

Excess total mortality in 2021 in Italy was about one third of that observed in 2020

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ABSTRACT

Background: Italy was severely hit by the Covid-19 pandemic with an excess of around 90,000 total deaths in 2020. Comparable data in 2021 are needed for monitoring the effects of the interventions adopted to control its spread and reduce the burden. This study estimates the excess mortality in Italy in the first eight months of 2021, with a focus on the working age population. **Methods:** Excess mortality was estimated as difference between the number of registered deaths and the expected deaths. Expected deaths in March–December 2020 and January–August 2021 were estimated separately by sex, through an over-dispersed Poisson regression model using mortality and population data for the period 2011–2019 (before the Covid-19 outbreak). The models included terms for calendar year, age group, a smooth function of week of the year and the natural logarithm of the population as offset term. **Results:** In the first eight months of 2021, we estimated 34,599 excess deaths (+7.9% of the expected deaths), of these 3667 were among individuals of working age (25–64 years). In this age group, mortality was 8.2% higher than expected with higher excesses among men (2972 deaths, +10.7%) than women (695 deaths, +4.1%). **Conclusions:** The excess deaths in the first eight months of 2021 account for about one third of that registered in 2020. Current data indicate that around 5000 excess deaths are expected by the end of the year, leading to a total excess for 2021 of around 40 thousand deaths. Despite the absence of influenza in January–March 2021, a relevant excess was also observed among the working age population.

INTRODUCTION

Excess total mortality is the best indicator to evaluate the overall impact of the Coronavirus disease 2019 (Covid-19) pandemic in terms of lives lost. It quantifies not only the deaths directly related to Covid-19 but also those occurring as a consequence of the reduced capacity of the health system to provide care for other medical conditions. Moreover, excess total mortality is not biased by possible under- or overestimation of Covid-19 deaths due

to changes in testing rates. Underestimation was particularly evident during the first phase of the pandemic in Italy (March–May 2020), when the number of excess total deaths approached 44,000, while official data reported only 33,000 Covid-19 deaths (1).

Several attempts have been made to estimate the excess mortality in Italy in 2020, some of them compared the observed deaths in 2021 with the average deaths registered in the previous quinquennium (1–4), other used statistical models to account

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for the demographic changes and/or temporal improvements in mortality rates (5–9). However, no estimates have been published on the impact of the pandemic in 2021 in Italy.

In absolute terms, most of the excess estimated in 2020 was observed at ages >80 years, however non-negligible excesses were also observed at age before 65. In a previous work, we estimated more than 5000 excess deaths at ages 25–64 years in 2020 that exceeded 6000 when we excluded January and February, months characterized by a mortality lower than expected (10).

The increase in premature deaths among the population of working age has important implications not only for the individuals and their families but also for the whole society which loses a share of the economically active population. In addition, from a public health perspective, deaths at those ages make a relevant contribution to the number of years of life lost due to the pandemic. Therefore, this study aims at estimating the excess mortality in Italy in the first eight months of 2021, with a focus on the working age population.

METHODS

The work is based on daily mortality data from 1 January 2011 to 31 August 2021 (the last day of available mortality data) and resident population data of each year of the same period. These data are of public domain and were downloaded from the repositories of the National Institute of Statistics (11–13).

Annual age-standardized mortality rates from all causes (ASMRs) (per 10,000) between 2011 and 2021 were computed at all ages and at ages 25–64 years separately by sex, using the 2013 European standard population (14). To obtain the ASMR for 2021, we added up the number of deaths registered between January and August 2021 and the number of expected deaths in the following months (September–December 2021). The expected deaths in September–December 2021 were obtained from the product of 2021 population data and the sex and age-specific mortality rate of September–December of the year preceding the pandemic (i.e. 2019).

We evaluated the excess total mortality in two periods, i.e. March–December 2020 and the first eight

months of 2021 up to 31 August 2021. The excess total mortality was estimated through the difference between the number of deaths registered in the two periods and the expected deaths in the same periods. The expected deaths were estimated separately by sex, through over-dispersed Poisson regression models using mortality and population data for the period 2011–2019 (before the Covid-19 outbreak). The model included a linear term for calendar year (to take into account temporal trends in mortality), age groups as categorical variable (to capture the demographic changes over the period), a smooth function of week of the year (to capture seasonal variations), and the natural logarithm of the population as offset. A natural spline was used as a smooth function with number of knots chosen on the basis of quasi-Akaike Information Criterion (QAIC). Up to 10 equally spaced knots were tested.

