



COVID-19

Analysis of the correlation between mortality in nursing homes and among elderly population in Italy during the first phase of COVID-19 pandemic

ANTONIO SEBASTIANO¹, UMBERTO RESTELLI^{1,2}, SOFIA SILVOLA¹, ROBERTO PIGNI¹¹ Center for Health Economics, Social and Health Care Management, Università Carlo Cattaneo - LIUC, Castellanza, Italy;² School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

Keywords

COVID-19 • Mortality • Nursing homes • Elderly

Summary

Introduction. The objective of the analysis is to investigate whether there is a correlation between deaths occurred within nursing homes in Lombardy Region and those related to the whole elderly population residing in the municipalities of their location at the beginning of the COVID-19 pandemic.

Methods. The analysis considered a sample of 17 nursing homes belonging to the same legal entity (with a total of 2,197 beds). The changes occurred in the trend of deaths in 2020 between January the 1st and February the 20th, and between February the 21st and April the 4th, compared with the average number of deaths occurred in the same time intervals of the previous three-year period (2017-2019) were investigated. To verify the presence of a correlation between deaths occurring within nursing homes

and those related to the whole elderly population residing in the municipalities of their respective locations, Pearson correlation index was calculated, distinguishing between elderly over 65 years of age and elderly over 85 years of age.

Results. A statistically significant correlation was identified between the number of deaths among the overall population and the number of deaths among nursing homes residents between February the 21st and April the 20th, while no correlations were identified between January the 1st and February the 20th.

Conclusions. The number of deaths occurred in the nursing homes of the sample considered shows similar trends to those of the elderly population of the municipalities in which they are located.

Introduction

Year 2020 will be remembered as that in which SARS-CoV-2 related infections pandemic started. On December the 31st 2019 the first cases of SARS-CoV-2 related pneumonia emerged in the city of Wuhan (Hubei Province, China). SARS-CoV-2 reached 210 countries and territories spreading quickly and widely [1].

Italy is one of the first European countries in which cases of COVID-19 were diagnosed. The first case was diagnosed in Lombardy Region (in February 2020) and further diagnoses followed in other Northern Italian regions, spreading then throughout the whole national territory [2].

Through an analysis of death registry data within 4,100 municipalities in Northern Italy between January the 1st and May the 15th 2020, Ciminelli and colleagues (2020) estimated COVID-19 to be responsible for the death of almost 45,000 persons, more than 0.15% of local residents, during the so called “first wave” of the pandemic [3].

At the beginning of the pandemic, Lombardy was the most affected Italian region, with 37% of total COVID-19 national cases (73,348) and 53% of total COVID-19 related deaths, with a case-fatality rate of 18.3, compared with a national rate of 1.6% [2].

In Italy a broad media emphasis was given between March and April 2020 to the fact that nursing homes

were one of the main sites of COVID-19 spread, however it seems to have ignored that, in the same period, the entire elderly population has been affected by a staggering increase in deaths compared to previous years. This phenomenon involved mainly the regions most affected by the pandemic, as Lombardy, and often with an earlier onset within the communities than within nursing homes.

As reported by Trabucchi and De Leo (2020), in Lombardy, Veneto and Emilia-Romagna (three regions located in Northern Italy with a cumulative population in 2021 of more than 19 million inhabitants, representing more than 32% of the Italian resident population) during the first half of 2020, nursing homes reported commonly “10-15 deaths due to COVID-19 out of 70 guests” [4, 5].

Furthermore, a study conducted by the Italian National Institute of Health showed that between February the 1st and May the 5th 2020, in a sample of 1,356 nursing homes, among 97,521 elderly residents (78% of which in Northern Italy and 28% in Lombardy) 3,092 deaths were attributable to the COVID-19 (48% of which in Lombardy) [6].

The Italian 2020 mortality data, progressively made available by the Italian Institute of Statistics (ISTAT), further supported the hypothesis that the official pandemic data represented only the “tip of the iceberg”,

Tab. I. Percentage variation and total number of deaths between February the 21st 2020 and April the 4th 2020 vs mean value of the 3 previous years in each Italian Region (Source: reprocessing of data published by ISTAT).

