda Sanitaria 10, Florence). The data covers a 2-year period, 2002-2003, from June 1st to August 31st. Only the admission data of people whom were residents abroad were considered. Patients from countries where people usually come to Italy for reasons other than tourism (for example: job, asylum, etc.) were excluded. Only hospital admissions due to acute events were included in the study, based on the reading of the diagnoses performed by doctors. The total number of hospital admissions of tourists for all causes was 455. This sample was divided into four groups according to residence data: Central and Northern European, mainly coming from Germany, Austria, United Kingdom, France, and the Scandinavian countries; Mediterranean, mostly coming from Spain and Greece; North American, coming from the United States and Canada; and Central and South American, prevalently coming from Mexico, Ecuador, Brazil and Argentina.

Meteorological data and the biometeorological index

Hourly meteorological data of air temperature (°C), relative humidity (%), wind velocity (ms^{-1}), cloud cover (in eighths) and global radiation (Wm^{-2}) were obtained from the urban weather station located in the centre of Florence for the summers of 2002 and 2003. This weather station is managed by the Regional Office for Environmental Protection in Tuscany (ARPAT). The two summer seasons considered in this study include the months of June, July and August. To evaluate daily thermo-physiological discomfort conditions for tourists, a thermal index based on the energy balance model for humans, the Physiological Equivalent Temperature (PET) (6,7), was applied by using the RayMan model version 2.0 (8). This model integrates physical factors influencing the body-atmosphere thermal state, listed above, and considers several body characteristics, such as metabolic rate (80 W), posture (standing) and clothing (0.9 clo). Daily average, maximum and minimum PET (PET_ave, PET_max, PET_min, respectively) were assessed for the period studied.

Statistical analyses

Statistical analyses were performed assessing the relative risk (RR, or RRs if plural) of event rates for each daily value of PET. This examination was performed for each group of hospital admissions of tourists, according to residence data. A RR of 1.0 means that the probability of admissions of tourists on days with a specific value of PET is equal to the probability observed on

days when these specific values are not observed. A regression analysis was carried out on the values of RRs and the percentages of variations of event rates, according to PET modifications in both summer 2002 and 2003, and were derived from each RR by using the following expression: 100×(RR-1).

Consecutive days characterized by high biometeorological values, corresponding to the 90th percentile of daily PET_ave (PET_ave ≥ 31°C), PET_max (PET_max ≥ 47°C) and PET_min (PET_min ≥ 18°C) were assessed, and the hospital admissions of the last of these consecutive days were counted. For each group of consecutive days a RR was performed.

RESULTS

The Italian summers of 2002 and 2003 showed very different weather conditions from a biometeorological point of view. The summer of 2003 showed a shift of daily frequency distributions of PET_ave, PET_max and PET_min, reaching higher values in comparison to the summer of 2002 (Fig. 1).

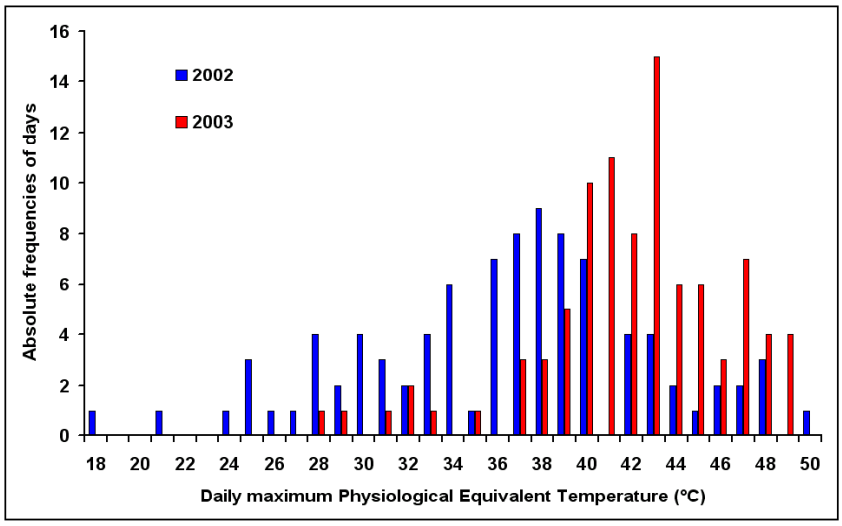

Figure 1: Distribution of daily maximum Physiological Equivalent Temperature during the summers 2002 and 2003

