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Regional variations in Italy's COVID-19 death toll: a descriptive analysis of excess mortality and associated factors from 2020 to 2021

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Abstract

Background Italy implemented various measures, including lockdowns and a mass vaccination campaign, to address the COVID-19 pandemic. This study aims to describe the temporal and regional differences in mortality trends between March 2020 and December 2021, along with associated socioeconomic, policy, and behavioral factors.

Methods We used National Ministry of Health data on COVID-19 mortality, excess mortality (EM), and vaccine uptake, along with data from the Italian arm of a European survey of preventive behaviors and attitudes, such as trust in institutions. The analysis was conducted across four macro regions and five study periods. Avertable mortality was calculated as observed EM minus the lowest EM at the macro-regional level for each study period.

Results In 2020–21, the estimated total EM was 180,169 deaths, with 76.4% officially attributed to COVID-19. This proportion ranged from 13.5% in the South and Islands (June–October 2020) to 140.0% in the Northeast (March–July 2021). Excess and avertable mortality peaked in the North during the first two periods (March 2020 – February 2021) and in the South and Islands thereafter (March–December 2021). Survey data revealed reduced adherence to stay-at-home orders in the North and lower trust in hospitals and reduced vaccine uptake, especially among the elderly, in the South and Islands. After the initial period, 33,587 deaths (18.6%) could have been averted if each macro-region had matched the lowest rates observed in that period. An estimated 40.7% of avertable deaths occurred in Southern and Insular Italy, which constitutes 33.7% of the national population.

Conclusions Due to differential misreporting, EM estimates offer a more accurate view of regional and temporal patterns in COVID-19 mortality than official rates. The higher EM in northern Italy during the first year of the pandemic might be linked to lesser adherence to control policies, possibly associated with higher private-sector employment. The higher EM in the South and Islands post-March 2021, contributing to 40.7% of avertable EM, could be partly explained by the lower vaccination rates in the population aged 80 and older, who experienced the highest age-specific mortality rates and lower trust in the healthcare system in this macro-region.

Keywords Excess mortality, Italy, Vaccine uptake, Non-pharmaceutical measures, Pandemic management, COVID-19

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Background

Italy was among the first countries to face the global COVID-19 pandemic and ranks among those with the highest cumulative reported mortality from COVID-19 [1]. Focusing on the national total, however, may conceal the impact of interventions such as lockdowns and mass vaccination campaigns that took place at different times. In previous work we observed fluctuating reported COVID-19 mortality rates throughout 2020 and 2021, reflecting both the global emergence of new variants and behavioral measures in Italy [2, 3]. Furthermore, the impact of the pandemic was not uniform throughout the country. At the outset, the northern regions of the country were the hardest hit, but over the following two years, other parts of the country experienced higher mortality rates than those in the north at times.

This study aims to describe the temporal and regional differences in mortality trends between March 2020 and December 2021, along with associated socioeconomic, policy, and behavioral factors. Recognizing the challenge of establishing cause-and-effect relationships in observational studies, especially when many factors are simultaneously at play, we chose to conduct a descriptive analysis of the extent to which Italy's regions experienced the pandemic over time, in relationship to regional differences in socioeconomic, policy, and behavioral factors. Our intention is to identify insights that can inform effective public health policies and approaches for managing future outbreaks, contributing towards achieving higher health standards across the entire nation.

Regional variation in COVID-19 outcomes partly reflects differences in the underlying health status of the population at risk, mirroring demographic and socioeconomic differentials, as well as the availability of quality healthcare. These factors reflect pre-pandemic patterns that did not change markedly in 2020 and 2021. Other factors, instead, changed throughout the pandemic years at a different pace across regions. This may include the prevalence of susceptible individuals in areas that experienced high mortality rates early in the pandemic. Shifting regional differences in mortality during the pandemic may also reflect unequal implementation and adherence to control policies, adoption of preventive behaviors, and vaccine uptake [2–4]. These, in turn, may be influenced by differences in trust in the healthcare system and public institutions. Consequently, the primary goal of this analysis was to describe the patterns of mortality, along with social-behavioral correlates, across four statistical macro-regions of Italy from March 2020 through December 2021.

While many studies have examined the effects of the pandemic in Italy [2, 3], this analysis is innovative in three ways. First, we use "excess mortality" (EM) estimates rather than official death counts [4, 5]. Consistent with findings in the United States [6] and elsewhere [7, 8], official counts tend to be lower than EM estimates, and the ratio of the two varies across regions and over time. Second, we present the results at a temporal and geographic scale with sufficient but not excessive detail (e.g. in four macro-regions) to visualize major trends and differentials in EM rates, along with possible explanatory factors. Third, we present the results in terms of absolute numbers of "avertable" deaths, rather than relative rates, to emphasize the magnitude of regional differences and the potential impact of more effective control strategies. It is not possible to know how many deaths could have been avoided with different policy or health system responses, and our goal is not to identify the impact of particular responses. Rather, these deaths are "avertable" in the sense that the rates are higher than the lowest rate in any macro-region the same time period. This assumes that the lowest rate in each macro-region and time period was achievable in the other macro-regions.