Excess deaths were provided with 95% confidence intervals (CI) at all ages and by the following age groups: 0–24, 25–64, 65–79 and ≥ 80 years. In this work, we defined the working population as those aged 25–64 years, to avoid the inclusion of individuals who may still be in education, and those who are retired. Excess total mortality was also quantified as percent relative difference compared to the expected deaths. These last quantities were used to compute the changes in excess deaths in January–August 2021 as compared to March–December 2020, as difference between the two periods divided by the value estimated in March–December 2020 and multiplied by 100.

RESULTS

Table 1 gives the number of deaths registered over the two periods considered in this study (i.e. March–December 2020 and January–August 2021), the number of expected deaths and the estimates of excess mortality, stratified by sex and age groups. During the first eight months of 2021 we estimated 34,599 excess deaths (+7.9% of the expected deaths), which account for about a third of those estimated in March–December 2020 (99,289 deaths). In both periods, the excess deaths were higher in men than in women with 52.9% of the excess estimated among men in 2020 and 62.4% in 2021. In March–December 2020, two-thirds of the excess,

Table 1. Observed, expected deaths and excess total deaths in Italy during the Covid-19 pandemic, disaggregated by sex, age and periods (March-December 2020 and January-August 2021)

Sex	Age group	Observed deaths	Expected deaths ¹	Difference (Observed-Expected deaths)			Percentage difference		
				Estimate	95% LCL	95% UCL	Estimate	95% LCL	95% UCL
<i>March-December 2020</i>									
Women	0-24	892	960.4	-68	-114	-25	-7.1	-11.9	-2.6
	25-64	21,942	20,373.3	1569	1319	1814	7.7	6.5	8.9
	65-79	60,037	51,304.0	8733	8393	9070	17.0	16.4	17.7
	80+	238,484	201,933.3	36,551	35,444	37,651	18.1	17.6	18.6
	All ages	321,355	274,571.1	46,784	45,043	48,510	17.0	16.4	17.7
Men	0-24	1442	1641.1	-199	-256	-144	-12.1	-15.6	-8.8
	25-64	38,778	33,938.0	4840	4510	5166	14.3	13.3	15.2
	65-79	96,248	77,013.0	19,235	18,779	19,688	25.0	24.4	25.6
	80+	170,234	141,604.3	28,630	27,813	29,441	20.2	19.6	20.8
	All ages	306,702	254,196.4	52,506	50,847	54,151	20.7	20.0	21.3
All sexes	0-24	2334	2601.6	-268	-370	-170	-10.3	-14.2	-6.5
	25-64	60,720	54,311.3	6409	5829	6981	11.8	10.7	12.9
	65-79	156,285	128,317.0	27,968	27,173	28,758	21.8	21.2	22.4
	80+	408,718	343,537.6	65,180	63,257	67,092	19.0	18.4	19.5
	All ages	628,057	528,767.5	99,289	95,889	102,662	18.8	18.1	19.4
<i>January-August 2021</i>									
Women	0-24	681	781.1	-100	-137	-65	-12.8	-17.5	-8.3
	25-64	17,703	17,007.5	695	487	901	4.1	2.9	5.3
	65-79	47,110	42,143.4	4967	4680	5252	11.8	11.1	12.5
	80+	175,956	168,522.5	7434	6474	8388	4.4	3.8	5.0
	All ages	241,450	228,454.4	12,996	11,503	14,476	5.7	5.0	6.3
Men	0-24	1168	1317.2	-149	-195	-105	-11.3	-14.8	-8.0
	25-64	30,733	27,761.4	2972	2699	3241	10.7	9.7	11.7
	65-79	72,423	62,131.5	10,291	9910	10,670	16.6	16.0	17.2
	80+	125,968	117,478.0	8490	7786	9190	7.2	6.6	7.8
	All ages	230,292	208,688.2	21,604	20,200	22,996	10.4	9.7	11.0
All sexes	0-24	1849	2098.3	-249	-332	-170	-11.9	-15.8	-8.1
	25-64	48,436	44,769.0	3667	3186	4143	8.2	7.1	9.3
	65-79	119,533	104,274.9	15,258	14,590	15,922	14.6	14.0	15.3
	80+	30,1924	286,000.5	15,924	14,259	17,578	5.6	5.0	6.1
	All ages	471,742	437,142.6	34,599	31,703	37,472	7.9	7.3	8.6

