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ABSTRACT

The COVID-19 pandemic in the US has been particularly devastating for nursing home residents. A key question is how have some nursing homes been able to effectively protect their residents, while others have not? Using data on the universe of US nursing homes, we examine whether establishment quality is predictive of COVID-19 mortality. Higher-quality nursing homes, as measured by inspection ratings, have substantially lower COVID-19 mortality. Quality does not predict the ability to prevent any COVID-19 resident or staff cases, but higher-quality establishments prevent the spread of resident infections conditional on having one. Preventing COVID-19 cases and deaths may come at some cost, as high-quality homes have substantially higher non-COVID deaths, a result consistent with high excess non-COVID mortality among the elderly since March. The positive correlation between establishment quality and non-COVID mortality is driven entirely by nursing homes located in counties with below-median COVID-19 case rates. As a result, high-quality homes in these counties have significantly more total deaths than their low-quality counterparts. The concentration of excess death in low-risk areas suggests that future suffering could be avoided with more nuanced guidelines, such as those recently suggested by CMS that outline a role for in-person visits in lower-risk areas.

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I. Introduction

The COVID-19 pandemic in the US has been particularly devastating for residents of nursing homes. As of September 14th, 2020, there have been a total of 192,221 COVID-related deaths in the US. We estimate that 39 percent of these deaths are among nursing home residents. The death rate for non-nursing home residents is about 37 per 100,000.[1] The death rate for nursing home residents is more than 150 times that number at roughly 5,600 per 100,000. The death rate in nursing homes is even orders of magnitude larger than the death rate for those 65 and over outside of nursing homes, which we calculate to be about 208 per 100,000. In at least three states, Connecticut, Massachusetts, and New Jersey, more than 8 percent of the nursing home population at the beginning of the year has died as a result of the pandemic.

These horrific figures likely understate the true number of nursing home deaths associated with the pandemic. Quickly after the pandemic hit the US, most nursing homes banned all visitors, disrupting the daily routines of many residents.[2] An abundance of qualitative evidence from nursing home staff, administrators, and resident family members suggests that the lack of in-person contact with loved ones and other residents is not only generating feelings of loneliness, isolation, and despair, but may also expedite death (Aronson, 2020; Paulin, 2020; Graham, 2020). Population-wide trends in mortality support this claim. Figure 1 uses provisional data from the Centers for Disease Control (CDC) to show average weekly total deaths for the population 65 and older in 2018-2019, compared to 2020, where the latter are decomposed into total and non-COVID deaths. The figure highlights that in addition to COVID-19 deaths, there has been a dramatic increase in non-COVID deaths among seniors. While all seniors do not live in nursing homes, many of the most fragile do,

[1] We outline the data used in these calculations in the next section.
[2] On March 13th, 2020, the Centers for Medicare and Medicaid recommended that nursing homes to restrict visitors and non-essential personnel (CMS, 2020a). The Kaiser Family Foundation notes that early in the pandemic, 27 states banned visitors and 22 states recommended that nursing homes ban visitors (Tolbert et al., 2020). Two states provided no guidance.

suggesting that many of these excess deaths may very well occur in nursing homes. For example, excess mortality for Alzheimer's is particularly high. While only 12.5 percent of Alzheimer patients live in nursing homes (Lepore et al., 2017), just under half of nursing home residents have Alzheimer's (CDC, 2020a). In 2018, 50.6 percent of all deaths listing Alzheimer's as an underlying cause occurred in nursing homes.[3] In Figure 2, we report the CDC's estimate of excess Alzheimer's deaths estimate based on provisional data through September 26th. They estimate almost 30,000 excess deaths during the pandemic with an Alzheimer's diagnosis, but only 23 percent have a corresponding positive COVID-19 diagnosis, leaving 77 percent of these deaths as not directly related to the disease but to other aspects of the pandemic.

COVID-19 deaths among nursing home patients is heavily influenced by infection and transmission rates in the surrounding community, which varies substantially by region. For example, non-nursing home COVID-19 deaths rates vary from a low of 4 per 100,000 in Vermont to a high of 143 per 100,000 in New York. Yet, community risk alone cannot explain the vast variation in nursing home death rates. Even in the three states mentioned above with the highest death rate, 23 percent of nursing homes with over 100 beds had not experienced a single COVID-19 mortality by the beginning of September. A key research question is then how have some nursing homes been able to effectively protect their residents, while others have not?

