Cette présentation a été effectuée le 23 novembre 2007, au cours de la journée « Gestion de la pollution atmosphérique et des gaz à effet de serre, vers des pratiques novatrices pour améliorer la santé et l'avenir de notre planète » dans le cadre des Journées annuelles de santé publique (JASP) 2007. L'ensemble des présentations est disponible sur le site Web des JASP, à l'adresse http://www.inspq.qc.ca/archives/.

Years of life lost (YoLL) due to high summer temperatures in 15 European cities

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for PHEWE Work Package 7

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Objective

Generally, to estimate the impact of high summer temperatures on the health of European urban populations

Specifically, to generate estimates of Years of Life Lost associated with high summer temperatures, through the secondary analysis of mortality versus ambient temperature functions derived as part of the PHEWE study

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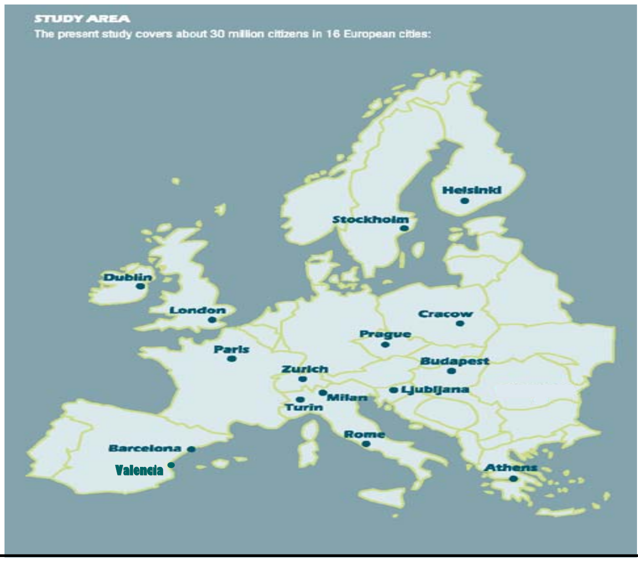
Assessment and Prevention of acute Health. Effects of Weather conditions in Europe=PHEWE



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OVERVIEW: Steps in estimating Years of Life lost (YoLL)

For each city, for the period 1990-2000, using a probabilistic Monte Carlo approach…..

- **Specify temperature *by* day functions**
- **Import data-based daily death *by* temperature functions**
- ***And based on a data-driven* “excess” temperature threshold**

Estimate attributable temperature-associated deaths

Then

Estimate YoLL assuming current life table expectations
***and* under alternative life expectancy scenarios**

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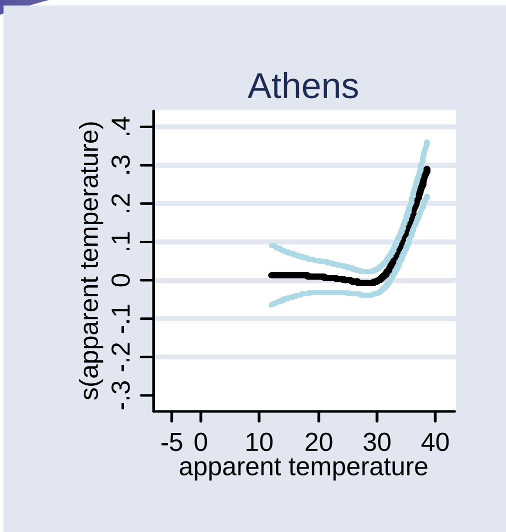
Summer deaths by 4-Day Apparent Tmax, Athens, April-September 1990-2000 (adjusted for sectoral trend, NOx)

I6



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Summer deaths by 4-Day Apparent Tmax, Budapest, April-September 1990-2000 (adjusted for sectoral trend, NOx)

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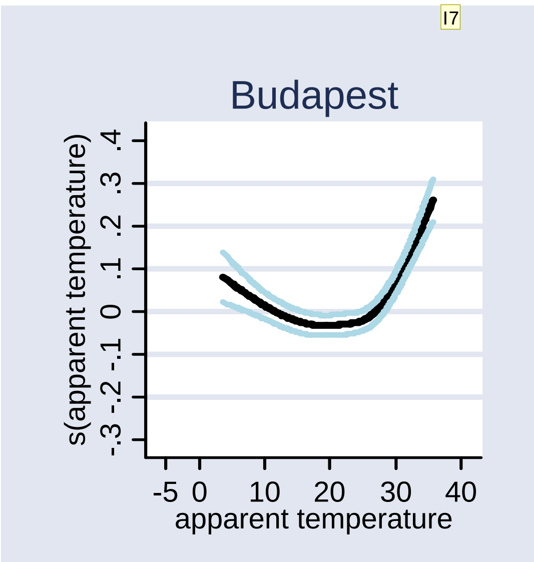

