'diseases of the circulatory system' (758 estimated excess deaths, of which about 370 were 'cerebrovascular disease', about 145 were 'ischaemic heart disease' and 118 were 'heart failure'), 'diseases of the respiratory system' (about 255 excess deaths) and 'all malignant neoplasms' (about 131 excess deaths).

These full effect estimations clearly show that the 2003 heat wave was different from the 1981 heat wave in several ways: most importantly, the mortality impact differed in age groups, with children being spared, and it was more intense for women.

Direct comparisons between final full heat wave effect and preliminary estimate is not possible, for two main reasons: the time periods in the two methodologies are different; and the underlying starting data are different.

While the final full effect estimate is based on the date of death, basic data of the preliminary estimation methodology is solely the number of deaths registered by the civil registrar's offices on each given working day, which does not account for locally displaced deaths, holidays and other similar phenomena.

This limitation could be overcome by having a wider period of civil registrar office notifications, allowing for all deaths during the intended period of study to be accounted for, but such a solution is against the intended nature of the methodology meant to give a timely estimate of possible effects of the heat wave. This is a valuable solution when definitive mortality data is not available quickly enough.

The sooner this rapid method is applied to estimate heat wave effects, either during or after the heat wave occurrence, the more likely it is that mortality impact estimates will be biased towards the lower limits, but when significant impact is shown, the method's objectives are met.

Further developments

In the summer of 2004, a system of daily mortality surveillance was established that will henceforth operate annually in tandem with the ÍCARO surveillance system. This new daily mortality surveillance system was created based on the experience and methodology described in this paper. This system consists mainly of collecting very simple data (the total number of registered deaths) on a daily basis from a sample of 67 civil registrar's offices distributed throughout the districts of mainland Portugal. Of these 67 offices, 31 are from district capitals and participated in the work presented here.

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References

1. Nogueira PJ, Nunes B, Dias CM, Falcão JM. Um sistema de vigilância e alerta de ondas de calor com efeitos na mortalidade: o índice Ícaro. Revista Portuguesa de Saúde Pública. Volume temático 1; 1999:79-84
2. Henschel A, Burton LL, Margolies L, Smith J E. An analysis of the heat deaths in St. Louis during July 1966. Am J Public Health. 1969; 59(12):2232-2242
3. Jones TS, Liang AP, Kilbourne EM, Griffin MR, Patriarca PA, Wassilak SG, Mullan RJ, Herrick RF, Donnell HD Jr, Choi K, Thacker SB. Morbidity and mortality associated with the July 1980 heat-wave in St Louis and Kansas City. JAMA; 1982; 247(24):3327-3331.
4. CDC Heat-related deaths--Philadelphia and United States, 1993-1994. MMWR Morb Mortal Wkly Rep. 1994; 43(25): 453-455.
5. Semenza JC, Rubin CH, Falter KH, Selanikio JD, Flanders WD, Howe HL, Wilhelm JL. Heat-related deaths during the July 1995 heat wave in Chicago. N Engl J Med. 1996;335(2):84-90.
6. Falcão JM, Castro MJ, Falcão MLM. Efeitos de uma onda de calor na mortalidade da população do distrito de Lisboa. Saúde em números. 1988;3(2):9-12
7. Garcia AC, Nogueira PJ, Falcão JM. Onda de calor de Junho de 1981 em Portugal: efeitos na mortalidade Revista Portuguesa de Saúde Pública. Volume temático 1. 1999; 1:67-77
8. Paixão EJ, Nogueira PJ. Efeitos de uma onda de calor na mortalidade. Vigilância epidemiológica. 2003; 21(1): 41-53.
9. Direcção Geral de Viação, Observatório de Segurança Rodoviária – Relatório de 2 000 Elementos Estatísticos, Continente. 2002
10. Nogueira PJ, Paixão EJ, Falcão JM, Botelho J, Catarino J, Carreira M, Calado R. Onda de calor de Agosto de 2003: os seus efeitos sobre a mortalidade da população portuguesa. Relatório científico. Observatório Nacional de Saúde e Direcção-Geral da Saúde 2004.
11. Silcocks P. Estimating confidence limits on a standardized mortality ratio when the expected number is no terror free. J Epidemiol Community Health. 1994;48:313-317.