Region	Number of deaths between 21 st February and 04 th April				Δ number of deaths (%)
	Years 2017-2019 (mean)		Year 2020		
	Number	% of subjects over 65 years of age	Number	% of subjects over 65 years of age	
Abruzzo	1,770	90.2%	2,045	89.7%	275 (15.5%)
Basilicata	708	88.1%	735	91.4%	27 (3.8%)
Calabria	2,452	88.7%	2,574	89.7%	122 (5.0%)
Campania	6,404	85.3%	6,565	86.2%	161 (2.5%)
Emilia-Romagna	6,113	91.2%	9,819	91.7%	3,706 (60.6%)
Friuli-Venezia Giulia	1,755	90.6%	2,018	92.1%	263 (15.0%)
Lazio	6,593	88.7%	6,516	89.3%	-77 (-1.2%)
Liguria	2,612	91.4%	3,934	93.8%	1,322 (50.6%)
Lombardy	12,212	89.9%	30,962	92.5%	18,750 (153.5%)
Marche	2,034	91.5%	2,940	92.3%	906 (44.5%)
Molise	399	89.5%	396	90.2%	-3 (-0.7%)
Piedmont	6,215	90.2%	9,240	92.2%	3,025 (48.7%)
Apulia	4,742	89.2%	5,236	89.0%	494 (10.4%)
Sardinia	1,919	87.3%	2,197	88.7%	278 (14.5%)
Sicily	6,189	89.1%	6,316	89.5%	127 (2.1%)
Tuscany	5,342	91.4%	5,996	92.4%	654 (12.2%)
Trentino-Alto Adige	1,108	90.1%	1,845	92.2%	737 (66.5%)
Umbria	1,264	91.9%	1,328	92.5%	64 (5.0%)
Valle d'Aosta	171	89.7%	284	93.7%	113 (66.1%)
Veneto	5,681	89.9%	7,021	91.2%	1,340 (23.6%)
Total	75,683	89.6%	107,967	91.2%	32,284 (42.7%)

underestimating the real extent of COVID-19 and subsequent deaths [3, 7].

While an increase in the number of deaths occurred in 2020 compared with previous years, it might not be attributable exclusively to the spread of SARS-CoV-2, the mortality trends observed in the peak period of the pandemic suggests that deaths directly or indirectly attributable to COVID-19 were more than those reported in official data (i.e. people who died at their domicile or in nursing homes not being diagnosed through a swab and a subsequent molecular biology testing).

Starting from these premises, the objective of the analysis presented is to investigate whether there is a statistical correlation between the deaths occurred within 17 nursing homes, belonging to the same legal entity, located in Lombardy (Northern Italy) and those related to the whole elderly population residing in the municipalities of their location.

Methods

The analysis conducted adopted a cumulative approach. The sample of 17 nursing homes considered includes 2,197 beds, with an average number of 130 beds per each nursing home (with a minimum number of beds of 60 and a maximum number of beds of 204). From a territorial point of view, the analysis involved 13 municipalities located in Lombardy (including Milan),

