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Excess Total Mortality in Italy: An Update to February 2023 with Focus on Working Ages

Gianfranco Alicandro[1,2*], Alberto G. Gerli[3], Stefano Centanni[4], Giuseppe Remuzzi[5], Carlo La Vecchia[3]

[1]Department of Pathophysiology and Transplantation, Università degli Studi di Milano, Milan, Italy
[2]Cystic Fibrosis Centre, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy
[3]Department of Clinical Sciences and Community Health, Università degli Studi di Milano, Milan, Italy
[4]Respiratory Unit, Department of Health Sciences, ASST Santi Paolo e Carlo, Università degli Studi di Milano, Milan, Italy
[5]Istituto di Ricerche Farmacologiche Mario Negri IRCCS, Bergamo, Italy

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Abstract

Background: *Italy had a persistent excess of total mortality until July 2022. This study provides updated estimates of excess mortality in Italy until February 2023.* **Methods:** *Mortality and population data from 2011 to 2019 were used to estimate the number of expected deaths during the pandemic. Expected deaths were obtained using over-dispersed Poisson regression models, fitted separately for men and women, including calendar year, age group, and a smoothed function of the day of the year as predictors. The excess deaths were then obtained by calculating the difference between observed and expected deaths and were computed at all ages and working ages (25-64 years).* **Results:** *We estimated 26,647 excess deaths for all ages and 1248 for working ages from August to December 2022, resulting in a percent excess mortality of 10.2% and 4.7%, respectively. No excess mortality was detected in January and February 2023.* **Conclusions:** *Our study indicates substantial excess mortality beyond those directly attributed to COVID-19 during the BA.4 and BA.5 Omicron waves in the latter half of 2022. This excess could be attributed to additional factors, such as the heatwave during the summer of 2022 and the early onset of the influenza season.*

1. Introduction

Excess total mortality is a major indicator of the impact of the COVID-19 pandemic [1]. It refers to the difference between the observed deaths during the pandemic period and the expected number of deaths based on historical data. Unlike COVID-19 deaths – i.e. deaths registered as COVID-19 –, total excess mortality provides a comprehensive picture of the pandemic as it is not affected by uncertainties in the definition of the underlying cause of death and underreporting. In addition, it accounts for the indirect effects of the pandemic on the management of other conditions. Thus, variations in total mortality may be influenced by causes other than COVID-19.

We previously estimated a total excess of approximately 100,000 deaths in Italy in March-December 2020 and around 60,000 deaths in 2021, with persistent excess up to July 2022 [2-4]. In this update, we have extended our analyses until February 2023 [2-4].

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*Corresponding Author: Gianfranco Alicandro, Department of Pathophysiology and Transplantation, Università degli Studi di Milano, Milan, Italy; E-mail: gianfranco.alicandro@unimi.it

2. Methods

The study analyzed national daily mortality data from January 1, 2011, to February 28, 2023, and population data for the same period [5]. Data were provided by the National Institute of Statistics (ISTAT).

To estimate the number of excess deaths, we compared the number of observed deaths during the pandemic period to the expected number of deaths had the pandemic not occurred. Daily expected deaths were estimated separately for men and women using an over-dispersed Poisson regression model. The model included a linear term for the calendar year to account for temporal trends in mortality, age groups (<1, 1-4, 5-9,..., ≥100 years) to consider the effect of age on mortality rate, and a natural spline function of the day of the year to capture seasonal variations. To account for the population's demographic changes in size and age structure, the model included the natural logarithm of the population as an offset term. The number of knots of the spline function was selected based on the quasi-Akaike Information Criterion (QAIC), testing up to 10 equally spaced knots. The model's coefficients were estimated using daily mortality data between January 1, 2011, and December 31, 2019.

We presented the results on excess deaths in both absolute terms (i.e., the difference between observed and expected deaths) and relative terms (i.e., percent relative differences) for all ages and working ages (25-64 years). The working-age population was defined as individuals aged 25-64, excluding those still in education or retired.

We run a Monte Carlo simulation to calculate the 95% Confidence Intervals (CI) for excess deaths. We sampled 10,000 sets of model parameters from a multivariate normal distribution, using the parameter's estimates and the variance-covariance matrix. Then, we computed the difference between the number of observed deaths and the expected deaths obtained from each iteration to obtain the estimate's variance. Then the 95% CI was computed using the quantiles of the standard normal distribution.

