

Health Economics

Exploring the relationship between care homes and excess deaths in the COVID-19 pandemic: Evidence from Italy

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Manuscripts

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3 **The presence of care homes and excess deaths**
4 **during the COVID-19 Pandemic: Evidence from Italy**
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22 **Abstract**
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26 This paper explores the relationship between the spatial distribution of excess deaths
27 and the presence of care home facilities during the first wave of the COVID-19
28 outbreak in Italy. Using registry-based mortality data for Lombardy, one of the areas
29 most severely hit by the pandemic we show that the presence of a care home in a
30 municipality is associated with significantly higher excess death rates in the
31 population. This effect appears to be driven by excess mortality in the elderly
32 population of 70 years old and older. Our results are robust to controlling for the
33 number of residents in each care home, suggesting that the presence of such facilities
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6 level.
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10 **JEL:** I10, I18, I30

11 *Keywords:* Care Homes, COVID-19, excess mortality
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15 **1 Introduction**

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17 With fatalities of COVID-19 concentrated among the elderly, demographic structures have
18 been deemed as a key determinant of the geographical differences in the extent and severity of
19 the pandemic (Dowd et al, 2020). Across countries, with a larger old-age population, in
20 particular, intergenerational contacts are considered at risk of accelerating outbreaks and
21 worsening the death count (Esteve et al, 2020). However, while a higher prevalence of
22 intergenerational bonds, particularly the rate of co-residence and contacts between family
23 members, are positively associated with the rate of COVID-19 case fatalities at the country
24 level, this association turns negative at a more fine-grained, sub-national level (Arpino et al,
25 2020). Questions thus remain over which other proximate mechanisms may articulate the role
26 of the age structure in shaping COVID-19 outcomes at the population level (Nepomuceno, et
27 al, 2020). In this study, we estimate the concentration of excess mortality in municipalities with
28 care homes. We use registry-based daily mortality records by municipality (*comuni*) from
29 Lombardy (Italy), among the areas hardest-hit by the pandemic worldwide. Our identification
30 strategy relies on estimating differences in excess mortality between municipalities with and
31 without care homes, with respect to the previous five years' average. Italy was the first western
32 country to experience a severe COVID-19 outbreak. Excess deaths in Lombardy's care homes
33 are at the center of media and policy attention as well as judicial enquiries for a lack of clear
34 rules on containment practices such as the reception of patients with COVID-19-related
35 symptoms, testing, availability of protective gear, and contact with outside visitors.⁷ Besides
36 the share of elderly persons, attention on their living conditions is rapidly rising amidst
37 dramatic reports of death rates in long-term residential and nursing facilities, henceforth care
38 homes, described as 'besieged castles' during the pandemic (Trabucchi and De Leo 2020). In
39 several of these facilities, lack of adequate rules on containment practices have in fact
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59 ⁷ <https://www.ilpost.it/2020/04/17/regione-lombardia-rsa/>
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determined a rapid and lethal spread of SARS-CoV-2. Furthermore, the fact that care homes do not have an infrastructure of acute medicine may have exacerbated the challenge of the pandemic. Although there is consensus in the epidemiological literature on the role played by the environment, including in long-term care, in determining the spread of infectious diseases, up to date rigorous, non-anecdotal evidence on how care homes might have added on the burden of COVID-19 is currently lacking. Our analyses show that the excess mortality of adults aged 70+ was significantly higher in municipalities with at least one care home, reaching up to 18 additional daily excess deaths per 100,000 inhabitants by the end of March. On the contrary, we do not find a significantly robust linear relationship between the number of beds in care homes and excess mortality. Our findings show that the result does not simply map the number of vulnerable people resident in care homes, who are prone to higher mortality risk due to pre-conditions, but are driven by the presence of care homes. To consider the locally correlated nature of the pandemic, we show a spatial autoregressive model (SAR), confirming our results.

2 Data

We use death registry data for Lombardy (ISTAT, 2020), which provide daily deaths by age between January 1st and March 31st, for the years 2015 to 2020, by municipality of residence. The sample includes 131,040 observations from 1440 municipalities (95% of Lombardy). We measure municipality-level excess mortality rates as the difference between (daily or total) deaths per 100,000 individuals by age group between January 1st and March 31st 2020 and the corresponding 2015-2019 average. Differencing total deaths with respect to previous years allows us to account for the differential baseline mortality in municipalities with care homes⁸ (Vandoros, 2020). Another advantage over official COVID-19 deaths is that our measure does not depend on how deaths are classified. We link this dataset with the location of residential care homes (RSAs) by municipality.⁹¹⁰ Figure 1 illustrates the spatial distribution of care homes and excess mortality rates. Care homes are present in 34% of the municipalities and distributed widely across the region. Excess death rates present some geographical clustering.

⁸ “Care homes” refer to all non-acute residential facilities that host patients for long-term care needs.

⁹ <https://www.regione.lombardia.it/wps/portal/istituzionale/HP/DettaglioServizio/servizi-e-informazioni/cittadini/salute-e-prevenzione/strutture-sanitarie-e-sociosanitarie/residenze-anziani>

¹⁰ Unfortunately, data on the specific cause of death are not available at the municipality level. We also do not have information on the type of services provided by each nursing home.