ORIGINAL ARTICLES

Surveillance report

SUMMARY OF THE MORTALITY IMPACT ASSESSMENT OF THE 2003 HEAT WAVE IN FRANCE

P Pirard, S Vandentorren, M Pascal, K Laaidi, A Le Tertre, S Cassadou, M Ledrans
Institut de Veille Sanitaire, Département Santé Environnement, Saint-Maurice, France

France experienced a record-breaking heat wave between 2 and 15 August 2003. All the French regions were affected by this heat wave, which resulted in an excess of 14 800 deaths between 1 and 20 August. The increase in the number of excess deaths followed the same pattern as the increase in temperatures. No deviance from the normal death rate was observed in the month of August during the last third of the month, nor during the following three months. There was a clear discrepancy in the impact of the heat wave from city to city. If the effect of duration of consecutive days with high minimal temperatures and deviance with the seasonal normal temperature was patent, this could not explain all of the observed variability of the death incidence. The victims were mainly elderly women older than 75 years. In terms of relative risk and contribution to the

global toll, deaths linked to heat were the most important. Based on these results, the French government developed a Heat Health Watch Warning System and set up a preventive action plan for each region in 2004.

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Key words: Heat wave, France

Introduction

Europe experienced an unprecedented heat wave in the summer of 2003. In France, it was the warmest summer recorded for 53 years in terms of minimal, maximal and average temperature and in terms of duration. Between 2 and 15 August 2003, an intense heat wave affected the country. From the beginning of August, various signals received by the Ministry of Health aroused suspicion that a large scale epidemic might be occurring. Due to this exceptional situation, the Ministry of Health organised an accelerated process for the collection of death certificates from August and September. The Institut de Veille Sanitaire (InVS, National Institute of Public Health) and the Institut National de la Santé et de la Recherche Médicale (INSERM, National Institute of Health and Medical Research) were asked to assess the health impact of this heat wave. The aim of this article is to summarise and discuss the methods used for this assessment and its results.

Assessment of the total excess mortality in France

Methodology

In France, the physician fills in the death certificate and after folding the paper part containing the medical description of the cause of death to make it secret, sends it to the “mairie” (town council). The town council sends the census information (first name, last name age address] to the Institut National des Statistiques et Etudes Economiques (INSEE, national institute of statistics and economics) and the health information to the physician at the Departmental (‘county’) Health Office (Direction Départementale des Affaires Sanitaires et Sociales). The departmental health office checks the cause of death and sends it to INSERM to record national statistics. This process takes several months. During the heat wave, the town councils and the departmental health offices were asked to send their respective death certificates to INSERM and INSEE daily, and to give a daily count to InVS for August and September 2003. Regular cross-checking of the three sources meant that accurate information could be obtained [1].

InVS compared the observed number of deaths from 1 to 15 August 2003 with the average rate for the years 2000, 2001 and 2002, modified by population projections for 2003 (the last census was in 1999) [2]. The INSERM study compared the number of deaths by sex and age from 1 to 20 August 2003 with the mean daily number of deaths observed during July, August and September 2000, 2001 and 2002 [1]. More recently, INSERM produced additional results based on validated mortality data between 1 August and 31 December [3]. The reference used to assess the number of deaths in France for this period was the mortality rate by sex and age observed during the period 2000-2002, modified by an estimation of the evolution of death rates and population size for the period 2000-2003.

Meteo-France (the national meteorological service) produced minimal, maximal and average 24 hour temperatures on the basis of a sample of 180 stations representative of French cities [1].

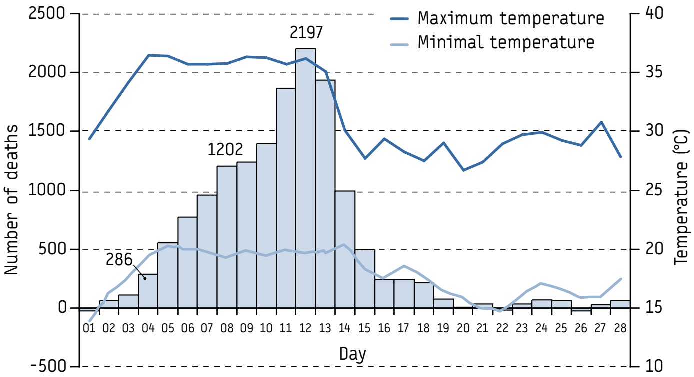
Results

The temperatures increased between 1 August (daily maximal temperature of 25°C) and 5 August (37°C) and maintained themselves at very high levels up to 13 August 2003. They fell abruptly to 28°C between 13 and 16 August (Figure 1). Moreover, the high temperatures and the stagnant atmospheric conditions significantly increased ozone levels, with observed concentrations ranging between 130 and 200 µg/m³ in almost every town between 3 and 13 August [1,2].