¹ Estimated from 2011-2019 mortality and population data, separately by sex, through an over-dispersed Poisson regression model including a linear term for calendar year (to take into account the temporal improvement in mortality), age groups as categorical variable (to capture the demographic changes over the period), a smooth function of week of the year with 7 equally spaced knots (to capture seasonal variations), and the natural logarithm of the population as offset term.

LCL: Lower Confidence Limit; UCL: Upper Confidence Limit.

corresponding to 65,180 deaths, were among individuals aged >80 years, while only 6.5% of the total excess (6409 deaths) was among individuals of

working age. In the first eight months of 2021, the share of the excess at ages >80 years decreased to 46.0% of the total excess, corresponding to 15,924

deaths, while it increased to 10.6% (3667 deaths) among individuals of working age.

Figure 1 shows the trend in ASMRs at all ages and at working age. Up to 2019 the ASMRs tended to decline in both age groups and sexes, though some peaks can be detected in 2015, 2017 and 2020 at all ages and in 2015 and 2020 among working-age men. The highest peak was observed in 2020, when the ASMR at all ages reached the value observed in 2012 among men and in 2015 among women. ASMR among working-age men approached the value observed in 2015.

Figure 2 shows the percentage difference between the number of observed and expected deaths in the two periods by sex and age groups, while Figure 3 shows the percentage change in the excess total mortality between March-December 2020 and January-August 2021. At ages <25 years, the number of deaths observed in the two periods were lower than expected, whereas important excesses were observed in the remaining age groups. Among individuals of working age, the excess mortality was

smaller in 2021 as compared to 2020 by 25.2% in men (from 14.3% in 2020 to 10.7% in 2021) and by 46.8% in women (from 7.7% in 2020 to 4.1% in 2021). Corresponding figures at ages 65-79 years were 33.6% among men (from 25.0% in 2020 to 16.6% in 2021) and 30.5% among women (from 17.0% in 2020 to 11.8% in 2021). At ages >80 years, the excess death remarkably decreased by 64.4% among men (from 20.2% in 2020 to 7.2% in 2021) and by 75.7% among women (from 18.1% in 2020 to 4.4% in 2021). Of note, the male-female sex ratio in relative excess mortality increased in January-August 2021 as compared to the previous period (from 1.22 in 2020 to 1.82 in 2021), in particular among individuals of working age, for whom the sex-ratio increased from 1.86 in 2020 to 2.61 in 2021. The male-female sex ratio did not increase at ages 65-79 (1.47 in 2020 and 1.41 in 2021), while at older ages it increased from 1.12 in 2020 to 1.64 in 2021.

Figure 4 shows the percentage difference between the number of observed and expected deaths by month, disaggregated by sex and age groups. At