Methods

Macro-areas and time periods

For statistical purposes, Italy is subdivided into five first-level NUTS (Nomenclature of Territorial Units for Statistics) macro-regions: Northwest, Northeast, Center, South, and Islands. These are composites of the 21 regions and autonomous provinces that form the highest level of Italy's political administration, each with its own regional health system. The regions exhibit diverse geographic, demographic, and socioeconomic characteristics [9, 10], which may have contributed to disparities in health outcomes during the pandemic. Variations in healthcare infrastructure, resources, and access may have also played a significant role in shaping the regional response to the COVID-19 pandemic. As shown in Supplementary Fig. 1, Southern and Insular Italy were combined into a single macro-region to maintain consistency with survey data that were tabulated in this way.

We aggregated the data described in the next paragraphs into five time periods chosen to reflect broad changes in the evolution of the pandemic and national control strategies. The initial Italian cases were identified, and a state of emergency declared in some areas, in February 2020. However, deaths occur weeks after diagnosis and weekly excess mortality estimates did not become positive until March 2020. Thus, we used the following study periods for this analysis:

- Period 1 (March 2 – June 21, 2020): the initial wave;
- Period 2 (June 22 – November 1, 2020): a quiescent period before the second wave;
- Period 3 (November 2, 2020 – February 29, 2021): the second wave, characterized by the Alpha variant and regional-level control strategies;

- Period 4 (March 1 – August 1, 2021): vaccine campaign roll-out, using different approaches by region;
- Period 5 (August 2 – December 26, 2021): Green Pass implemented nationally.

Data sources

The primary data for this analysis were the weekly estimates of total (all-ages) mortality per 100,000 population published by the Italian National Institute of Statistics (ISTAT) from March 2020 to December 2021 (see Supplementary Fig. 2) [11]. We also used ISTAT regional population data to translate rates to numbers of deaths.

As illustrated in Supplementary Fig. 3, following ISTAT methodology, EM estimates for each macro-region were derived as the difference between observed and expected mortality rates on a weekly basis, using the annual average calculated over the pre-pandemic period 2015–2019 as the counterfactual to quantify expected deaths [12]. EM for each time period was calculated by summing the weekly estimates provided by ISTAT. The gray lines represent the rates for each individual year in the pre-pandemic period, demonstrating that the rates during the pandemic were far in excess of normal year-to-year variation. Supplementary Fig. 3 also suggests that there are no substantial temporal trends in mortality over this period.

The EM approach, used by the World Health Organization [13], the Institute for Health Metrics and Evaluation [14], and many countries [15–20], has been widely employed to assess the global impact of COVID-19. This approach is favored for its accuracy in measuring the pandemic's impact, transcending differences in testing, reporting, and cause-of-death attribution [5]. The reason is that reported cases, hospitalizations, and deaths are prone to substantial misreporting, influenced by factors such as hospital resources [21, 22], patient and physician awareness and concern, as well as test availability and use [23, 24]. All these factors varied markedly during the pandemic and throughout Italy. In this context, EM estimates more accurately reflect the impact of differential implementation and adherence to control policies, adoption of preventive behaviors, and vaccine uptake.

We obtained the daily confirmed COVID-19 death toll from the Italian Civil Protection Department [12]. COVID-19 deaths were then aggregated by macro-region and time period, and divided by EM for comparative analysis. We also obtained data on COVID-19 vaccine coverage from the Italian Council of Ministers' Presidency [25] stratified by age group. Supplementary Figs. 4 and 5 show these data on a weekly basis for each macro-region.

Statistical analyses

We calculated avertable mortality by assuming that the lowest EM rate observed in any macro-region during each period could have been achieved by all macro-regions. In practice, this was achieved by subtracting EM estimates, using the lowest rate recorded at the macro-region level as the benchmark for each time period. We assume that no deaths were avertable in the first period up to June 2020, before much was known about treating or preventing COVID-19. Given the markedly higher age-specific mortality rates for older individuals, all calculations were repeated for individuals under 80 years versus those aged 80 years or older.

Survey of preventive behaviors and attitudes

As an indicator of regional differences in preventive behaviors and attitudes, such as trust in institutions, we used data collected within the framework of the Italian arm of the WHO Regional Office for Europe study [26]. This web-based survey, conducted in five waves, involved a sample of Italian citizens aged 18–70 years. The sample was stratified by gender, age, geographical area, education, employment, and other factors. At the end of each wave, the data were weighted by the same factors to restore the proportionality of the sample to the most recent ISTAT data for reference population. For our analysis, we focused solely on data from the first four waves, which corresponded to our study period. We combined data from Waves 1 and 2 (January/February 2021), a sample of size 5,006, to match study Period 3, when control strategies were in place at the regional level. Similarly, we combined data from Waves 3 and 4 (April/May 2021), a sample of size 5,007, to match Period 4, during which the vaccine campaign was being rolled out.