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Diapositive 5

16 Informatique; 2007-11-22

Diapositive 6

17 Informatique; 2007-11-22

Model definition: 1

- **We assumed that increases of temperature (Tmax$_{-3\rightarrow 0}$) under a threshold do not affect mortality and that <u>the effect is linear</u> above the threshold.**
- *The same temperature threshold by city is used for all age classes (15-64,65-74,75+). Thresholds are based on posterior city-specific estimates from Bayesian meta-analyses of Northern or Mediterranean city groupings.*
- *Above-threshold slopes are obtained from age-class specific meta-analytic posterior distributions.*

$$y = y_{baseline} \qquad x \le x_o$$
$$y = y_{baseline} \exp(\beta(x - x_o)) \qquad x > x_o$$

Number of deaths

threshold

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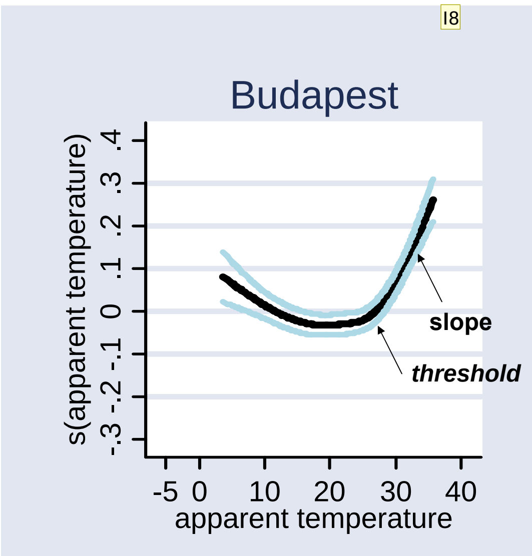
Summer Deaths by 4-Day Apparent Tmax, Budapest, 1990-2000



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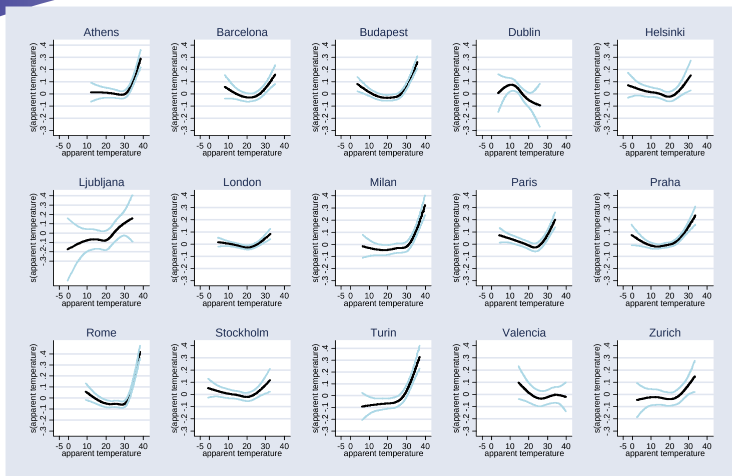
Diapositive 8

18 Informatique; 2007-11-22

Summer Deaths by 4-Day Apparent Tmax, 15 PHEWE Cities, 1990-2000



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Model definition: 2

- *We assumed that increases of temperature ($Tmax_{-3\rightarrow 0}$) under a threshold do not affect mortality and that the effect is linear above the threshold.*

- **The same temperature threshold by city is used for all age classes (15-64,65-74,75+). Thresholds are based on posterior city-specific estimates from Bayesian meta-analyses of Northern or Mediterranean city groupings.**