In this work, we focus on one particular dimension of the problem: nursing home quality. Starting in 2008, the Centers for Medicare and Medicaid (CMS) began providing a "five-star" rating of nursing home quality based on three elements: health inspections, staff-to-resident ratios, and quality metrics such as rates of falls and bedsores, with the first element having the greatest weight in an "overall" rating. We merge this quality data with data on COVID-19 cases and mortality that is reported weekly by nursing homes to CMS starting the week ending May 24th. In count-data models

[3] Authors' calculations from CDC Wonder Multiple Cause of Death data.

that control for local risk factors and nursing home characteristics, we find that the inspection rating is highly predictive of mortality, with five-star homes having 24 percent fewer resident COVID-19 deaths by September 13th than one-star homes. The inspection rating is more correlated with COVID-19 deaths than the overall rating, the latter of which researchers used in earlier work (i.e., using data from early March) to argue that high-quality homes were unable to prevent cases (Abrams et al., 2020). In addition to having less predictive power, we provide evidence that the overall quality metric is more correlated with deaths after mid-May than those occurring before, rationalizing these disparate findings by suggesting that the virulence of the disease caught all nursing homes by surprise, but that the best homes adjusted with time.

We identify several mechanisms through which quality nursing homes lowered mortality. First, we show that the chance of having any COVID-19 cases among residents or staff is not explained by nursing home quality, meaning even high-quality homes were unable to prevent COVID-19 from entering their facility. That said, in models that condition on having at least one confirmed case, we show that higher-quality nursing homes more successfully prevent the spread of the disease among residents. Unfortunately, we do not have detailed data on the policies and procedures that enabled these establishments to prevent the spread of the disease. We do show that quality homes experience fewer outages in personal protective equipment (PPE) and fewer staff shortages, which may help with patient monitoring and isolation. Furthermore, we show that conditional on quality, homes avoiding PPE outages and staff shortages have fewer COVID-19 deaths.

A likely scenario is that higher-quality establishments did a better job at isolating residents both from outside risks from visitors and other residents. This may have come at a cost. When we change the outcome in the count-data model from COVID-19 deaths to non-COVID deaths, we find that higher-quality nursing homes have much higher non-COVID mortality and that aggregate

mortality is not generally impacted by nursing home quality. Moreover, when we conduct this analysis separately for nursing homes in high- and low-risk counties, as measured by cumulative cases per capita, we find that (i) quality is not consistently associated with non-COVID deaths in high-risk counties, (ii) high-quality homes have significantly and substantially more non-COVID deaths than low-quality homes in low-risk counties, and (iii) in low-risk counties, aggregate mortality is increasing in nursing home quality.

One possible explanation is that there is incomplete reporting of COVID-19 or strategic use of defining COVID-19 deaths by nursing homes to mitigate the damage to their reputation from the CMS reports. To lessen concerns that our results are driven by these problems, we estimate an additional model for nursing homes located in counties with zero COVID-19 deaths, meaning risk of infection within a nursing home is very low. There are roughly 700 nursing homes in this sample by mid-September and there can be little strategic use of redefining deaths in areas that have no COVID-19 mortality. In these counties, we find that non-COVID deaths are increasing with nursing home quality and the highest-quality establishments have 35 percent more non-COVID deaths than the lowest quality ones.[4]

Given the number of COVID-19 related deaths and an early understanding that the elderly die at higher rates, there is surprisingly little research on deaths in nursing homes. As a result, this paper contributes to the literature on the health effects of COVID-19 along several dimensions. A number of papers have examined the general relationship between CMS five-star ratings and COVID-19 cases and/or deaths in nursing homes but much of this work was either in a single state (Bui et al., 2020; Harrington et al., 2020; He et al., 2020; Li et al., 2020a) or occurred very early in the pandemic (Abrams et al., 2020). Some studies have used various versions of the CMS data used in

[4] We also show that, conditional on nursing home quality, staff shortages and PPE outages do *not* predict non-COVID deaths. One would expect a positive relationship if non-COVID deaths were truly misreported COVID deaths.

this study. Gorges and Konetzka (2020) show that county incidence rates are the strongest predictor of resident mortality and staff levels have modest impacts on the spread of the disease. Li et al. (2020b) document much higher COVID-19 death rates in homes with greater minority patients. Chen et al. (2020) show that contractors that service multiple nursing homes in a local area helped spread the disease. The data from the CDC showing large excess death rates for the elderly and especially Alzheimer's patients has helped put this issue into the public discussion, yet there is little research other than efforts to document the extent of the problem and almost no research on the factors that lead to excess mortality.

