Estimated number of premature deaths attributable to heat in England, July 6-14th 2013.

Ben Armstrong 17/7/2013 13:30

Estimate (rounded to nearest 10) : 650 premature deaths ; confidence (uncertainty) interval: 540-760.

This estimate was derived from epidemiological research published in 2011 on heat-mortality association in England and Wales between 1993-2006, together with figures of regional daily temperatures for the period 6-14th July 2013.

Assumptions:

Main:

1. The epidemiological model that we used for this 2013 estimate is that published in the Armstrong et al JECH 2011 paper [1] using region-specific estimates of risk due to heat for 1993-2006. Other published estimates of heat effects in England and Wales are broadly similar.
2. This 2013 estimate thus assumes that vulnerability to heat in 2013 is the same as during 1993-2006, which may not be the case.

More technical:

3. This estimate is for the nine days from when the current hot period broadly started to the last day for which data was available: July 6-14th 2013. The daily maximum temperatures, to which the model was applied, were provided to me by Tom Wipple and to him by the met office. These were from representative monitoring stations in each region rather than the all-station means used in the JECH paper, to enable rapid assembly. This miss-match will have introduced some error but we believe small.
4. The model assumes that the heat effect on a particular day depends on the average of that day's and the previous day's maximum temperature.
5. The model assumes that daily deaths increase after this two-day mean of maximum temperature exceeded a region-specific threshold estimated from the data.
6. The model assumes that risk of dying increased linearly with each degree above the threshold.

Other notes:

1. In the 2011 JECH paper we estimated risks irrespective of certified cause of death. A companion paper to the JECH paper (Gasparrini OEM 2011[2]) for heat effects for specific

causes of death found excess risk of deaths from almost all causes. Very few of the excess deaths were certified as due to heat, and it is unlikely that those premature because of heat would have been distinguishable individually from others for which heat played no part.

2. The Gasparrini paper however found much higher risks among the elderly. For example about 75% (17,500/23,600) of premature deaths due to heat in the 1993-2006 period were among persons aged 75 and over. We would expect this to be the case also for the 2013 excess deaths we estimate here.
3. There is evidence that some of the deaths estimated to have been premature due to heat would have been among very frail persons who would have died just a few weeks later. We cannot be sure what this proportion this is.
4. Thresholds were found to be higher in regions with hotter summers (eg 20.9 degrees in NE, 24.7 in London) suggesting some adaptation to hot weather in communities more used to heat.
5. The average increase in deaths per degree above the threshold was 2.1% over all regions but it was greater in the hotter regions (eg 3.8% per degree in London).
6. For ways to protect yourself and your elderly neighbours from adverse effects of heat see the DH Heat Wave Plan and associated pamphlets.

Table: Region-specific estimates of premature deaths attributable to heat 8-14th July 2013 (rounded to the nearest ten)

Region	Thres-hold	Increase in risk per °C above theshold(%)*	Mean daily max temp 6-14th July	Premature deaths 6-14th July*
North East	20.9	0.8(0.2,1.3)	23.0	10(0, 20)
N West	21.7	1.3(1.0,1.6)	24.0	50(40, 60)
Yorks & Hum	22.2	1.7(1.3,2.1)	24.9	60(40, 70)
E Midlands	23.0	2.3(1.9,2.8)	23.3	30(20, 40)
W Midlands	23.0	2.2(1.9,2.6)	26.6	90(80,110)
East	23.9	2.4(2.0,2.8)	24.9	50(40, 60)
London	24.7	3.8(3.4,4.1)	27.9	150(140,170)
S East	23.5	2.6(2.6,2.9)	26.2	120(100,130)
S West	22.3	2.1(1.7,2.5)	26.0	90(70,110)
Total	22.8			650(540,760)

* The table entries show the best estimate followed by the confidence (uncertainty) interval in parentheses.

1. Armstrong BG, Chalabi Z, Fenn B, Hajat S, Kovats S, Milojevic A, Wilkinson P. Association of mortality with high temperatures in a temperate climate: England and Wales. *Journal of Epidemiology and Community Health* 2011;**65**(4):340. web link

2. Gasparrini A, Armstrong B, Kovats S, Wilkinson P. The effect of high temperatures on cause-specific mortality in England and Wales. *Occup Environ Med* 2011. web link

Addendum added 22/07/2013 in response to requests for more detail on calculations.

