

Long-Term Care Facilities as a Risk Factor for Death Due to COVID-19: Evidence from European Countries and U.S. States

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Abstract

Background:

A large percentage of the deaths from COVID-19 occur among residents of long-term care facilities. There are two competing explanations for this phenomenon. First, the structural features of such settings may lead to death. Alternatively, individuals living in these facilities are in poorer health than those living elsewhere, and they would have died even if they had not been in these facilities. Using both European and U.S. data, we examine these competing hypotheses.

Methods:

We collected data on Covid-19 mortality rates and on the number of long-term care beds, in each of (1) thirty-two European countries and (2) the fifty U.S. states. We estimate a linear and a log/log regression with robust standard errors, controlling for other relevant factors: people over the age of 75, hospital bed capacity and population density.

Results:

We find that there is a significant positive association between the number of long-term care beds (LTCB) per capita and COVID-19 mortality rates. Moreover, LTCB capacity explains 45 (19) percent of the variation in mortality rates among European countries (US states) that remains after controlling for the other factors.

Conclusions:

This finding provides support for the claim that long-term care living arrangements of older people are a significant risk factor for dying from COVID-19. These findings raise policy implications. Efforts should be geared to protecting older adults living in long-term care settings. Policy makers might even consider alternative dwelling options during the epidemic period, such as encouraging residents to live with their families whenever possible.

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1. Introduction

A large percentage of the deaths worldwide from COVID-19 have occurred among residents of long-term care institutions.² Public media had reported that deaths due to COVID-19 among such long-term care residents could account for more than 50% of all COVID-19 deaths in Europe and the U.S. The U.S. Center for Disease Control and Prevention (CDC) has formally stated that generally, people 65 years and older, and in particular “People who live in a nursing home or long-term care facility” are at high-risk for severe illness from COVID-19.

There are two competing explanations for the higher COVID-19 mortality rates in long-term care facilities:

1. The structural features of such settings, such as a communal living area, multiple residents in a room, care provided by multiple caregivers to multiple care recipients, etc., increase the chances of infection and death.
2. Individuals living in these facilities are in poorer health than those living outside of such facilities and they would have been likely to die even if they had not been living in these facilities.

These two explanations have different policy implications. This paper examines the two competing explanations by studying the association between long-term care beds per capita and COVID-19 deaths per capita³ in European countries and U.S. states.

1.1 Related Literature

Ciminelli and Garcia-Mandicó (2020a) examine the effectiveness of different lockdown policies in Italy using death registry data. They find that shutting down non-essential services reduced COVID-19 mortality, while closing factories did not. Sá (2020) uses data on infections and mortality for small regions in England and Wales to study the association between socioeconomic factors and COVID-19. They find that areas with large households and areas with greater use of public transport have higher infection rates. Ciminelli and Garcia-Mandicó (2020b) show that within the area of the epidemic epicenter in Italy, the COVID-19 mortality rate was up to 50% higher in municipalities far from an intensive care unit (ICU.) Bayer and Kuhn (2020) attribute some of the difference in COVID-19 fatality rates to intergenerational interactions. None of these papers examines how LTCB per capita are associated with COVID-19 mortality.

² See Comas-Herrera et. al. (2020).

³ The death rates are for the country or the state as a whole, not just the older population.

2. Analysis Using Data from European Countries and U.S. States⁴

This research seeks to examine the factors that are associated with the death rate from COVID-19, and, in particular, the number long-term care beds.

2.1 Data⁵

The data employed in the study are

- Deaths = deaths from COVID-19 per million residents⁶
- LTCB = number of long-term care beds per million residents⁷
- Over75 = number of persons over the age of 75 per million residents
- HospBeds = number of hospital beds per million residents
- PopDen = population density: residents per square kilometer

In the case of Europe, we include all European countries for which we have data on long-term care beds with more than 600,000 residents.⁸ In the case of the U.S. we included all fifty states and Washington D.C.⁹

Figure 1a shows a scatter plot of COVID-19 deaths per million residents in relation to long-term care beds per million residents for European countries. The figure shows that there are large variations in each of the variables and suggests that there is a positive association between them. Figure 1b a similar scatter plot for U.S. states, and is qualitatively similar to Figure 1a. Descriptive Statistics are shown in Table 1.

