Investigating Disparities in Cause-Specific Mortality Based on Education in Italy

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Introduction

Reducing socio-economic inequalities in mortality is a significant global public health challenge (Beenackers et al., 2016). Disparities in mortality based on socio-economic status (SES) have long been evident and were worsened by the economic crisis and COVID-19 pandemic (Bambra et al., 2020), particularly in Italy. Addressing socio-economic disparities is crucial to promote social justice, increase labour productivity and reduce health care costs, especially for disadvantaged groups (Bambra et al., 2020; Marmot 2006).

Educational attainment is a reliable and accessible proxy for SES in health research, as it is strongly correlated with employment, income, and access to health care. In particular, lower educational levels are associated with higher unemployment, poor health literacy, and a greater prevalence of risk factors like smoking and obesity, all of which contribute to worse health and higher mortality rates (Rogers et al., 2010).

Studies on cause-specific mortality reveal that inequalities are particularly high for cardiovascular and respiratory diseases, as well as external causes linked to riskier jobs more common among the less educated (Marí-Dell'Olmo et al., 2015; Rogers et al., 2010). Lung and cervical cancers show greater disparities, while breast cancer exhibits fewer disparities, probably due to better healthcare in high-income countries. Regional differences exist, with fewer inequalities in Southern than in Northern and Eastern Europe (Iammarino et al., 2019). In Italy, men face higher mortality disparities from cancer, AIDS/HIV, liver disease, and respiratory issues, while women see greater inequalities in deaths from diabetes, AIDS/HIV, liver disease, and genitourinary diseases (Alicandro et al., 2018). Despite these recognized inequalities, few studies have explored regional differences in Italy, a gap that is significant given that health policies are managed regionally and can influence healthcare access. To address this, the Italian National Institute of Statistics (ISTAT) launched the Mortality Inequality Database 2019–2020, integrating data on deaths and education to provide detailed insights on mortality by education, age, sex, cause of death, and region (ISTAT, 2024). ISTAT will soon release data for the year 2021, offering more up-to-date insights into regional mortality inequalities.

This study aims to measure all-cause and cause-specific mortality inequalities across Italian regions, testing the hypotheses that disparities vary by cause of death and are shaped by regional differences in healthcare access. The findings will help inform targeted public health strategies aimed at reducing socio-economic inequalities.

Data and Method

Data and Measurements

We used the Mortality Inequality Database 2019–2020 (ISTAT, 2024). The database combines two key national sources: the National Register of Causes of Death, covering all deaths in 2019 and 2020, and the National Base Register, which includes demographic data, including place of residence and

education level. The linkage between these datasets was highly successful, with a performance rate of 98.5%, ensuring the reliability of the data (ISTAT, 2024).

We focused on the Age-Standardized Mortality Rates (ASMR) by sex, age group (30–69, 70–84, 85+), and cause of death. We used education as a proxy for socio-economic status and four levels of education were considered: none or primary, lower secondary, upper secondary, and post-secondary or higher. The analysis focused on 18 major causes of death, including sepsis, cancers (stomach, colon, lung, breast), diabetes mellitus, metabolic disorders, nervous system diseases, dementia and Alzheimer's, ischemic heart disease, cerebrovascular diseases, hypertensive diseases, influenza and pneumonia, chronic lower respiratory diseases, cirrhosis and fibrosis, symptoms and abnormal findings, external causes (accidents, injuries), and COVID-19. These causes were selected for their prevalence and documented links to socioeconomic factors, providing a broad overview of how education and mortality are related across various health conditions.