Hospital admissions prevalently occurred during the summer of 2003, representing 72.7% of the total sample, against 27.3% during the summer of 2002. The maximum frequency of hospital admissions concerned tourists coming from Central and Northern Europe, with 30.1% in 2003 and 10.1% in 2002. This was followed by tourists coming from North America, with 19.8% in 2003 and 7.7% in 2002, those living in Mediterranean areas, with 19.8% in 2003 and 7.3% in 2002, and the minimum frequencies where observed for tourists coming from Central and South America, with 8.8% in 2003 and 2.2% in 2002.

Considering data for the summers of 2002 and 2003 together, plots of RRs of hospital admissions versus daily PET values often suggested a linear relationship. This was especially true when taking into consideration the relationships between daily PET_min and tourists coming to Florence from different countries, with the only exception being tourists coming from Central and South America. In particular, for 1°C increase in PET_min the increase in RRs of event rates was 43% for Central and North European tourists ($P<0.01$), 27% for Mediterranean tourists ($P<0.001$) and 18% for North American tourists ($P<0.001$) (Fig. 2).

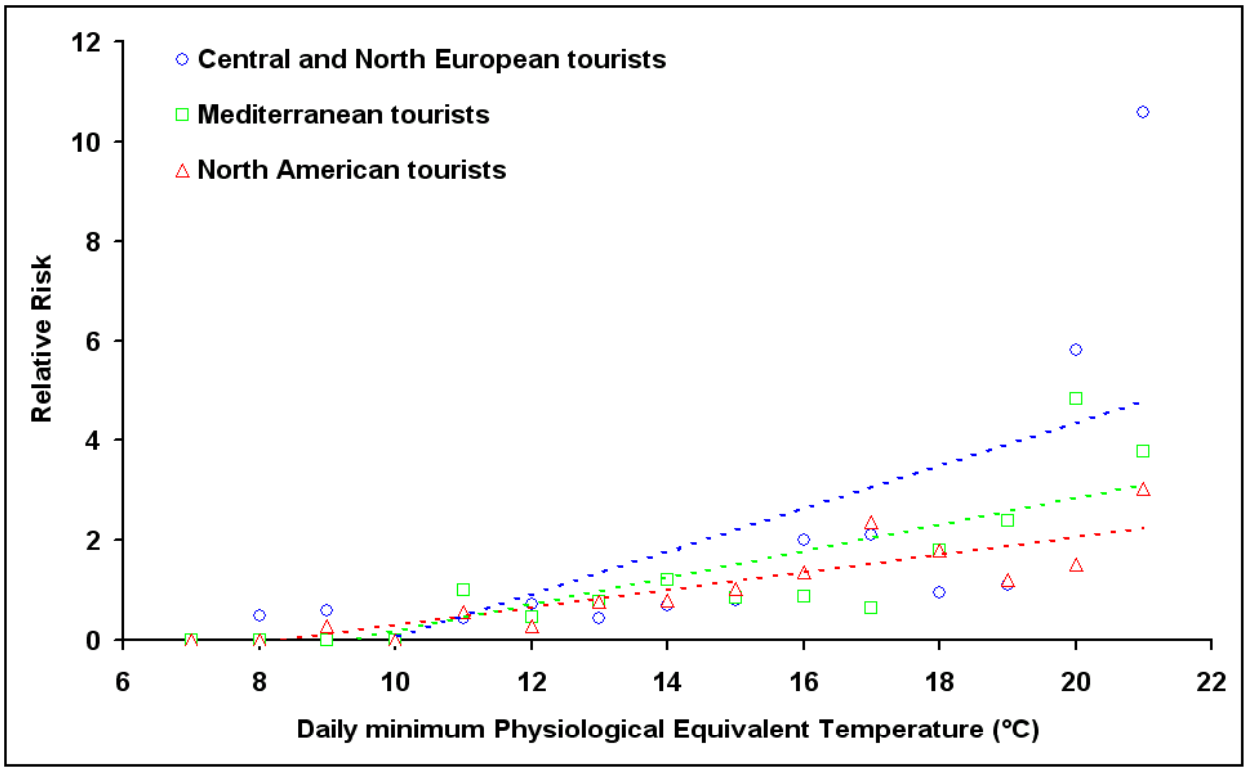