Table 2 reports the correlations among the natural logarithm of the variables.¹⁰ The natural logarithm of long-term beds per million is positively correlated with the natural logarithm of COVID-19 deaths per million for both European Countries (0.53) and U.S. states (0.43).¹¹

⁴ We run the analysis separately because the European and U.S. definitions of long-term care beds are different.

⁵ Data sources are in the appendix.

⁶ We wanted to use data after the “first wave.” Hence, for Europe we use data from mid-May and from the U.S. we use data from mid-June.

⁷ The U.S. definition is of LTCB in the U.S. is as follows: nursing facility residents in certified nursing facilities surveyed in the U.S. The European Health Information Gateway, which is the source for the European data, defines for long-term care beds as “beds available for people requiring long-term care in institutions (other than hospitals.) Although the quality of the settings, and their structures may differ, the facilities included are consistent and well-defined in both the U.S. and Europe.

⁸ We exclude two small islands, Iceland and Malta. We also excluded Russia and Turkey, since these countries are primarily in Asia. Results are unchanged if we include Russia and Turkey.

⁹ The results are unchanged if we exclude Washington D.C., Alaska and Hawaii.

¹⁰ As we discuss below, the log/log model, where the variables appear in logarithms is our preferred model.

¹¹ In the case of the levels, the correlation between the variables is 0.45 for European countries and 0.31 for U.S. states.

3 Statistical Model

Our regression equation has COVID-19 Deaths per million (Deaths) on the left-hand side. On the right side of the equation, we include long-term care beds per million (LTCB), as well as the other variables: persons 75 and older per million (Over75), hospital beds per million (HospBeds) and the population density (PopDen), all of which are exogenous:

$$(1) \text{ Deaths} = \beta_0 + \beta_1 * \text{LTCB} + \beta_2 * \text{Over75} + \beta_3 * \text{Hosp.Beds} + \beta_4 * \text{PopDen} + \varepsilon.^{12}$$

The coefficient of interest is β_1 , which is the association between LTCB per capita and the deaths per capita after controlling for the other three factors. ε is the error term. Since the right hand side variables are exogenous, we estimate this equation using ordinary least squares.¹³

From Figures 1a and 1b, it appears that the variance of the dependent variable increases with the number of long-term care beds. Hence, we use robust standard errors, which is the standard way to address this issue.

3.1 Analysis and Results:

In Column 1 of Table 3, we estimate a linear model using equation (1) for Europe. In this case, we find that the estimated coefficient on long-term care beds is positive and statistically significant at the 95 percent level of confidence. In column 2, we estimate (1) using a log/log model. The results are qualitatively similar to those of the linear model in Column 1; the estimated coefficient on long-term care beds is positive and statistically significant at the 99 percent level of confidence. The table also shows that the four factors in the log/log model explain 67 percent of the variation in the death rate for European countries (versus 53 percent for the linear model.) We prefer the specification of the log/log model since it provides much better fit and both models provide qualitatively similar results.

Columns 3 and 4 show that the results for the U.S. regarding the association between long-term care beds and deaths is qualitatively similar to those using European countries. The estimated coefficients on long-term care beds is positive and statistically significant at the 99 percent level of confidence for both the linear and log/log models.

To get a sense of how much of the variation in deaths rate LTCB alone explains, we first include just the other three factors. In the case of Europe, the model explains 40 percent of the variation

¹² This equation can be derived from a statistical model. Details are available from the authors.

¹³ In the robustness analysis, we include many other factors in the regression as well and our results are qualitatively unchanged.

in the death rates among countries. By adding LTCB per capita, the model explains 67 percent of the variation in the death rates in the death rates among countries. Thus, LTCB explains an additional 45 percent of the variation in death rates!¹⁴ In the case of the U.S., LTCB explains an additional 19 percent of the variation in death rates!

Robustness Analysis

Additionally, after controlling for other factors as well that may also be associated with COVID-19 mortality rates, such as Gross Domestic Product (GDP) per capita, and a mobility index, LTCB per capita remains positively associated with deaths per capita and the effect is statistically significant for both Europe and the U.S.

