Mortality related to the heat-wave of August 2003 in France : I.Mortality distribution by socio-demographic groups and post heat wave mortality time course

Grégoire Rey[1] (Email : rey@vjf.inserm.fr), Anne Fouillet[1], Eric Jougla[2], Françoise Laurent[2], Denis Hémon[1]

1 : INSERM - U170 – IFR 69 – Recherches épidémiologiques et statistiques sur l'environnement et la santé
2 : INSERM – CepiDC-IFR69 – Centre d'épidémiologie sur les causes médicales de Décès

Introduction

During August 2003's first half, metropolitan France has experienced an exceptional heat wave, because of its duration (nearly 2 weeks) and its intensity. In the meantime, a strong excess mortality was recorded. We describe here the evolution of mortality during the heat wave and after the heat wave until the end of the year 2003.

Objectives

Quantify the excess mortality during the heat wave by socio-demographic groups : age, gender, place of death and marital status. Then, we try to identify a low mortality compensation or, on the contrary, a residual excess mortality after the heat wave.

Material and methods

Observed number of deaths (O)
INSERM CépiDc
INSEE – Demographic department

Population
Departmental population estimations by age and gender from 2000 to 2003 provided by INSEE.

Comparative approach
Comparisons of observed (O) and expected (E) numbers of deaths.

Individual factors modulating this relation (INSERM-INSEE sources) :
Demographics: Age, gender, marital status
Medical : place of death (public hospital, private clinic, home, retirement home)

Expected (E) number of death estimation
Need for precision to study post heat wave mortality. Noticeable evolution of the populations by age and death rates by age groups

The number of expected death is calculated by applying an estimate of the death rate to the population provided by INSEE for 2003
The expected death rate by age - sex (reference 2000-2002) is calculated by a Poisson regression with monthly effect and annual trend
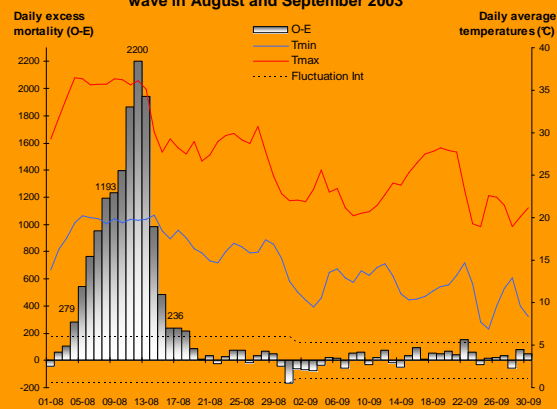
Fluctuation intervals
Overdispersion hardly estimable by month
$\Rightarrow$ AR(1) hypothesis on the daily death process

Validation
March-June 2003: period separated with reference period and close to august 2003

Results

Figure 1: Number of excess deaths observed during the French heat wave in August and September 2003

The X axis shows the 61 days of August 1st to September 30th 2003. The left Y axis shows excess mortality (O – E). The histogram shows the numerical values for August 4, 8, 12 and 16. The right Y axis shows the temperatures, red line for maximum temperatures, blue line for minimum temperatures.
O = observed number of deaths; E = expected number of deaths, estimated from the observed mortality in the reference period: 2000 - 2002. The unbroken horizontal lines show the limits of the 95% fluctuation intervals of the daily number of deaths. The limits were estimated from the reference period (2000-2002).

Figure 2: Mortality ratios (O/E) by age and gender August 1st to 20th, 2003
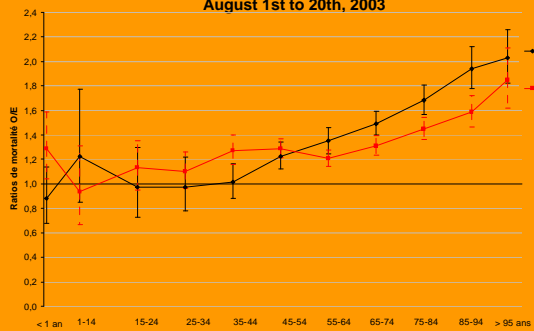
O = observed number of deaths; E = expected number of deaths; O/E : mortality ratio ; vertical bars represent 95%poisson confidence intervals

Excess deaths for boys aged less than 1 year (figure 2)
25 excess deaths
Geographic coherence: - Ile de France : +55%*
                                    - remaining metropolitan France : +12%
Temporal coherence: excess mortality from 6 to 10 of august

Table 1: Excess deaths by place of death, marital status, number of "very hot days" France - August 1st to 20th, 2003.