Each survey item used a 7-point response scale, ranging from "never" (coded 1) to "very often" (coded 7). We dichotomized the responses, reporting the proportion who answered 6 or 7. For example, one question asked whether respondents stayed home from work or school, and we calculated the proportion who responded "often" or "very often." To identify differences among the four macro-regions, we calculated 95% confidence intervals for each proportion and identified instances where the national proportion fell outside these intervals. Since we were not formally testing hypotheses, we did not use survey weights or adjust for multiple comparisons.

Results

In the first two years of the pandemic, Italy experienced 180,169 more deaths than expected based on historical levels. The official count of COVID-19-related deaths during this period was 137,649, accounting for 76.4% of the estimated EM. This proportion varied over the two years and across macro-regions. As shown in

Supplementary Table 1, the reported COVID-19 deaths as a proportion of EM ranged from 99.5% in Period 4 (March to July 2021) to 28.4% in Period 2 (June to October 2020). Over the two-year period, the proportion was highest in the Northeast (92.0%) and lowest in the South and Islands (61.9%). Considering both macro-region and period, the fraction ranged from 13.5% in the South and Islands in June–October 2020 to 140.0% in the Northeast in March–July 2021.

Differences in excess mortality across macro-regions and over time

Figure 1, Panel A, illustrates how EM rates per 100,000 population (expressed per day for comparative purposes) varied throughout the study period. The first period (March–June 2020) was characterized by exceptionally high rates in the Northwest (2.03 per 100,000), followed by the Northeast (0.73 per 100,000) and substantially lower rates in the rest of the country (Center: 0.18 per 100,000; South and Islands: 0.12 per 100,000). Rates were