Further, we find that additional health (risk) factors that are associated with mortality from COVID-19 (like diabetes and obesity) explain virtually none of the variation in the death rates from COVID-19. This is true both for European countries and U.S. states. When we add these variables to the right hand side of equation (1,) we find that their estimated coefficients are not significantly different from zero. Further, and critically important for our main result, adding these variables to the regression does not affect the estimated coefficient on long-term care beds.¹⁵

4. Discussion and Further Work

Using (I) country-level data from Europe and (II) state-level data from the United States, and controlling for the percentage of older adults in the population, the number of hospital beds per capita, and the population density, we find that there is a significant positive association between the number of long-term-care beds per capita and total COVID-19 mortality rates in European countries and U.S. states. This finding supports the thesis that living in long-term care facilities presents a significant mortality risk factor for older people contracting COVID-19. The fact that the results regarding the association between long-term care beds per capita and death rates per capita are qualitatively similar across European countries and U.S. states suggests that they are robust. Our results also provide a partial, preliminary explanation as to why the death rates from COVID-19 differ so widely both among European countries and among U.S. states.

Our results suggest that the structural features of such settings are associated with death from COVID-19. In European countries and U.S. states with more long-term care beds per capita,

¹⁴ The calculation is $(67-40)/60=0.45$, where 67 percent is the amount of unexplained variation without LTCB per capita in the regression.

¹⁵ The results from the analysis in this section are available from the authors upon request.

the death rate from COVID-19 is higher. These findings raise policy implications. In particular, efforts should be geared to protecting older adults living in long-term care settings. Policy makers might even consider alternative dwelling options during the epidemic period, such as encouraging residents to live with their families whenever possible.

It appears that additional regional and county data concerning long-term care facilities may be available in the next few months, allowing us to continue and improve our analysis. The one European country that did have such regional data available was Italy. The correlation of deaths per capita and long-term care beds per capita is 0.74 in the case of twenty Italian regions.

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Appendix:

Data Sources

Description	Source	Notes
European Long-term care beds	https://gateway.euro.who.int/en/indicators/hfa_491-5101-number-of-nursing-and-elderly-home-beds/visualizations/#id=19556&tab=table	Primarily from 2015
European COVID-19 deaths	https://www.worldometers.info/coronavirus/	Data ss of May 13, 2020
European Demographic statistics	https://www.cia.gov/library/publications/the-world-factbook/docs/rankorderguide.html	2020 (Est.)
Italy regional long-term care beds	http://dati-anziani.istat.it/index.aspx?lang=en&SubSessionId=83aaf6dc-879c-457e-abe0-ce4781c6f43a	2016 Data
Portugal long-term care beds	Lopes, H., Mateus, C, Hernández-Quevedo, C. (2018) ¹⁶	2016 Data
Italy regional COVID-19 statistics	https://statistichecoronavirus.it/regioni-coronavirus-italia/toscana/	Data as of May15, 2020
European Population density by Country	https://covid.ourworldindata.org/data/owid-covid-data	Year 2020 (Est.)
European population 75 and older by Country	https://population.un.org/wpp/Download/Standard/Population	Year 2020 (Est.)
European Hospital Beds by Country	https://data.oecd.org/health/hospital-beds.htm https://datarepository.wolframcloud.com/resources/OECD-Data-Hospital-Beds-Per-Country	2016, as reported by the Wolfram Data Repository
U.S.A population 75 and older	https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-detail.html	Year 2019 (Est.)
U.S.A hospital beds	https://www.kff.org/health-costs/issue-brief/state-data-and-policy-actions-to-address-coronavirus/?utm_source=web&utm_medium=trending&utm_campaign=covid-19	Data as of 2018
U.S.A Long-term care beds	https://www.kff.org/other/state-indicator/number-of-nursing-facility-residents/ ¹⁷	Data as of 2017
US Population Density	Wolfram Alpha	
US COVID-19 deaths	https://github.com/CSSEGISandData/COVID-19	As of June 18

¹⁶ Ten Years after the Creation of the Portuguese National Network for Long-Term Care in 2006: Achievements and Challenges. Health Policy.

¹⁷ Kaiser Family Foundation analysis of Certification and Survey Provider Enhanced Reports data

Table 1: Descriptive Statistics (Europe and US)

Variable	Mean	Std. Error	Minimum	Maximum
Deaths per million	153 294	198 340	5 12	760 1,449
LTCB per million	6,196 4,246	3,945 1,629	81 831	12,140 7,492
Over75 per million	87,923 69,607	16,638 9,640	59,154 41,403	118,515 94,608
Hospital Beds per million	5,897 2,431	1,968 646	2,200 1,460	11,200 4,484
Population Density	124 138	96.6 519	14.5 0.43	412 3,723

- Black - 32 European Countries. Red - 50 US States and Washington D.C.

Table 2: Correlations among the natural logarithm of the Variables (Europe and US)

- Black - 32 European Countries. Red – 50 US States and Washington D.C.