¹¹ Death records are based on the municipality of residence. If patients died in another municipality but did not change residence, this occurrence would still be counted as a death in the place of residence

(Figure 1 around here)

3 Empirical Analysis and Results

During the first wave of the pandemic in the Spring of 2020, 85.6% of COVID-19 deaths occurred among the over 70 (ISS 2020). To account for differential mortality risks between age groups, we consider separately the 70+, 50-69, and 0-49. To investigate the relationship between excess mortality and care homes, we use municipalities as units of analysis. In Figure 2, we plot excess daily death rates by age group in 2020 for municipalities with and without a care home. To account for the fact that 2020 is a leap year and there is no corresponding data for February 29 in the previous years, we have excluded the 29th of February from the sample. Including February 29 does not significantly affect our estimates. Figure 4A in the Appendix shows no evidence of significant trends before 2020.

Before the first announced COVID-19 case (February 21st), there was no significant difference. Since the second week of March, municipalities with a care home exhibited significantly higher excess daily deaths for individuals aged 70 + (panel 3). By the end of March, they reached up to 18 additional excess deaths per 100,000 inhabitants.

(Figure 2 around here)

To consider the differential timing of the outbreak, in the fourth panel we normalize time by the first day in which a municipality recorded a positive excess death rate after the epidemic onset. This is done separately for each age group. Next, we regress daily excess death rates on the presence of care homes by age group (*age*) as follows:

$$(1) \Delta Excess\ Death\ Rate_{d,m}^{age} = \alpha + \tau_d + \beta CareHome_m + \delta RedArea_{m,d} + \chi_m + \varepsilon_d^{age}.$$

τ_d are days after January 1st-fixed effects, *CareHome* (0-1) indicates the presence of at least one care home in municipality *m*, *RedArea* (0-1) marks the first complete lockdown for ten municipalities¹² (February 23rd). χ_m is a vector of municipality characteristics: presence of a hospital, population (%) above age 70, women (%) in the age group, and province fixed effects.

¹² Bertinico, Casalpusterlengo, Castelgerundo, Castiglione d'Adda, Codogno, Fombio, Maleo, Somaglia, San Fiorano, and Terranova dei Passerini.

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3 $\Delta Excess\ Death\ Rate_{d,m}^{age}$ is the difference between the daily death rate in m by age group in
4 2020 and its 2015-2019 average. Table A.1 (Appendix) describes the variables.
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8 Table 1 reports the Results. For the 70+ (column 1), the coefficient of care homes is positive
9 and significant, with 4.91 excess daily deaths per 100,000 individuals (42% of the mean, 11.6).
10 For the other age groups (50-69 and 0-49), coefficients are positive but not significant. In the
11 Appendix, we report the results of an analysis of the relationship between excess deaths in the
12 group 70+, per capita care home beds, and the presence of large care homes. The results suggest
13 that the extensive margin (the presence of a care home) is more relevant than the intensive one
14 (the number of beds in care homes), and there may be a non-linear relationship between care
15 homes size and excess deaths (see also Table A.2). These results are not affected by intra-week
16 variation in reporting as shown in Table A.3 which re-estimates the main results using a 7-day
17 moving average.¹³¹⁴
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26 We confirm the results for people 70+ using total excess death rates as a dependent variable
27 (column 4). Next, we perform the Moran's I test for spatial correlation in residuals. The result
28 of Moran is positive and significant, indicating spatial dependence: contiguous municipalities
29 tend to show similar total excess mortality rates.¹⁵ To account for this, as robustness, we
30 estimate a spatial autoregressive model (SAR) for total excess mortality rates using contiguity
31 matrix assigned weights 1 when municipality i and j are contiguous according to the queen
32 contiguity criterion and 0 otherwise (Baltagi et al. 2018). Column 5 reports the results. The
33 spatial autocorrelation adjustment (*spatial parameter*) exhibits a statistically significant
34 coefficient of 0.10. When comparing the coefficient of Care Homes with the OLS model
35 (column 4 vs column 5), we find that the size declines only slightly (4.36 versus 4.19). For
36 robustness analysis, we report in Appendix also a difference-in-differences estimation that
37 accounts for fixed municipality characteristics that may correlate with excess deaths. This
38 specification confirms our results.
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52 ¹³ While our data do not include bed occupancy rates, there is evidence that care homes were at full capacity at
53 the onset of the pandemic, with long waiting lists. For example, Ciminelli and Garcia-Mantico' (2020)
54 calculated that, in Lombardy, for each care home bed available there are on average 157 people in the waiting
55 list.

56 ¹⁴ There are only 81 municipalities with more than 1 care home (approximately 5% of the 1440 municipalities).
57 Furthermore, only in 7% of the municipalities there was a change in the number of nursing homes between 2015
58 and 2020. Excluding these municipalities does not affect the results.

59 ¹⁵ The Moran I test is based on the contiguity matrix. We also used inverse distance matrix and used a Spatial
60 Error Model. Results are confirmed. For sake of brevity we showed only SAR.