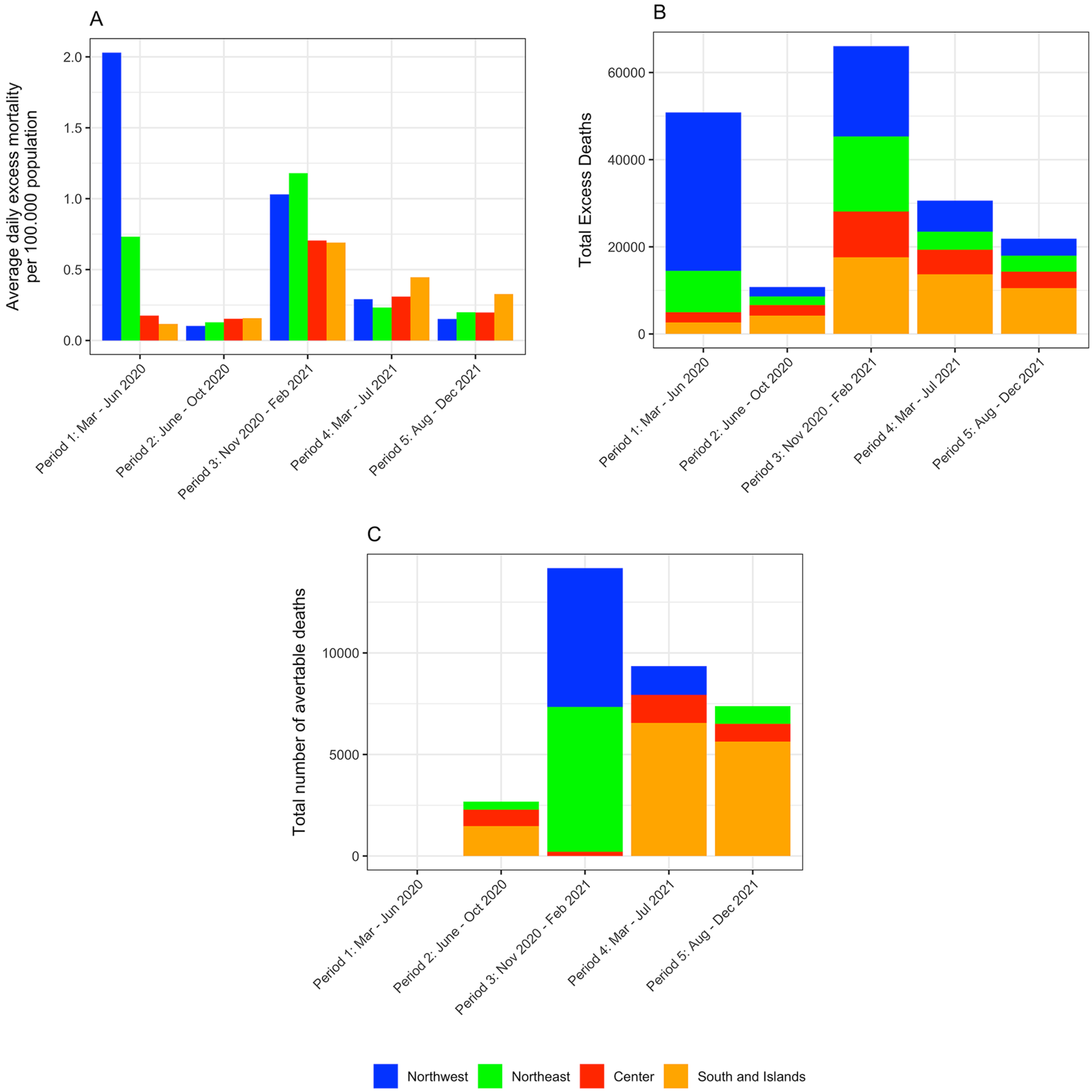

Fig. 1 Excess and avertable mortality by macro-region and time-period, Italy, March 2020 – December 2021. Panel **A**: Daily excess mortality per 100,000 population per day. Panel **B**: Excess mortality (counts). Panel **C**: Avertable excess mortality (counts). The minimum EM rate for calculating avertable mortality in each period was as follows: Period 2 – Northwest, Period 3 – South and Islands, Period 4 – Northeast, Period 5 – Northeast

low in the second period (from 0.10 per 100,000 in the Northwest to 0.16 per 100,000 in the South and Islands) but rose uniformly across Italy during the global Alpha wave (November 2020 – February 2021) from 0.69 per 100,000 in the South and Islands to 1.18 per 100,000 in the Northeast. EM rates dropped after March 2021 but remained relatively high in the South and Islands (Period 4: 0.45 per 100,000; Period 5: 0.33 per 100,000).

In absolute terms, the Northwest experienced 70,265 excess deaths between March 2020 and December 2021, constituting 39.0% of total EM for a macro-region with 26.8% of the national population. In contrast, the South and Islands, which account for 33.7% of Italy's population, experienced 48,673 excess deaths, constituting 27.0% of EM. The Northeast, which makes up 19.6% of Italy's population, experienced 36,613 excess deaths (20.3% of EM), while the Center, which accounts for 19.9% of Italy's population, experienced 24,618 excess deaths (13.7% of EM).

As shown in Fig. 1, Panel B, more than a quarter of all excess deaths (50,831, 28.2%) occurred during the first period (March–June 2020), with a disproportion impact in the Northwest (51.7%) compared to the other macro-regions (Northeast: 26.1%; Center: 6.4%; South and Islands: 5.4%). However, the greatest number of deaths (66,061, 36.7%) occurred in the third period from November 2020 to February 2021. These deaths were more evenly distributed by macro-region. Throughout the study period, the proportion of deaths occurring in the South and Islands grew from 5.2% in Period 1 to 48.1% in Period 5. A relative increase was also observed for deaths in Central Italy (from 4.6% in Period 1 to 17.1% in Period 5), while the Northwest and Northeast experienced a decline, especially the Northwest (from 71.5% in Period 1 to 17.8% in Period 5).

Because EM rates varied so markedly, we calculated how many deaths could have been averted if each macro-region had the same rates as the best-performing macro-region for each time period. Subsequently, we counted as "avertable" the difference between the actual rates and the lowest macro-regional rate in each period—Northwest for Period 2, South and Islands for Period 3, Northeast for Period 4, and Northwest for Period 5. This estimate resulted in a total of 33,587 avertable deaths, of which 2,684 (8.0%) occurred in June–October 2020, 14,173 (42.2%) in November 2020 – February 2021, (27.8%) 9,350 in March–July 2021, and 7,380 (22.0%) in August–December 2021. This means that half of the avertable deaths occurred after March 2021, when the national vaccine campaign was in full operation. As displayed in Fig. 1, Panel C, the largest number of avertable deaths was observed in Southern and Insular Italy (13,658, 40.7%), followed by Northeastern Italy (8,415, 25.1%), Northwestern Italy (8,249, 24.6%), and Central Italy (3,265, 9.7%).

Excess mortality by age group

Out of the 180,169 excess deaths that occurred during the study period, 47,904 (26.6%) were individuals aged <80 years, while 132,265 (73.4%) were individuals aged ≥80 years. The proportion of EM affecting the older population was similar in the Northwest (52,409 out of 70,265 deaths, 74.6%), Northeast (28,939 out of 36,613, 79.0%) and Center (19,368 out of 24,618, 78.7%), but remarkably lower in the South and Islands (31,549 out of 48,673, 64.8%). As shown in Fig. 2, Panel C, this translates into Southern and Insular Italy having the highest number of avertable deaths at <80 years among all macro-regions (Period 2: 644; Period 3: 1,904; Period 4: 3,550; Period 5: 2,866).