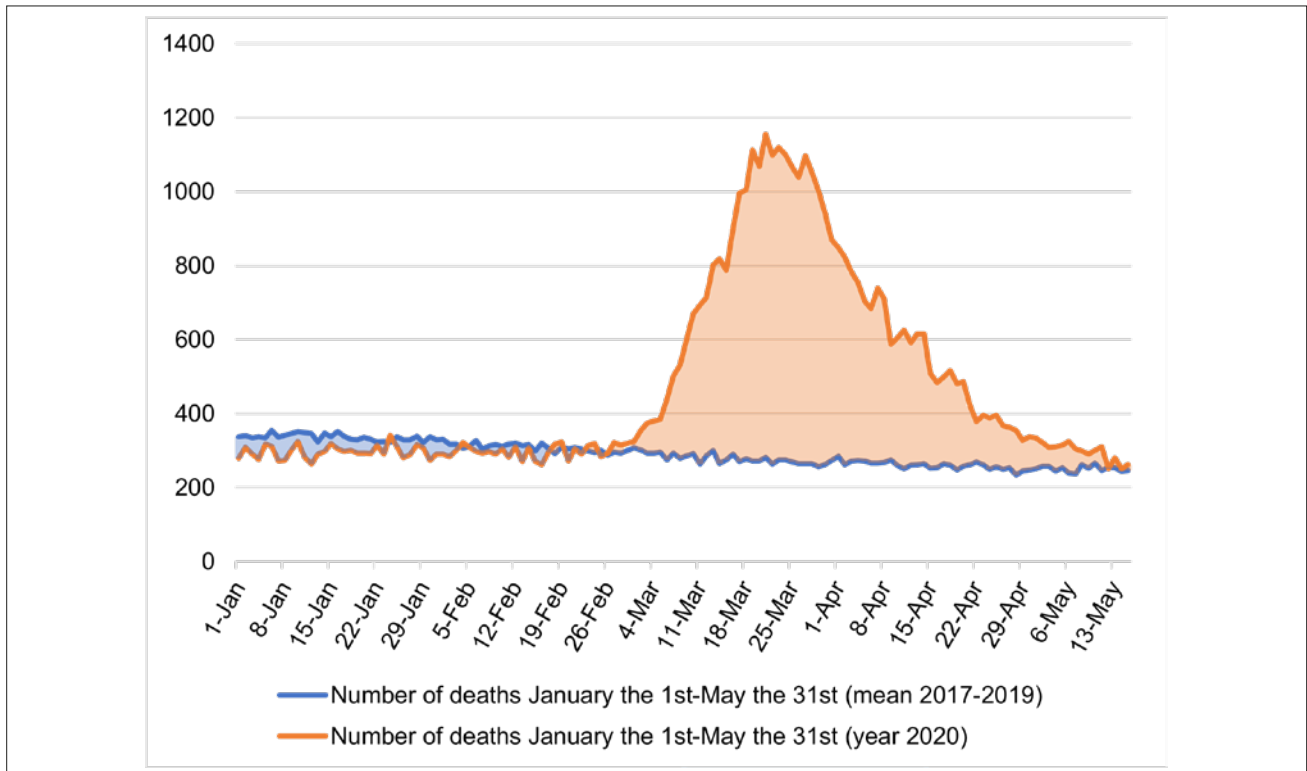
located in 5 different provinces (Bergamo, Brescia, Como, Milan, and Monza e Brianza).

Specifically, the changes that occurred in the trend of 2020 deaths in the period between January the 1st 2020 and February the 20th 2020, and in the period between February the 21st 2020 and April the 4th 2020, compared with the average number of deaths occurring in the same time intervals of the previous three-year period (2017-2019) were studied and analysed. The choice to operate a focus on Lombardy is because it was the Italian Region most affected by the pandemic in the first half of 2020.

As reported in Table I, between February the 21st 2020 and April the 4th 2020, the total number of deaths increased by 153.5% compared with the mean number of deaths in the same period in 2017-2019 and 92.5% of cases were represented by subjects with more than 65 years of age. Data reported refers to the 7,270 Italian municipalities included in the “Anagrafe Nazionale della Popolazione Residente” and the total number of subjects included is equal to 93.5% of the Italian resident population on January the 1st 2019. At a regional level, the percentage of subjects included in the data reported in Table I is between 98.6% (Lombardy) and 78.7% (Molise) of the regional resident population.

The total number of daily deaths occurring in Lombardy from the beginning of the year 2020 to May the 15th 2020 and the average number of daily deaths in the same period in the previous three years (2017-2019) is reported in Figure 1.

Fig. 1. Number of daily deaths in Lombardy between January the 1st 2020 and May the 15th 2020 vs mean value of the previous 3 years (Source: reprocessing of data published by ISTAT).



