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RESEARCH ARTICLE

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

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ABSTRACT

**Background:** A large percentage of the deaths from the first wave of COVID-19 in 2020 occurred among residents of long-term care facilities .

**Objective:** 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 .

**Methods:** Using both European and U.S. data, we empirically examine these competing hypotheses, which have very different public policy implications. 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.

**Results:** Controlling for other relevant factors, we find that there is a significant positive association between the number of long-term care beds per capita in a country or state and overall COVID-19 mortality rates in countries and states.

**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 an epidemic period, such as encouraging residents to live with their families whenever possible.

**Introduction:**

A large percentage of the deaths worldwide from the first wave of COVID-19 in 2020[ii] occurred among residents of long-term care institutions.[iii] 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 capita[iv] in European countries and U.S. States during the first wave of COVID-19 in 2020.

The background for this research is that a large percentage of the deaths from the first wave of COVID-19 in 2020 occurred among residents of long-term care facilities.

Our methodology is as follows: Using both European and U.S. data, we examine these competing hypotheses, which have very different public policy implications. 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, as well as health risk factors such as hypertension, diabetes and obesity.

Our main result is the following: Controlling for other relevant factors, we find that there is a significant positive association between the number of long-term care beds per capita in a country or state and overall COVID-19 mortality rates in countries and states. (Just to be clear, we are explaining overall/total death rates, not death rates in long term care facilities.) Moreover, and importantly, the variable "long-term care beds" capacity explains 45 (19) percent of the variation in mortality rates among European countries (US states) that remains after controlling for the other factors. This is quite a large amount given that we have controlled for other key risk factors.

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 which we discuss in the final section of the paper.

**Literature:**

Before beginning the analysis, we review the relevant literature related to the first COVID-19 wave. Ciminelli and Garcia-Mandicó (2020) 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. Bayer and Kuhn (2020) attribute some of the difference in COVID-19 fatality rates to intergenerational interactions. Onder et al (2020) examined the Italian fatality rate and the characteristics of the patients who died using data from the first wave in Northern Italy. Comas et al (2020) examine mortality associated with COVID-19 outbreaks in care homes for various countries. Using US data, Chen et al (2020) show that connections between staff working at multiple nursing homes predict future COVID-19 cases. None of these papers examines how long-term care beds per capita are associated with COVID-19 mortality.

**Methods:**

Our analysis uses data from European Countries and U.S. States.[v] 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.

The key data[vi] employed in the study are

- Deaths = deaths from COVID-19 per million residents[vii]
- Long-term care beds (LTCB) = number of long-term care beds per million residents[viii]
- 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.[ix] In the case of the U.S. we included all fifty states and Washington D.C.[x]

**Results:**

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.