- **Above-threshold slopes are obtained from age-class specific meta-analytic posterior distributions.**

$$y = y_{baseline} \qquad x \leq x_o$$

$$y = y_{baseline}\exp\left(\beta\left(x - x_o\right)\right) \qquad x > x_o$$

Number of deaths

threshold

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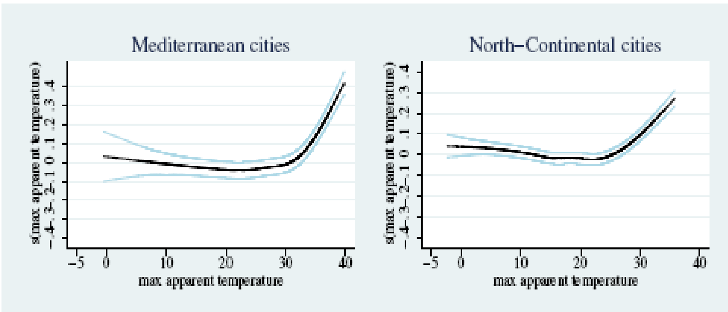
Diapositive 9

I1 Informatique; 2007-11-22

Bayesian meta-analyses of the temperature-mortality function for Mediterranean and Northern European city groupings



Mortality impact measure

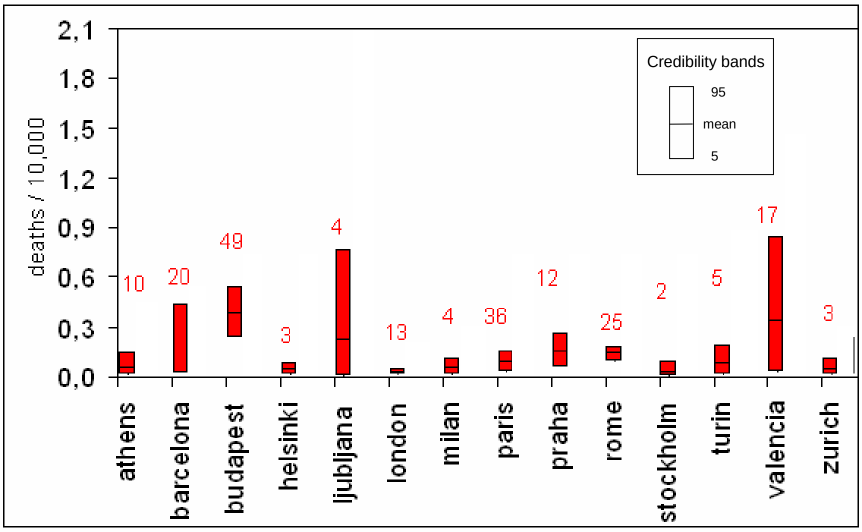
- The number of daily attributable deaths (AD) was calculated by day as the difference between the number of deaths given the scenario-based temperature for that day and the *baseline* number of deaths calculated fixing temp=*threshold*.

$$AD = y_{temp=x} - y_{temp=threshold}$$

where

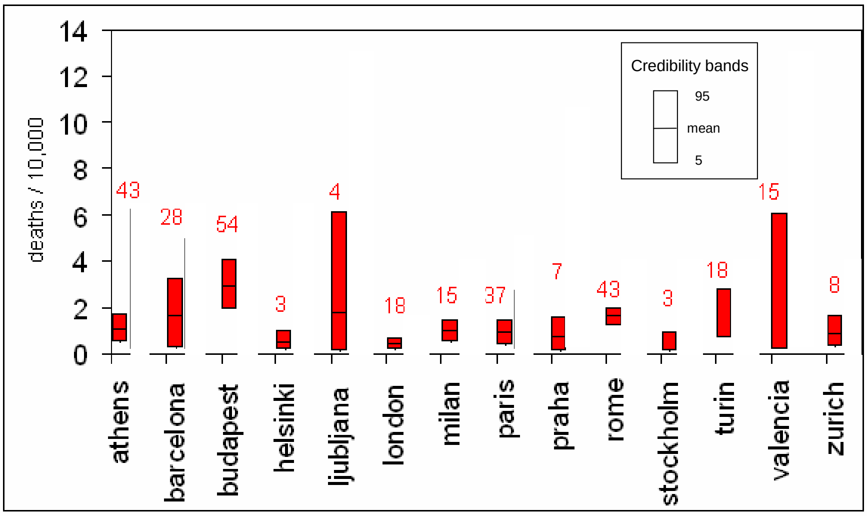
$$y_{temp=x} = \exp\left((terms) + \beta\left(x - x_o\right)\right)$$