Statistical Analysis

First, we estimated the Age-Standardized Mortality Rate Ratios (ASMRR), defined as the ratio between ASMR of each education level (*j*) and the ASMR of the reference group (highest education level) by sex, age group, cause of death, and region. Second, we employed quantile regression models to analyse disparities in mortality in the Italian regions. The model is defined as:

$$Q_{Y_{ij}}(\tau) = \beta_0 + \sum_{i=1}^{22} \beta_{R_i}(\tau) R_i + \sum_{j=j}^{3} \beta_{E_k}(\tau) E_j + \epsilon_{ij}(\tau)$$

where:

- Y_{ij} = $log(ASMRR)$ for region *i* and educational level *j*
- $Q_{Y_{ij}}$ = τ-*th* quantile of $log(ASMRR)$
- β_0 = Intercept
- R_i = Dummy variables for region *i* (*i* = 1, 2, …, 21) (reference: *Italy*)
- E_j = Dummy variables for educational level *j* (*j* = 1 [*low*], 2 [*mid-low*], 3 [*mid-high*]) (reference: 4 [*high*])
- τ = Quantile of interest (i.e., median = *0.5*)

Separate models were estimated by sex, age group, and cause of death to account for the specific effects of each variable. Quantile regression provides advantages in analyzing mortality disparities across educational levels. It allows for a comprehensive comparison between the lowest and highest education levels while considering the intermediate levels, capturing the full range of socioeconomic inequalities. The method also offers reliable estimates, even in regions with missing educational data, ensuring robust and complete analysis. By reducing the influence of outliers, it offers a clearer insight into mortality patterns, identifying regions and groups with significant disparities.

Preliminary results

The study of mortality disparities in Italy reveals a complex interplay of education, age, sex, and region. Mortality rates are higher in the South compared to the North, with the most pronounced differences observed among individuals aged 30–69. Disparities become less significant as age increases. Males aged 30–69 most commonly die from lung cancer across most regions, although in some areas, external causes and ischemic heart disease are more prevalent. For older males, ischemic heart disease becomes the leading cause of death, particularly after age 85. Among females aged 30–69, breast cancer is the predominant cause, except in Lazio and Trento where lung cancer is more

common. As women age, cerebrovascular and ischemic heart diseases become more significant, with dementia and Alzheimer's also emerging as leading causes in some regions.

The analysis reveals striking educational disparities in mortality. Across the Italian regions, individuals with lower education levels face mortality rates 1.5 to more than 3 times higher than those with higher education, with males experiencing more pronounced overall inequalities in most of the regions (see Figure 1). Although the gap narrows with age, it remains substantial.

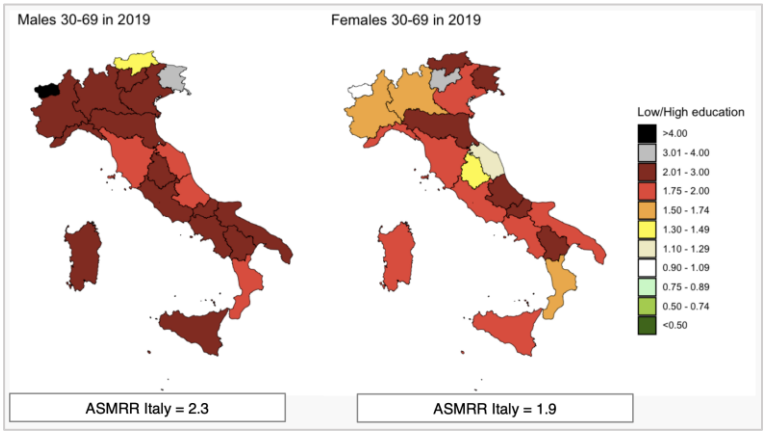

Figure 1. Age-Standardized Total Mortality Rate Ratio (ASMRR) at age group 30-69, by sex and region.

Interestingly, chronic lower respiratory diseases exhibit the largest educational disparities (ASMRR ~ 5.0, among younger females and males). In addition, inequalities in diabetes mortality are higher among females (ASMRR = 5.4) than males (ASMRR = 3.7). These disparities persist into older age, especially for diabetes, with significant inequalities in dementia and Alzheimer's mortality in females (ASMRR ~ 2.0). The COVID-19 pandemic has further exacerbated these existing inequalities, particularly in Northern regions where the virus spread more aggressively. Between 2019 and 2020, educational disparities in mortality increased, with significant rises in the ASMRRs for both males and females at all ages, especially aged 85+ (25% and 17% increases in inequality in males and females, respectively). COVID-19 mortality also showed greater inequalities among females compared to males, especially at younger ages (3.1 in females and 1.9 in males). While male lung cancer mortality followed expected patterns with higher mortality rates among the less educated, an inverse trend emerged for older females. As displayed in Figure 2, at the 70-84, female ASMRRs in many Italian regions are below one. This pattern persisted in the oldest age group. Finally, breast cancer mortality exhibited minimal educational inequalities at younger ages but higher rates among higher-educated females at older ages (see Figure 3).