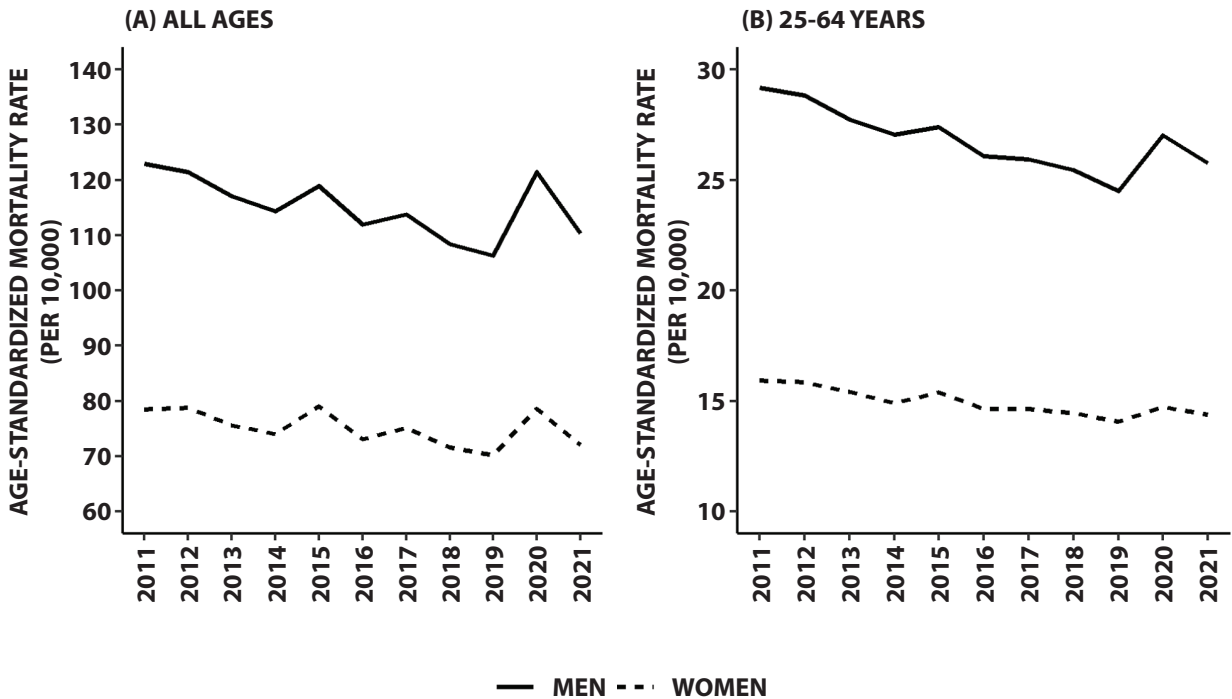


Figure 1. Annual trend in age-standardized mortality rates (per 10,000) at all ages (Panel a) and at ages 25-64 years (Panel b) in Italy by sex. Period: 2011-2021

