Impact of temperatures on mortality in nine French cities between 2001 and 2009

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Background

In France, several major heatwaves have been characterized by an excess mortality, the worst one being in August 2003 [1]. These extreme events have been extensively documented, while the relationship between the temperature and the mortality has not been described for France.

We investigated the mortality impact of temperatures, warm and cold, in nine French cities between 2001 and 2009, and its changes over time.

Methods

The analysis was performed in nine large French urban areas, for the period 2001-2009.

The associations between temperature and non-accidental mortality were investigated in each city using a generalized additive Poisson regression model. The mean temperatures at lag 0 and 1-7 were introduced as natural splines with 3 degrees of freedom.

The short-term effect of warm temperatures was assessed as the increase in mortality when the temperatures increase from the percentile 90 (P90) to 99 (P99) of the temperature distribution.

The short-term effect of cold temperatures was assessed as the increase in mortality when the temperatures decrease from the percentile 10 (P10) to the percentile 1 (P1) of the temperature distribution.

Models were created for one period before the prevention plan 2001-2003 (with and without the August 2003 heat wave) and two after the prevention plan 2004-2006 (with and without the July 2006 heat wave) and 2007-2009.

City specific results were combined using random effect models.

Results

Daily mean mortality and temperatures were comparable across the four periods. The August 2003 heat wave was the most extreme episode of the period, with 237°C over P99 cumulated for this month only (91°C for July 2006). 2001-2003 also was the coldest period, and less extremely warm days were observed in 2007-2009 (figure 1, table 1).

A classical temperature-mortality relationship was observed in all cities, as illustrated for lag 0 in figure 2 for Paris, where August 2003 strongly influences the model. By contrast, in Marseille, the 2003 heat wave had little influence (figure 3). For the warm temperatures, the effect is mainly driven by the temperatures at lag 0, as illustrated in Figure 2 and 3. By contrast, the effect of the cold temperature is observed at lag 1-7.