Concerning the observation period, the choice to stop the analysis on April the 4th 2020 is due to the fact that after this date the variations in deaths on a weekly basis show the consolidation of a trend of continuous and significant decrease, until it returns to values close to those of the previous three years in the last week of May, as reported in Figure 2 (weeks are defined as seven consecutive days intervals starting from the first seven days of March 2020; May the 15th 2020 is the last day in 2020 for which data were available at the time of the analysis from the Italian Institute of Statistics).

With the aim of verifying the presence of a correlation between deaths occurring within nursing homes and those related to the whole elderly population residing in the municipalities of their respective locations, Pearson correlation index was calculated. The index was calculated as the percentage ratio between deaths that occurred in the nursing homes of the sample in 2017-2019 and 2020 (pre-pandemic and pandemic periods), and the percentage ratio between deaths recorded in the overall elderly population of the respective municipalities in 2017-2019 and 2020 (pre-pandemic and pandemic periods), distinguishing between elderly over 65 years of age and elderly over 85 years of age. This choice is due to the fact that the latter is the main catchment area of nursing homes. In this regard, data published by the Sectorial Observatory on Nursing Homes at LIUC University reports an average age at admission to Nursing Homes in Lombardy of 84.6 years between 2013 and 2018 [8].

The comparison between the number of deaths occurred

in the elderly population within the municipalities in which the nursing homes included in the sample are located is presented in Table II, along with the number of deaths occurred in the nursing homes, between January the 1st and February the 20th, and between February the 21st and April the 4th in the pre-pandemic period (mean value 2017-2019) and pandemic period (2020).