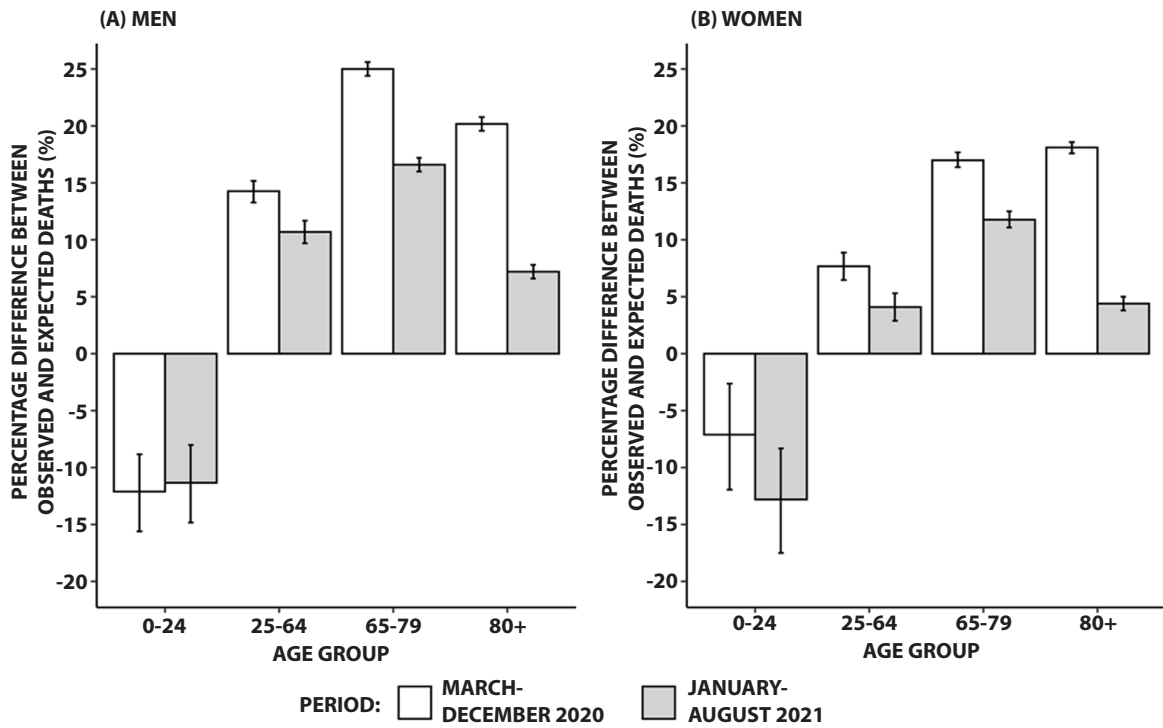


Figure 2. Percentage differences between observed and expected total deaths in Italy in March-December 2020 and January-August 2021 in men (Panel a) and women (Panel b), by age groups. Error bars are 95% confidence intervals

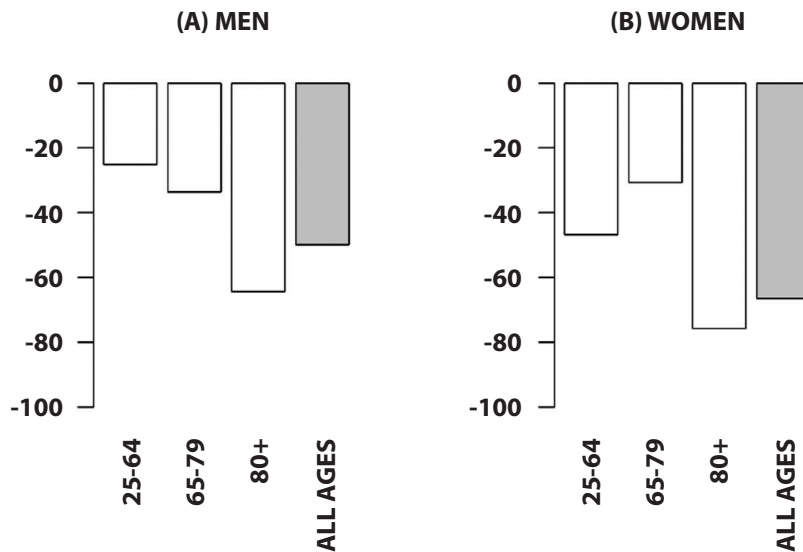


Figure 3. Percentage changes¹ in excess total mortality in Italy between March-December 2020 and January-August 2021 in men (Panel a) and women (Panel b), by age groups

¹Percentage changes were computed as difference between the relative excess estimated for January-August 2021 and that estimated in March-December 2020, divided by the estimate of March-December 2020 and multiplied by 100.