While much of the previous work studies determinates of outbreaks, only a few studies such as Liu et al. (2020b) and Gorges and Konetzka (2020) consider mortality in a nationwide sample as we do. Moreover, we identify that this relationship is most likely explained by high-quality homes reducing the spread of the virus once it enters the homes and it is not due to a home's ability to prevent the entry of the disease. Importantly, our paper is the first to establish a positive link between nursing home quality and non-COVID-19 mortality. This relationship is so pronounced in areas with low COVID-19 risk, that high-quality nursing homes are found to have significantly higher *total* mortality than low-quality homes in these areas. This is not surprising. The initial CMS directives about nursing home operations during COVID-19 recommended prohibiting visitors regardless of the underlying risk. As some nursing homes face little COVID-19 risk, they assumed many of the negative of the costs of isolation without much benefit. CMS has recently begun to recognize that that these restrictions have taken a toll on residents. In a memo released September 17th outlining revised procedures for nursing homes during the pandemic, CMS notes that "…we recognize that physical separation from family and other loved ones has taken a physical and emotional toll on residents. Residents may feel socially isolated, leading to increased risk for depression, anxiety, and other expressions of distress. Residents living with cognitive impairment or

other disabilities may find visitor restrictions and other ongoing changes related to COVID-19 confusing or upsetting" (CMS, 2020b). In this memo, CMS outlines policies for outdoor visitation and relaxed policies for indoor visitation in lower-risk settings such as counties with low positivity rates in the general population. The goal of reducing COVID-19 risks is laudable but as economists are want to point out, all policies have costs and we have just begun to recognize the costs of these restrictions. Our results suggest that efforts to control the spread of the virus may have come at some cost. A more general discussion about reducing COVID-19 risks without disrupting the lives of vulnerable seniors is in order.

II. Data

II.A. Data Sources and Reporting Accuracy

There are two primary sources of information about COVID-19 case and mortality incidence at the nursing home level. The first is a weekly data set released by the Centers for Medicare and Medicaid (CMS) that has COVID-19 surveillance information by nursing home. On May 8th, 2020, CMS released a final ruling that required nursing homes to report confirmed and suspected COVID-19 cases of residents and staff to both the residents and their representatives. The ruling also required that nursing homes report weekly totals of surveillance items to the Centers for Disease Control (CDC) National Healthcare Safety Network, starting with the week ending May 24th, 2020. Reporting was mandatory with $1,000 fines issued after four-weeks of non-reporting. Fines increased by $500 per week of non-reporting (CMS, 2020c).

The first weekly file was released by CMS in early June and updates are released on Thursdays, 11 days after the end of the reporting period, which is a Monday to Sunday period. The initial release of this data set was in a word, messy. There were obvious key-punch errors and variables were frequently reported in the wrong columns. Subsequent releases of the data corrected

many of these recording errors and the most recent releases of the data are now relatively free from these obvious errors, although some naturally exist. Reporting has always been high. In the first release of the data, 14,548 nursing homes reported data and 96 percent passed a quality assurance check. This number increased to 15,214 for the week ending September 13th, and 98 percent passed a quality assurance check. Based on the size of the CMS five-star data set, this represents about 98 percent of all nursing homes.

The CMS nursing home data reports weekly and cumulative values for confirmed COVID-19 cases for residents and staff, suspected cases for these two groups, COVID-19 deaths (which includes suspected and confirmed), plus all deaths among residents. All these variables are reported weekly and cumulatively since January 1st, 2020. Deaths are for residents regardless of the location, so if a nursing home resident is moved to a hospital and dies there, the death is counted as a nursing home resident death. The survey asks nursing homes if they have shortages of key staff including nursing staff, clinical staff, and aids, and whether they have adequate supplies of specific personal protective equipment (PPE) such as N95 masks, surgical masks, gowns, etc. Beginning the week ending August 16th, the survey also asks a series of questions about COVID-19 testing procedures.