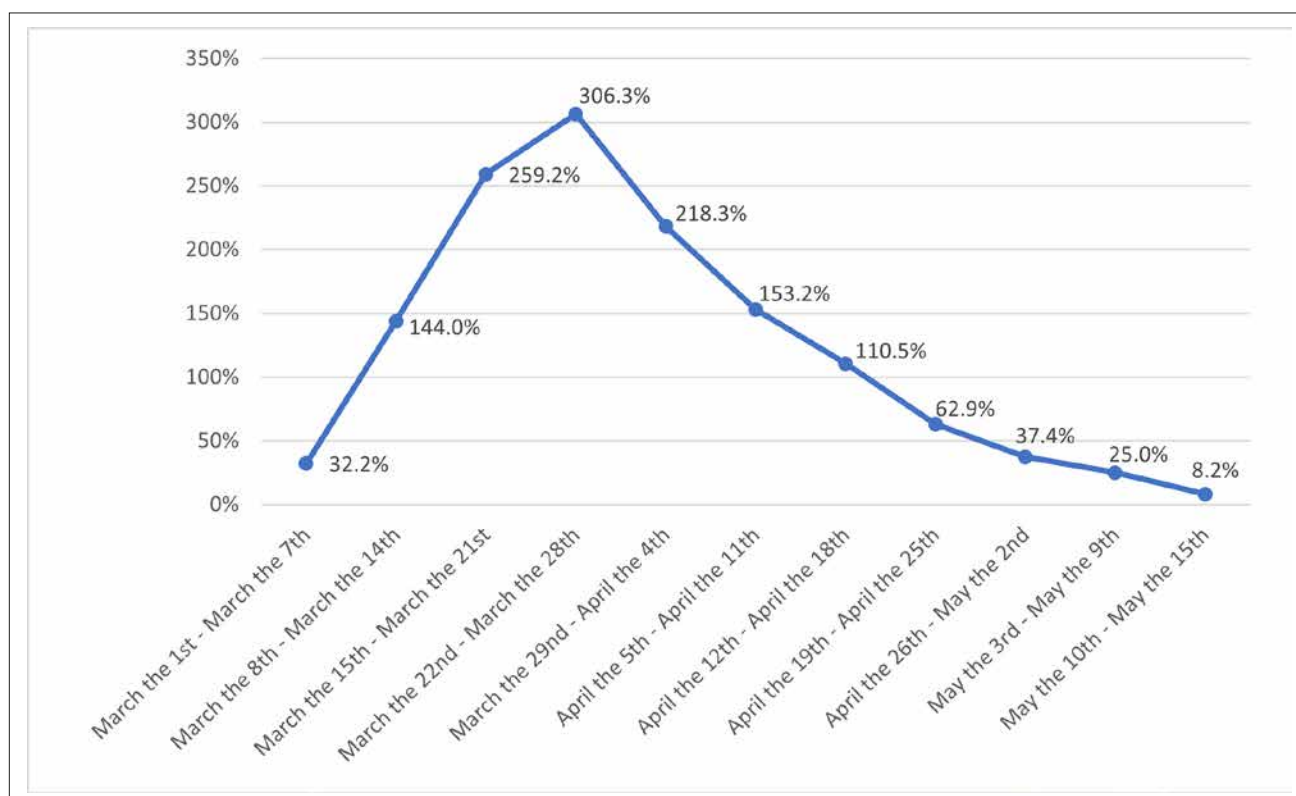
Results

The correlation coefficients between the number of deaths in the overall resident population and the number of deaths among the residents of the nursing homes included in the sample between January the 1st and February the 20th, and between February the 21st and April the 4th in the pre-pandemic period (mean value 2017-2019) and pandemic period (2020) are reported in Table III, both considering subjects over 65 years of age and subjects over 85 years of age.

In the period prior to the outbreak of the pandemic there is no statistically significant correlation between the number of deaths among the overall population and the number of deaths among nursing homes residents (both considering subjects over 65 years and over 85 years).

On the contrary, these correlations are both statistically significant between February the 21st and April the 4th, even assuming a rather significant intensity, especially with reference to the segment of the subjects over 85 years, as reported in Figure 3. Given that the correlation index does not express a causal link, it is plausible

Fig. 2. Percentage variation in the number of weekly deaths between March the 1st 2020 and May the 15th 2020 vs the mean value of the 3 previous years.



Tab. II. Number of deaths occurred in the nursing homes, between January the 1st and February the 20th, and between February the 21st and April the 4th in the pre-pandemic period (mean value 2017-2019) and pandemic period (2020).

	Resident population (age ≥ 65)		Resident population (age ≥ 85)		Nursing home residents (age ≥ 65)	
	January 1 st - February 20 th	February 21 st - April 4 th	January 1 st - February 20 th	February 21 st - April 4 th	January 1 st - February 20 th	February 21 st - April 4 th
Number of deaths 2017 - 2019 (mean)	2,974	2,105	1,694	1,148	139	95
Number of deaths 2020	2,478	4,199	1,415	2,304	146	265
Δ 2020 / mean 2017-2019 (N)	-496	+ 2,094	-279	1,156	7	170
Δ 2020 / mean 2017-2019 (%)	-16.68%	99.51%	-16.47%	100.70%	4.78%	177.97%

to suppose that mortality within each nursing home was conditioned by the spread of the pandemic in the relative municipalities of location and that the guests of the nursing homes were exposed to a greater risk of contagion and, consequently, of mortality, in the areas in which there was a greater spread of the SARS-CoV-2.

The underlying hypothesis is reinforced by two relevant aspects. The first is the absence of statistical correlations between the number of deaths in the overall resident population and the number of deaths among nursing homes residents in the pre-pandemic period (January the 1st - February the 20th).

The second aspect is to be found in the fact that all the nursing homes included in the sample, can be traced back to a common legal entity that managed at a unitary level the adoption of every single measure of prevention and contrast to the spread of the pandemic

from the definition of protocols and safety procedures to the procurement of personal protective equipment (surgical masks/FPP2, disposable gowns, disposable gloves, visors/glasses, etc.). The decision-making discretion of each nursing home was therefore reduced to a minimum, and they therefore faced the pandemic with a homogeneous approach and equal resources at their disposal.