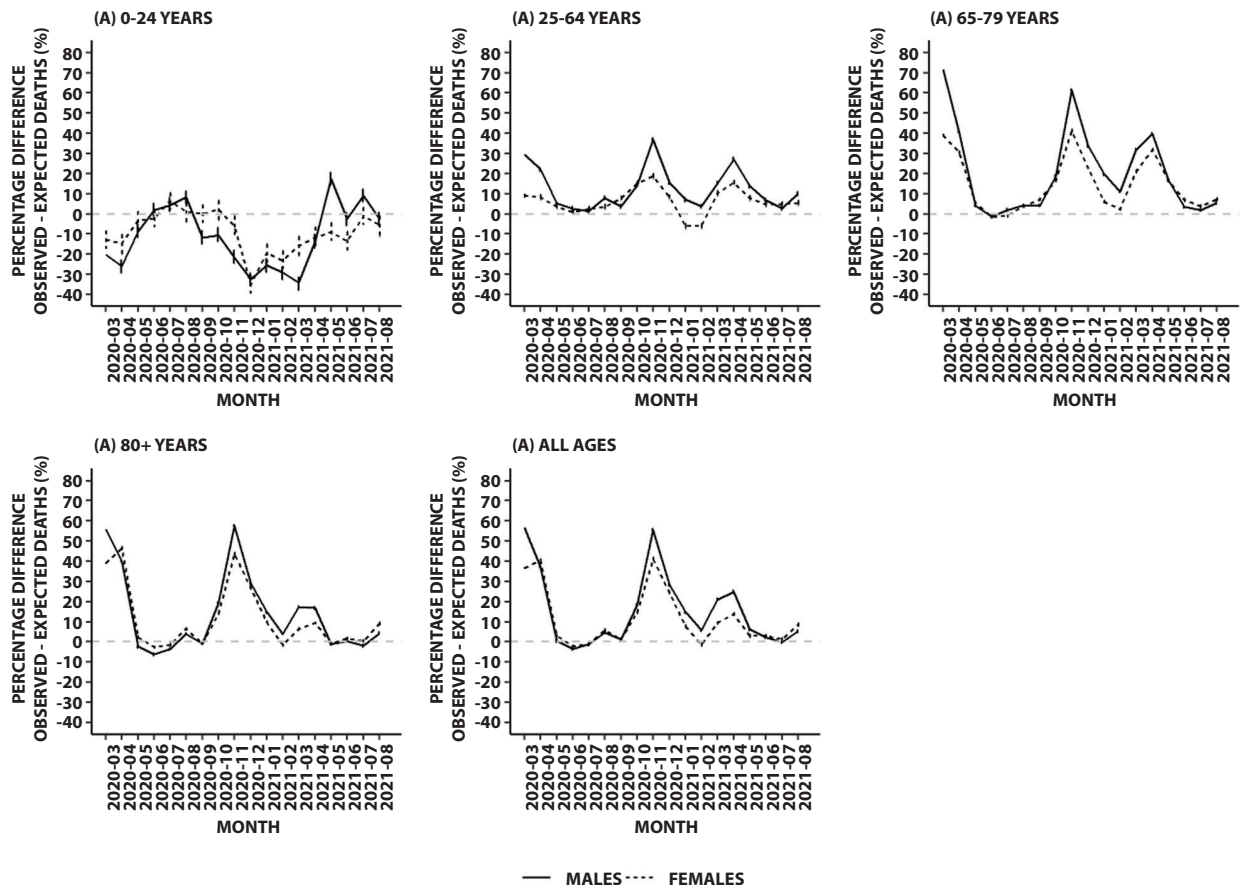


Figure 4. Monthly trend in percentage differences between observed and expected total deaths in 2020 in Italy in the age group 0-24 (Panel a), 25-64 (Panel b), 65-79 (Panel c), 80+ (Panel d) and at all ages (Panel e), by sex. Period: March 2020-August 2021

ages <25 years, no excess mortality was found over the periods, apart from two peaks in May and July 2021, while three peaks can be detected for the remaining age groups, all observed in March 2020, November 2020 and March-April 2021. The excess was generally greater among men than women.

DISCUSSION

The study provides estimates of the excess deaths in the first eight months of 2021, disaggregated by sex and age groups. We estimated an excess of over 34 thousand deaths in this period, about one third of the excess estimated in 2020. We also documented a reduced excess in all age groups, especially among older individuals, and an increased share of the total excess attributed to individuals of working age.

As of August 31, 2021, official data registered 129,221 deaths due to Covid-19 of them 74,159 registered in 2020 and 55,062 registered in 2021 (15). Thus, our estimates of the excess in total mortality was higher than the Covid-19 deaths registered in Italy in 2020 suggesting a substantial amount of underestimation of Covid-19 deaths due to low testing rate, especially in the first months of the pandemic. However, in 2021 these figures reversed and the excess in total mortality became 37% lower than the Covid-19 deaths. The absence of deaths from influenza in January-March 2021 may partly explain the difference between the number of deaths attributed to Covid-19 and the excess total deaths. Although other factors may have also contributed, including the increasing number of individuals registered as Covid-19 deaths who would have died shortly any-

way due to other causes and the selective recording of Covid-19 as underlying cause of death.