Heat attributable deaths / 10,000 / year by PHEWE city, persons 15-64



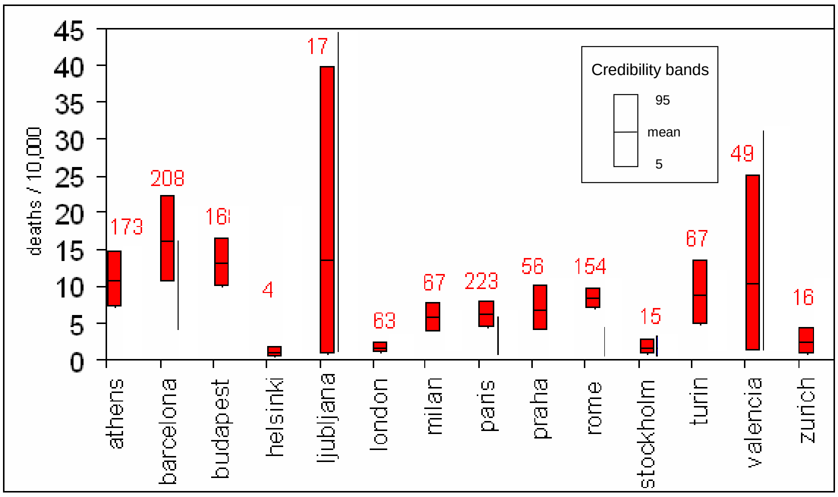
Deaths over 10 years due to linear effect above the threshold of apparent Tmax

Heat attributable deaths / 10,000 / year by PHEWE city, persons 65-74



Deaths over 10 years due to linear effect above the threshold of apparent Tmax

Heat attributable deaths / 10,000 / year by PHEWE city, persons 75+



Deaths over 10 years due to linear effect above the threshold of apparent Tmax

Monte Carlo approach

- The Monte Carlo approach incorporates independent sampling (N=1000) from
  - temperature distributions (real and modified) by city
  - city-specific Bayesian posterior distributions of threshold and slope (assuming independence of correlation between threshold and slope)
  - and calculation of attributable deaths using the sampled data.

We obtained maximum likelihood and credibility band estimates of heat attributable deaths by calendar day for each city for 1990-2000

Alternative scenarios

Temperatures	Slopes	Lags
Hottest year	*Based on three coolest years*	Cumulative 0-30 day lag
Coolest year	*Based on three hottest years*	
Second-to-coolest by calender date for the 10 years	*Based on April-June only*	
Second-to-hottest by calender date for the 10 years		

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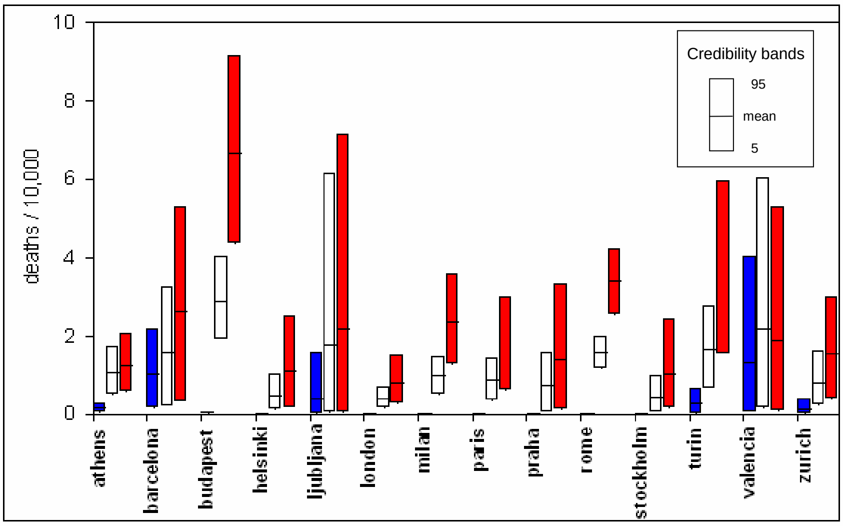
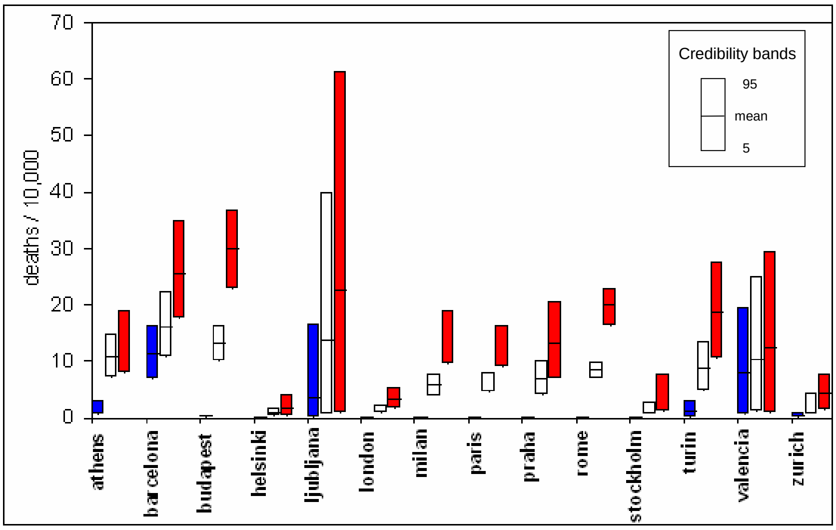
Heat attributable deaths / year under low & high temperature scenarios, persons 65-74



