GEOGRAPHICAL VARIATIONS IN MORTALITY AND UNEMPLOYMENT IN ITALY

Vanessa Santos Sánchez, Gabriele Ruiu, Lucia Pozzi, Marco Breschi, Giovanna Gonano

1. Background

As underscored by Regidor et al. (2015), in recent years an increasing number of research efforts have been devoted to refining the statistical methods for analysing mortality in small geographical areas. However—and to some extent, surprisingly—there are very few empirical works exploring the geographic pattern of disparities in mortality (see also Divino et al. 2009).

Small-area analyses allow exploring not only the distribution of mortality in detail, but also the possible relationship between mortality and other contextual variables that could, at least in part, explain the health status of a population, such as socioeconomic or environmental variables.

In this context, Italy seems to be a particularly interesting case. The country is indeed well known in demography for being among those with the highest life-expectancy at birth but also for the substantial economic divide between the northern and the southern parts of the country (Daniele and Malanima 2017). Nevertheless, little is known about geographical differences in mortality at the municipal level.

To our knowledge, the bulk of previous research focuses on the regional (NUTS 2) or provincial (NUTS 3) level (Egidi et al. 2005). The few that consider the municipal level limit their analysis to the territory of a single region (Biggeri et al. 2006), to a few municipalities extracted from different macro-areas (Lillini and Vercelli 2018), or they do not take into account the eventual role played by economic differences among municipalities. An important exception is the work of Caranci et al. (2010). Their study uses 2001 census data to construct a social deprivation index at the municipal and census block level to show that the geographical pattern of deprivation was compatible with the geographical pattern of general mortality. However, only the correlation between mortality rates and these indicators was furnished, without taking into account the presence of spatial-autocorrelation. As pointed out by Valcu and Kempenaers (2010), this may lead to several statistical issues, such as an increased type I error rate in a simple correlation exercise or the violation of independence-of-error terms in linear and generalized linear models.

This paper focuses on a single dimension of economic deprivation: unemployment. It should be mentioned that the relation between unemployment and general mortality is quite controversial. In particular, the role of unemployment as a determinant in mortality from all causes has been questioned in the literature (see discussion in Clemens et al. 2015). Specifically, it may be argued that unemployed individuals are selected from those in poor health, therefore the eventual increase in mortality risk could have a cause other than the unemployment itself. In order to partly cope with this possible criticism, we calculated the unemployment rates at the municipal level using data from the 2011 Italian Census. Given that this was a period of severe economic recession in Italy, unemployment should have hit all individuals as it climbed, without particular health–based selection effects (see Lagravinese 2015 for a discussion of the Italian economic recession), thus moderating its selection as an unemployment effect. To have an idea of the changes in unemployment levels, we observe that, according to ISTAT data, at the end of 2007, the unemployment rates (both sexes considered together) in Italian macro-areas were: 3.8% in north-western Italy, 3.1% in north-eastern Italy, 5.3% in central Italy, and 11% in southern Italy. By the fourth quarter of 2011, these rates soared to 7.2%, 7.1%, 9.1%, and 14.8%, respectively.

This work aims to offer a spatial analysis of municipal mortality for the whole of Italy in the period 2012–2016, and to assess whether the very large geographical disparities in unemployment levels, may be of help in explaining mortality differentials across the country

The paper is organized as follows: in the next section, we present data and methods; in the third section, we illustrate and discuss the main results; and the last section is devoted to final considerations.

2. Data and Methods

We carried out a cross-sectional small-area study with the municipality as the spatial analysis unit for the period 2012–2016. The study includes all the 7,998 Italian municipalities that existed in the year 2016.

We used death entries, broken down by municipality, year, and gender, as case source.

Municipal populations, broken down by age group (20 groups of five not-overlapping years) and gender were obtained for each year. The population for the whole period was calculated by adding the population of each year.

Mortality and population data came from the official statistics produced by the Italian National Institute of Statistics (Istat).