The excess mortality we estimated in this work is the result of a combination of factors including the dynamic of the pandemic in Italy, the preparedness of our health system, the measures adopted by the Government to prevent the spread of the disease and the successful vaccination campaign. At the beginning of the pandemic, we were not prepared to face this new clinical entity, treatment options were scanty and we suffered from a shortage of beds in intensive care units and ventilators (16). This led in March-April 2020 to a surge in the number of deaths, especially in the North of the country, where the epidemic started in Italy. Then thanks to a series of measures to contain the spread of the infection, including the use of face masks, closing of non-essential services, lockdowns and tracing of positive cases, as well as to a reorganization of the health system and an increasing knowledge of the disease, we were able to avoid further excess deaths in the summer of 2020. However, new and more transmissible variants of the virus became to circulate in July 2020 and by October 2020 the pandemic spread all over the country with a new peak of deaths (17). In February-March 2021, the vaccination campaign started in Italy for healthcare workers and clinically vulnerable individuals and was subsequently extended to the remaining population, with priority given to older individuals. The increasing coverage of the vaccination which showed adequate protection also against the more aggressive variants was mirrored by a remarkable reduction of the number of deaths in the summer of 2021 (18).

The lower reduction in the excess deaths registered among individuals of working age as compared to older individuals may be explained by the delayed vaccination at those ages (19). In addition, other factors including a more active social life and more frequent contacts at work may have had a role. We also found a remarkable increase in sex-ratio excess mortality that favoured the working-age women. This can be partly attributed to the higher prevalence of pre-existing conditions among middle-aged men that likely increased the risk of severe Covid-19 in that population. However, this finding deserves further investigation in the risks

associated with the different occupations. A relevant impact of the pandemic in the working age population was also documented in England and Wales, with almost 8000 Covid-19 deaths reported at ages 20-64 years between March and December 2020, two-thirds registered among men, with high rates among workers in elementary occupations, in caring, leisure and other service occupations (20). Between March and November 2020, an excess of 22% was also documented among working-age adults in California with excesses which exceeded 30% among workers in the food/agricultural and transportation/logistics sectors (21).

Our estimates cover the first eight months of 2021. By the end of October, the number of cases in Italy have progressively increased, despite having vaccinated more than 80% of the population. Between September 1 and November 15, 2021, 3598 Covid-19 deaths were registered, with an average of 48 deaths per day over the period and a recent increment. Thus, assuming that the average number of deaths would increase to 100 deaths per day, about 4600 additional Covid-19 deaths are expected by the end of the year that would account for about 5000 additional total excess deaths (assuming the same ratio between Covid-19 deaths and excess total deaths) in the period not covered by our estimates.

When interpreting our results, it should be noted that the estimates we provided on individuals of working age do not reflect the risk of death from Covid-19 of the active Italian population, since mortality data disaggregated by employment status and type of occupations are not available in Italy. Thus, a certain amount of the excess deaths in this age group likely occurred among the inactive population including housewives or -men and those with long-term illnesses that prevent them from working. This should be carefully considered when interpreting the excess mortality in working-age women due to the high rate of inactivity among Italian women.

Despite these limitations, our study provides reliable estimates of the excess death covering the second and the third waves of the pandemic in Italy, taking into account the temporal improvement in mortality rates and the demographic changes that occurred in the Italian population over the period.

CONCLUSIONS

In the first eight months of 2021 in Italy we had about one third of the excess deaths registered in 2020 with around 10% of the over 34 thousand excess deaths occurred in the working age population.

DECLARATION OF INTEREST: The authors declare no conflict of interest.