A second source of data are state COVID-19 dashboards. Each state has a frequently-updated web page that provides detailed information about the progression of the pandemic in their state. The data provided varies across states, with some reporting information on nursing homes and others not. Once CMS began releasing their data, some states dropped their nursing home reports. We checked all state COVID-19 dashboards starting at noon on Monday, September 14th and found 33 that reported data on nursing home mortality. In many cases, the states report only nursing home deaths (e.g., AZ, MI, ME), some report these totals combined with assisted living centers (e.g., NJ, IL, IN, VA, MN, WA), and some report these two groups separately (e.g., CA, NY, FL, MA, PA, RI, TX). We categorize these data as nursing home deaths, regardless of whether they

include assisted living. In general, assisted living deaths are a minority of deaths. In two hard-hit states, NY and PA, assisted living deaths represent only 2 and 10 percent of total fatality deaths in congregate settings.

COVID-19 nursing home mortality from these two sources is reported in Table 1. We report data as of September 13th from both sources. In the top third of the table, we report data from the 33 states that report nursing home COVID-19 mortality on their dashboard. In the first column, we report all COVID-19 deaths as reported on state webpages, in the second, what states are reporting on dashboards, and in the third, death counts in the CMS data. The states reporting nursing home data on web pages report 68,180 COVID-19 nursing homes deaths, which is 39 percent of all COVID-19 deaths. The number of deaths as reported by CMS is 33 percent lower than what states are reporting. The differences in reporting a driven primarily by a lack of reported deaths in high-count states. In Figure 3, we plot data for the 33 states reporting in both sources, with death counts from state web pages on the x axis and counts from CMS on the y axis. Most states lie along the 45-degree line with the undercount in the CMS data greatest for the 6 states with the highest counts of deaths: NY, NJ, MA, PA, FL and IL. These six states account for 72 percent of the undercount.

The undercount appears to be driven by differences in what nursing homes are reporting to the two entities rather than response rates, as the response rate is rather high for the CMS data. One explanation for this undercount in the CMS data is that at the time of the first report (May 24th), CMS allowed nursing homes the choice to report cases and deaths from the prior week *or* cumulative cases and deaths since January 1st. Thereafter, homes report weekly counts and a cumulative count is calculated by CMS; thus, if a home fails to report the cumulative count since January 1st on May 24th, the cumulative count that CMS calculates in future weeks is incorrect. It is clear from the abundance of cases and deaths reported in the first week, particularly from nursing

homes located in areas hit hard by the virus, that most nursing homes chose to report cumulative figures; however, some surely did not.

To demonstrate this point, we matched nursing homes that reported to both the May 24th and September 13th CMS surveys to nursing homes listed on the state of New York dashboard, where May 25th and September 14th reports of COVID-19 deaths among residents are reported. We matched 372 nursing homes which represents 93.2 percent of deaths in the New York data at the earlier date and 94.4 percent of deaths in the CMS data for the week ending September 13th. In Figure 4, we report a scatter plot of cumulative counts as of September 13th for nursing homes with 10 or more deaths in the New York data. We restrict the sample to these nursing homes as this makes the data easier to see. This is 192 nursing homes. Circles of larger size represent multiple establishments reporting the same pair of numbers. There is a pronounced undercount in the data with 64 percent below the 45-degree line, 34 percent above the line and only 2 percent on the line. The total deaths reported on state dashboards in this limited sample are 50 percent larger than the CMS counts, which is consistent with the notion outlined above that many nursing homes were reporting weekly counts for the first CMS survey.