4 Discussion and conclusions

Our paper provides evidence of significantly higher excess death rates in municipalities where a care home is present, compared to municipalities without any care home. These findings suggest that care homes drive higher death rates, and this relationship goes beyond the fact that their presence implies a larger population of at-risk individuals. However, as official data on COVID-19 deaths in care homes for Italy are not available, our analysis cannot precisely differentiate the proportion of fatalities that happened inside a care home from our death counts. Because of a lack of information on pre-existing co-morbidities at the municipality level, our identification strategy also assumes that there were no significant changes in the prevalence of underlying co-morbidities in 2020 compared to the 2015-2019 average. Finally, we do not have information on the safety practices adopted by each home care in response to the pandemic. In this respect, policy choices may also be relevant, with reports emerging that the Lombardy region promoted practices of discharge of COVID-19 patients into care homes - a factor that is likely to have further the spread of the disease. Existing data show in fact that care homes in Lombardy registered a mortality rate of 6.5%, against a national average of 3.1% (ISS 2020). Although this weighs on the generalizability of our results, it should be noted that similar practices of discharge into care homes have been reported in other countries, such as the United Kingdom, see NHS report 2020. As such, our study documents the association between the presence of care homes and excess deaths during the first-wave of COVID-19 in Northern Italy. With a population estimated by the World Health Organization to have surpassed 2 million elderly worldwide in 2014, our results hold central policy significance for the establishment of future preparedness and containment policies. Our results call for a better understanding of the role of home care facilities and home care quality in the pandemic. We document a significant relationship between the presence of nursing homes and excess deaths, more work is needed to shed light on mechanisms and factors behind this result. Having access to more granular data released by governments and nursing home facilities may enable future researches to better assess the role of different factors (i.e., quality of care, externalities, protocols etc.) and whether the positive association between excess mortality and care home facilities we have detected is the result of pre-COVID existing differences in quality across care homes or the system's integration. This is crucial to shape interventions targeted at improving not only hospital quality but also care home quality and their interconnection (see also Cronin and Evans, 2020).

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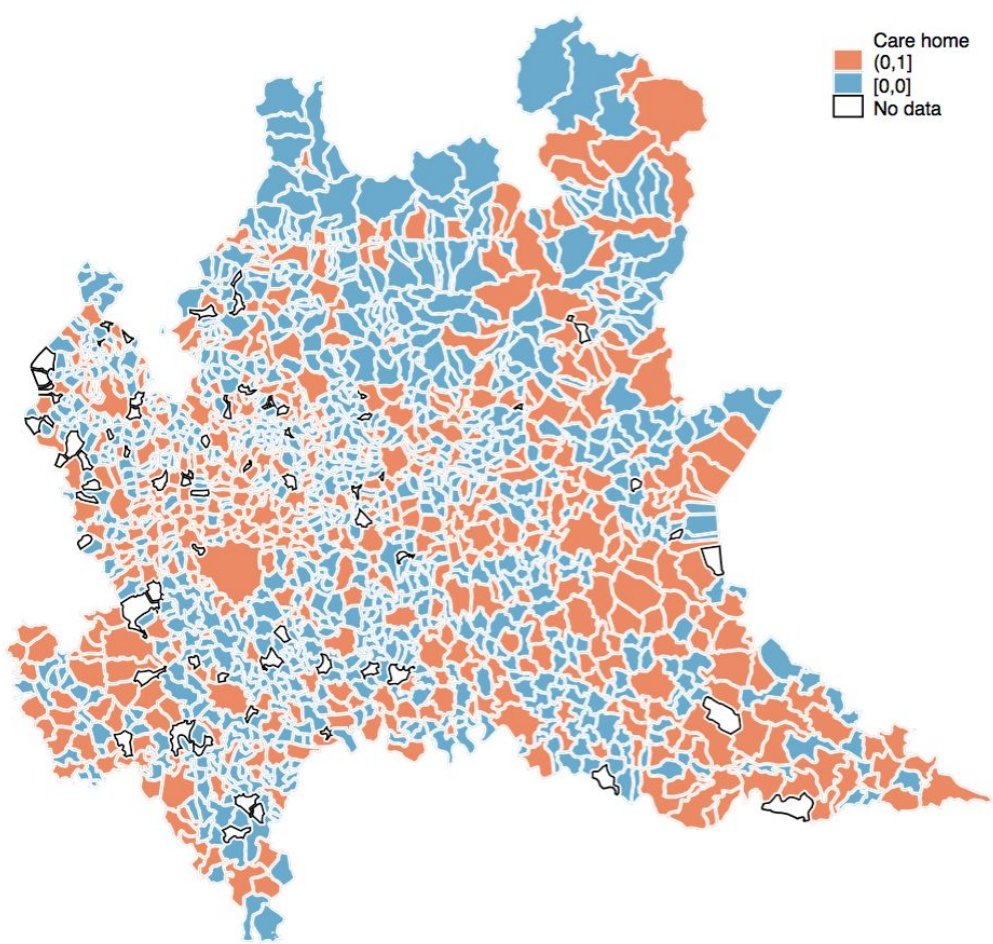
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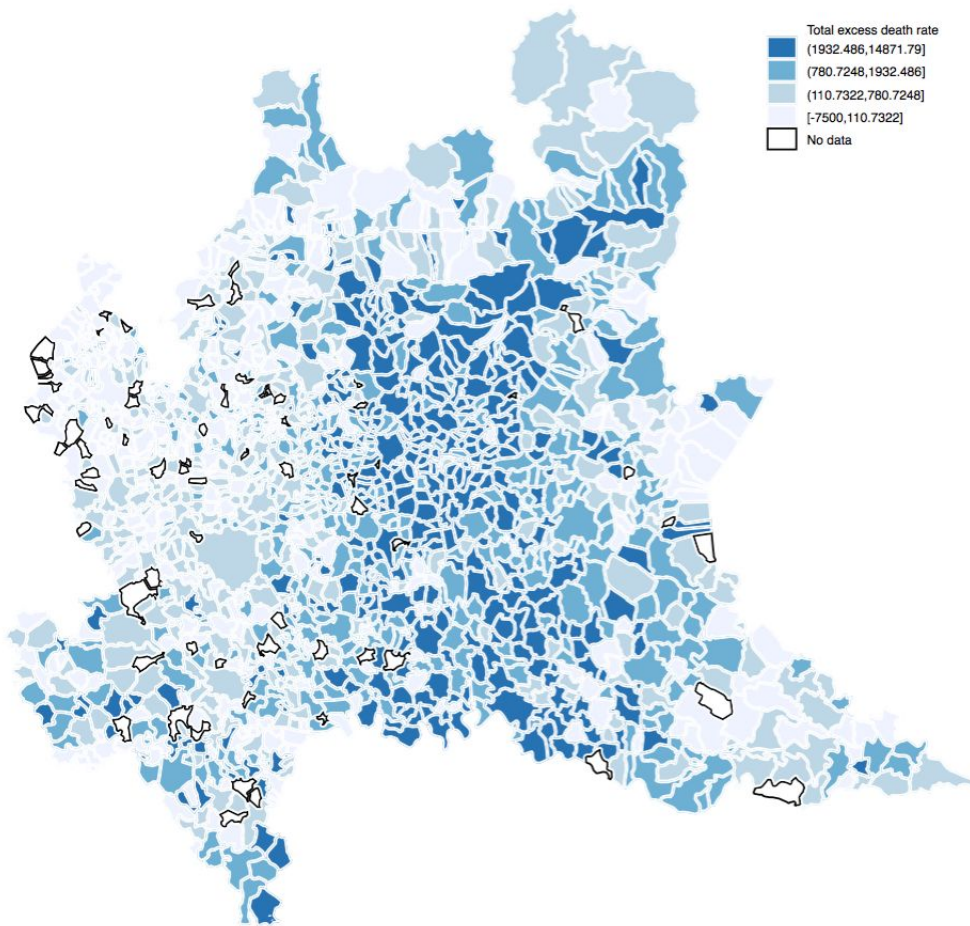
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25 **Figure 1: Care homes and excess mortality rates in Lombardy's municipalities**
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30 Panel A: Care Homes
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Panel B: Excess Mortality