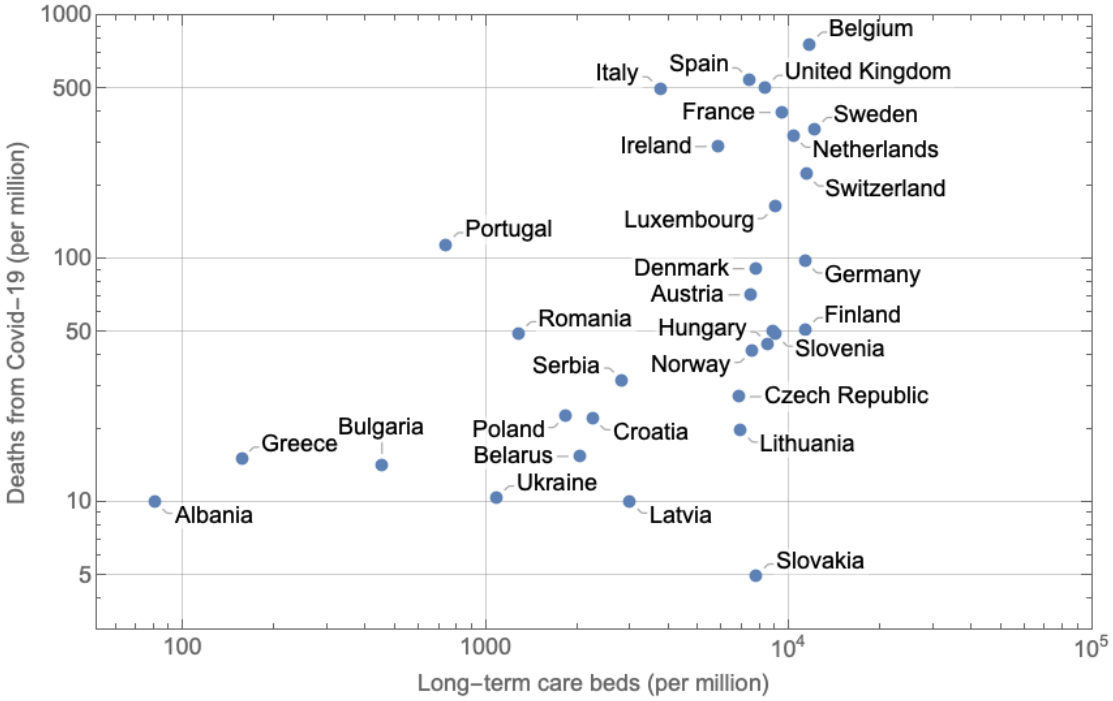


**Figure 1a:** COVID-19 Deaths per capita versus LTCB per capita: 32 Countries: logarithmic scale.

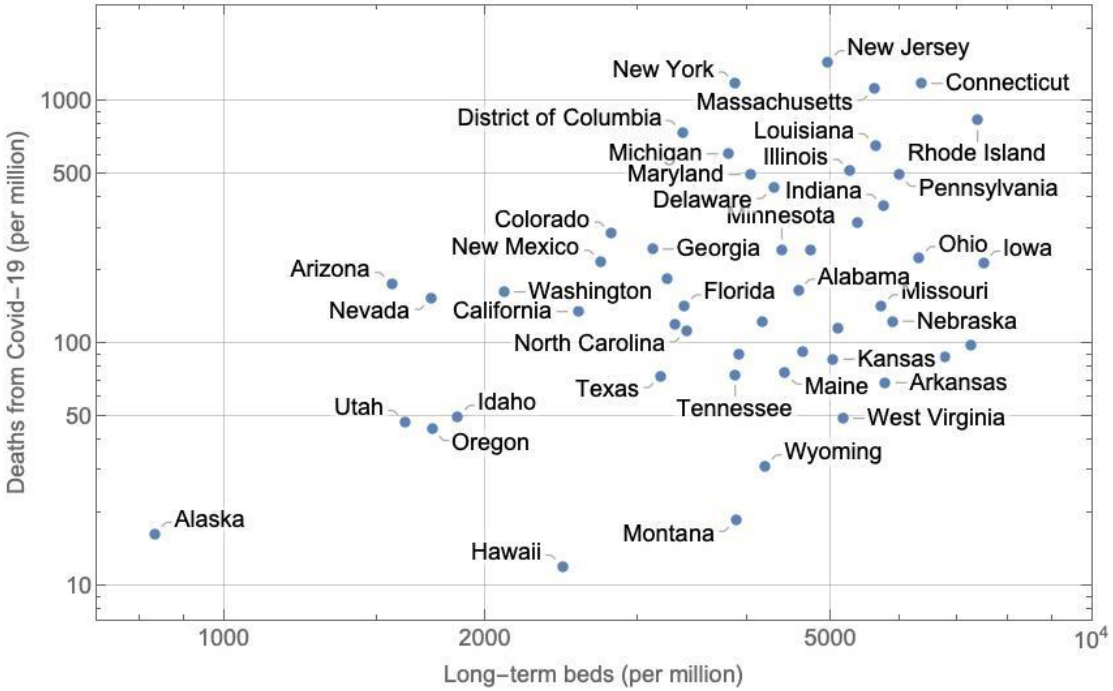


**Figure 1b:** COVID-19 Deaths per capita versus LTCB per capita: U.S. States + DC: logarithmic scale.

Descriptive Statistics are shown in Table 1. Long-term beds per million is positively correlated with COVID-19 deaths per million for both European Countries (0. 45) and U.S. states (0.31.)