3. Results

Table 1 displays the monthly number of observed and expected deaths for all ages and working ages between August 2022 and February 2023. From August to December 2022, we estimated 26,647 excess deaths for all ages and 1,248 for working ages, resulting in percent excess mortality of 10.2% and 4.7%, respectively. The highest excess mortality for all ages was observed in August 2022 (+13.3%) and December 2022 (15.8%), while at working ages, observed deaths were higher than expected in August 2022 (+9.8%), September 2022 (+9.5%) and October 2022 (+5.7%). Since November 2022 for working ages and January 2023 for all ages, the number of observed deaths has been lower than expected.

Figure 1 provides estimates of excess deaths (in absolute and relative terms) for all ages and working ages in March-December 2020, the whole of 2021, and 2022. In March-December 2020, 99,335 excess deaths (+18.8%) were estimated for all ages, and this number decreased to 60,353 deaths (9.3%) in 2021 and 66,304 deaths (+10.2%) in 2022. For individuals of working age, excess mortality accounted for 5057 deaths (+7.5%) in March-December 2020, 6760 deaths (+10.2%) in 2021, and 2848 deaths (+4.3%) in 2022.

Figure 2 shows the estimated monthly number of excess and COVID-19 deaths during the pandemic period [6]. Excess deaths were considerably higher than COVID-19 deaths in March-April 2020 (47,740 excess deaths *vs.* 27,938 COVID-19 deaths), November 2020 (25,489 excess deaths *vs.* 16,958 COVID-19 deaths), August 2021 (5812 excess deaths *vs.* 1158 COVID-19 deaths), July-August 2022 (20,340 excess deaths *vs.* 7242 COVID-19 deaths) and December 2022 (9257 excess deaths *vs.* 3288 COVID-19 deaths).

4. Discussion

The persistent excess mortality observed from August to December 2022 can be attributed to multiple factors. One of the major factors is the emergence of new sub-lineages of the Omicron variant (BA.4 and BA.5) in June-October 2022 in Italy,

Table 1. Observed, expected deaths and excess total mortality between August 2022 and February 2023 in Italy among the working-age population and the whole Italian population.

Period	Observed deaths	Expected deaths[1]	Absolute Difference (95 % CI)	Percent difference (95% CI)
Working ages				
August 2022	5661	5158	503 (470 to 535)	9.8 (9.1 to 10.4)
September 2022	5379	4912	467 (436 to 497)	9.5 (8.9 to 10.1)
October 2022	5477	5181	296 (264 to 327)	5.7 (5.1 to 6.3)
November 2022	5326	5329	-3 (-36 to 30)	-0.1 (-0.7 to 0.6)
December 2022	5955	5970	-15 (-53 to 23)	-0.3 (-0.9 to 0.4)
August – December 2022	27,798	26,550	1248 (1100 to 1389)	4.7 (4.1 to 5.2)
January 2023	6064	6761	-697 (-751 to – 652)	-10.3 (-11.0 to -9.6)
February 2023	5318	5875	-557 (-595 to -518)	-9.5 (-10.1 to -8.8)
All ages				
August 2022	57,423	50,665	6758 (6493 to 7022)	13.3 (12.8 to 13.9)
September 2022	50,334	48,255	2079 (1842 to 2315)	4.3 (3.8 to 4.8)
October 2022	54,965	50,905	4060 (3809 to 4310)	8.0 (7.5 to 8.5)
November 2022	56,848	52,355	4493 (4224 to 4761)	8.6 (8.1 to 9.1)
December 2022	67,870	58,613	9257 (8946 to 9567)	15.8 (15.3 to 16.3)
August – December 2022	287,440	260,793	26,647 (25,594 to 37,693)	10.2 (9.8 to 10.6)
January 2023	65,779	66,637	-858 (-1222 to -493)	-1.3 (-1.8 to -0.7)
February 2023	57,416	57,909	-493 (-799 to -186)	-0.9 (-1.4 to -0.3)

CI: Confidence Interval.

[1]Estimated from 2011-2019 mortality and population data, separately by sex, through over-dispersed Poisson regression models including a linear term for the calendar year, age groups as a categorical variable, a smooth function of the day of the year with seven equally spaced knots, and the natural logarithm of the population as an offset. Values were rounded up to the smallest integer.

which resulted in approximately 4 million registered COVID-19 cases. This number represents only a fraction of the actual cases [7]. Another possible contributing factor is the deferral of medical care, particularly during the first phase of the pandemic, which may have led to poorer outcomes for patients affected by chronic conditions [8-10]. The heat wave of June to August 2022 may also account for part of the excess during summer. Furthermore, the excess mortality could be partially attributed to the increased cardiovascular events among COVID-19 patients [11, 12], which may account for the nearly 10% excess mortality within the working-age population during the summer of 2022.