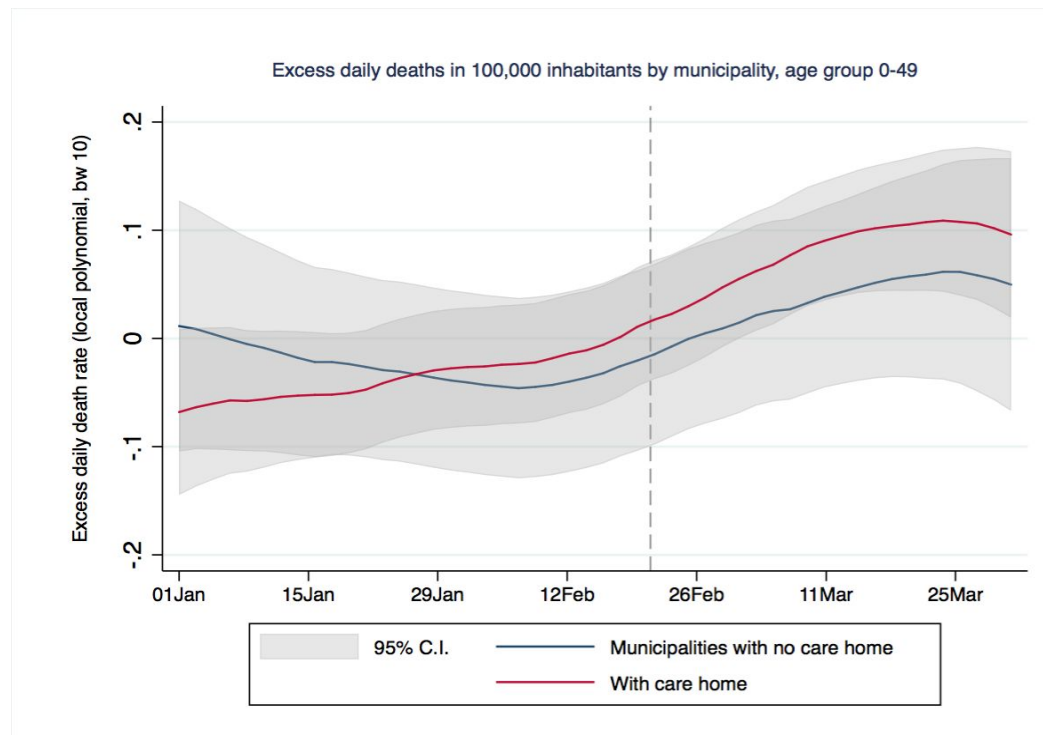


Own elaborations based on Lombardy region, Ministry of Health, and ISTAT data, 2020.