Unemployment data at the municipal level were obtained from the 2011 Census. The unemployment rate (ur) was calculated as the ratio between the number of unemployed or looking for a first occupation persons (both sexes considered together) by municipality and the total labour force. Subsequently, in order to create an index, the quintiles of the distribution of the rates were calculated, assigning level 1 to the municipalities with the lowest level of unemployment and level 5 to those with the highest unemployment (see Figure 1). The intervals defined by quintiles are, respectively: ur ≤ 0.0531, 0.0531< ur ≤ 0.069, 0.069 < ur ≤ 0.0901, 0.0901< ur ≤ 0.1547, ur > 0.1547. Looking at Figure 1, we see that territorial differences in unemployment levels are quite impressive. Note that almost all southern municipalities fall in the fourth or the last quintile.

Standardized mortality ratios (SMRs) were calculated as the ratio of observed to expected deaths. To calculate the number of expected cases, age- and sex-specific mortality rates for Italy as a whole were multiplied by the corresponding municipal population.

Smoothed municipal relative risks (RRs) with their corresponding 95% credibility intervals and posterior probabilities (PRPs), when the smoothed RR was greater than one, were calculated using the conditional autoregressive model proposed by Besag et al. (1991). This model fits a Poisson spatial model with two types of random effects—a non-structured effect that takes into account the municipal heterogeneity, and a structured effect, the spatial term, that considers municipal contiguity. To define area contiguity, we used the adjacent municipal boundaries. The model takes the following form:

$$O_i \sim Po(E_i \lambda_i)$$
$$\eta_i = \log(\lambda_i) = \alpha + h_i + b_i \quad (1)$$

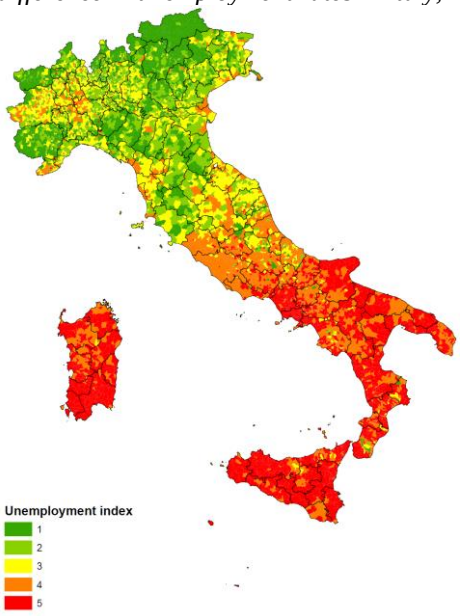
where λ_i is the RR in area i, O_i is the number of observed cases, E_i is the number of expected cases, α is the intercept, h_i is municipal heterogeneity and b_i is the spatial term. The non-spatial random effect (heterogeneity) is assumed to be normally distributed with zero mean and constant variance. For the random effect that reflects spatial variability, an autoregressive CAR conditional model was used (Clayton et al. 1993).

To analyse the effect of unemployment on mortality, the municipality's unemployment index was included as an explanatory variable in the model, taking the municipalities with the lowest unemployment as reference category. As such, the model takes the following form:

$$\eta_i = \log(\lambda_i) = \alpha + h_i + b_i + \beta \quad (2)$$

where e^{β} is the RR associated with the unemployment index.

Figure 1 – *Geographical difference in unemployment rates in Italy, 2011.*



The tool used for Bayesian inference of subsequent marginal distributions was Integrated Nested Laplace Approximations (Rue et al. 2009). For this purpose, we used the R-INLA library available in the R statistical package.[1] Maps of the smoothed RRs were divided into seven quantiles in order to guarantee homogeneity in all geographic areas. Regarding PRPs, following the criterion proposed by Richardson et al. (2004), we will consider that municipalities with 'high mortality risk' are those with a value equal to or greater than 0.8, and municipalities with 'low mortality risk' are those with a value equal to or less than 0.2. For this purpose, ArcMap software version 10.5 was used.

