MORTALITY RELATED TO THE HEAT WAVE OF AUGUST 2003 IN FRANCE : II. MODELISATION OF THE RELATIONSHIP BETWEEN MORTALITY AND TEMPERATURE

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INTRODUCTION

From 1st to 20th August, 2003, metropolitan France was exposed to a heat wave of unprecedented amplitude and duration. Almost 15000 excess deaths occurred during this period.

Excess mortality clearly followed the heat wave period, established from 4 to August 13, with a national average maximum temperature close to 35°C.

During this period, usual maximum temperature is around 25.5°C.

OBJECTIVES

- Analysis of geographical heterogeneity of excess mortality between *départements* of metropolitan France from 1st to 20th August, 2003

- Modeling the relationship between mortality and meteorological outcomes

MATERIAL AND METHODS

Mortality data

O : daily observed death counts for the period 1st - 20th August 2003

E : daily expected death counts estimated with the data of the reference period 2000-2002, and the population 2000 - 2003

Source : Inserm – INSEE

O/E : mortality ratio

Statistical unit : 95 "*départements*" of metropolitan France

Meteorological data

2003: daily minimum (***Tmin***) and maximum (***Tmax***) temperatures recorded in a 192 meteorological stations network

Usual temperature: average of decadal temperatures recorded between 1971 and 2000

Source : Météo-France

Relative temperatures: difference between temperatures observed from 1st to 20th August 2003 and usual temperatures

"Very hot days" : days when Tmin et Tmax exceed the cut points ***Tmin**** et ***Tmax**** respectively

Statistical analyses

- Determining the cut points which optimize the relationship between mortality and number of "very hot days" (nbj) using a Poisson regression :

$$E(O_{dep}) = E_{dep} \exp(\beta_0 + \beta_1 \, nbj_{dep})$$

-Classification of the 95 *département* in quartiles of the number of "very hot days" weighted by the expected number of deaths *E*

- Estimation of the mortality ratio according to the number of "very hot days" for three age groups

RESULTS

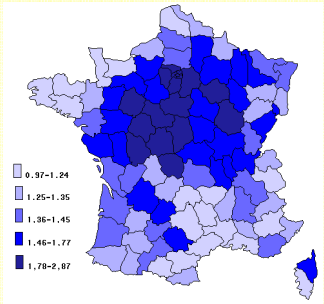
1. Geographical distribution of excess mortality

An important geographic heterogeneity is observed between *départements* of metropolitan France (Figure 1):

- highest excess mortality in the *départements* of *Ile de France* (+142%) and the *Centre* (+104%) regions

- a lower excess mortality in the coastal regions : *Bretagne* (+17%), *Languedoc-Roussillon* (+17%), *Basse-Normandie* (+19%) and *Nord-Pas-de-Calais* (+21%)

Figure 1: mortality ratio by *département* in metropolitan France, from 1st to 20th August, 2003



2. Determination of temperature cut points

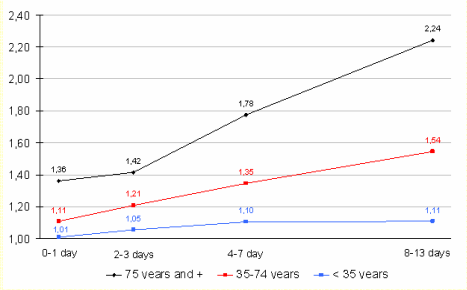
Temperature cut points which optimize the relationship between mortality and absolute temperature are 22°C for minimum temperature and 38°C for maximum temperature.

Considering relative temperature, optimal cut points are 5°C for minimum temperature (Trmin) and 9°C for maximum temperature (Trmax).

We analyse the relationship between mortality and number of "very hot days", defined as days when minimum and maximum temperatures are 5°C and 9°C over the usual temperatures respectively.

3. Relationship between mortality and the number of "very hot days" by age groups

Figure 2: Mortality ratio by age group according to the number of "very hot days" when Trmin > 5°C and Trmax > 9°C, from 1st to 20th August, 2003 in France



The number of days when minimum and maximum temperatures respectively exceed 5°C and 9°C the usual temperatures varies from 0 to 13 days.

Moderate but significant increase for subjects aged less than 35 years (Figure 2),

Significant and very marked increase for subjects aged 35 to 74 years,

Significant and more pronounced increase for subjects aged 75 years and older.

Geographical distribution of the number of "very hot days" during the heat wave period (Figure 3) is close to the geographical distribution of excess mortality (Figure 1).

Figure 3: Number of days when minimum and maximum temperatures are respectively 5°C and 9°C over the usual temperatures

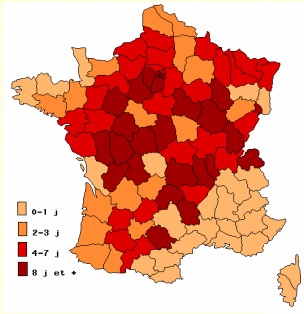
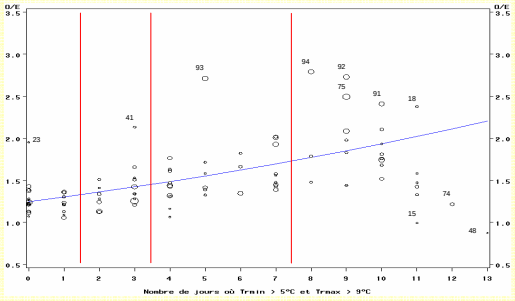


Figure 4: Mortality ratio by number of very hot days, from 1st to 20 August, 2003 in metropolitan France

The size of circle is proportional to the number of inhabitants in each *departement*



Significant increase of excess mortality with the number of "very hot days", beginning with an excess mortality of +25% at « 0 day ». (Figure 4)

Satisfying adjustment of the model to the mortality ratios observed in departments with 0 to 7 "very hot days" during the 2003 heat wave.

An important heterogeneity of mortality ratios is observed in *departements* with a high number of "very hot days".

CONCLUSION

- Significant increase of excess mortality in *départements* with the greatest number of "very hot days" (more marked in the older age groups).

- Geographical distribution of the number of "very hot days" is quite similar to the excess mortality distribution but that is far from a perfect concordance.

- The meteorological indicator of heat exposure used is still insufficient to explain the heterogeneity of excess mortality related to the August 2003 heat wave, at the *département* scale.

References

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