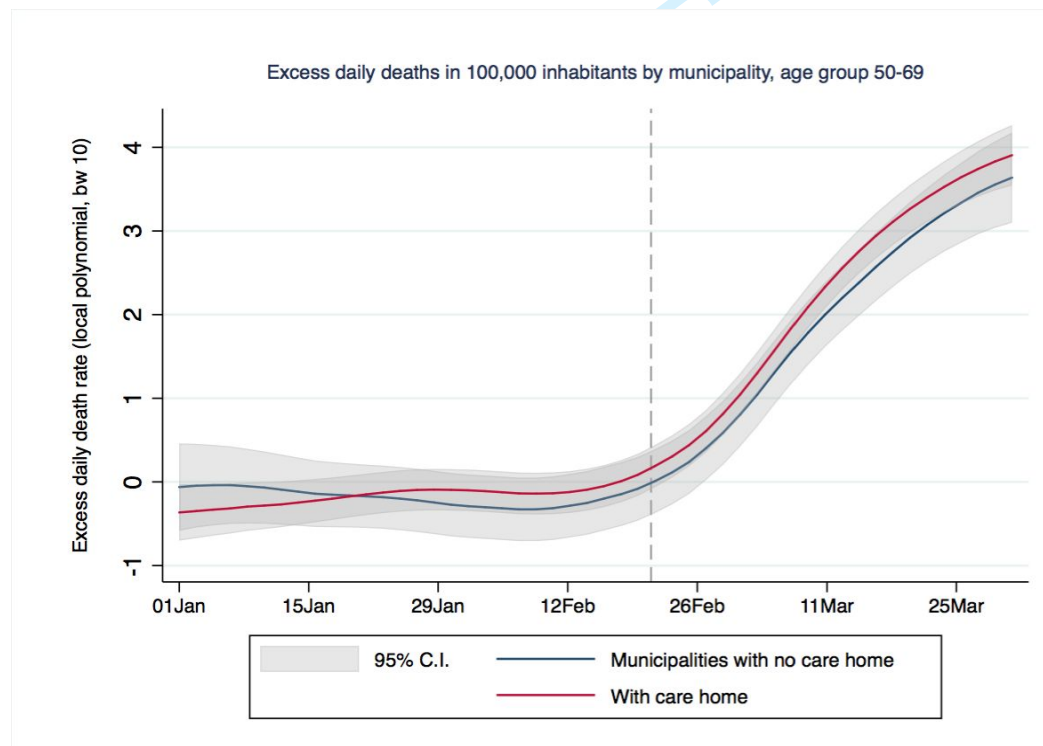
Preview

Figure 2: Excess daily death rates in 2020 in municipalities with and without care homes