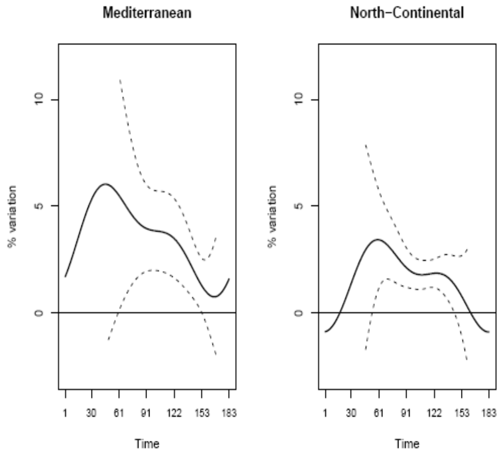
second to coolest calendar days
observed time series
second to hottest calendar days

Heat attributable deaths / year under low & high temperature scenarios, persons 75+



second to coolest calendar days
observed time series
second to hottest calendar days

Influence of day during the summer season on the effect of temperature on overall mortality



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Alternative scenarios

Temperatures	**Slopes**	Lags
Hottest year	*Based on three coolest years*	Cumulative 0-30 day lag
Coolest year	*Based on three hottest years*	
Second-to-coolest by calender date for the 10 years	***Based on May-June only***	
Second-to-hottest by calender date for the 10 years		

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Attributable deaths under early and mid-summer acclimatization scenarios

City	*Base-case* Attributable deaths per year	Scenario april-june	Scenario july-august
Athens	230 (172, 290)	694 (521, 861)	208 (149, 278)
Budapest	399 (346, 463)	510 (425, 594)	310 (262, 359)

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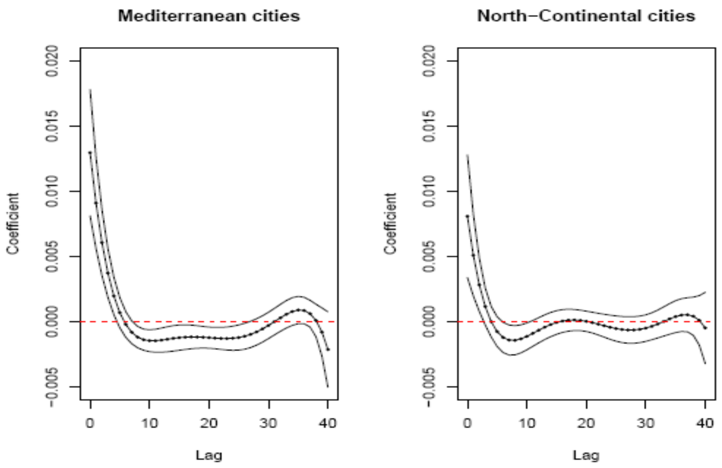
Lagged deaths to 30 days, all ages



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Alternative scenarios

Temperatures	Slopes	**Lags**
Hottest year	*Based on three coolest years*	**Cumulative 0-30 day lag**
Coolest year		
Second-to-coolest by calender date for the 10 years	*Based on three hottest years*	
	Based on May-June only	
Second-to-hottest by calender date for the 10 years		