3. Results

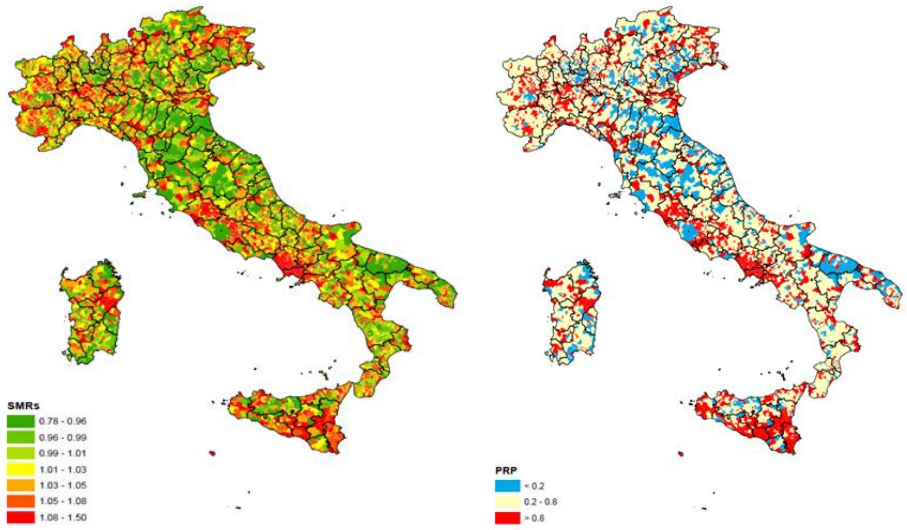
In the period 2012–2016, the Istat recorded a total of 3,074,775 deaths—1,478,525 (51.91%) were male deaths and 1,596,250 (48.09%) were female ones.

[1] : http://www.r-inla.org/. [Accessed 22 November 2018].

For men, a spatial pattern of mortality is observed in the SMRs (Figure 2 panel A). The map shows municipalities with higher mortality in the south-west of the Peninsula, specifically in the regions of Campania (Caserta and Naples Provinces) and Latium (Viterbo Province). Nuoro Province in Sardinia also stands out, as well as the south-eastern part of Sicily. The pattern of mortality observed in SMRs is maintained for PRPs (Figure 2 Panel B).

Figure 2 – *SMRs and PRPs men. Italy, 2012–2016.*

A - *SMRs* B -*PRPS*



The spatial mortality pattern for women is very similar (Figure 3 Panel A). The regions of Campania and Sicily remain the areas characterized by the highest mortality, although in the case of men, more provinces in Sicily report elevated mortality. The situation of the Apulia region in the south of the Peninsula is also noteworthy. As seen in Figure 3 Panel B, all these regions show statistically significant high mortality.

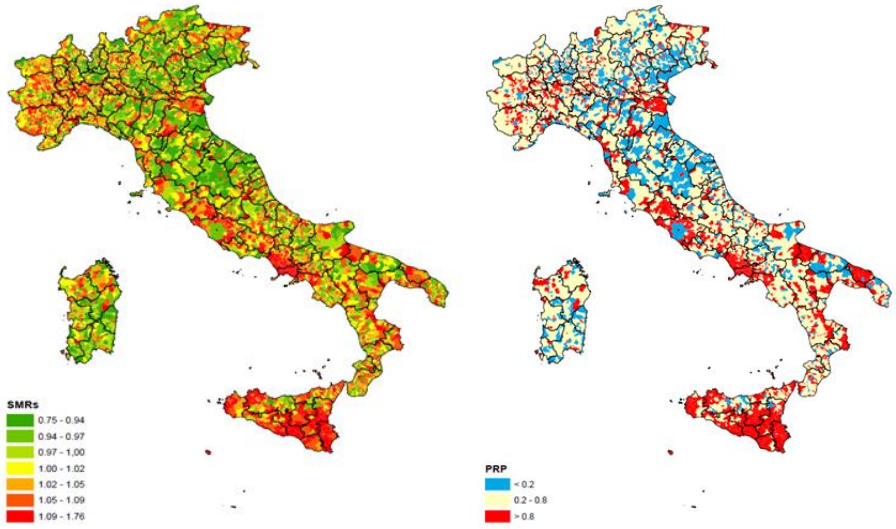
It should be noted that one of the largest European steel mills, whose production site has been classified by the Italian Ministry of the Environment as causing high environmental pollution, operates in the territories of Taranto in Apulia. Similarly, a high-polluting petrochemical plant was located in Gela (south-eastern Sicily) from 1963 to 2014. In the appendix, Figure 4 shows the map of the distribution of municipalities with industrial facilities registered as polluters in the European

register E-PRTR. All facilities are required to declare emissions above designated thresholds, and the data are used to create an inventory of geo-located facilities in Europe that have an environmental impact.