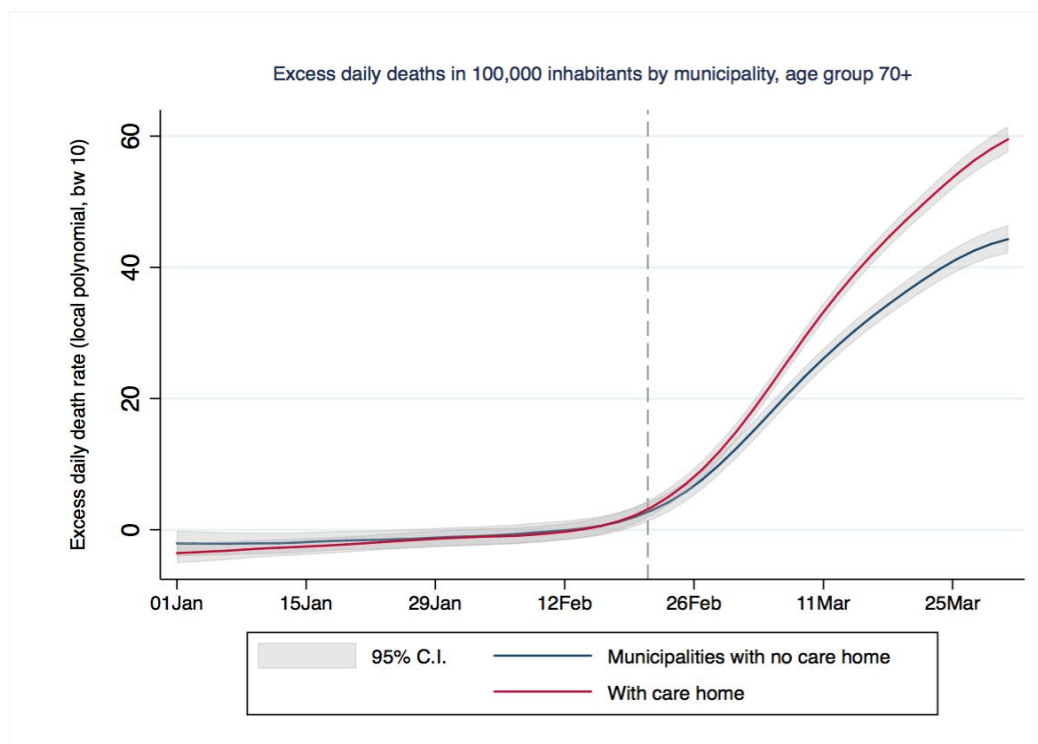
Panel 1



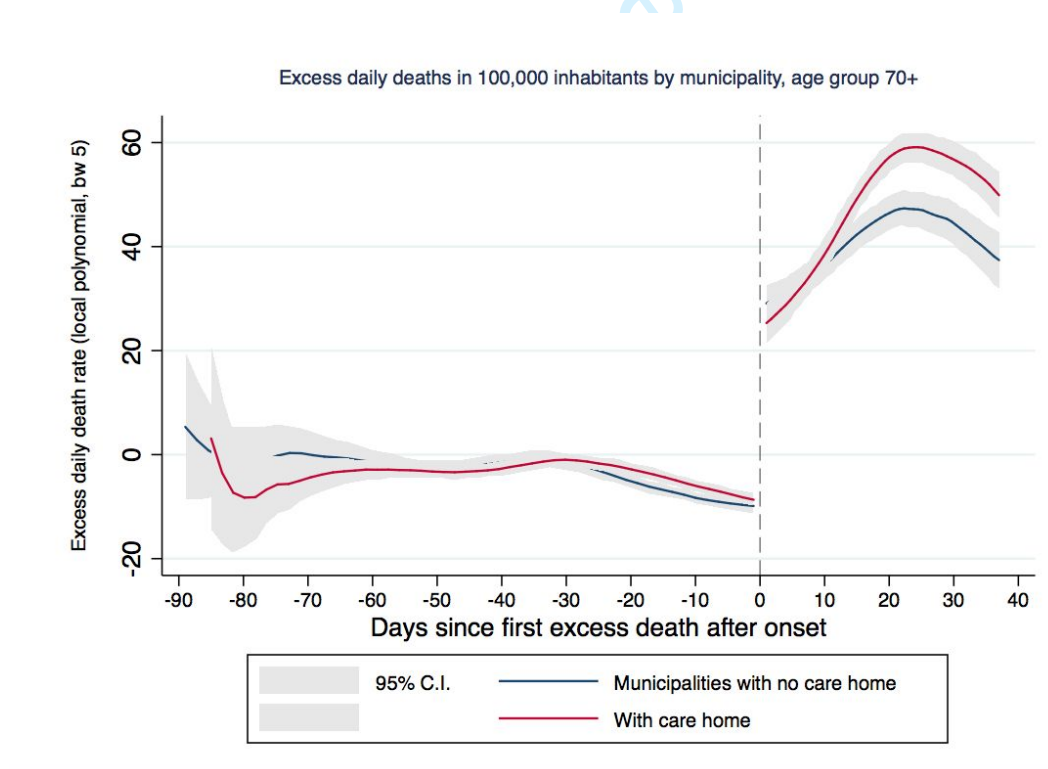
Panel 2



Panel 3



Panel 4



Own elaborations based on ISTAT, Lombardy, and Ministry of Health data (2020). Panel 4 normalises the number of days before and after the first excess death recorded in a municipality within a positive seven-days moving average (day 0), after the regional pandemic onset.

Table 1: Regression estimations of excess mortality in 2020 (1 January - 31 March)

	OLS			SAR	
Outcome:	Excess daily death rate			Total excess death rate	
	(1)	(2)	(3)	(4)	(5)
Age group	70+	50-69	0-49	70+	70+
Care home present	4.912*** (0.875)	0.320* (0.167)	0.00685 (0.0391)	4.36*** (0.793)	4.19*** (0.798)
Spatial Parameter					0.103*** (0.0434)
Observations	129,600	129,600	129,600	1440	1440
R-squared	0.034	0.004	0.001	00.321	0.322
Mean dep. var.	11.60	0.798	0.00364	10.44	10.43
Std dev.	128.1	31.41	6.861	15.59	15.58
Moran I (residuals)				3.630***	
Wald Test					5.790***

Outcome, columns 1-5: daily deaths per 100,000 inhabitants in 2020 minus 2015-2019 average. Additional controls: day FE, province FE; % population 70+, presence of hospital ; % women in age group, first “red

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3 area” municipalities. SE clustered at municipality level. Outcome in columns 6-7: total excess death rate. ***
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For Peer Review

Appendix

A) Difference-in-Differences

We estimate a difference-in-differences (DiD) model to investigate the dynamic of COVID-19-related excess deaths in relation to the presence of care home facilities, according to the following specification:⁽²⁾