The increase in the number of excess deaths followed the same pattern as the increase in temperatures. Nationwide, the impact hit on 4 August, when there were 300 excess deaths. The daily excess rose progressively, reaching 1800 deaths on 8 August and about 2200 deaths on 12 August. It regressed quickly on 13 of August to return to normal levels on 19 August [1] [FIGURE].

FIGURE

Daily excess of deaths during August 2003 and minimal and maximal daily temperatures [1], France



Source: [Ref. 1]

The analysis of death certificates given by the departmental health offices allowed InVS to produce a first estimate on 28 August of 11 435 excess deaths (excess of 55%) between 1 and 15 August 2003 [2]. On 25 September, INSERM estimated the cumulative excess deaths between 1 and 20 August at 14 800 (excess of 60%) [1].The impact was greater for women (70% increase in excess total mortality) than for men (40% increase in excess mortality)(1). This was the case even for same age groups. Excess mortality reached 20% in the 45-74 year age group, 70% in the 75-94 year age group and 20% in people aged 94 years and over [1].

INSERM also showed that during the last third of the month of August and the month of September the mortality had reached the usual level [3]. October and November 2003 showed the usual death rates in every region.

Assessment of the total mortality in excess between cities

Methodology

For 13 cities, InVS received [TABLE] the death certificates for all deaths of local residents, except for fetal deaths, from the town councils [4] and meteorological data from representative stations in towns. The towns were representative of the different regions. For the Eastern third of the country,from South to North: Nice, Grenoble, Lyon, Dijon, and Strasbourg were chosen. For the middle third and from South to North Marseille and Paris were chosen. For the western third and from South to North Toulouse, Bordeaux, Poitiers, Le Mans, Rennes and Lille were chosen. The excess mortality rate was calculated as the division of the number of deaths 2003 minus the mean of 1999-2002 deaths by the mean of 1999-2002 deaths, for the period between 1 and 19 August.

TABLE

Excess deaths, number of maximal temperatures > 35°C, minimal temperatures > 22°C, average delta of mean temperatures between 1-19 August for thirteen cities, France, 2003

Cities	Number of deaths	Excess deaths (%)	Number of days with maximal temperature ≥ 35°C	Number of days with minimal temperature ≥ 22°C	Delta of daily mean temperature
Lille	200	4	3	0	4.0
Marseille	571	25	11	14	4.3
Grenoble	148	28	12	0	6.3
Rennes	156	36	6	2	5.6
Toulouse	315	36	12	6	6.6
Bordeaux	318	43	12	7	6.2
Strasbourg	253	51	10	0	5.9
Nice	341	53	1	18	4.3
Poitiers	184	79	11	1	7.3
Lyon	447	80	11	9	6.8
Le Mans	204	82	10	3	7.0
Dijon	168	93	11	4	7.4
Paris	1854	142	9	9	6.7

Results

Dijon, Paris, Poitiers, Le Mans and Lyon clearly showed the highest difference between the usual (1999-2002) and 2003 daily mean temperatures from 1 to 19 August 2003 (>6.7°C) [TABLE]. Toulouse and Bordeaux, presented similar meteorological characteristics but with a milder delta (respectively 6.6° and 6.2° C). Grenoble and Strasbourg, with deltas of 6.3°C and 5.9°C, did not experience very high minimal temperatures. Rennes was less affected by the heat wave, with lower numbers of days with high maxima or high minima and a mean delta of 5.6°C. Marseille and Nice had numerous days with very high minima, but their mean delta was relatively small (4.3°C). The number of excessively warm days in Lille was very low, as was the delta (4.0°C).

In the thirteen cities in the study, a lag of 1 to 3 days between the start of the heat wave and the increase in the number of deaths was observed [4]. An excess in mortality was found in every city, and the disparity of the impact of the heat wave depending on the city appeared clearly. In Dijon, Paris, Poitiers, Le Mans and Lyon, the excess in mortality was particularly marked (>78%) whereas in Lille, the excess of deaths was very low (+4%). Contrasts in the excesses of death could be noted between some towns with quite similar meteorological situations. The excess of deaths in Nice was of 53% whereas in Marseille it was 'only' 26%. Strasbourg suffered a 51% excess of deaths whereas Grenoble 'only' had an excess of 28%.

