

Effects of apparent temperature on summer mortality in Lisbon and Oporto



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DELTA IN TIMES OF CLIMATE CHANGE, ROTTERDAM, 2010

Introduction

Health impacts due to climate change are occurring

- Increase average temperature
- Health risks due to heat-waves (summer 2003)
- Increase in mortality
- Mediterranean region is one of the most affected

Getting warmer and drier !

- Heat stress for Southern Europe
- Portugal is very vulnerable to heat stress (heat waves in the past)

Objective

- Investigate the association between **mean apparent temperature** and daily mortality in Lisbon and Oporto during the **warm season**.

Material and Methods



Oporto

- second largest Portuguese city
- north of the country
- north maritime climate.
- Douro River
- 1.2 million people



Lisbon

- Lisbon city, the capital of Portugal
- central of the country
- Tagus River
- 2.1 million people



Material and Methods

- Generalized additive models (GAM), Poisson regression models
- **Exposure period:** warm period (April to September)
- Models controlled:
 - for time trend (using natural cubic spline smoothing function)
 - day of the week (indicator variable)
- Confounding effects of air pollution
 - ozone and PM₁₀

Exposure variable

$$\text{Apparent temperature } ^\circ\text{C (AT)} = -2.653 + (0.994 \times \text{temperature } ^\circ\text{C}) + 0.0153 \times (\text{dew point temperature } ^\circ\text{C})^2$$

AT – individual's perceived air temperature given the humidity.

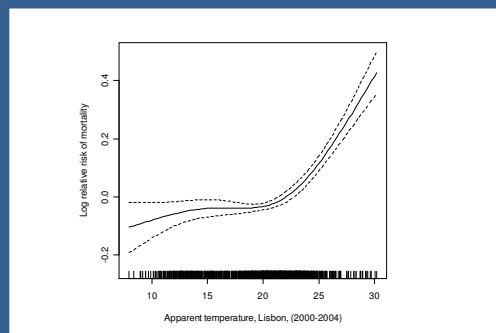
In our study apparent temperature is used to represent the effect of the typical temperature exposure that is commonly experienced during the warmer months.

Results

Summary statistics of daily mortality data and environmental variables in the **warm season** (April to September).

City (time period)	Variables	Mean	SD	Min	Median	Max
Lisbon (2000-2004)	All-causes all ages	53.4	9.5	27.0	53.0	101.0
	Cardiovascular all-ages	21.7	5.8	7.0	21.0	53.0
	Respiratory all-ages	3.1	2.0	0.0	3.0	12.0
	Mean Apparent temperature (°C)	19.6	4.3	7.9	20.3	31.6
	Mean temperature (°C)	20.0	3.8	9.7	20.4	33.5
	PM ₁₀ (µg/m ³)	35.4	17.0	9.7	31.1	161.4
	O ₃ (µg/m ³)	71.7	22.2	18.0	69.9	151.3
Oporto (2000-2004)	All-causes all ages	34.9	6.5	20.0	34.0	64.0
	Cardiovascular all-ages	11.3	3.6	1.0	11.0	29.0
	Respiratory all-ages	2.9	1.8	0.0	3.0	10.0
	Mean Apparent temperature (°C)	17.0	4.1	5.8	17.5	31.3
	Mean temperature (°C)	17.3	3.3	8.3	17.4	30.4
	PM ₁₀ (µg/m ³)	38.0	22.4	7.3	32.3	151.6
	O ₃ (µg/m ³)	74.2	22.7	18.4	71.4	169.8

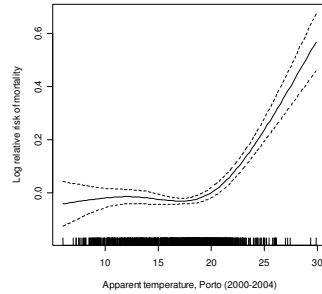
City-specific plots of the smoothing function of mean apparent temperature in the warm season (April to September) in Lisbon, 2000-2004.



Models ^{a,b}	% Increase	95% CI
All-causes mortality		
All-ages	2.1	1.6, 2.5
> 65	2.7	2.2, 3.2
Cardiovascular diseases		
All-ages	2.4	1.7, 3.1
> 65	2.8	2.1, 3.6
Respiratory diseases		
All-ages	1.7	0.1, 3.4
> 65	2.3	0.5, 4.1



City-specific plots of the smoothing function of mean apparent temperature in the warm season (April to September) in Oporto, 2000-2004.



Models ^{a,b}	% Increase	95% CI
All-causes mortality		
All-ages	1.5	1.0, 1.9
> 65	1.8	1.2, 2.3
Cardiovascular diseases		
All-ages	2.1	1.3, 2.9
> 65	2.2	1.3, 3.0
Respiratory diseases		
All-ages	2.7	1.2, 4.3
> 65	3.0	1.4, 4.7



Percentage increase (95% Confidence Interval) in all-causes mortality for a 1°C increase in mean apparent temperature(lag01), adjusted by individual pollutant(lag 0).

	Lisbon		Oporto	
	% Increase	95% CI	% Increase	95% CI
All-ages				
Base model: AT+ day of week	2.1	1.6, 2.5	1.5	1.0, 1.9
+ Particulate matter	1.6 ↓	1.0, 2.1	1.1 ↓	0.6, 1.6
+ 8-hr average ozone	1.9	1.4, 2.3	1.0 ↓	0.5, 1.5
> 65 years				
Base model: AT + day of week	2.7	2.2, 3.2	1.8	1.2, 2.3
+ Particulate matter	2.1 ↓	1.5, 2.6	1.4 ↓	0.8, 2.0
+ 8-hr average ozone	2.5	2.0, 3.9	1.3 ↓	0.7, 1.8

Conclusions

- In the summer season there is an association between mean apparent temperature and daily mortality, even when controlling for the effects of air pollution in Lisbon and Oporto;
- The population in Lisbon was more vulnerable than the population in Oporto, to heatstress;
- The adaptation measures to protect public health from impacts from thermal stress should be developed at the local level and take into account the city specific vulnerabilities.