	< 55 years		55 - 74 years		≥ 75 years		All	
	O - E	O / E	O - E	O / E	O - E	O / E	O - E	O / E
Place of death								
Home	343	**1.35** *	951	**1.56** *	3836	**1.91** *	5130	**1.74** *
Institutions, retirement homes	2	**1.15**	190	**1.90** *	2382	**1.91** *	2574	**1.91** *
Public hospitals	239	**1.15** *	1038	**1.27** *	4719	**1.60** *	5996	**1.45** *
Private hospitals and clinics	24	**1.11**	24	**1.03**	459	**1.36** *	507	**1.22** *
Street	29	**1.08**	9	**1.06**	-7	**0.90**	30	**1.05**
Marital status								
Single	389	**1.27** *	627	**1.76** *	1354	**2.02** *	2370	**1.66** *
Divorced	128	**1.25** *	345	**1.48** *	553	**1.91** *	1026	**1.56** *
Widowed	13	**1.19**	454	**1.47** *	6930	**1.75** *	7397	**1.72** *
Married	214	**1.16** *	762	**1.18** *	2606	**1.48** *	3583	**1.33** *

O = observed number of deaths; E = expected number of deaths; O-E : excess death; O/E : mortality ratio;" * ": the difference between O and E is statistically significant in a 5% Poisson test

Excess mortality during heat wave (figures 1 and 2, table 1):
The relative increase in mortality is:
• significant from 4 to 18 august, increasing until 12 august where it reaches its maximum
• significant from 35 years for men and 45 years for women and increasing with age
• markedly greater at home and in retirement homes
• lower for married people

Those results are also true by finer age groups

Table 2: Mortality ratios September to December 2003

		September	October	November	December
		O/E	O/E	O/E	O/E
Men					
	< 35 years	1,04	0,92	0,95	0,88 *
	35-74 years	1,01	0,99	0,98	1,03
	≥ 75 years	1,01	1,01	1,01	1,09 *
	Total	**1,01**	**1,00**	**1,00**	**1,06** *
Women					
	< 35 years	0,96	0,89	0,95	1,02
	35-74 years	1,03	0,96	0,97	1,04
	≥ 75 years	1,01	1,01	1,01	1,08
	Total	**1,01**	**0,99**	**1,00**	**1,07**
Total					
	< 35 years	0,96	0,89	0,95	1,02
	35-74 years	1,03	0,96	0,97	1,04
	≥ 75 years	1,01	1,01	1,01	1,08
	Total	**1,01**	**1,00**	**1,00**	**1,07**

O = observed number of deaths; E = expected number of deaths; O-E : excess death; O/E : mortality ratio;" * ": the difference between O and E is statistically significant in a 5% Poisson test with overdispersion

Mortality from august 21st to December 31st 2003 (figure 2 and table 2)

Excepted in December, mortality does not deviate from its usual fluctuation intervals:
• already in the last decade of august
• by age, gender, place of death and marital status
• except for approximately 5% of the observations distributed without any link with heat wave's related excess mortality
In december :
Mortality influenced by cold spells and infectious disease epidemics.
No spatial correlation between December and August's excess mortality.

Conclusion

The heat wave of August 2003 affected very broad categories of the population.
The excess mortality has been more important for :
the elderly, women, death occurring at home and in retirement homes, singles, divorced and widowed people.
The marital status effect is possibly representative of an aggravating isolation effect, married people having been less affected.
Post heat wave mortality has returned into normal fluctuations until the end of November for the whole studied subpopulations.
It is therefore likely that in the absence of the heat wave, the excess deaths would not have occurred a few days or weeks after it.

References
1 Basu R, Samet JM. Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. *Epidemiol Rev* 2002;**24**(2):190-202.
2 Besancenot J. Vagues de chaleur et mortalité dans les grandes agglomérations urbaines. *Environnement, risques et santé* 2002;**4**(1):229-240.

Inserm
Institut national
de la santé et de la recherche médicale