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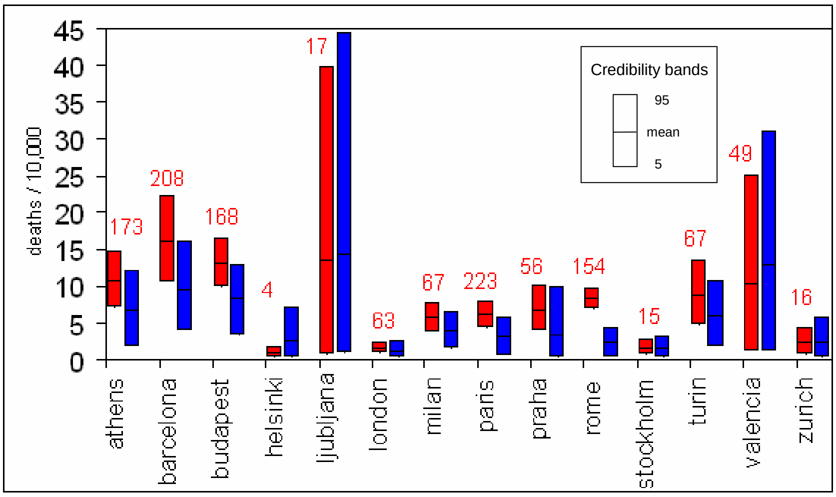
Heat attributable deaths / 10,000 / year by PHEWE city, persons 75+



Deaths due to linear effect above the threshold of apparent Tmax

Deaths due to cumulative (up to lag 30 days) effect above the threshold of apparent Tmax

Results(attributable deaths)

- We estimate <60 excess temperature-related deaths per year during 1990-2000 in each city among persons aged 15-64 and 65-74
- Among persons of 75+, we estimate 150-200 excess deaths per year in each of Paris, Barcelona, Athens, Budapest, and Rome
- The estimated number of excess deaths in persons 75+ in the above four cities is reduced by 35-60 percent when those displaced by less than 30 days are set aside (but not for those not aged <75)
- Paris, Budapest, Rome, Turin, and Barcelona appear particularly sensitive to a high temperature scenario
- All cities are sensitive to early-summer lack of acclimatisation
- There is a high degree of estimate uncertainty

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From attributable deaths to YoLL

- Life tables (by single year of age or five-year classes) were acquired or developed by city for a reference year between 1993-1998
- We assumed that the age distribution of excess deaths by day ***within*** each large age class (15-64,65-74,75+) was equal to that of all deaths occurring during the reference year
- *The effect of cumulative mortality displacement during the 30 days after a day of above-threshold heat was assessed*

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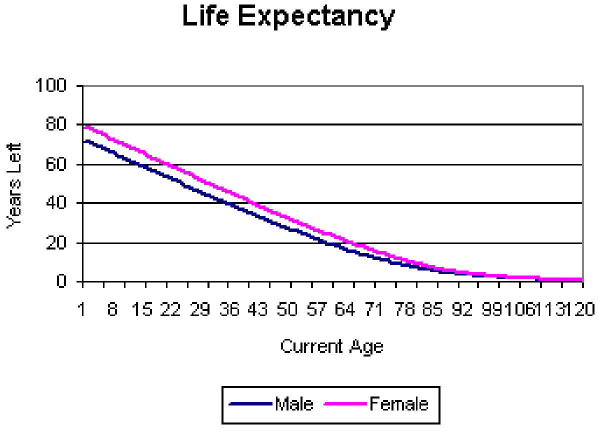
Life expectancy by year of current life