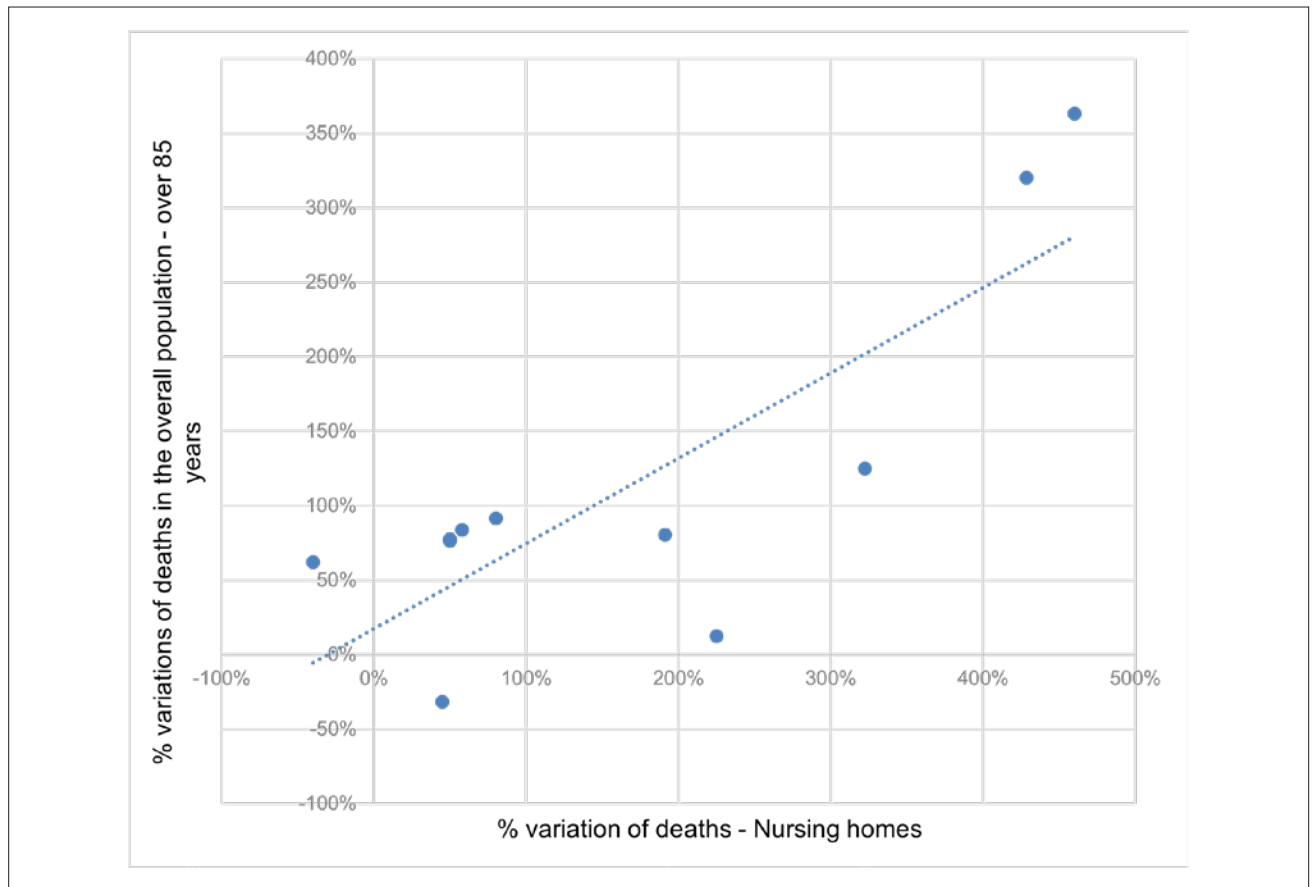
Discussion and conclusions

Nursing homes residents are mainly elderly (over 85 years) non-self-sufficient subjects, with several comorbidities and frequent cognitive impairment, and prognostic indicators compatible with a reduced life expectancy. As confirmed in literature, elderly patients, patients with

Tab. III. Correlation coefficients between the number of deaths in the overall resident population and the number of deaths among nursing homes residents between January the 1st and February the 20th, and between February the 21st and April the 4th in the pre-pandemic period (mean value 2017-2019) and pandemic period (2020).