REFERENCES

- Alicandro G, Remuzzi G, La Vecchia C. Italy's first wave of the COVID-19 pandemic has ended: no excess mortality in May, 2020. *Lancet*. 2020;396(10253):e27-e28. doi:10.1016/S0140-6736(20)31865-1
- Alicandro G, Remuzzi G, La Vecchia C. COVID-19 pandemic and total mortality in the first six months of 2020 in Italy. *Med del Lav*. 2020;111(5):351-353. doi:10.23749/mdl.v111i5.10786
- Alicandro G, La Vecchia C, Remuzzi G, Gerli A, Centanni S. The impact of COVID-19 on total mortality in Italy up to November 2020. *Panminerva Med*. Published online 2021. doi:10.23736/S0031-0808.21.04301-9
- Istituto Nazionale di Statistica. Impatto dell'epidemia Covid-19 sulla mortalità totale nella popolazione residente. Published 2021. Accessed November 15, 2021. <https://www.istat.it/it/archivio/258463>
- Islam N, Shkolnikov VM, Acosta RJ, et al. Excess deaths associated with covid-19 pandemic in 2020: Age and sex disaggregated time series analysis in 29 high income countries. *BMJ*. 2021;373. doi:10.1136/bmj.n1137
- Blangiardo M, Cameletti M, Pirani M, Corsetti G, Battaglini M, Baio G. Estimating weekly excess mortality at subnational level in Italy during the COVID-19 pandemic. *PLoS One*. 2020;15(10). doi:10.1371/journal.pone.0240286
- Dorrucci M, Minelli G, Boros S, et al. Excess Mortality in Italy During the COVID-19 Pandemic: Assessing the Differences Between the First and the Second Wave, Year 2020. *Front Public Heal*. 2021;9. doi:10.3389/fpubh.2021.669209
- Gianicolo EAL, Russo A, Büchler B, Taylor K, Stang A, Blettner M. Gender specific excess mortality in Italy during the COVID-19 pandemic accounting for age. *Eur J Epidemiol*. Published online 2021. doi:10.1007/s10654-021-00717-9
- Scortichini M, Schneider Dos Santos R, De' Donato F, et al. Excess mortality during the COVID-19 outbreak in Italy: a two-stage interrupted time-series analysis. *Int J Epidemiol*. 2021;49(6):1909-1917
- Alicandro G, La Vecchia C, Remuzzi G, Gerli A, Centanni S. Excess mortality in Italy in 2020 by sex and age groups accounting for demographic changes and temporal trends in mortality. *Panminerva Med*. Published online 2021. doi:10.23736/s0031-0808.21.04397-4
- Istituto Nazionale di Statistica. Decessi e cause di morte: cosa produce l'Istat. Published 2021. Accessed November 15, 2021. <https://www.istat.it/it/archivio/240401>
- Istituto Nazionale di Statistica. Popolazione residente ricostruita - Anni 2002-2019. Accessed November 15, 2021. <http://dati.istat.it>
- Istituto Nazionale di Statistica. Popolazione residente al 1° gennaio. Accessed November 15, 2021. <http://dati.istat.it>
- EUROSTAT. Revision of the European Standard Population, Report of Eurostat's Task Force, Methodologies and Working Paper, 2013 edition. Published 2013. <https://data.europa.eu/doi/10.2785/11470>
- Presidenza del Consiglio dei Ministri - Dipartimento di Protezione Civile. Andamento nazionale Covid-19. Published 2021. Accessed November 15, 2021. <https://dati-covid.italia.it/>
- Fagioli S, Lorini FL, Remuzzi G. Adaptations and Lessons in the Province of Bergamo. *N Engl J Med*. 2020;382(21):e71. doi:10.1056/nejmc2011599
- World Health Organization. COVID-19 Weekly Epidemiological Update, Edition 65. Published 2021. Accessed November 15, 2021. <https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---9-november-2021>
- Istituto Superiore di Sanità, Ministero della Salute. *Impatto Della Vaccinazione COVID-19 Sul Rischio Di Infezione Da SARS-CoV-2 e Successivo Ricovero e Decesso in Italia (Report N° 4 27.12.2020 - 29.08.2021)*; 2021. <https://www.epicentro.iss.it/vaccini/pdf/report-valutazione-impatto-vaccinazione-covid-19-6-ott-2021-it.pdf>
- Presidenza del Consiglio dei Ministri; Commissario Straordinario Covid-19; Ministero della Salute. Report Vaccini Anti COVID-19. Published 2021. Accessed November 15, 2021. <https://www.governo.it/it/cscovid19/report-vaccini/>
- Office for National Statistics. *Coronavirus (COVID-19) Related Deaths by Occupation, England and Wales: Deaths Registered between 9 March and 28 December 2020*; 2021 <https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/causesofdeath/bulletins/coronaviruscovid19relateddeathsbyoccupationenglandandwales/deathsregisteredbetween9marchand28december2020>
- Chen YH, Glymour M, Riley A, et al. Excess mortality associated with the COVID-19 pandemic among Californians 18-65 years of age, by occupational sector and occupation: March through November 2020. *PLoS One*. 2021;16(6 June). doi:10.1371/journal.pone.0252454