Even though the areas with a high risk of mortality tend to coincide with the location of high polluting industrial plants, without cause-of-death data at the municipal level (not publicly available), establishing a link between environmental pollution and high mortality is not feasible.

Figure 3 – *SMRs and PRPS women. Italy, 2012–2016.*

A - *SMRs* B -*PRPS*



Turning our attention to the relationship between territorial socio-economic differences and mortality disparities, Table 1 reflects the distribution of mortality RRs adjusted by the unemployment index for all Italian municipalities. For both sexes there is high mortality risk in municipalities with a higher level of unemployment (the first quintile of ur is used as reference category), although the results are more pronounced in women: RR = 1.11, 95% CI = (1.09–1.12) in women vs RR = 1.05, 95% CI = (1.04–1.07) in men. Note that these results take into account the presence of spatial auto-correlation and municipal heterogeneity.

Table 1 - *RRs adjusted by unemployment index category and gender.*

Unemployment level	Men		Women	
	RR	CI 95%	RR	CI 95%
1	1.00		1.00	
2	0.98	0.97-0.99	1.00	0.99-1.01
3	**1.01**	1.00-1.02	**1.02**	1.01-1.03
4	**1.02**	1.01-1.03	**1.05**	1.04-1.06
5	**1.05**	1.04-1.07	**1.11**	1.09-1.12

Reference level: Level 1 of unemployment index. Bold: Statistically significant result

This result may seem surprising, as the vast majority of epidemiological studies in the literature report that the effect of unemployment on overall mortality tends to be higher for men than for women (e.g., Clemens et al. 2015). Laliotis and Stavropoulou (2018) argue that the effect of unemployment may vary among different population groups, depending on the degree of their vulnerability to a general worsening of economic conditions. Because our data refer to a period of severe economic crisis in Italy, it could be hypothesized that Italian women were more severely hit by the great recession than men. In a pooled cross-section time series analysis involving European countries and focusing on the relationship between mortality from heart disease/stroke and unemployment, Brenner (2016) finds that the effect of rising unemployment is stronger for women than for men.

In addition, Brenner (2016) finds that the effect of unemployment on male mortality is mainly exerted on those of working age, while women are hit both earlier and later in life by periods of economic hardship; they tend to suffer the negative consequences of such events despite being out of the work force. He proposes a possible explanation based on the psychological stress suffered by the whole family when one member is hit by an episode of job loss (see also the review by Mucci et al. 2016). A period of prolonged stress may result in increased blood pressure with associated increase of mortality from cardiovascular diseases and/or the accompanying unhealthy behaviours, such as increased alcohol consumption or smoking (Brenner 1987), or in extreme cases, suicide (Blakely et al. 2003). In line with this view, Marcus (2013), using data from Germany, shows that unemployment episodes reduce the psychological well-being of spouses almost as much as the direct effect on the individual experiencing the episode. Following Brenner (2016), the mechanism of psychological stress should be even stronger in countries like Italy and Greece, where traditional gender roles remain strong, and women are expected to provide the emotional support for the family.

5. Conclusions

Italy is recognized as having wide differences in the level of structural unemployment, but it should be mentioned that, even though the initial macro-economic conditions were already very disparate across the country, the 2008 economic recession was particularly harsh throughout the entire country. This dramatic event afforded an occasion to moderate a possible problem of selection into employment status by health status. To our knowledge, this is indeed the first study in Italy to analyse the relationship between the spatial distribution of mortality and unemployment at the municipal level by means of a hierarchical spatial model. Not surprisingly, we find that the municipalities characterized by the highest unemployment rate are also more likely to be at high risk of mortality. This result suggests that, when elaborating social indicators to evaluate the impact of unemployment on the well-being of a community, one should take into account also its side effects on mortality.

A more surprising result is that associated with gender. In particular, we find that the effect seems to be stronger for women than for men. Similar findings were obtained in Greece, suggesting that strongly diversified gender roles existing in the two countries may exacerbate the effect of psychological stress on mortality, as previously described in Brenner's (2016) findings.

