P 1.8 EPIDEMIOLOGIC STUDY OF MORTALITY DURING THE SUMMER OF 2003 IN ITALY

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1. INTRODUCTION

Italy is characterized by Mediterranean climate: this sort of climate is usually defined temperate. Seasons are clearly drawn: winter is generally moderate cold, spring is rainy with sunny days, summer is warm and dry, autumn is almost cloudless, quite rainy, but never severe. During the summer there are scarce or null rainfall and temperatures are not usually higher than 35°C. Rarely there are meteorological extreme events and generally they regard limited areas.

Heat-waves can be defined as extreme and exceptional events, but it has been observed that in the last decades they became more frequent in different parts of the World. The heat-wave which interested Europe from May to September 2003 represented an extreme event for Italy in relation to the high temperature values, their long persistence, the long duration of drought, and the great spatial distribution of the phenomenon: the weather anomalous conditions, in fact, involved all Italian regions, from Alps to Islands.

Starting from the last half part of May 2003 until the end of the summer, the anticyclone of the Azores was firmly blocked on the medium-European regions, driving anomalous meteorological conditions (high temperature and absence of precipitations) on the western and southern Europe. The anticyclone intercepted and deviated the atmospheric western flows and it prevented to alleviate those extreme discomfort conditions perceived from people.

It is widely recognized that extreme climatic conditions during the summer months can constitute a major public health threat. Persons living in cities have an elevated risk of death when the temperature (and humidity) are high and persistent also during the night, compared with those living in suburban and rural areas ("urban heat island effect"). Heat-wave maximum effects essentially regard old people: there is an increase of their mortality percentage because they have a reduced ability to thermo-regulate body temperature and their sweating threshold is generally more elevated than younger people; moreover, they are affected by other risk-factors linked to the high frequency of disability, disease, and loneliness.

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2. MATERIALS AND METHODS

The meteorological dataset is composed of daily temperature values (minimum and maximum) and relative humidity collected during the period June 1st -August 31th 2003 and during the same period of 2002 in 74 stations of the Italian meteorological network of Central Office for Crop Ecology (UCEA).

The dataset was elaborated to calculate several discomfort indexes, such as the Humidex, one of the most used at international level, , developed in Canada in 1965, described and formally defined in 1979; through such index it is possible to represent the temperature effectively perceived by the human body which is a function of the air temperature e and of the relative humidity.

The index Humidex (h) is defined as follows:

$$H = T + 5/9 *(e-10)$$

where T = *air temperature (°C)*
e = *vapour pressure (hPa)*

Since the measure of the vapour pressure is not generally available, it is estimated through a function which associates relative humidity to air temperature, in the following way:

$$e = 6.112*10\ [(7.5*T) / (237.7 +T)] * UR/100$$

where UR = *air relative humidity (%)*.

Humidex represents the perceived temperature and it is expressed in Celsius degrees. Values of H identify different classes of physical discomfort that correspond to the following levels of attention:

Normality	H < 27	Comfort
Caution	27 ≤ H < 30	Light discomfort
Extreme Caution	30 ≤ H < 40	Discomfort
Danger	40 ≤ H < 55	Great discomfort
High Danger	H ≥ 55	Imminent Blow of Heat

In this study it has been analyzed the Italian meteorological scenario during the great heat - wave of summer 2003 and it has been compared with the meteorological situation of 2002, through daily calculation of the Humidex and its distribution during the three Summer months.

Elaboration results have been processed through GIS tools (ArcView 8.2) to obtain a spatial representation of the analyzed index, to allow a comparison among the different Italian areas and to test differences between 2003 and 2002. GIS tools have been realized in the framework of the National Research Programme of the Ministry of Agriculture on Agriculture and Climate change, called "CLIMAGRI".

The summer mortality during the heat wave of 2003 has involved above all the urban areas and for this reason the statistical analysis of mortality has been carried out on 21 cities.

In order to analyze the mortality phenomenon, summer months have been subdivided in sub-periods of 15 days (1-15 june, 16-30 june, 1-15 July, 16-31 July, 1-15 August and 16-31 August).

In order to elaborate data, it has been considered the Italian population during 1991 Census; data have been analyzed for gender and age and it has been calculated the absolute number of deaths and their standardized percentage for age. Differences between the numbers of dead people observed in the two years have been tested with the test z.

The relation observed between mortality and climatic situation has been firstly studied through the correlation between daily mortality and the Humidex value of the same day; the correlation has been calculated through the index ρ of Pearson.