Preventive behaviors and attitudes

As seen in Table 1, panel A, most items in the WHO EURO survey did not display strong regional differences. There were, however, some exceptions. The South and Islands and Central Italy had higher adherence to some preventive measures such as avoiding touching eyes, nose and mouth with unwashed hands, and disinfecting surfaces. In terms of what are now recognized as the most effective preventive measures, respondents in the South and Islands were more likely to report having avoided a social event in Waves 1 and 2, corresponding to study Period 3 (72% in the South and Islands vs. 66% in the Northwest). Additionally, respondents in the South and Islands were more likely to have stayed home from work or school (57% in Waves 1 and 2 and 53% in Waves 3 and 4, matching study Period 4). The corresponding proportions were 36% and 39%, respectively, in the Northeast and 42% and 43% in the Northwest.

There were fewer consistent patterns in the trust items. However, in both survey waves participants in the Northeast and Northwest reported significantly higher trust in hospitals, with 38% and 34%, respectively, in Waves 1 and 2, and 37% and 34%, respectively, in Waves 3 and 4 reporting trusting hospitals "a lot" or "very much". The corresponding proportions in the South and Islands were 24% in both waves. Respondents in the Northeast and Northwest also exhibited higher levels of trust in their own general practitioner, although the regional differences were less substantial.

Vaccination coverage

As shown in Supplementary Fig. 5, the vaccine roll-out was very similar in the four macro-regions. This is true despite marked differences in approach taken at the regional level. Campania and Lombardy, the two largest regions of Italy—one in the South and the other in the Northwest—adopted a centralized approach focused on vaccination centers set up in hospitals. Other regions such as Apulia (South) [27] and Liguria (Northwest)