A note of caution is advisable in interpreting our results. While we can define the geographic distribution of mortality thanks to the cross-sectional design of the study, the ecological fallacy must be considered. However, as argued by Clayton et al. (1993), the use of hierarchical spatial models with explanatory variables at the municipal level reduces the risk of incurring such problems.

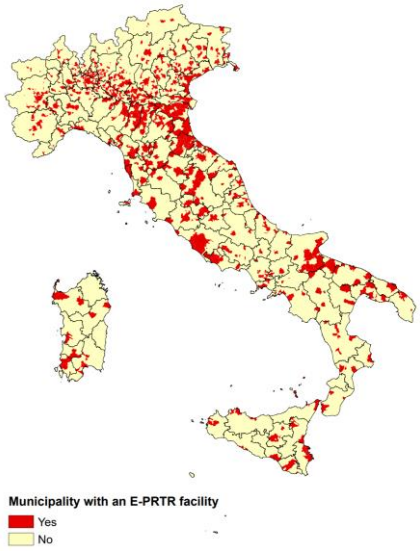
Further, we are unable to explain exactly why the risk is higher in particular areas, nor the relation between mortality and the risk factor being studied. For instance, the geographical pattern in mortality observed in Campania, Sicily, and Apulia may be due to the higher level of unemployment, to environmental factors, or to a combination of the two. It can be argued that the high polluting industrial plants in Southern Italy are not located there by accident. Indeed, the Italian industrial plan elaborated in the sixties decade of the 20th century (Felice and Lepore 2017) tried to cope with the problem of large disparities across regional economies by favouring the location of heavy industries in the south. The strategy elaborated to mitigate both the high level of structural unemployment and the well-known process of mass migration from southern to northern Italy seems to have failed in both aims in the long-run. Indeed, according to Istat (2018), the migratory balance in all the southern regions has been consistently negative in the last 20 years, and the migratory flows from south to north acquired particular strength in the years of the crisis. In addition, the failure in solving the problem of divergence in the unemployment level, the

deterioration of environmental conditions of a large part of southern Italy may have created a particularly fragile socio-ecosystem and caused unexpected disparities in mortality. The use of the conditional tense is a must, given that further research is needed to clarify whether a causal relation exists. Despite this, we believe that the Italian case represents an interesting one that offers a better understanding of the policies for improving the conditions of developing countries.

Finally, another possible limitation lies in the joint analysis of all causes of death, rather than a separate analysis by cause, which proved impossible due to lack of data. A future extension of this work is to widen the time period under analysis to gain an idea of the evolution of the geographical patterns of mortality from the 1960s (when industrialization started in the South) to the present.

Appendix

Figure 4 - *Municipalities with a facility registered in E-PRTR.*



Acknowledgments

This work was supported by the LONGPOP (Methodologies and Data Mining Techniques for the Analysis of Big Data Based on Longitudinal Population and Epidemiological Registers) project, which received funding from the European

Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie grant 676060.

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SUMMARY

Geographical variations in mortality and unemployment in Italy

This work aims to offer a spatial analysis of municipal mortality for the whole of Italy in the period 2012-2016 and to assess whether the very large geographical differences in unemployment levels may be of help in explaining mortality differentials across the country. We find that the municipalities characterized by the highest unemployment rate, are also more likely to be at high risk of mortality. The effect seems to be stronger for women than for men. We suggest that when elaborating social indicators for evaluating the impact of unemployment on the well-being of a community, also its side effects on mortality should be taken into account.

Vanessa SANTOS SANCHEZ, Dipartimento di Scienze Economiche e Aziendali, Università di Sassari, vanesasantossanchez@gmail.com

Gabriele RUIU, Dipartimento di Scienze Economiche e Aziendali, Università di Sassari, gruiu@uniss.it

Lucia POZZI, Dipartimento di Scienze Economiche e Aziendali, Università di Sassari, lpozzi@uniss.it

Marco BRESCHI, Dipartimento di Scienze Economiche e Aziendali, Università di Sassari, breschi@uniss.it

Giovanna GONANO, Dipartimento di Scienze Economiche e Aziendali, Università di Sassari, mggonano@uniss.it.