Finally it has been analyzed the "time of delay", an aspect of remarkable interest in the Public Health, that is the time that passes between the exposure to the wave heat and the outcome (in our case mortality). For persons over 75 years of age, it has been calculated the correlation between the daily number of deaths and the average of the Humidex index of the previous days, to focus the delay period of maximum correlation; even in this case it has been used the index ρ of Pearson.

The elaborations have been effected through the statistical SW SPSS.

3. RESULTS AND DISCUSSION

In Italy, during summer 2003 meteorological conditions have been extreme and of long persistence; all values (relative humidity, maximum and minimum temperature) have been constantly elevated, and brought a situation of persistent physical discomfort particularly injurious to the health, also during the night. The meteorological extreme events have major effect on old people which are the most sensitive persons and for this reason the mortality excess during the heat wave regarded them, particularly those who live in the cities.

Compared with 2002, there was an overall increase in mortality of 3,134 unities (from 20,564 in 2002 to 23,698 in 2003) - increase of 15.2%. The greatest increase regarded elderly people: 2876 deaths (92%) occurred among people aged 75 years and older, which have recorded a mortality increase of the 21.3%, respect to summer 2002. The increase in mortality was greatest in the cities with a typical cool climate (**table 1** and **2, figure 1**).

The major increase of mortality has been recorded in the Northwest of Italy (31,5%), (areas near France, with similar climatic conditions) but also in the southern cities located at high altitude, (L'Aquila, at 700 meters of altitude and Potenza, at 800 meters on the sea level). Mortality has been of the 17,8% in the South, of the 16,4% in the Northeast and the 16,3% in the Centre .

Concerning mortality of the over 75 aged in each city, the greatest increase was observed in Turin (45%) - where the deaths number is doubled during the first fifteen days of August- , Trento (35%), Milan (30.6%) and Genoa (22.2%). In the second half of August some Southern cities experienced their highest increase in mortality, for example, in Bari the overall mortality excess was 33.8%, but it reached 137% in the last part of August. In Rome the mortality increase (16.9%) was distributed in all summer season (**table 3, figura 2**). In all these cities, the relationship between mortality and climatic indexes (t. max, Humidex) was investigated and a clear correlation was observed.

This study has obtained the same results observed in several parts of the world during the heat waves:

- Referring to heat wave, mortality is usually greater in temperate climate cities which are located in the northern areas of the boreal hemisphere or of the single Countries: this phenomenon is known as "inverse effect of the latitude".
- the time of delay, that passes between extreme meteorological conditions and increase of mortality is short, of the order of few days (**table 4**).

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Table 1: Mortality in the period 1st June – 31st August 2002 e 2003. Deaths number in each city resident people (**** p < 0.01 * p < 0,5 (Test z))**

	All ages				75 years and over			
Cities	**2002**	**2003**	**Difference 2003-2002**	**Difference %**	**2002**	**2003**	**Difference 2003-2002**	**Difference %**
	1780	2341	**561**	**31.5**	1134	1643	**509**	**44.9****
Aosta	96	101	**5**	**5.2**	59	70	**11**	**18.6**
Genova	1829	2136	**307**	**16.8**	1295	1575	**280**	**22.2****
Milano	2438	2953	**515**	**21,1**	1612	2105	**493**	**30,6****
North West	**6143**	**7531**	**1388**	**22.6**	**4100**	**5393**	**1293**	**31.5**
Trento	168	223	**55**	**32.7**	122	165	**43**	**35.2****
Bolzano	196	251	**55**	**28.1**	135	156	**21**	**15.6**
Venezia	706	763	**57**	**8.1**	491	541	**50**	**10.2**
Trieste	795	835	**40**	**5.0**	571	606	**35**	**6.1**
Bologna	968	1144	**176**	**18.2**	698	880	**182**	**26.1****
North Est	**2833**	**3216**	**383**	**13.5**	**2017**	**2348**	**331**	**16.4**
Northen Italy	**8976**	**10747**	**1771**	**19.7**	**6117**	**7741**	**1624**	**26.5**
Ancona	271	309	**38**	**14.0**	187	227	**40**	**21.4**
Firenze	941	1015	**74**	**7.9**	707	790	**83**	**11.7****
Perugia	332	368	**36**	**10.8**	229	268	**39**	**17.03**
Roma	5246	5849	**603**	**11.5**	3334	3899	565	**16.9****
Centre Italy	**6790**	**7541**	**751**	**11.1**	**4457**	**5184**	**727**	**16.3**
Napoli	2033	2339	**306**	**15.1**	1231	1458	**227**	**18.4****
L'Aquila	125	138	**13**	**10.4**	77	96	**19**	**24.7**
Campobasso	71	78	**7**	**9.9**	42	54	**12**	**28.6**
Bari	535	675	**140**	**26.2**	340	455	**115**	**33.8****
Potenza	109	122	**13**	**11.9**	63	79	**16**	**25.4**
Catanzaro	135	142	**7**	**5.2**	86	76	**-10**	**-11.6**
Palermo	1469	1558	**89**	**6.1**	896	1010	**114**	**12.7***
Cagliari	321	358	**37**	**11.5**	208	240	**32**	**15.4**
Suthern Italy	**4798**	**5410**	**612**	**12.8**	**2943**	**3468**	**525**	**17.8**
Total Italy	**20564**	**23698**	**3134**	**15.2**	**13517**	**16393**	**2876**	**21.3**