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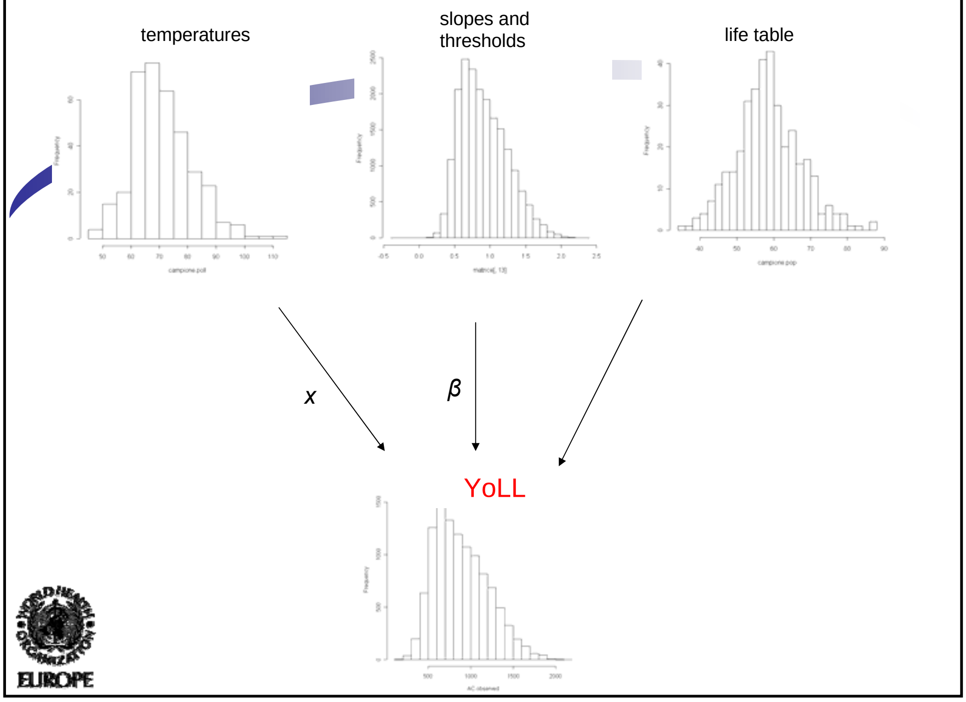
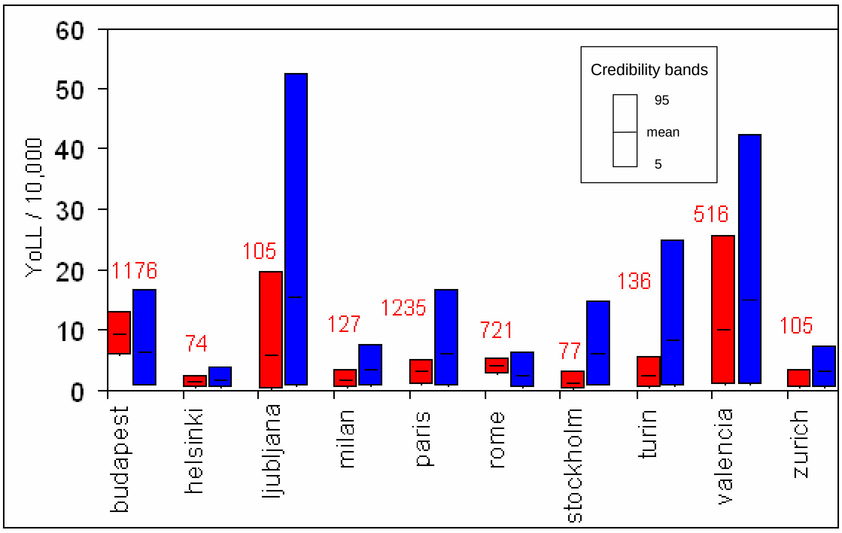


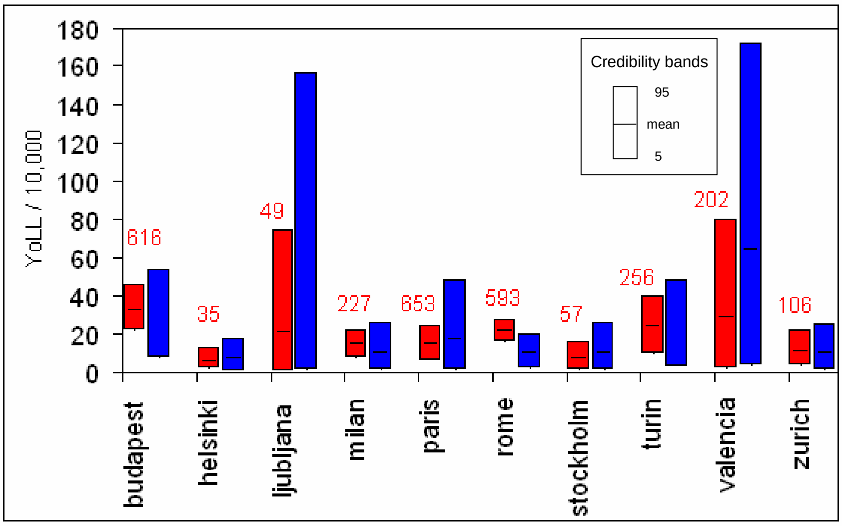
Years of life lost / year by PHEWE city, persons 15-64