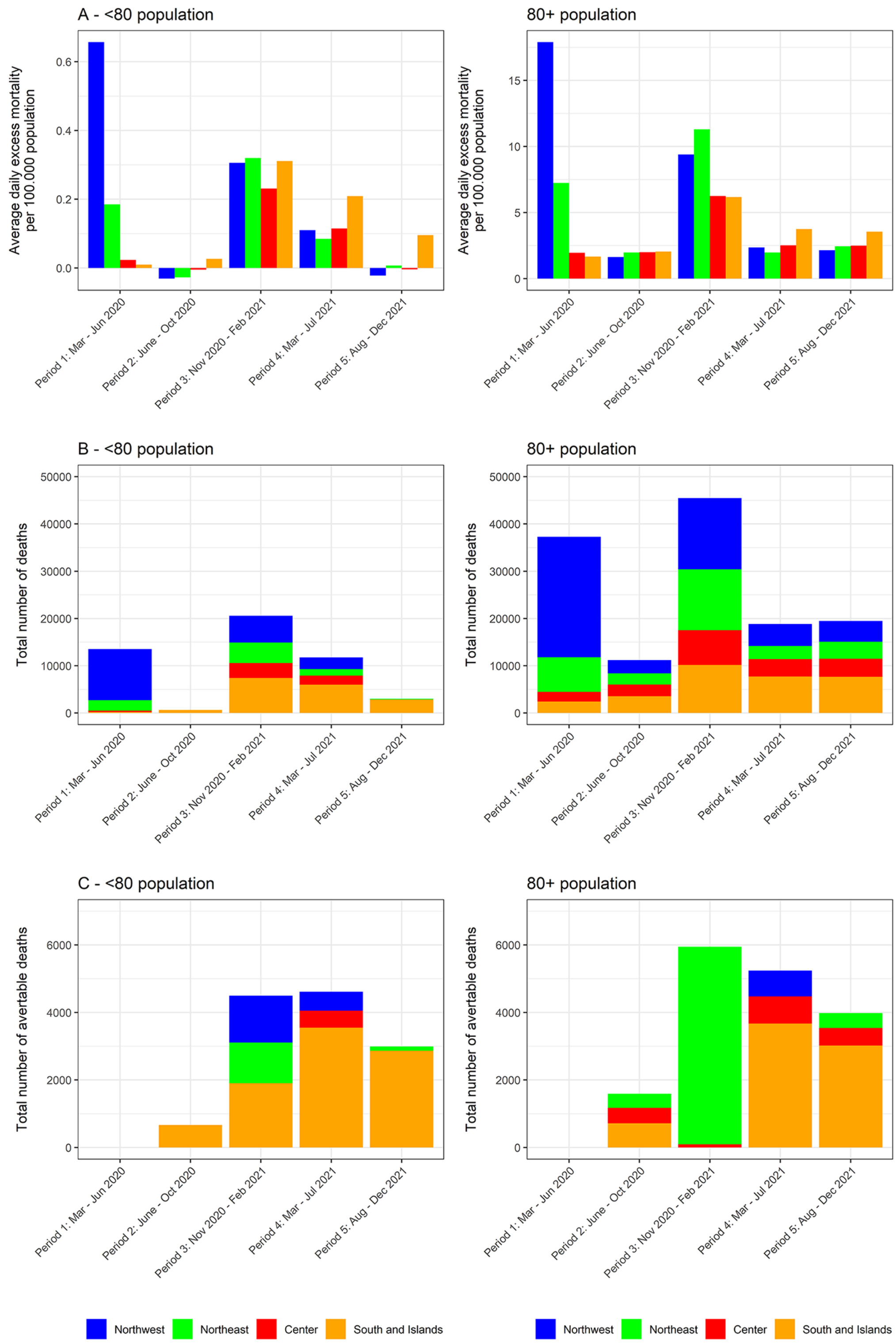

Fig. 2 Excess and avertable mortality by macro-region, time-period and age group, Italy, March 2020 – December 2021. Panel **A**: Excess mortality per 100,000 population per day. Panel **B**: Excess mortality (counts). Panel **C**: Avertable excess mortality (counts). Note that the vertical axes in Panel **A** have different ranges for the <80 and ≥80 populations. The minimum EM rate for calculating avertable mortality in each period were the same as in Fig. 1

Table 1 WHO EURO survey results by wave and macro-region

	Waves 1 & 2 (January/February 2021)					Waves 3 & 4 (April/May 2021)				
	Italy (n=5006)	NTW (n=1340)	NTE (n=964)	CTR (n=966)	SIL (n=1736)	Italy (n=5007)	NTW (n=1353)	NTE (n=982)	CTR (n=954)	SIL (n=1718)
A. Preventive actions adopted "often" or "very often"										
Washed my hands with soap and water for at least 20 s	71%	70%	69%	71%	72%	69%	69%	68%	69%	70%
Avoided touching my eyes, nose and mouth with unwashed hands	59%	57%	56%	58%	63%	59%	57%	57%	61%	61%
Used hand sanitizer when soap and water not available	75%	73%	74%	74%	76%	73%	71%	72%	77%	73%
Avoided a social event I wanted to attend	69%	66%	68%	69%	72%	67%	65%	66%	68%	70%
Used medicines to prevent COVID-19	5%	4%	5%	5%	6%	5%	6%	4%	4%	6%
Wore a mask in public	93%	93%	94%	94%	92%	91%	91%	93%	93%	89%
Complied with physical distancing in public	82%	80%	84%	82%	81%	79%	79%	80%	82%	78%
Disinfected surfaces	53%	48%	51%	51%	58%	53%	51%	51%	54%	57%
Stayed home from work or school	48%	42%	36%	49%	57%	47%	43%	39%	50%	53%
B. Trusting institutions "a lot" or "very much"										
Respondent's general practitioner	33%	34%	37%	33%	31%	31%	32%	33%	31%	29%
Hospitals	31%	34%	38%	34%	24%	31%	34%	37%	33%	24%
The Ministry of Health	28%	27%	27%	30%	29%	24%	23%	24%	24%	26%
Istituto Superiore di Sanità (National Institute of Health)	31%	28%	30%	34%	31%	26%	24%	27%	27%	27%
Schools	11%	12%	12%	11%	11%	11%	10%	13%	9%	12%
Public transport companies	4%	4%	4%	4%	4%	4%	4%	5%	2%	6%
Police	21%	18%	22%	21%	22%	18%	16%	19%	17%	20%
Respondent's employer	44%	48%	41%	40%	43%	44%	44%	45%	46%	43%
Respondent's parish	27%	29%	26%	26%	28%	28%	26%	29%	28%	28%

Notes: Percentages significantly above or below the national average are indicated by green or red text. Hypothesis testing was conducted with the asymptotically normal one-sample proportion test

Abbreviations: NTW, Northwest; NTE, Northeast; CTR, Center; SIL, South and Islands

adopted a decentralized approach, relying more on existing Local Healthcare Authorities [3, 28].

The exception to this pattern is the population 80 years of age or older (Panel D): the proportion vaccinated in the South and Islands fell behind the rest of the country starting in April 2021 (Period 4) and remained substantially lower through January 2022. By the end of 2021, the proportion of individuals aged 80 and older in the South and Islands who were not vaccinated was roughly double that of the rest of the country.

Discussion

The primary goal of this study was to describe the temporal and regional differences in mortality trends between March 2020 and December 2021. We used EM rather than official death counts, hypothesizing that in Italy, as elsewhere, official counts may not only be different from EM estimates, but that their discrepancy may vary among the regions and over time. We found that, in the first two years of the pandemic, Italy had 180,169 more deaths than would have been expected based on historical trends. The official COVID-19 death count during this period was 137,649, accounting for 76.4% of the estimated number. Among these excess deaths, 33,587 (18.6%) could have been averted if each macro-region had matched the rate of the macro-region with the lowest mortality after the first study period.