Figure 1 : Difference percentage of resident people deaths number in each city
1st June – 31st August 2002 and 2003

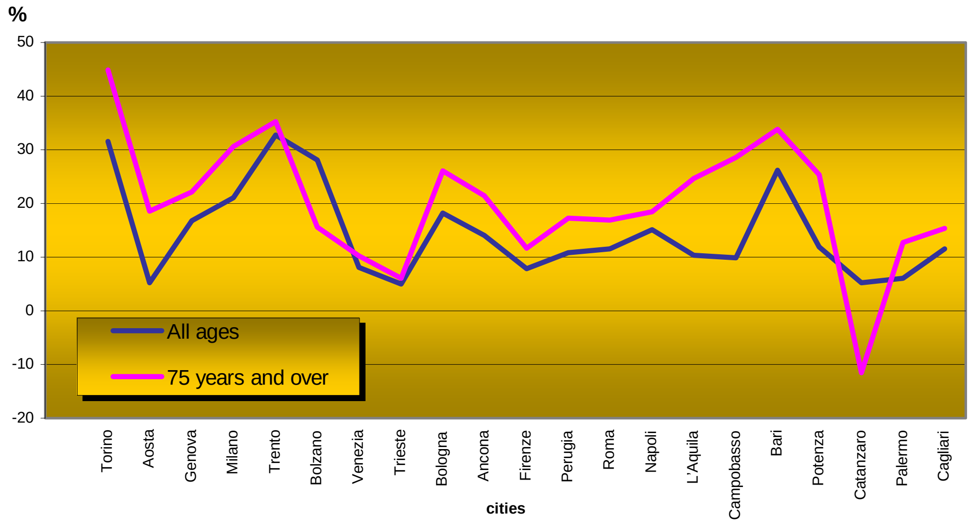

Table 2: Number of deaths - 75 aged and over 1st June– 31st August 2002 and 2003 sub-periods 15 days

	1-15 June		16-30 June		1-15 July		16-30 July		1-15 August		16-31 August	
Cities	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**
Torino	191	264	277	265	174	213	171	243	153	431	168	227
Aosta	12	14	8	8	6	16	13	7	12	14	8	11
Genova	211	229	263	231	201	184	194	285	204	430	222	216
Milano	260	365	415	347	249	260	218	278	235	494	235	361
Trento	19	27	23	27	17	21	25	29	21	34	17	27
Bolzano	31	28	29	22	21	23	24	29	18	30	12	24
Venezia	78	91	102	82	71	68	76	90	89	117	75	93
Trieste	84	92	106	93	92	97	104	100	86	117	99	107
Bologna	113	139	180	161	101	119	95	133	94	159	115	169
Ancona	36	45	38	45	22	30	27	32	30	28	34	47
Firenze	116	132	164	127	109	103	101	155	103	134	114	139
Perugia	36	34	53	38	42	40	37	52	20	48	41	56
Roma	531	630	850	708	566	543	460	760	447	614	480	644
Napoli	135	194	319	307	146	172	277	310	118	172	236	303
L'Aquila	15	9	18	19	13	9	9	18	10	19	12	22
Campobasso	6	13	10	9	8	10	8	7	8	4	2	11
Bari	56	63	54	82	66	69	64	91	71	67	29	83
Potenza	11	18	13	13	8	8	9	13	9	11	13	16
Catanzaro	21	13	9	13	13	12	20	13	9	10	14	15
Palermo	140	167	154	167	148	151	167	230	162	142	125	153
Cagliari	27	34	33		42	40	33	55	36	31	37	38

Table 3: Standardized mortality percentage for 1000 persons 75 aged and over – 1st June – 31st August 2002 - 2003