The excess mortality observed in November and December 2022 among all age groups, but not within the working age population, is likely due to the early onset of influenza in Italy last winter. The influenza epidemic in Italy for 2022-2023 peaked in December 2022 and then levelled off. This may also explain the higher number of excess deaths compared to COVID-19 deaths in December 2022, as well as the lower-than-expected number of deaths in January and February 2023 [13]. The difference between COVID-19 deaths and total excess deaths in 2022, particularly at working age, suggestrs that it is partly due to causes other than COVID-19.

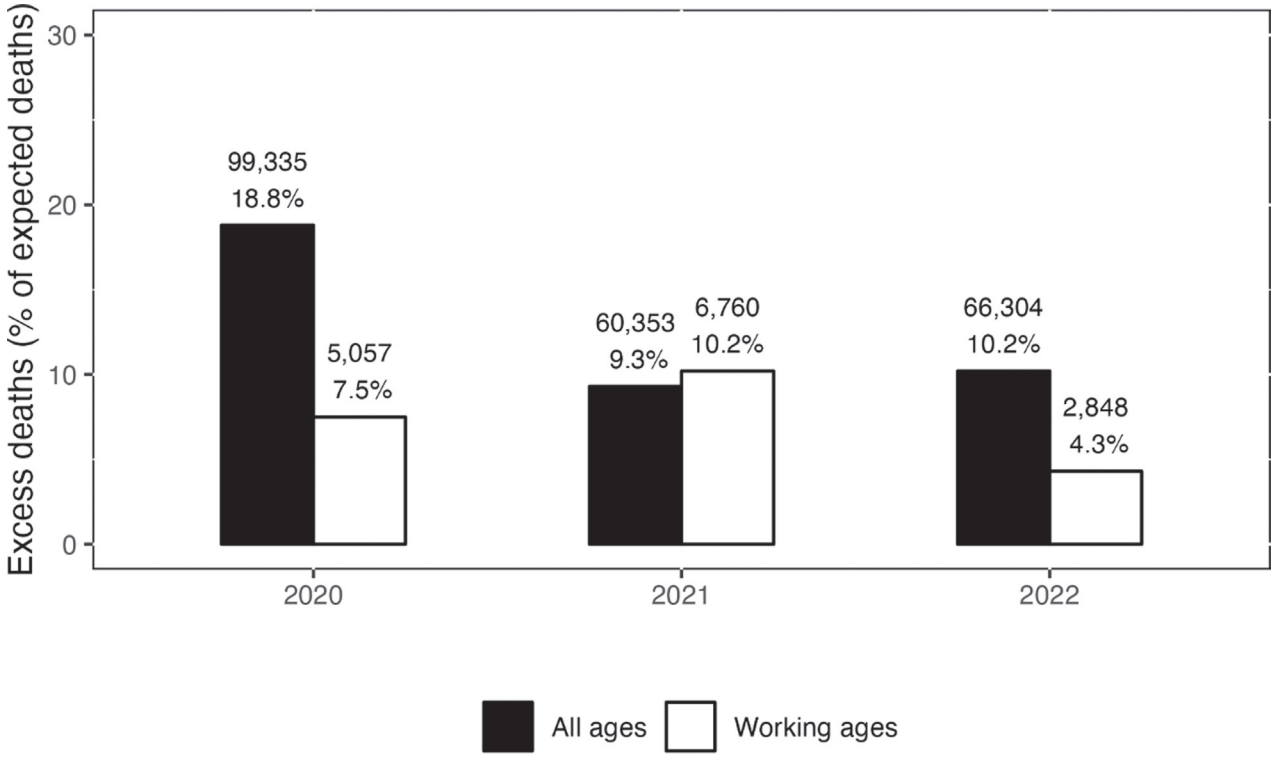

Figure 1. Excess total mortality in Italy at all ages and working ages (25-64 years) in 2020-2022.