	Correlation coefficient of the number of deaths	
	Pre-pandemic period January the 1 st - February the 20 th	Pandemic period February the 21 st - April the 4 th
Subjects over 65 years of age - overall population / nursing homes residents	0.40	0.67**
Subjects over 85 years of age - overall population / nursing homes residents	0.47	0.81**

Fig. 3. Scatter plot on the percentage variations of deaths in the two periods considered among the overall population over 85 years and residents of the nursing homes included in the sample.



comorbidities (chronic obstructive pulmonary disease, cardiovascular disease, hypertension) and patients with dyspnoea are more vulnerable to more severe morbidity and mortality related to COVID-19 [9, 10]. These elements might explain the high level of lethality of SARS-CoV-2 infection within nursing homes, also considering that they are not designed for isolation, but, on the contrary, they are integrated into the communities in which they are located, as well as strongly oriented to ensure frequent moments of socialization between residents.

Despite this, the number of deaths occurred in the nursing homes of the sample considered shows similar trends to those of the elderly population of the municipalities in which they are located.

A retrospective study conducted by Veronese and

colleagues (2021) confirmed that, considering different degrees of frailty of nursing home residents, COVID-19 was associated with a higher risk of all-cause mortality than those not infected [11].

Moreover, as reported in Table IV, extending the period of observation to May the 15th, the highest variations in the number of deaths between 2020 and 2017-2019 are observed in the 75-85 years age group (+ 128.1%) and in the 65-74 years age group (+ 126.0%), the latter being under-represented among nursing homes residents due to younger age. The deaths of subjects in the 65-74 years age group are likely to have been occurred at domicile, which should then not be considered a safer place than nursing homes and/or other residential services for the elderly population.

Tab. IV. Percentage variation and number of deaths in Lombardy per age group between February the 2nd 2020 – May the 15th 2020 and the mean value of the previous 3 years (2017-2019)-

Age group	Number of deaths February the 2 nd - May the 15 th		Δ number of deaths (%)
	Mean 2017-2019	Year 2020	
0-14 years	69	61	-8 (-11.6%)
15-64 years	2,315	3,705	1,390 (60.1%)
65-74 years	2,960	6,690	3,730 (126.0%)
75-84 years	6,799	15,511	8,712 (128.1%)
85 years and more	10,537	22,636	12,099 (114.8%)
Total	22,680	48,603	25,923 (114.3%)

The most important interventions to protect nursing homes residents from COVID-19 reported in literature are the implementation of clear procedures to contain the virus, the ability to isolate any positive case and the availability of personal protection equipment [10]. On this topic, Kosar and colleagues (2021) conducted a study in the United States among 12,271 nursing home residents, and reported that mortality rates among nursing home residents declined from March 2020 to November 2020 identifying as potential explanatory factors the improvements in personal protective equipment supply and use, and specific changes in the clinical management of COVID-19 [12].

Furthermore, a study conducted in the Spanish context found a statistical correlation between mortality in nursing homes and a lower staff to a resident ratio, showing “a 0.44 percentage point reduction in the share of nursing home fatalities for each additional staff per place” [13]. Finally, a study conducted in the United States confirmed these latest findings by stating that “nursing homes with higher registered nurse staffing have the potential to better control the spread of the novel coronavirus and reduce deaths” [14].

The results of the analysis conducted should be taken into due consideration while re-organizing the actual territorial system of long-term care, in order to avoid distorting prematurely and in an unjustified way the role of nursing homes within the supply chain of services for non-self-sufficient subjects.

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Conflict of interest statement

Authors declare no conflict of interest.

Authors' contributions

AS: study conception and design, data collection, data analysis, interpretation of data, drafting of the manuscript; RP: data collection, data analysis, interpretation of data, editing and critical revision of

the manuscript; SS, UR: support on data collection, support on interpretation of data, editing and critical revision of the manuscript. All authors have read and approved the final manuscript.

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Correspondence: Umberto Restelli, Corso Matteotti 22, 21053, Castellanza (VA), Italy. Tel.: + 39 0331 572346 - E-mail: urestelli@gmail.com

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