The estimate of premature deaths was based in the first place on the estimated threshold temperatures and increment in relative risk per degree for each region r, termed IRR_r . These model parameters (in the Table above , estimated from previous research) were applied to maximum temperatures on each day i for each region r supplied by the Met Office ($tmax_{r,i}$). We then calculated for each day the two-day average of these $tmax\_av_{r,i} = (tmax_{r,i} + tmax_{r,i-1})/2$, and the number of degrees this two-day average was above the threshold (termed $heat_{r,i}$) . Finally we needed baseline daily numbers of deaths for each region for July ($base\_deaths_r$) on which the percentage increases would act. These were taken as the average daily deaths for each region for July 2000-2006, available from the ONS. This period was chosen for convenience (they were to hand from our previous research) and as a compromise between having enough years to smooth out any unusual years but close enough in time that populations and death counts would not be expected to have changed radically.

The table A1 below gives the detailed day-by-day calculations for one region and the model formulas used to do so and Table A2 gives the full list of temperatures provided by the Met Office and baseline deaths.

Table A1: Example calculation: NW England
(r= NW, $threshold_r$ = 21.7 deg C. IRR_r=1.3%=0.013. $Base\_deaths_r$ = 181.5)

date (i)	$tmax_{r,i}$	$tmax\_av_{r,i}$	$heat_{r,i}$	premature $deaths_{r,i}$
05/07/2013	20.3			
06/07/2013	20.9	20.6	0.00	0.00
07/07/2013	23.9	22.4	0.70	1.65
08/07/2013	26.2	25.05	3.35	8.03
09/07/2013	25.4	25.8	4.10	9.87
10/07/2013	23	24.2	2.50	5.96
11/07/2013	23.6	23.3	1.60	3.79
12/07/2013	25.3	24.45	2.75	6.56
13/07/2013	26.2	25.75	4.05	9.75
14/07/2013	21.8	24	2.30	5.47
Total 6-14 July				51.07

Formulas (applied to each day):

- $heat_{r,i} = tmax\_av_{r,i} - threshold_r$, or 0 if $tmax\_av_{r,i} < threshold_r$
- $premature\ deaths_{r,i} = base\_deaths_{r,i} \times \{(1+IRR_{r,i})^{heat(r,i)} - 1\}$

Example: 07/07/2013

- heat= 22.4-21.7= 0.7
- premature deaths = $181.5 \times (1.013^{0.7}-1) = 181.5 \times (1.0091 - 1) = 181.5 \times 0.0091 = 1.65$

Note: The calculations carried out for the full table used model parameters to more decimal places (available from me on request), but this would only lead to small differences.

Table A2: Daily maximum temperatures

	South West	South West	South West	London	West Midlands	North West England	North East	Yorkshire/ Humber	East Midlands	East of England	South East England
Date	Cardinham	Exeter Airport	Average	Heathrow	Hereford	Preston, Moor Park	Wallington	Topcliffe	Waddington	Santon Downham	Benson
05/07/2013	20.5	22.1	21.3	26.5	24.2	20.3	19.4	22	23	25	24.5
06/07/2013	22.2	24.3	23.25	28.4	25.7	20.9	22.4	26	26	26.8	26.1
07/07/2013	27.2	27.3	27.25	30	27.2	23.9	23.1	27	25.7	28.3	28.3
08/07/2013	26.8	27.9	27.35	27.9	26.2	26.2	23.4	23	17.7	24.1	25.8
09/07/2013	26	27.4	26.7	27.6	26.1	25.4	26.4	28	25	25.1	26.1
10/07/2013	26.1	27.3	26.7	24.9	24.9	23	16	18	16.8	20.8	24
11/07/2013	19.7	21	20.35	23.8	23	23.6	22.4	21	20.1	20.1	22.1
12/07/2013	23.5	23.8	23.65	26.6	27.7	25.3	27.3	28	25.4	25.5	24.4
13/07/2013	28.7	30.8	29.75	31.8	30.1	26.2	22.9	27	28.6	28.8	30.4
14/07/2013	27.9	29.6	28.75	29.9	28.3	21.8	22.9	25.9	24.5	24.8	28.9
Average July deaths			134.4	141.5	135.0	181.5	68.6	129.0	107.2	133.8	196.3