FIGURE 1 Mean temperatures and percentiles per city between 2001 and 2009

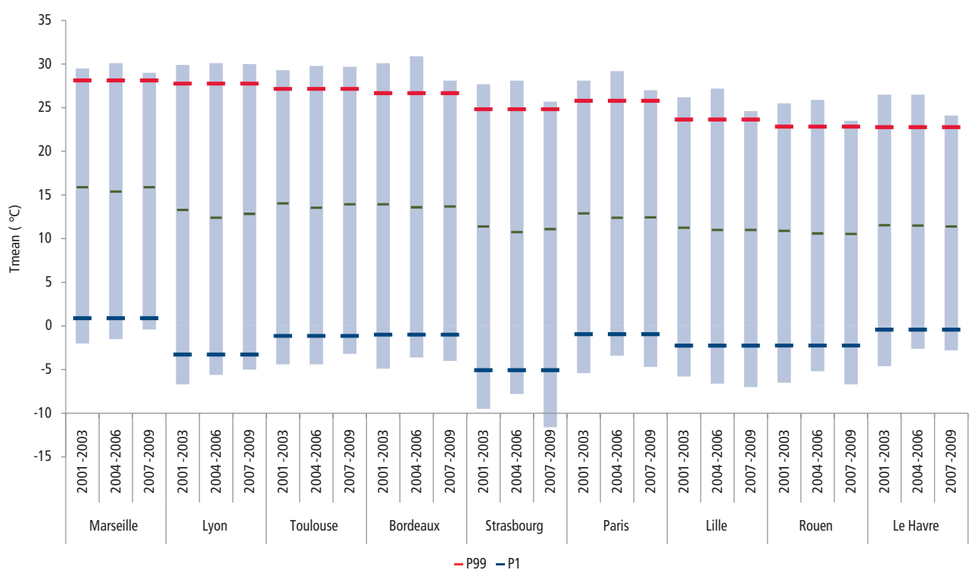


FIGURE 2 Relationship between mean temperature at lag 0 and mortality in Paris

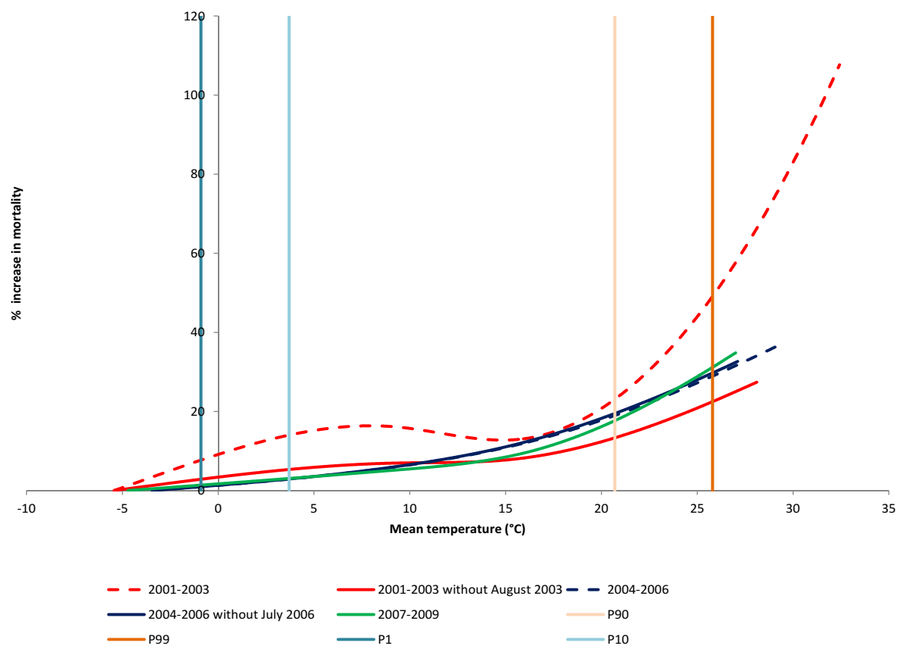
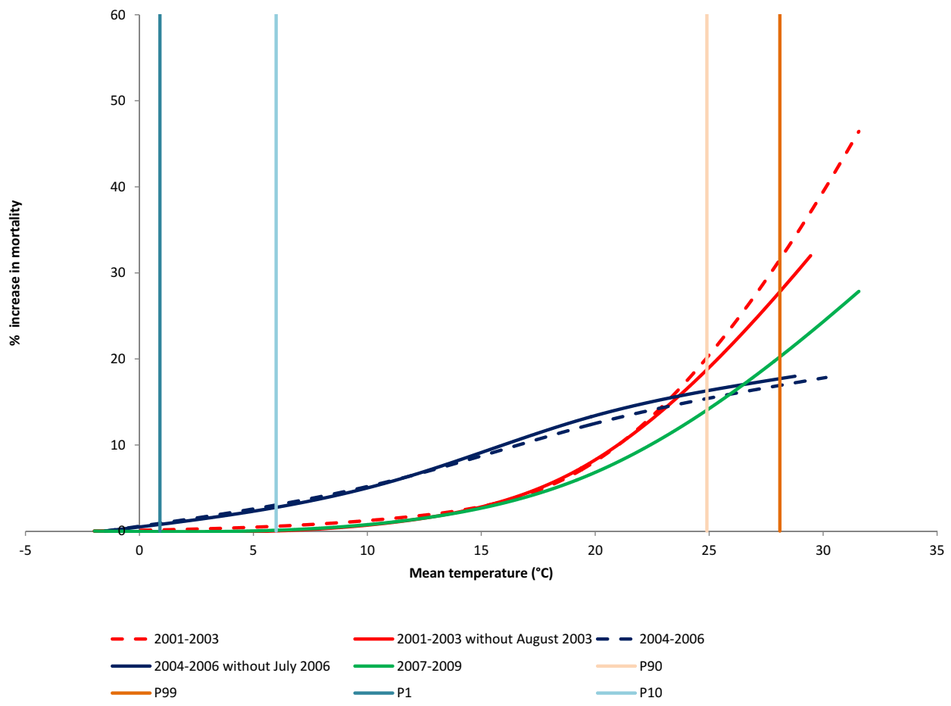


FIGURE 3 Relationship between mean temperature at lag 0 and mortality in Marseille



For the 2001-2009 period, the mortality increases by 6% [95% confidence interval; 3:8] when the temperatures increase from P90 to P99, and by 5% [3:6] between the temperatures decrease from P10 to P1.

August 2003 strongly influences the risk estimates for the 2001-2003 period (table 1). There is a balance between the warm and the cold effect, with a greater cold effect in the recent period.

TABLE 1 Number of days exceeding percentiles, °C cumulated above percentiles, and associated % mortality increase

	N days >P99	°C cumulated >P99	N days >P90	°C cumulated >P90	% increase in mortality P90/P99
2001-2003	161	306	1,087	2,824	24 [6:45]
2001-2003 without August 2003	104	69	837	1,782	7 [4:11]
2004-2006	159	122	966	2,647	7 [5:9]
2004-2006 without July 2006	42	31	875	1,764	3 [0:6]
2007-2009	49	15	727	1,260	3 [0:6]

	N days <P1	°C cumulated <P1	N days <P10	°C cumulated <P10	% increase in mortality P10/P1
2001-2003	118	173	795	2,188	-2 [-6:3]
2001-2003 without August 2003	118	173	795	2,188	3 [1:6]
2004-2006	81	73	1,033	3,013	5 [1:6]
2004-2006 without July 2006	81	73	1,033	3,013	4 [2:6]
2007-2009	118	89	775	2,196	6 [3:10]

Discussion

Our results show that even after the implementationof the heat prevention plan, mortality remains higher during warm days. Unlike August 2003, the July 2006 did not differ much from the usual temperature-mortality relationship [2].

With the current information, it is not possible to confirm that the prevention plan has globally modified the temperature-mortality relationship. Its impact seems restricted to the most extreme events.

Reversing trends between the cold and the warm effects might indicate a balance between these two effects, consistent with the idea of a common pool of vulnerable people [3].

The analysis will be extended to a longer period and 7 more cities to better reflect the geographic and climatic variability.

References

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