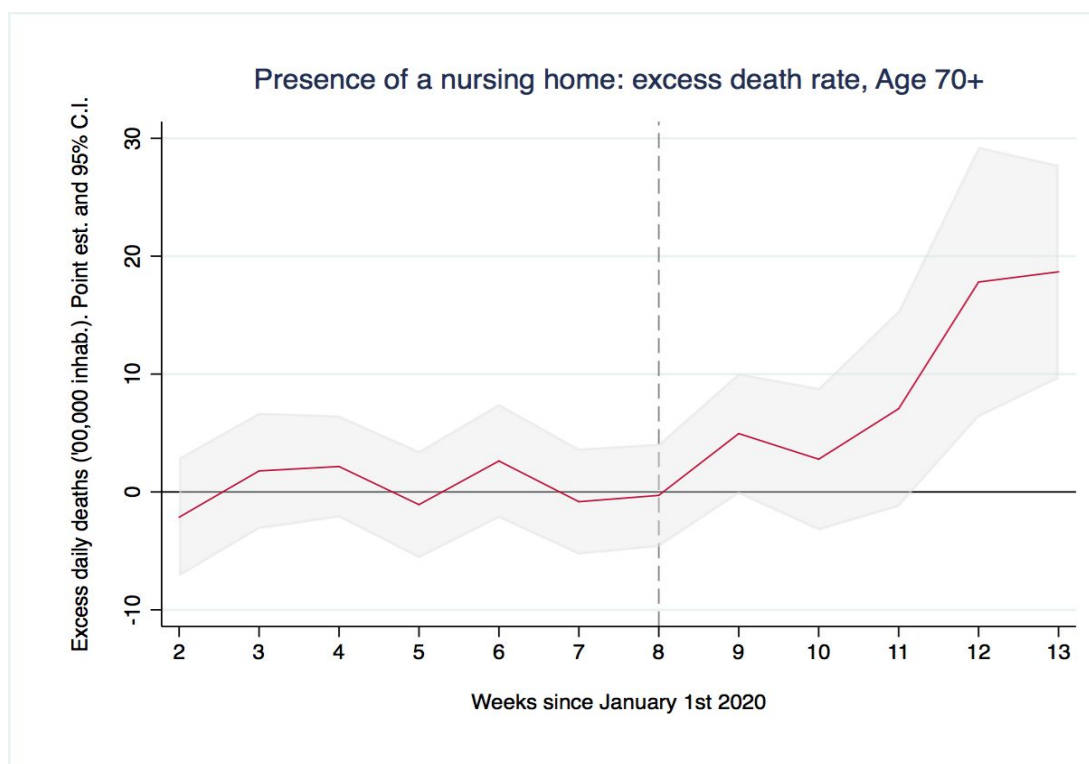
$$\Delta Excess\ Death\ Rate_{d,m}^{age} = \alpha_m + \tau_d + \sum_{w=1}^{13} (\beta_w Week \times CareHome_m) + \vartheta_w + \delta RedArea_{m,d} + \varepsilon_{m,d}^{age}$$

α_m, τ_d , and ϑ_w are municipality, days after January 1st, and week fixed effects. Week w indicates the week after January 1st, 2020; $CareHome$ is a dummy variable for the presence of at least one care home in municipality m , and $RedArea$ indicates the first isolation measure¹. The dependent variable, $\Delta Excess\ Death\ Rate_{d,m}^{age}$ is computed as the difference between the share of daily deaths on the relative age-group population in 2020 (age) and an average of the five previous years' daily death rate. The coefficients of interest (β_w) correspond to the interaction of the presence of a care home with each week. This specification allows us to include municipality-specific fixed effects, which account for all the time-invariant municipality-specific characteristics that may directly or indirectly correlate with death rates and may thus generate an omitted variable bias in OLS-based results.

We plot the $Week \times CareHome$ coefficients relative to the 70+ age group in Figure 3A (full results are available upon request). Week 8 (vertical dash line) corresponds with the onset of the crisis (February 21st). The figure shows that, before the onset of the health emergency (week 8), there was no significant difference in excess daily death rates for municipalities with a care home and those without. The results indicate that, after the 11th week of the year, municipalities with a care home registered significantly higher rates of excess mortality.

¹ See Equation 1

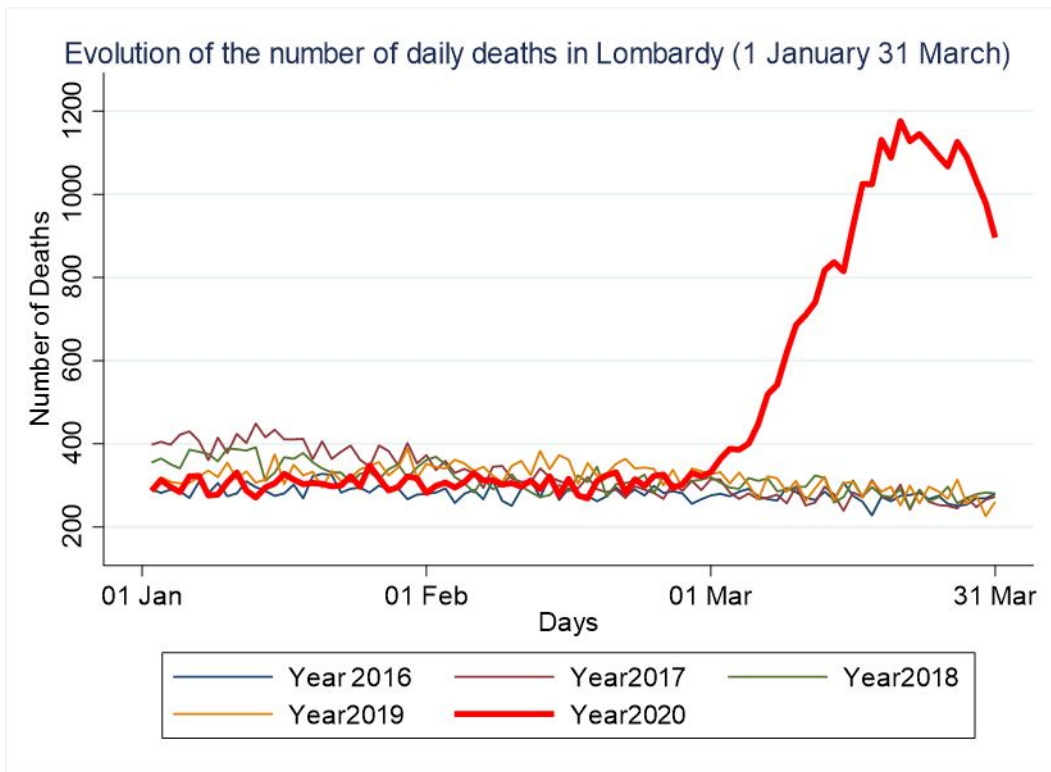
Figure 3A: Excess death rate in municipalities with care homes, DiD coefficients



Coefficients and 95% confidence interval of a difference in differences estimation.

