French Heat Health Watch Warning System: Validation of Temperature Thresholds

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Context and objectives

In response to the heat wave in France in 2003, a heat health watch warning system (HHWWS) was developed for the summer 2004. Its aim is to prevent major heat related epidemic events.

This system is founded on the monitoring of biometeorological indicators for which thresholds are defined on the basis of a high excess mortality.

The aim of this study is to compare these thresholds to those developed under a time series approach. This comparison will be held in three major cities: Lyon, Marseille, Paris.

The French heat health watch warning system

Principle

The HHWWS is based on a double biometeorological indicator.

This indicator is a mix of maximal and minimal temperatures averaged over three days.

An alert will be proposed when the means over three days of maximal and minimal temperatures exceed simultaneously threshold values, corresponding to a high excess mortality.

These thresholds were defined in 14 pilot cities, distributed on the whole metropolitan country.

Excess mortality

The daily excess mortality was computed by comparing the daily mortality with the daily mortality averaged over the three previous years.

Due to the important variability of the daily mortality, the excess mortality was cumulated over three days and the excess mortality threshold was 50% for Paris, Lyon, Marseille and Lille and 100% for the smaller cities.

Choice of temperature thresholds

Various possible values of temperature thresholds corresponding to an excess mortality of 50% or 100% were tested.

For each value of temperature thresholds, the number of alerts (total, true alerts, false alerts, alert missed), the sensitivity, the specificity, the positive predictive value, the negative predictive value of the system were calculated.

The best threshold was the one for which the number of false and missed alerts was minimum.

Limits

This approach considers that all the overtakings of excess mortality thresholds are owed to a meteorological event, which is obviously false.

We propose to take into account confounding factors and temporal events in the development of the temperature thresholds.

Data

Period and area of study

Three great French agglomerations were selected: Lyon, Marseille and Paris. The period of study covered the years 1973 to 2003.

Meteorological data

Meteorological data were obtained from Météo France. The daily minimum and maximum temperatures were collected.

Mortality data

All cause and all age daily mortality data were obtained from the National Institute of Statistic and Economic Studies (Insee: Institut national de la statistique et des études économiques).

Methods

Predictive model

We used Poisson regression model to predict mortality from temperatures levels, adjusted on confounding factors.

Possible confounders included long term trend, seasonal variations and days of the week.

Minimal and maximal temperatures on several lags up to three days were simultaneously introduced in the model.

Seasonal variations and temperatures were adjusted using penalized spline functions to capture possible non-linearities in the response.

Diagnostic tools for the models included partial autocorrelation function of the residuals and plot of the residuals. Final lags and number of degrees of freedom for the different temperatures were selected by Akaïke information criteria.

Excess mortality

The daily excess mortality was estimated by comparing the predicted mortality with the expected mortality if the temperatures were equal to the average temperatures observed for the summertime between 1973 and 2003.

Temperature thresholds

Between the 1st of June and the 31st of August, over the period 1973-2003, the days whose excess mortality exceeds 50% were selected.

For each day thus detected, the means over three days of maximal and minimal temperatures were calculated.

The threshold for the minimal temperatures corresponds to the smallest average over three days of minimal temperatures. The threshold for the maximal temperatures corresponds to the smallest average over three days of maximal temperatures.

Results

Table 1: Biometeorological indicator thresholds (IBMn – IBMx) associated with an excess mortality threshold of 50%. IBMn (in degrees Celsius) is the average over three days of the minimal temperatures and IBMx (in degrees Celsius) is the average over three days of the maximum temperatures.

Cities	Time series IBMn – IBMx	HHWWS IBMn – IBMx
Lyon	21.83 - 35.53	20 - 34
Marseille	23.90 - 36.43	22 - 34
Paris	20.83 - 33.60	21 - 31

These new thresholds are roughly 2°C higher than those of the French HHWWS, except for Paris where the threshold of the minimal temperatures is slightly lower (see table 1).

Discussion and Conclusions

Contrary to the empirical method used in the French HHWWS, our method takes into account confounding factors and temporal events. Thus, it is not surprising that the thresholds resulting from a time series analysis are somewhat different to those from the HHWWS. Moreover, these predictive models made it possible to estimate daily excess mortality that could be used as an additional criterion in the proposal of an alert in the framework of the French warning system for heat waves.