YoLL due to linear effect above the threshold of apparent Tmax

YoLL due to cumulative (up to lag 30 days) effect above the threshold of apparent Tmax

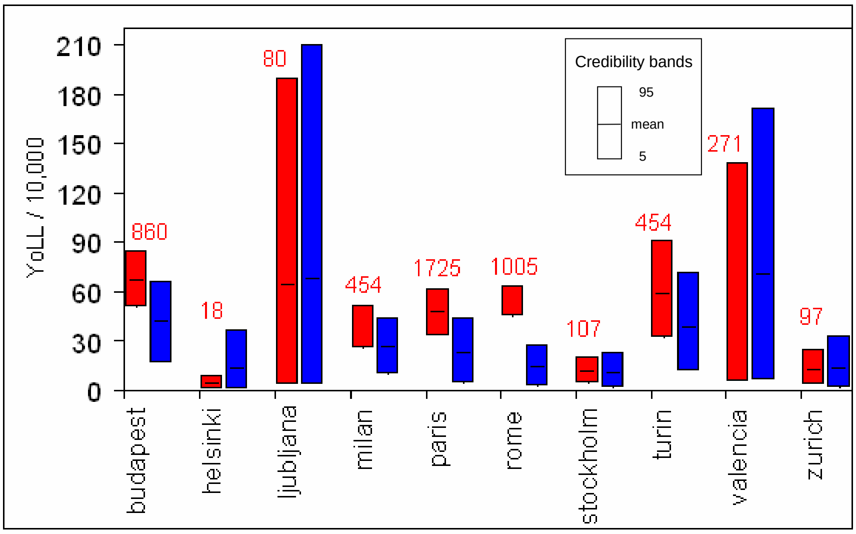
Years of life lost / year by PHEWE city, persons 65-74



YoLL due to linear effect above the threshold of apparent Tmax

YoLL due to cumulative (up to lag 30 days) effect above the threshold of apparent Tmax

Years of life lost / year by PHEWE city, persons 75+



YoLL due to linear effect above the threshold of apparent Tmax

YoLL due to cumulative (up to lag 30 days) effect above the threshold of apparent Tmax

Results: YoLL

YoLL (calculated so far for 10 cities) suggest that for the age groups:

A. 15-64 : over 1000 YoLL/year in Budapest and Paris

B. 65-74 : over 500 YoLL/year in Budapest, Paris, and Rome

C. 75 + over: 1500 YoLL/year in Paris, and over 700/year in Budapest and Rome, with sharp reductions if deaths displaced by less than 30 days are excluded.

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Towards " burden of disease "

Note that, so far, we have considered only YoLL on excess temperature days and not:

- YoLL among those who survive 3 (or 30) days but with subsequent shortened life expectancy
- DALYs/QALYs: loss of working capacity or occurrence of disability due to pathology/dysfunction associated with heat

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Thank You

PHEWE TEAM

FRANÇOIS TESSIER
Marie-Claude Gaudin

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Assessing the burden of excess summer heat

The burden of disease approach

(Murray CJ, Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, 2003)

The burden of disease approach permits the quantification of health risks expressed as "health loss", a common denominator combining both truncated lifespan and years lived with disability. This approach has been applied to situations where the effect of exposure on both disease incidence and on disability given disease (as well as on mortality) is positive and can be estimated: its application may not be pertinent where effects of exposure are primarily in persons of retirement age and where sudden death or hospitalisation with recovery are the demonstrated consequences of exposure.

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Assessing YoLLs due to excess summer heat

We have opted for an approach based on **years of life lost** (YoLL) (Romeder JM and McWhinnie, 1977)

…where we estimate both a threshold for temperatures considered adverse and a post-threshold mortality function, estimate excess adverse temperature-associated mortality from the observed distribution of city-specific temperatures, and attach to each death in excess of those occurring under non-adverse conditions, an estimate of reduced lifespan. Our assessment, presented as loss of life expectancy over the city population as a function of summer weather, incorporates temperature and response simulations and sensitivity analyses.

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