Conclusions

COVID-19 has exacerbated mortality inequalities, with the less educated experiencing a greater increase in mortality than the more educated. Geographically, inequalities are most pronounced in Northern regions and the disadvantaged South, highlighting the need for targeted regional strategies to address health inequalities. The association between education and mortality varies by cause of death, sex, and age, highlighting the complexity of these inequalities and the need for tailored public health interventions to enhance health care access and outcomes across Italy. In conclusion, the implementation of policies that support education is crucial for promoting health equity and protecting the most vulnerable.

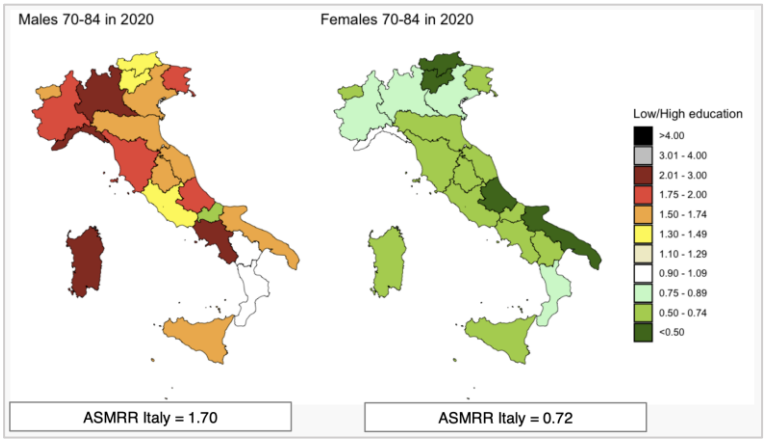

Figure 2. Age-Standardized Mortality Rate Ratio (ASMRR) for lung cancer, at age group 70-84, by sex and region.

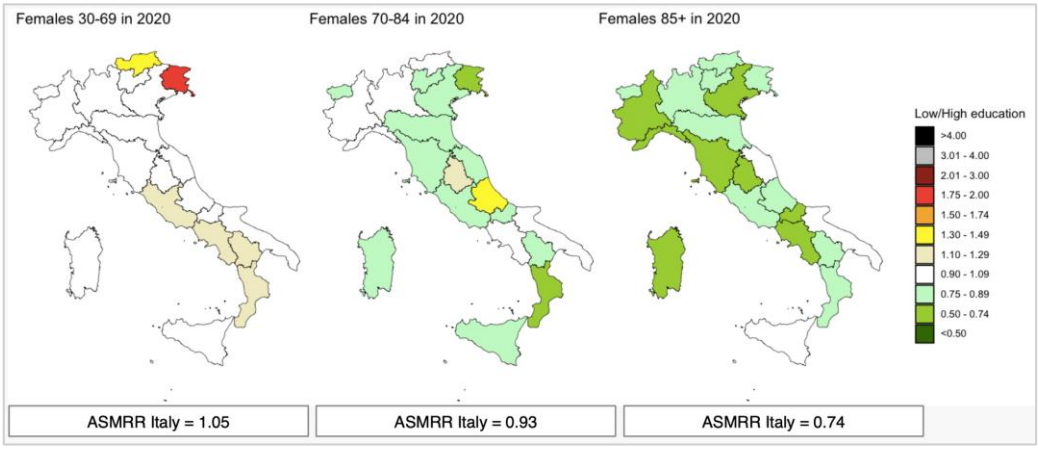

Figure 3. Age-Standardized Mortality Rate Ratio (ASMRR) for female breast cancer, by age and region.

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