Assessment of the excess mortality by diseases

Methodology

The analysis of death causes was done by INSERM for the period between 1 and 20 August for the whole of France. This information was compared to the cause of deaths of 2000 and 2001 for the same period. Data for 2002 were not fully validated. The initial cause of death was taken into account with the classification in 65 categories and 17 CIM chapters from Eurostat. A chapter on death directly linked to heat was created by merging the categories of dehydration, hyperthermia and heatstroke [3].

Results

The analysis of deaths by causes of death between 1 and 20 of August from INSERM [3] did not show any significant impact of heat on deaths under ages of 5 years. For people aged under 45 years the observed excess were mild (19%), and only for deaths caused by undefined conditions, heatstroke, dehydration and hyperthermia, and only for men. Among the 2565 excess deaths observed in the 45-74 year age group, 439 were due to heat related illnesses, 418 to undefined causes, 365 to cardiovascular diseases, and 249 to cancer. The highest relative increase concerned heat related deaths (with 434 cases registered in 2003 compared to a mean of 9 cases for the same period in 2000-2001), mental illness (170%), undefined causes (110%), diseases of the nervous system (70%), genito-urinary diseases (70%), endocrine diseases (60%), infectious diseases (60%) and pulmonary diseases (50%). The relative increase was lower for cardiovascular diseases, cancers and accidental deaths (< 20%). Among the 11 891 excess deaths in people aged 75 years and over, 2852 were directly linked to heat, 2633 to cardiovascular diseases, 1265 to undefined causes, 1213 to respiratory diseases, and 781 to diseases of the nervous system. The relative progressions were most important for heat related diseases (1860%), infectious diseases (130%), accidental falls (130%) and undefined causes (110%). Relative excesses by causes of death were generally more pronounced in women than in men for the same age periods.

Discussion

France was very heavily by the 2003 heat wave. It suffered 14 800 excess deaths between 1 and 20 August (+60%). The calculation of this excess can be considered reliable. It is based on the cross-checking of different sources of information (InVS counts, INSEE data and INSERM data). This epidemic event was not immediately followed by any deficit in mortality. INSERM showed that the excess of death observed during the August heat wave had not yet been compensated for at the end of 2003.

No other country in Europe reached such a toll, but other countries differed from France in terms of geographic and temporal extent of the very intense heat wave. Throughout France, 2/3 of the meteorological stations recorded temperatures above 35°C [2].

It is also worth emphasising that elevated odds ratios have been observed in towns where the climatic phenomenon was similar in length and intensity. For example the relative excesses of deaths in Paris, Barcelona and Torino were important [2]. Results from a number of different studies all favour an important role for this exceptional heat stress in the toll registered. The INSERM study showed a strong correlation between the number (n=0-1; n=2-5; n=5-10) of consecutive very hot days (Tmax > 35°C and Tmin > 20°C) and the relative risk of excess deaths among administrative departments (RR=1.3 ; RR=1.5 ; RR=1.8) [1]. There is also a trend between the relative excess mortality among the thirteen cities and the delta between the usual temperatures and the observed ones for August 2003 as shown in table 1.

Other factors can explain the heterogeneity between towns and regions regarding the impact of extreme temperatures. A chronological study of deaths, temperature, and ozone in 9 cities showed that the proportion of observed deaths explained by these last two variables was very low for Lille, Strasbourg, Marseille, Toulouse, moderate for Bordeaux, Rouen and very important for Paris and Lyon [5]. This result is in favour of a geographical heterogeneity of vulnerability to heat wave. Sociodemographic factors can partly explain this difference. For example, the percentage of ages over 74 years is more elevated in Nice (12.7% in 1999) than in Marseille (9.2% in 1999). Other factors certainly intervene, such as the size of the cities, the urban heat island, cultural habits, or adaptation to very hot temperatures. For example, Marseille suffered a heat wave in 1983, and in 2003, an 'emergency plan' to help the public and the hospitals prevent extreme heat effects already existed. This meant that the population of Marseilles was more likely to cope better with a heat wave. The influences of those factors have been analysed by the InVS in specific studies focusing on pollution [5], and heat related risk factors [2].