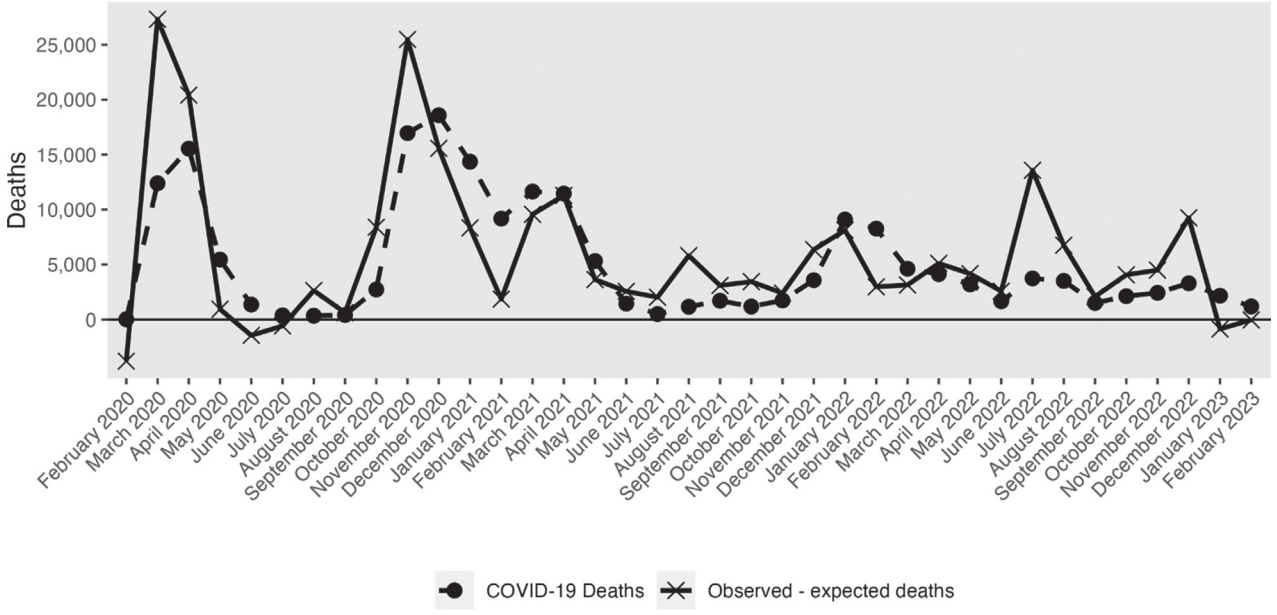

Figure 2. Excess and COVID-19 deaths at all ages from March 2020 to February 2023 in Italy.

Eurostat estimated excess mortality for European countries, including Italy, using the average deaths registered from 2016 to 2019 as a historical baseline not impacted by the COVID-19 pandemic [14]. Although their methodology differs from the current study, their estimates also demonstrate persistent excess mortality in the second half of 2022 in Italy and other European countries, with values ranging between +6.4% in October 2022 and +13.7% in December 2022 but no excess in January and February 2023.

Our study also shows important differences between total excess deaths and COVID-19 deaths. At the beginning of the pandemic (March-April 2020) total excess deaths were substantially larger than the COVID-19 registered deaths, due to under-diagnosis [15]. This was evident in October-November 2020, too. In July-August 2022, total excess deaths were higher than COVID-19 deaths, likely due to the heatwave, which was associated to over 10,000 excess deaths [3]. In November-December 2022 the main likely reason for the higher total excess deaths was the early arrival of the influenza in winter 2022-23, later reflected in the reduced mortality in January-February 2023.

The findings of our study have important implications for public health. First, they highlight the importance of monitoring excess mortality as a complementary indicator to other COVID-19-related data, such as confirmed cases and hospitalizations. Excess mortality provides a comprehensive understanding of the pandemic's impact, as it captures the potential consequences of deferred medical care for non-COVID-19-related conditions. However, using a different baseline period to estimate the expected number of deaths may yield different results [16]. Additionally, while our model for expected deaths accounted for the seasonality of mortality and temporal trends, it did not remove the effect of occasional peaks in mortality related to severe influenza seasons and heatwaves from the estimate of excess deaths. Finally, current estimates may differ somewhat from those previously published, as they were based on provisional mortality data that will be subject to revisions in future releases.

Conclusion

Our study has shown significant excess mortality during the COVID-19 pandemic in Italy, with approximately 27,000 excess deaths between August and December 2022. A smaller excess (around 1200 deaths) was also observed within the working-age population, and no excess was observed in January and February 2023. In this period, the excess mortality at all ages exceeded the 12,800 COVID-19 deaths. This difference is likely due to other factors, such as the heatwave of June-August 2022 and the early onset of influenza in November 2022. The early start of the influenza season may also be responsible for the absence of excess mortality in January and February 2023.

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