Additional regressors: a dummy variable for the period after the onset (Feb 21st 2020), a “red area”-dummy variable for the first ten municipalities on lockdown since February 23rd, days after Jan 1st FE, and week FE. Standard errors are clustered at the municipality level.

Figure 4A: Trends in daily deaths in Lombardy



Pre Review

Table A1. Descriptive statistics

Variables	Obs.	Mean	St.dev.	Min	Max	Source
Δ Excess daily deaths ('00,000) age 70+	131,040	1.163	12.78	-250	769.23	ISTAT, 2020
Δ Excess daily deaths ('00,000) age 50-69	131,040	0.079	3.12	-95.23	500	ISTAT, 2020
Δ Excess daily deaths ('00,000) age 0-49	131,040	0.0004	0.683	-57.14	138.88	ISTAT, 2020
Δ Excess deaths, total ('00,000) age 70+	1440	10.59	15.78	-75	148.71	ISTAT, 2020
Number of care homes	490	0.47	1.76	1	60	Ministry of Health
Number of hospitals	116	0.12	0.97	1	33	Ministry of Health
Municipality has at least one care home	1440	34.02 %	0.475	0	1	Lombardy region
Municipality has at least one hospital	1440	6.39%	0.24	0	1	Ministry of Health
Number of care home beds by municipality	99	347	940	25	9005	Lombardy region; Ministry of Health
Number of care home beds by municipality (excl. those with >1000)	95	210.35	164.8	25	831	Lombardy region;

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Number of hospital beds	116	255.56	753.84	0	7877	Ministry of Health
“Red area” (lockdown in first ten municipalities, Feb 23rd)	131,040	0.26%	0.05	0	1	Ministry of Health
Share of women 70+	1440	0.568	0.032	0.348	0.714	ISTAT, 2020
Share of women 50-69	1440	0.494	0.024	0.25	0.582	ISTAT, 2020
Share of women 0-49	1440	0.484	0.020	0.30	0.66	ISTAT, 2020
Share of population 70+	1440	0.085	0.019	0.021	0.20	ISTAT, 2020

Table A2 : Regression estimations of excess mortality in 2020 (1 January - 31 March)

Outcome: excess daily death rate, age group 70+						
	(1)	(2)	(3)	(4)	(5)	(6)
			Sample includes all municipalities		Sample includes only municip. with a care home	
Number of care home beds (/100 x Pop. age 70+)	0.272***	0.194			0.139	
	(0.0997)	(0.130)			(0.126)	
Care home present		2.584*	4.912***	4.688***		
		(1.540)	(0.875)	(0.905)		
Large care home present (pc beds > 75p)				5.848***		
				(1.422)		
Per capita beds, quartile 2						0.776
						(1.105)
Per capita beds, quartile 3						0.443
						(1.347)
Per capita beds, quartile 4						3.047*
						(1.668)
Hospital present	-1.094	-2.288**	-3.426***	-3.652***	-4.321***	-4.525***
	(0.916)	(1.017)	(0.992)	(1.036)	(1.182)	(1.300)
Constant	-15.18	-13.06	-27.08*	-15.44	-65.38**	-68.35*
	(12.82)	(13.12)	(14.61)	(13.67)	(33.01)	(36.07)
Observations	129,600	129,600	129,600	129,600	44,100	44,100
R-squared	0.034	0.034	0.034	0.034	0.090	0.090
Mean	11.60	11.60	11.60	11.60	13.71	13.71
Std Dev	128.1	128.1	128.1	128.1	93.34	93.34

Outcome: daily deaths per 100,000 inhabitants in 2020 minus 2015-2019 average among individuals aged 70+.

Per capita care home beds are computed as the share of available care home beds divided by the number of individuals aged 70+ (in hundreds) in a municipality. "Large care home present" in column 4 indicates the presence of a care home with a number of per capita beds equal or higher to the 75th percentile of the distribution. The omitted category in column 4 corresponds to no care homes present. Quartile categories in column 6 identify municipalities in the corresponding segment of the per capita beds distribution. Additional controls in all regressions: day FE, province FE; % population 70+, presence of hospital ; % women in 70+ age group, first "red area" municipalities. SE clustered at municipality level. Legend: *** p<0.01, ** p<0.05, * p<0.1

Table A3: Outcome variable: Excess daily death rate in 2020, seven-days moving average

	(1) 70+	(2) 50-69	(3) 0-49
Care home present	4.487*** (0.882)	0.318* (0.171)	0.0125 (0.0352)
Constant	-30.50** (13.05)	-0.727 (3.968)	0.303 (0.543)
Observations	120,960	120,960	120,960
R-squared	0.161	0.023	0.002
Mean	10.97	0.774	0.000968
Std dev	56.76	12.19	2.366

Outcome: daily deaths per 100,000 inhabitants in 2020 minus 2015-2019 average among individuals aged 70+.

Additional controls in all regressions: day FE, province FE; % population 70+, presence of hospital ; % women in 70+ age group, first "red area" municipalities. SE clustered at municipality level. Legend: *** p<0.01, ** p<0.05, * p<0.1