	Deaths	LTCB	Over75	HospBeds	PopDen
Deaths per million	1.00				
LTCB per million	0.53 0.43	1.00			
Over75 per million	0.29 0.13	0.15 0.52	1.00		
Hospital Beds per million	-0.40 -0.09	0.13 0.61	-0.13 0.21	1.00	
Population Density	0.43 0.71	0.09 0.31	-0.05 0.20	-0.01 -0.18	1.00

Table 3: Estimates from Equation (1): European Countries and US States

	European Countries		US States	
	Linear Model (1)	Log/Log (2)	Linear Model (1)	Log/Log (2)
LTCB per million	0.013** (0.0056)	0.59*** (0.086)	0.13*** (0.032)	1.23*** (0.44)
Over75 per million	0.0013 (0.0016)	1.14 (1.10)	0.00030 (0.0028)	-1.36 (1.10)
Hospital Beds per million	-0.030** (0.014)	-1.79*** (0.33)	-0.29*** (0.071)	-1.17** (0.50)
Population Density	0.95** (0.37)	0.65*** (0.11)	0.26*** (0.058)	0.41*** (0.063)
R ²	0.53	0.67	0.39	0.60
N	32	32	51	51

Dependent Variable: Deaths per million

Robust Standard Errors in parentheses

***= significant at 99% level, **= significant at the 95% level, and *= significant at the 90% level.

Figure 1a: COVID-19 Deaths per capita versus LTCB per capita: 32 Countries: logarithmic scale.

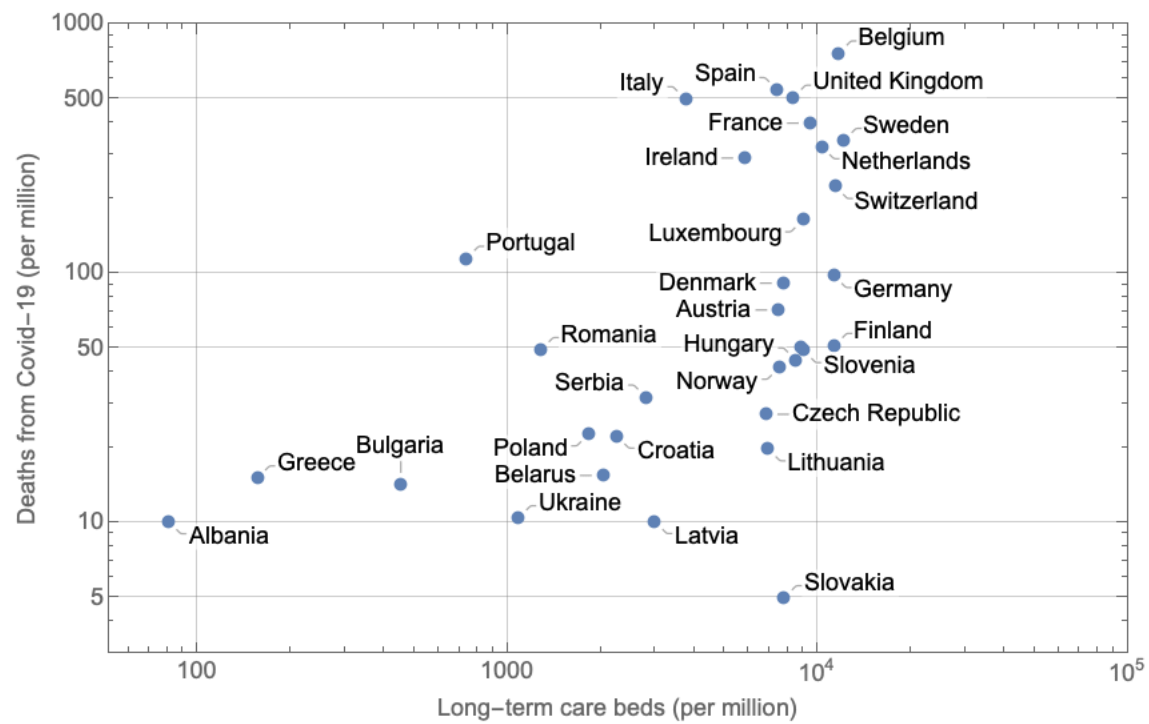


Figure 1b: COVID-19 Deaths per capita versus LTCB per capita: US States + DC: logarithmic scale.