Figure 2: Relative risk of daily event rates versus daily minimum Physiological Equivalent Temperature during summer 2002 and 2003. Blue, green and red broken lines represent linear regressions of relative risks for tourist coming from Central and North Europe, Mediterranean area and North America respectively

Similar linear relationships were also found between daily PET_ave and RRs of admission of Central and North European tourists ($P<0.001$) and North American tourists ($P<0.001$) (Fig. 3). Daily PET_max were only associated with the RRs of North American tourists ($P<0.01$). All of these significant linear relationships were more evident during the summer of 2003 than 2002, and especially concerned tourists coming from high northern latitudes in Europe and America.

Consecutive days with high daily average and maximum PET showed high RRs of event rates, especially for Central and North European tourists (Fig. 4). All RRs showed values higher than 1.0,

which means a higher probability of admissions than that occurring on non-consecutive days. In particular a probability of hospitalization of 243% occurred on the seventh consecutive day with a high PET_max.

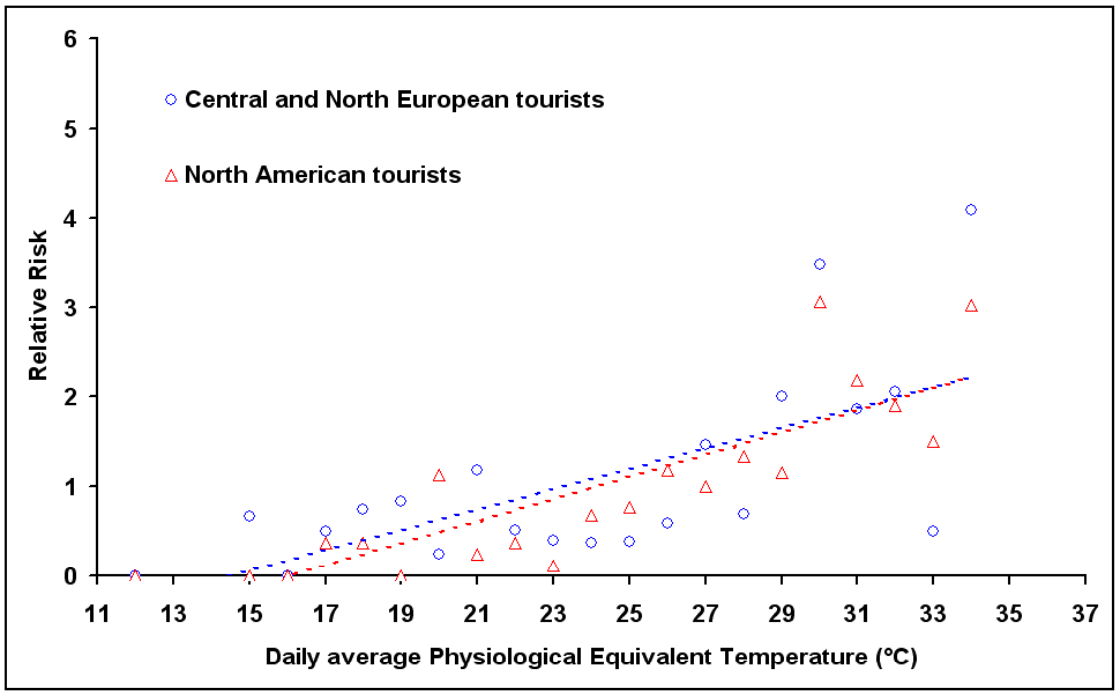

Figure 3: Relative risk of daily event rates versus daily average Physiological Equivalent Temperature during summer 2002 and 2003. Red and blue broken lines represent linear regressions of relative risks for tourist coming from North America and Central and North Europe respectively