	2002		2003		
Cities	**Percentage std**	**ES**	**Percentage std**	**ES**	**Diff.%**
Torino	15,6	0,4	23,3	0,5	49,2
Aosta	18,3	2,2	21,6	2,4	17,9
Genova	19,5	0,5	23,8	0,5	22,2
Milano	14,1	0,3	18,9	0,4	34,1
Trento	15,9	1,2	21,1	1,4	33,0
Bolzano	17,6	1,3	19,1	1,4	8,3
Venezia	19,6	0,8	21,1	0,8	7,4
Trieste	21,8	0,9	23,6	0,9	8,3
Bologna	15,8	0,5	21,5	0,6	36,3
Ancona	19,0	1,3	24,7	1,4	30,2
Firenze	17,6	0,6	20,2	0,6	15,0
Perugia	20,2	1,1	22,5	1,2	11,4
Roma	19,1	0,3	22,7	0,3	18,8
Napoli	24,0	0,6	29,5	0,6	22,9
L'Aquila	16,0	1,6	19,6	1,8	22,9
Campobasso	15,9	1,9	17,2	2,1	8,5
Bari	17,9	0,8	25,0	1,0	40,2
Potenza	20,7	2,0	26,9	2,2	29,5
Catanzaro	20,4	1,7	16,3	1,6	-19,8
Palermo	31,3	0,8	34,7	0,8	10,9
Cagliari	20,4	1,2	22,5	1,3	9,9

Figure 2: Standardized mortality percentage for 1000 persons 75 aged and over
1st June – 31st August 2002 and 2003

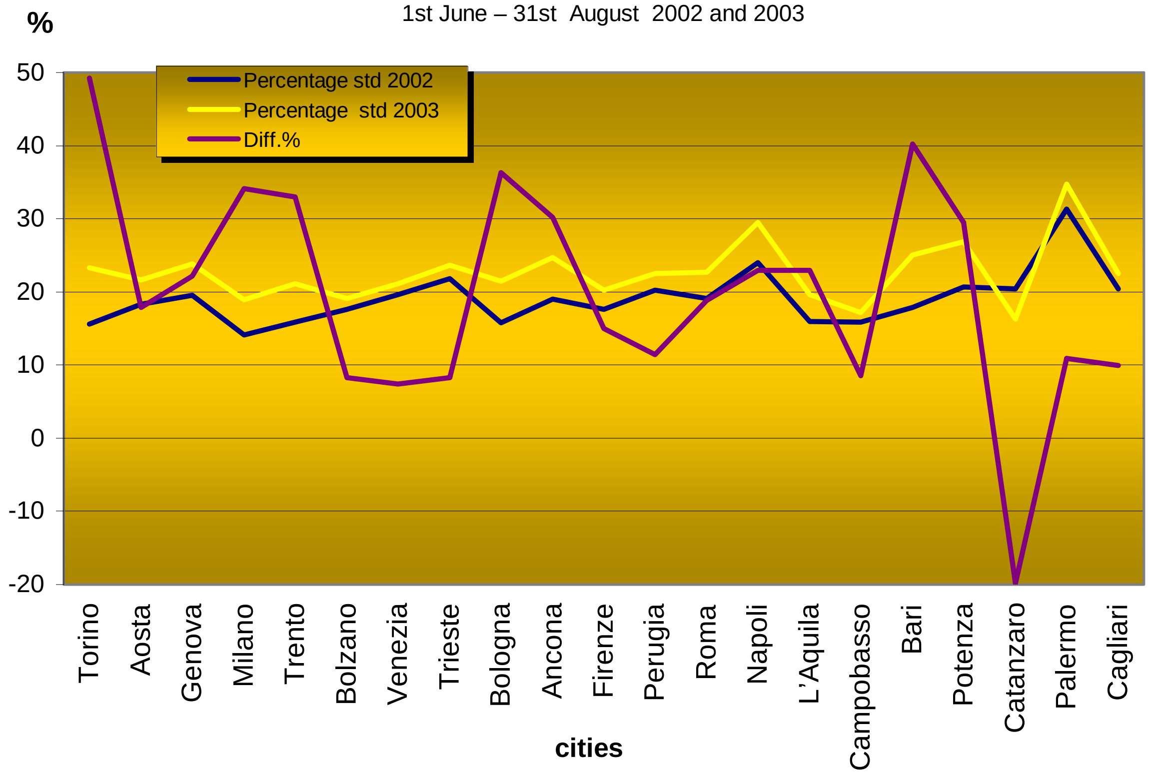

Table 4: Time of delay : Maximum Correlation period between daily deaths and daily mean Humidex – summer 2003 - 75 aged and over

Cities	**Period**	**Correlation (ρ of Pearson)**
Torino	4 days before	0,639
Milano	4 days before	0,741
Genova	3 days before	0,437
Roma	2 days before	0,445
Bari	3 days before	0,404