**Table 1:** Descriptive Statistics (Europe and US)

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

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

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, 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) $\text{Deaths} = \beta_0 + \beta_1 * \text{LTCB} + \beta_2 * \text{Over75} + \beta_3 * \text{Hosp.Beds} + \beta_4 * \text{PopDen} + \varepsilon$.[xi]

The coefficient of interest is $\beta_1$, which is the association between long-term care beds 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.[xii]

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.

In Column 1 of Table 2, 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 long-term care beds alone explains, we first include just the other three factors. In the case of Europe, the model explains 40 percent of the variation in the death rates among countries. By adding long-term care beds per capita, the model explains 67 percent of the variation in the death rates in the death rates among countries. Thus, long-term care beds explain an additional 45 percent of the variation in death rates![xiii] In the case of the U.S., long-term care beds explain an additional 19 percent of the variation in death rates.

**Table 2:** 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.

**Discussion:**

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 from the first wave of COVID-19 in 2020. In European countries and U.S. states with more long-term care beds per capita, the death rate from COVID-19 is higher.

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.

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, long-term care beds per capita remains positively associated with deaths per capita and the effect is statistically significant for both Europe and the U.S.[xiv]

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. Additionally, our results are robust to the alternative empirical specifications described earlier in this section.

Thus, our results provide a partial explanation as to why the death rates from COVID-19 in the first wave differed so widely both among European countries and among U.S. states.

**Conclusion:**

While the COVID-19 outbreak has caught the world unprepared in terms of policies to counter such a severe pandemic, it is important to prepare for potential new pandemics (either of new viruses or of new, vaccine-resistant variants of COVID-19 – see Lobinska et. al. 2022 and Zhang et. al., 2022). An important policy issue is to assess the risks associated with older people living in long-term care facilities.

Our results suggest that the structural features of such settings are indeed associated with death from COVID-19.[xv] This finding supports the thesis that living in long-term care facilities presents a significant mortality risk factor for older people contracting COVID-19.[xvi]

These findings raise policy implications. In particular, efforts should be geared to enacting policies that would protect older adults living in long-term care settings from future epidemics.[xvii] Policy makers might even consider alternative dwelling options during an epidemic period, such as encouraging residents to live with their families whenever possible.[xviii]

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**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)[xix] | 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/healthcat/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/[xx] | Data as of 2017 |
| US Population Density | Wolfram Alpha | |
| US COVID-19 deaths | https://github.com/CSSEGISandData/COVID-19 | As of June 18 |

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[ii] This paper was written shortly after the first wave of COVID-19 in 2020.

[iii] See Comas-Herrera et. al. (2020).

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

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

[vi] Data sources are shown following the bibliograpy. In the robustness analysis, we include other health risk factors.

[vii] 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.

[viii] The U.S. definition is of long-term care beds 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.

[ix] 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.

[x] The results are unchanged if we exclude Washington D.C., Alaska and Hawaii.

[xi] This equation can be derived from a statistical model. Details are available from the authors.

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

[xiii] The calculation is (67-40)/60=0.45, where 67 percent is the amount of unexplained variation without long-term care beds per capita in the regression.

[xiv] The results from the analysis is this section are available from the authors upon request.

[xv] Abrams, Loomer, Gandhi and Grabowski examined the characteristics of nursing homes with documented COVID-19 cases in the 30 states reporting the individual facilities that were affected.

[xvi] Pillemer, Subramanian and Hupert (2020) discuss the importance of distinguishing the rates and the pattern of disease occurring in the general population from those in long-term care facilities.

[xvii] D'Adamo, Yoshikawa and Ouslander (2020) provide recommended approaches to COVID-19 in the long-term facility setting, and He, Li and Fang (2020) studied whether COVID-19 cases and deaths in California are related to the nursing home reported quality.

[xviii] Barnett and Grabowski (2020) discuss the vulnerability of nursing homes and steps that can be taken to improve them.

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

[xx] Kaiser Family Foundation analysis of Certification and Survey Provider Enhanced Reports data