As we hypothesized, the proportion of official counts over EM estimates varied markedly by macro-region throughout the study period. Over the two years, the proportion was highest in the Northeast (92.0%) and lowest in the South and Islands (61.9%). Considering both macro-region and period, the fraction varied from 140.0% in the Northeast in March–July 2021. The low end of this range, at 13.5% in the South and Islands in June–October 2020, coincided with a period of overall low numbers and challenges in test availability. Thus, these results support our premise that EM provides a more comprehensive understanding of regional and temporal patterns of COVID-19 deaths than reported COVID-19 deaths.

We aimed to present results at both temporal and geographic scales, providing enough detail to visualize major trends and differences in COVID-19 death rates and potential explanatory factors. This approach ensures an adequate balance between detail and comprehensibility in both temporal and geographic dimensions. Similarly, we attempted to present the results in terms of total and avertable deaths to emphasize the magnitude of regional differences and the potential impact of more effective control strategies. Adopting this perspective brought to light a number of patterns that had not been apparent in other studies.

In particular, as is well known, the first period of the pandemic in Italy (March–June, 2020), during which 28.2% of the two-year excess mortality occurred, was concentrated in Northwestern Italy (accounting for 71.5% of deaths in those months), followed by the Northeast (18.8%). It is crucial to note that EM encompasses two distinct components: deaths caused by SARS-CoV-2 infection (which may have been underreported due) as well as deaths attributable to indirect effects of the pandemic, such as denied or delayed medical treatments for other conditions, psychological distress associated with isolation, and unhealthy lifestyle choices during lockdown periods [29].

Our analysis revealed markedly different regional patterns in the subsequent months of 2020 and in 2021. Following a relatively quiescent interval, the Alpha wave (November 2020 – February 2021) marked a significant resurgence in COVID-19 fatalities. This phase accounted for 36.7% of total EM and 42.2% of avertable deaths. Notably, regional disparities in mortality rates were less pronounced, yet the highest incidence was observed in the Northwest and Northeast. In these two macro-regions, an astounding 98.5% of avertable EM was recorded during this period. Prior to the widespread availability of COVID-19 vaccines, Italy's 21 regions and autonomous provinces deployed varying control strategies, based on a region-specific risk assessment [30–31]. The effectiveness of these strategies in mitigating EM remains challenging to quantify, particularly in regions with higher transmission and more stringent restrictions.

While a causal analysis of these data is not appropriate, the data suggest several reasons why the observed higher rates of both excess and avertable mortality in the North during this period. First, the vaccination campaign against COVID-19 was either not yet initiated or in its early stages [3]. Second, the population in the North is older on average, potentially contributing to higher vulnerability. Third, according to the survey, adherence to stay-at-home orders was lower in northern regions: 42% in the Northwest and 36% in the Northeast, compared to 57% in the South and Islands. Additionally, northern regions have a higher prevalence of in-person work and more interconnected internal transport networks, including denser rail and airport networks. These regions are also characterized by specific geographic and environmental factors, as the Po Valley is one of the most polluted areas in Europe due to levels of fine particulates. Also, climatic conditions in these regions tend to be colder, leading to more indoor activities [4]. Collectively, these factors offer a plausible explanation for the increased transmission of the virus in the north.

The introduction of vaccines dramatically changed the pandemic, saving some 1.4 million lives in Europe, mostly individuals above age 60 [32]. Relatedly, nearly half (49.8%) of Italian avertable deaths occurred after March 2021, when the national vaccine campaign was in full operation. The fraction of excess and avertable mortality in the South and Islands rose throughout the study period and became prominent in Periods 4 and 5, starting in March 2021. Out of the 16,730 avertable deaths in these periods, 12,181 (72.8%) occurred in the South and Islands, which make up 33.7% of the national population.

One possible explanation is the lower vaccination rates in the population aged 80 and older, who experienced the highest age-specific mortality rates. This could be associated with lower levels of trust in hospitals and healthcare providers in this macro-region. However, excess and avertable mortality in the South and Islands were also high in the population under age 80. This does not seem to be related to vaccine uptake, since the proportions vaccinated under age 80 did not vary appreciably by macro-region. It is plausible that there was less adherence to population-level restrictions in areas not covered by the survey data, or there might be reporting biases that varied by region.