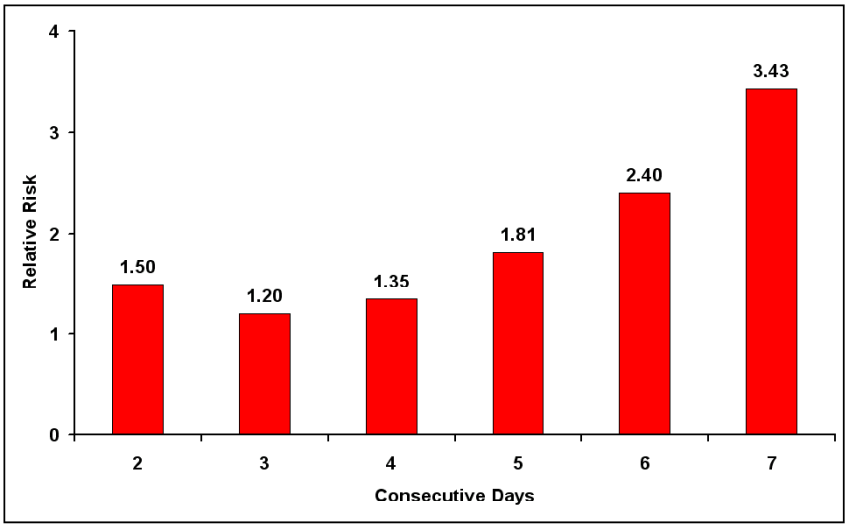

Figure 4: Relative Risks of hospital admissions for Central and North European tourists on consecutive days with high daily maximum Physiological Equivalent Temperature assessed during summer 2003

DISCUSSION

Although many aspects of the relationship between tourism and climate/weather have been investigated so far (1), the impact of some extreme events on the emergency room visits of tourists has been poorly studied. In the present study, the effects of thermo-physiological discomfort due to hot weather conditions on emergency room admissions of tourists has been found.

Florence is one of the most famous historical cities in the world and more than 2 million tourists visit its monuments every year. Some of these tourists are suffering from chronic diseases and some could be at risk for systemic diseases (for example cardiovascular diseases); in both cases, hot weather conditions could represent trigger factors determining acute events. The results of this study showed a significant increase in event rates when the daily minimum PET increased. This is probably caused by the fact that this parameter is perceived by tourists in a negative manner. PET_min is generally nocturnal, or occurs in the early diurnal hours, and therefore is a better indicator in comparison to the daily maximum and average PET. This is because during these hours the body needs physiological rest. These effects were more evident in the summer of 2003, characterized by a high rate and persistent extreme hot conditions. During the summer of 2002, extreme hot weather conditions only occurred in the second half of June. The effects of high daily average and maximum PET on hospital admissions of tourists were more evident when these discomfort conditions occurred on consecutive days - that is heat-waves. This high relationship might be the result of the impact of the addition of the time spent outside during the hottest hours of the day visiting monuments, followed by nights without rest.

The evaluation of the role of acclimatization in the susceptibility to the thermo-physiological discomfort caused by hot weather conditions showed that people usually living in colder countries at high northern latitudes of Europe and America were more affected than people coming from other countries. However, even tourists coming from Mediterranean countries, such as Spain and Greece, showed a great susceptibility when daily PET_min values increased. On the other hand, people coming from Central and South America did not show any vulnerability to such thermo-physiological discomfort conditions. The results of the present study have to be confirmed on a larger sample, extending this study to other years and seasons. However, they could represent the first step for the development of a watch/warning system for tourists that might be used by tour operators for planning sightseeing activities (outdoor or indoor), and to alert those tourists at high risk. Furthermore, it will be possible to improve hospital assistance when weather discomfort conditions are forecast. This is particularly necessary because, in the upcoming years, severe heat-waves, or short periods with extremely hot days, are very likely to increase in frequency in the Mediterranean area (9).

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