

Effect of Temperature on Mortality in Torino: the Role of Birthplace - preliminary analyses 1980-89¹

*L'Effetto della Temperatura sulla Mortalità a Torino:
il Ruolo del Luogo di Nascita - analisi preliminari 1980-89¹.*

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Riassunto: Gli effetti della temperatura sulla mortalità naturale per i residenti a Torino vengono analizzati stratificando per luogo di nascita. L'analisi è condotta attraverso serie temporali relative agli anni 1980-89 ed è complicata dalla presenza di *break-points* nei modelli. I risultati evidenziano che, nonostante l'esposizione alla temperatura sia la stessa fra i gruppi, l'effetto del caldo è maggiore per gente nata nelle zone più fresche ed inferiore per quelli nati nel Sud Italia suggerendo che l'acclimatazione nei primi anni di vita potrebbe essere importante, sebbene alcuni altri fattori confondenti dovrebbero essere valutati.

Keywords: temperature, breakpoint, mortality, migrants, acclimation.

1. Introduction

Health effects of environmental factors are well-known; in particular, temperature effects on mortality have been discussed in several studies and a V-like relationships has been repeatedly established: mortality reaches its minimum at some optimal temperature value (hereafter MMT, *Minimum Mortality Temperature*) and death excesses are observed as temperature gets colder and hotter (Keatinge *et al.*, 2000; Curriero *et al.*, 2002). Among possible modifier effects, age, gender and socioeconomic status has been studied by some authors (Gouveia *et al.*, 2003), but, up to our knowledge the role of the birthplace has never been taken into account. Assessing possible differences due to birthplace could be important to gain insights into possible health consequences of the greenhouse effect (Beniston, 2002). In fact, as hot is associated with death excesses, it is of interest to assess whether and how the global warming can induce modifications in mortality pattern. Some authors by comparing raw mortality data among several cities with different climatic conditions argue that adaptation to raising temperatures could avoid increases in hot-related mortality (Keatinge *et al.*, 2000). However we believe that studies on health effects of global warming and possible adaptation to climatic changes should concern people exposed to temperatures higher than the native ones. That is, the so-called acclimation during the early life should be taken into account, because global warming is going to expose to higher temperatures people born and grown up with lower temperatures.

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Hence the aim of this study is to compare the temperature effects on mortality on people having different birthplace: in particular the goal is to assess whether people born in warmer areas (i.e. the South of Italy) tolerate warm better than people born in North and not conformed to high temperatures.

2. Data and Methods

Anonymous records for all-natural causes mortality data 1980-89 were supplied by registry office of municipality of Torino. Information include year of birth, date of death, birthplace (region code) and schooling level (three categories, high, medium and low). Out of 80676 deaths for all residents, 3.8% of records were dropped because the birthplace information was missing or the birthplace were out of Italy. Three groups of residents were formed according to the birthplace: born in North (i.e. born in one of the following regions: Piemonte, Valle d'Aosta, Lombardia, Trentino AA, Veneto, Friuli VG); born in Middle (Liguria, Emilia-Romagna, Toscana, Umbria, Marche, Lazio, Abruzzi and Molise) and finally born in South (Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna). Such classification was motivated to guarantee series with moderate or large size.

In order to quantify the effects, the nonlinear mortality-temperature relationship is approximated by a piecewise linear function connected at the unknown MMT to be estimated. The main advantage coming from this formulation is that estimates of cold- and hot-related risks and MMT are directly available. Therefore let for the generic group (natives in North, born in Middle or in South) Y_t the count of daily death at day t , and $E[Y_t] = \mu_t$ its expected value to be explained through the log-linear model

$$\log \mu_t = \eta_t + \beta_1 \text{TEMP}_t + \beta_2 (\text{TEMP}_t - \psi)_+ \quad (1)$$

where $a_+ = a \times I(a > 0)$, β_1 and $(\beta_1 + \beta_2)$ are the log relative risks (logRR) for cold and hot respectively and ψ is the breakpoint, i.e. the MMT. TEMP_t is the current day mean temperature and η_t is a, possibly nonparametric, seasonality modeler (including the model intercept): here we use the simple categorical variable MONTH. The model is estimated throughout an algorithm recently proposed able to overcome the well-known difficulties related to broken-line models (Muggeo, 2003).

3. Results and Conclusions

Table 1 shows descriptive statistics for the three selected groups: prevalence on the total number of deaths, average daily death count, percentages of people older than 65 and 75 years and distribution of schooling level.

Natives in North and migrants from the Middle Italy exhibit similar features with respect to distributions of age and schooling level. On the other hand it is worth noting that migrants from South are younger and show an higher percentage of people with low instruction level. This is very likely a consequence of massive industrialization of North in the seventies that employed mostly unskilled labour coming from South.