Another possible explanation relates to regional differences in the quality of and attitudes about healthcare systems. For years, the quality of health care has been consistently lower in southern compared to central and northern regions [33–35]. Indeed, even before the pandemic, southern regions had higher 'avoidable' and 'amenable' mortality rates than the northern regions [36, 37]. Furthermore, residents of southern Italy have less trust in family doctors, and even less in hospitals (possibly linked to the lower perceived quality). This may lead to a 'late' recourse to healthcare facilities: when COVID-19 symptoms occur, patients do not immediately turn to the family doctor or the hospital. Thus, the mix of 'late recourse' to health services and lower quality of regional health systems may - at least to some extent - explain the higher rates of EM in southern regions in periods 4 and 5.

A final possibility is that in periods 1, 2 and 3, healthcare systems throughout Italy had to suspend, or at least greatly slow down, many of their ordinary activities such as elective surgery, prevention campaigns, check-ups, and mental health services. Part of the excess mortality may therefore be attributed not directly to SARS-CoV-2, but to the indirect effects of the pandemic, including care denied or postponed during the emergency. Perhaps the regional health services in the south, which have traditionally been less well equipped and less responsive, have re-organized themselves less effectively than systems in the north, which having greater 'institutional capacities' and organizational resilience.

Limitations

One limitation of this study is its reliance on EM methods, which hinge on estimates of what mortality rates would have been in the absence of the pandemic. Several methods exist to make these estimates, with various degrees of appropriateness [38]. In this analysis, the small differences in weekly total mortality rates in the five years before the pandemic give us confidence that the results are not overly dependent on baseline rate estimates. However, as we go further beyond the baseline period, the reliability of these methods may decline.

Furthermore, over time, the fundamental EM assumption that deaths exceeding previous trends are "caused" by the pandemic becomes more tenuous. For example, the death of someone unable to reach an emergency department while experiencing a heart attack in Milan in March 2020 can reasonably be attributed to the pandemic. In contrast, a suicide in another part of the country two years later might be attributed to despair influenced by the pandemic—and the response to it, — but it is harder to say it was caused by it. Given the known differential under-reporting of COVID-19 deaths in official statistics, we believe that EM estimates are more accurate for our study period. Making this claim in 2022 and subsequent years would become more challenging, though.

As noted in the Introduction, our calculation of "avertable" deaths is based on the imperfect assumption that the lowest rate in any macro-region in each time period was achievable in the other regions. The regions differ in age distribution, socioeconomic status, lifestyle, climatic conditions and organization of the health system, and other ways. Consequently, it is impossible to know whether different policy or health system responses could have achieved the same result in other regions. We might also have chosen the lowest rate in any of Italy's 21 regions and autonomous provinces, or other geographic areas, as the basis for the calculations. This would lead to higher numbers of avertable deaths, but to keep the results conservative we chose to make our calculations based on the four macro-regions.

There are many factors that impact an individual's susceptibility to SARS-CoV-2 infection, such as co-morbidities, but the only one available on a regional basis is age. We considered using three age categories (with breaks at ages 60 and 80 years), but found that patterns in excess mortality rates for individuals of 60–79 years of age were similar to those for younger ages. Consequently, we chose to use two age groupings to simplify the presentation of results without loss of information.

As mentioned in the background, establishing cause-and-effect relationships based on observational study is inherently difficult, and the challenge is amplified when many factors are simultaneously at play, as was the case during the pandemic. Therefore, we conducted a descriptive analysis to illustrate how the regions of Italy experienced the pandemic over time, considering socio-economic, policy, and behavioral differences. We believe that our findings can shed light on the potential impact of public health policies and approaches to managing future outbreaks. A more definitive analysis, however, is still needed.

Conclusions

In the first two years of the pandemic, Italy experienced an estimated 180,169 deaths, with 76.4% officially attributed to COVID-19. After June 2020, we estimate that 33,587 deaths (18.6%) could have been averted if each macro-region had matched the lowest rates observed in that period.

Excess and avertable mortality peaked in the North during March 2020 – February 2021 and in the South and Islands thereafter. The higher EM in northern Italy during the first year of the pandemic might be linked to lesser adherence to control policies, possibly associated with higher private-sector employment.

An estimated 40.7% of avertable deaths occurred in Southern and Insular Italy, which constitutes 33.7% of the national population. The higher EM in the South and Islands post-March 2021 could be partly explained by the lower vaccination rates in the population aged 80 and older, who experienced the highest age-specific mortality rates and lower trust in the healthcare system in this macro-region.

Abbreviations

EM Excess Mortality
ISTAT Italian National Institute of Statistics
WHO World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12963-025-00370-4.

Supplementary Material 1

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Author contributions

F.S., D.G. and M.A.S. conceived of and designed the study, and all authors contributed to data acquisition, analysis, and interpretation of the results. F.S., A.C., J.L. and M.A.S. drafted the manuscript and D.G., M.Z. F.T. and G.D. provided a critical review for important intellectual content. F.S., J.L., and M.A.S. conducted the statistical analysis.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable – analyses are based on publicly-available aggregate data.

Competing interests

The authors declare no competing interests.

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