

District vulnerability to extreme heat temperatures in Mainland Portugal

Introduction

Direct effects of ambient temperature on human health are known and, in the case of high temperatures, can range from moderate skin irritations to the so-called heat stroke.^{1,2}

Extreme temperature can also have adverse effects on health by aggravating preexisting diseases such as cardiovascular and cerebrovascular diseases, respiratory diseases, diabetes, among others.^{1,2} In Portugal, similarly to other countries, the effects of extreme heat on health are known, specifically on mortality, in situations of sudden, intense and prolonged temperature increase, meaning during the so-called heat waves.²⁻⁷

The **objective** of this work was to study the geographical distribution of the risk of death in mainland Portugal districts to extreme temperatures using summer data (from June 1st to September 30th) between 2008 and 2018.

Materials and Methods

Data: *Mortality* data was provided by VDM (Vigilância Diária da Mortalidade) system hold on Instituto Nacional de Saúde Doutor Ricardo Jorge (INSA)⁸, and *meteorological* data by Instituto Português do Mar e da Atmosfera (IPMA). Daily data was updated on March 3th, 2019.

Methods: Firstly a *descriptive analysis* of data was performed and secondly a *geoadaptive Regression Poisson family with BayesX*⁹ was applied to mortality rate (/100000 inhabitants) considering as predictors daily maximum temperature at district level, a spatial function, and weekend days. MCMC method was used to obtain estimates.

Mortality Rate Ratios were estimated considering as comfort temperature the one that corresponds to minimum mortality at district level (Table 1).

Results

Almost all districts (15 in 18) had registered temperatures above 39°C on at least one day, during the period of analysis.

The maximum temperature registered over the study period was 47.8°C on Portalegre (23-07-2015) followed by 46.3° on Santarém (04-08-2018). The extreme heat impacts are not equal all over mainland Portugal as expected, since each district has specific temperatures.

Considering as adverse temperatures: percentile 95 of district temperatures the mortality rate ratios varied between 1.079 and 1.224, respectively in Aveiro and Évora; and percentile 99 of district temperatures the mortality rate ratios varied between 1.147 and 1.263, respectively in Viana do Castelo and Évora.

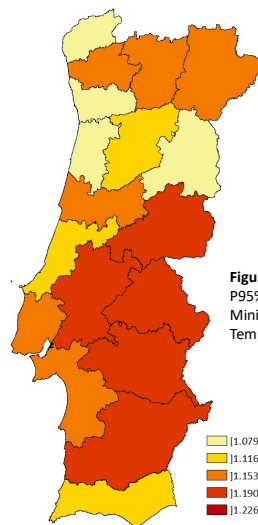


Figure 1. Rate Ratio between P95% of Temperature and Minimum Mortality Temperature.

Legend for Figure 1:
[1.079 - 1.116]
[1.116 - 1.153]
[1.153 - 1.190]
[1.190 - 1.226]
[1.226 - 1.263]

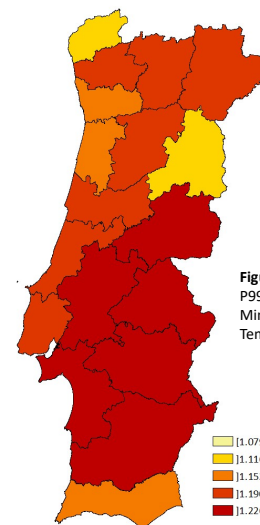


Figure 2. Rate Ratio between P99% of Temperature and Minimum Mortality Temperature.

Legend for Figure 2:
[1.079 - 1.116]
[1.116 - 1.153]
[1.153 - 1.190]
[1.190 - 1.226]
[1.226 - 1.263]

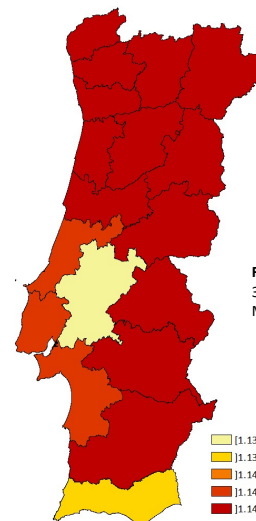


Figure 3. Rate Ratio between 35°C and Minimum Mortality Temperature.

Legend for Figure 3:
[1.133 - 1.137]
[1.137 - 1.141]
[1.141 - 1.145]
[1.145 - 1.149]
[1.149 - 1.154]

Table 1. Descriptive Analysis.

	Temperature			
	Minimum mortality	P95%	P99%	max
Aveiro	17.6	30.1	35.1	39.3
Beja	19.7	38.9	41.1	44.9
Braga	17.1	35.6	38.7	42.2
Bragança	15.5	35.3	37.3	39.7
Castelo Branco	18.5	38.0	40.1	43.5
Coimbra	17.2	35.6	38.6	41.3
Évora	18.0	39.1	41.2	45.4
Faro	22.2	33.8	36.4	37.8
Guarda	11.6	32.6	34.8	37.0
Leiria	20.7	34.5	38.1	42.3
Lisboa	19.9	35.8	38.9	44.0
Portalegre	16.5	37.4	39.6	47.8
Porto	19.4	31.5	35.5	38.6
Santarém	23.5	38.9	42.0	46.3
Setúbal	20.5	36.8	40.7	45.5
Viana do Castelo	18.0	30.7	34.7	39.3
Vila Real	14.5	35.4	37.3	39.6
Viseu	13.9	34.9	37.1	40.5

Conclusions

The heat impacts are not equal all over mainland Portugal and higher ratios were found in center and southeast mainland Portugal.

It means that although a district register high temperatures it doesn't imply that this district will have the higher impacts in terms of mortality rates. This might be due to some environmental adaptation and or possible preventive measures applied by public services, such as health authorities, regarding contingency plans previously established.

Further studies are needed in order to give local authorities more information regarding districts vulnerabilities to extreme heat.

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