Based on those results, the French government decided to develop a National Heat Health Watch Warning System (Système d'Alerte Canicule Santé (SACS)) adapted for each département. The objectives are to anticipate the health effects of heat waves and to alert the authorities in time to allow the setting up of preventive actions [6]. It has been developed on the basis of a retrospective analysis of mortality and minimal and maximal temperatures data in fourteen pilot cities. The cut-offs have been set in order to anticipate large scale events three days in advance, resulting in an excess mortality above 50% in Paris, Lyon, Marseille and Lille and above 100% in the smallest cities. The system was extended département-wide using the 98th centiles of minimal and maximal temperatures. The national action plan that integrates this watch warning system has four levels. They correspond to various degrees of activations of actors concerning public health surveillance, social supports, and medical preventive actions. It runs from 1 June to 31 September and results in a close cooperation between the meteorological services and the public health agencies. During 2004 no heat wave was observed but the climatologic predictions estimate that summers as hot as 2003 could be more frequent in the future [7].

The efficiency of the heat health watch warning systems has never been put to the test completely. However, some published results support the hypothesis of their effectiveness in the short term, as well as the possibility of adaptation of the population to hot temperatures in the long term [8-10].

References

1. Hémon D, Jougla E, Clavel J, Laurent F, Bellec S, Pavillon G. Surmortalité liée à la canicule d'août 2003 en France. *Bulletin Epidémiologique Hebdomadaire*. 2003;45-46:221-5.
2. InVS. Impact sanitaire de la vague de chaleur en France survenue en août 2003. Rapport d'étape, 28 août 2003. http://www.invs.sante.fr . 28-8-2003.
3. Hémon D, Jougla E. Surmortalité liée à la canicule d'août 2003. Suivi de la mortalité 21 Août- 31 Décembre 2003 - Causes médicales des décès 1-20 Août 2003. Rapport remis au Ministre de la Santé et de la Protection Sociale INSERM. 1-76. 26 Octobre 2004 Paris.
4. Vandentorren S, Suzan F, Medina S, Pascal M, Maulpoix A, Cohen JC, Ledrans M. Mortality in 13 French cities during August 2003 Heat Wave. Am J Public Health. 2004 Sep;94(9):1518-20.
5. Cassadou S, Chardon B, D'Helf M, Declercq C, Eilstein D, Fabre P, Filleul L, Jusot JF, Lefranc A, Le Tertre A, Medina S, Pascal L, Prouvost H. Vague de chaleur de l'été 2003 : relations entre température, pollution atmosphérique et mortalité dans neuf villes françaises. 2004 Rapport d'étude, InVS.
6. Laaidi K, Pascal M, Ledrans M, Le Tertre A, Medina S, Caserio C, Cohen JC, Manach J, Beaudeau P, Empereur-Bissonnet P. Le système français d'alerte canicule et santé 2004 (SACS 2004). Un dispositif intégré au Plan National Canicule. *Bulletin Epidémiologique Hebdomadaire*. 2004;30-31:134-136.
7. Menne B. The health impacts of 2003 summer heat-waves. Briefing note for the delegations of the fifty third session of the WHO regional Committee for Europe.WHO Europe, September 08 2003.
8. Donaldson GC, Keatinge WR, Nayha S. Changes in summer temperature and heat related mortality since 1971 in North Carolina, South Finland and South-East England. Environ Res. 2003;91(1):1-7
9. Kalkstein LS, Jamason PF, Greene JS, Libby J, Robinson L. The Philadelphia hot weather-health watch/warning system: development and application summer 1995. Bulletin of the American Meteorological Society 1996;77(7):1519-28.
10. Weisskopf MG, Anderson HA, Foldy S et al. Heat wave morbidity and mortality, Milwaukee, Wis, 1999 vs 1995: an improved response? Am J Public Health 2002 May; 92(5):830-3.

Original Articles

Surveillance report

Mortality in Spain during the heat waves of summer 2003

F Simón[1], G Lopez-Abente[1], E Ballester[1,2], F Martínez[1]

The effect of the elevated temperatures on mortality experienced in Europe during the summer of 2003 was observed in several countries. This study, carried out in Spain, describes mortality between 1 June and 31 August and evaluates the effect of the heat wave on mortality.

Observed deaths were obtained from official death registers from 50 provincial capitals. Observed deaths were compared with the expected number, estimated by applying a Poisson regression model to historical mortality series and adjusting for the upward trend and seasonality observed. Meteorological information was provided by the Instituto Nacional de Meteorología (National Institute of Meteorology).

1. Centro Nacional de Epidemiología, Instituto de Salud Carlos III, Spain
2. Programa de Epidemiología Aplicada de Campo (PEAC), Spain