Figure 1 plots the smoothed estimated temperature-mortality curve in the three groups of residents: the V-shaped curve is confirmed in each group with confidence bands depending strongly on the series size; anyway a broken-line approximation seems to be

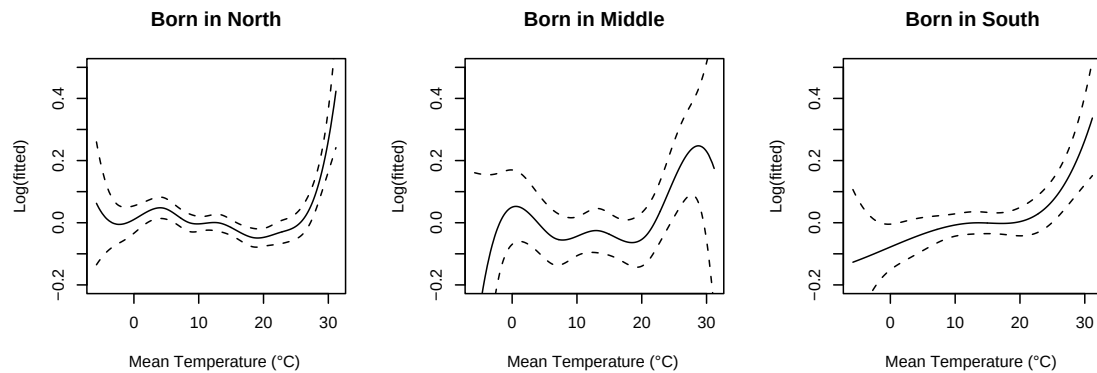
Table 1: Descriptive statistics for the three selected groups of residents in Torino deceased in 1980-89.

Group by birthplace	Deaths		Age(yrs)		Schooling Level		
	%	daily mean	65+	75+	high	medium	low
South	21.1	4.48	68.0	42.7	6.0	11.0	83.0
Middle	8.2	1.74	79.8	56.3	14.6	18.2	67.2
North	70.7	15.0	78.3	56.7	11.3	18.5	70.2

adequate. The left slope of each curve is substantially null, suggesting the cold effect to be negligible, while the heat-related risk (right slope) is rather pronounced and steeper in the natives' group.

Unlike migrants from Middle and South, the natives' curve shows two possible break-points located approximatively at 19°C and 25°C; here we do not discuss such feature and its possible explanations, and a broken-line model with just one break-point is estimated for each group to get comparable results.

Figure 1: Basis-splines smooth estimate of the temperature-mortality curve with 95% confidence bands adjusted for seasonality (modelled by the categorical variable MONTH) in three groups of residents in Torino deceased in 1980-89. The degrees of freedom (i.e. the amount of smoothing) in each group are 8, 6 and 4 from left to right and have been selected by generalized cross validation.



Estimates of logRR for cold and hot and MMT from three log-linear models as discussed in section 2., are presented in Table 2 where intercepts and parameters for the variables MONTH are omitted.

Table 2: Cold- and heat-related log relative risks (logRR, values $\times 10$) and MMT (°C) for the analysis of temperature effects in three groups of residents in Torino 1980-89: point estimates and 95% Wald-based confidence intervals.

Group by birthplace	Temperature effects		
	logRR - Cold	logRR - Hot	MMT
South	0.031(-0.027; 0.088)	0.253(0.089; 0.417)	20.8(17.4; 24.2)
Middle	-0.054(-0.152; 0.044)	0.392(0.189; 0.595)	20.0(17.1; 22.8)
North	-0.025(-0.053; 0.004)	0.669(0.412; 0.925)	25.7(24.8; 26.6)

Controlling for seasonality, the cold effect is low with corresponding confidence intervals including zero and also the MMT estimates do not seem to follow any gradient

South-North; only it is worth noting that the relevant confidence interval is much narrower in the natives' group where the segmented relationship is quite clear-cut. On the other hand, the heat related risk is always significant and progressively higher in South, Middle and North groups. A meta-regression model could be applied to test for such trend, but as pointed out by a referee, three estimates are really few to draw reliable inference from any fitted model.

Differences in distribution of schooling level in the three groups (see Table 1), could be responsible of different risks, but as an high schooling is usually associated with a decrease in mortality risks, adjusting for such a factor should reduce the heat-estimate just for the migrants from South and the results should strengthen the differences, leaving unchanged the findings. With regard to differences in the age distribution, again results were unchanged when the analysis was limited to people aged more than 65 or 75 years (results not shown). Finally conditioning air systems are well-known to be able to reduce heat effects but their diffusion was likely rather limited in eighties. However further factors to be properly considered are the 'family condition' (e.g. living alone or not) and the 'year of immigration' to understand the role of genetic factors.

Analyses in this study have involved citizens residents in Torino: despite the same exposure temperature we found differences in the three groups as regard to heat effect: people born in warmer areas (i.e. South or even Middle) than the exposure one (i.e. the North) turns out to be more tolerant to heat, while no cold-effect was observed probably due to heating houses.

These findings suggest that acclimatization in early life might important in fixing heat tolerance in adult life, and therefore global warming might increase heat related mortality, although results need to be confirmed by others studies concerning different periods and/or other cities.

References

- Beniston M. (2002) Climatic change: possible impacts on human health, *Swiss Medical Weekly*, 132, 332–7.
- Curriero F.C., Helner K.S., Samet J.M. *et al.* (2002) Temperature and mortality in 11 cities of the Eastern United States, *American Journal Epidemiology*, 155, 80–7.
- Gouveia N., Hajat S. and Armstrong B. (2003) Socio-economic differentials in the temperature-mortality relationship in Sao Paulo, Brazil, *International Journal Epidemiology*, 32, 390–7.
- Keatinge W.R., Donaldson G.C., Cordioli E. *et al.* (2000) Heat related mortality in warm and cold regions of Europe: observational study, *British Medical Journal*, 321, 670–3.
- Muggeo V.M.R. (2003) Estimating regression models with unknown break-points, *Statistics in Medicine*, 22, 3055–71.