We address this potential source of measurement error later in our robustness analysis, where we re-estimate our main model using cases and deaths since May 24th. The change in deaths from these two dates appears to be more accurately reported across the two samples. In Figure 4, we report the scatter plot of the difference in counts between September 13th and May 24th for the match sample for New York reported in Figure 4. Here, the points are more evenly spaced around the 45-degree line with 21 percent below, 34 percent above, and 45 percent on the line. This last number is driven by the fact that 32 percent of these establishments report no more deaths between May 24th and September 13th in both data sets. The average difference in "new" deaths in this sample is 17 percent higher in the CMS data, possibly reflecting the fact that the New York

dashboard only reports nursing home resident deaths from COVID-19 that occur within the nursing home and not in hospitals; the CMS data contains both.

In the last third of Table 1, we report aggregate data for the nation. We assume that the degree of undercount is the same in the 18 states not reporting on their state web pages as in the 27 states that are not the 6 largest death count states from Figure 3 and estimate total nursing home deaths in the nation to be 73,949. The numbers in this row suggest that COVID-19 nursing home deaths are between 29 and 39 percent of aggregate mortality. Given the systematic undercount of deaths in the CMS data, we believe the actual fraction of COVID-19 deaths in nursing homes is closer to the larger rather than the smaller number.

The staggering consequences of the pandemic for nursing home residents can be seen when we calculate COVID-19 death rates for nursing home residents and compare to the general population. The death rate (per 100,000 people) for non-nursing home residents is roughly 37. Dividing the imputed numbers by the nursing home residents alive at the beginning of the year,[5] the death rate for nursing home residents is about 5,600, or about 150 times then rate for the general population. We calculate that the COVID-19 death rate for people 65 and over living outside of nursing homes is 208,[6] meaning this nursing home death rate is about 27 times this number.[7]

[5] The CMS data indicates there are 1.1 million nursing home residents as of September 13th and there were about 200,000 deaths for all causes in nursing homes since the beginning of the year. Adding these two numbers together gives us roughly 1.3 million nursing home residents at the beginning of the year.

[6] Census estimates a US population of 328.2 million in 2019 including 54 million people 65 and older (US Census Bureau, 2020). One estimate suggests 15.5 percent of the nursing home population is under 65 (Howley, 2019), leaving 1.1 million 65 and over in nursing homes and 52.9 million people aged 65 or over outside of nursing homes. The CDC estimates that by September 19th, the deaths of the elderly outside of nursing homes totaled 110,163, leaving a death rate for the out of nursing home population at 208.

[7] The non-nursing home death rate for people 65 and over is likely overstated as the CDC reports place of death (e.g., hospital, at home, nursing home) so the counts for people outside nursing homes in places like hospitals, emergency rooms and hospice facilities would include some nursing home residents as well.

II.B. Heterogeneity Across Nursing Homes in COVID-19 Mortality

There is tremendous variation across states in the severity with which the pandemic struck nursing homes. In Figure 6, we graph deaths of nursing home residents from COVID-19 (deaths per 100,000) by state using the CMS data as of September 13th. By using CMS data, we are potentially under-reporting deaths by 33 percent, most notably in states with the highest death rate but these at least give a ranking using the same sample for all states. We define the denominator as occupied beds at that time plus the total number of deaths that have occurred up to that point in the year. This population number is roughly the number of people in a nursing home on January 1st, 2020. The crisis is heavily concentrated in a small handful of states. In ten states, more than five percent of the nursing home population has died, while in 3 states, more than 8 percent are dead. The top 15 states represent 35 percent of the nursing home population but half of all COVID-19 nursing home deaths.

The risk nursing home residents face from the disease is strongly correlated to the underlying risk in their state. In Figure 7, we graph the non-nursing home COVID-19 death rate at the state level versus the same value for nursing home residents. In this graph we use the CMS estimates of nursing home deaths and define non-nursing home COVID-19 deaths as all COVID deaths minus the nursing home numbers. The correlation coefficient between the two series is 0.78. The outlying observation in the bottom right section of the figure represents New York, which we showed above underreports deaths in the CMS data. If New York is removed from this analysis, the correlation coefficient increases to 0.87.

Despite the strong correlation between underlying risk and nursing home deaths, many nursing homes successfully avoid high death rates, even in the hardest hit areas. In Figure 8, we show the COVID-19 death rate distribution for nursing homes that have more than 100 beds and are located in counties in the top 10th percentile for total COVID-19 deaths. The top panel shows

that by May 24th, just under 60 percent of nursing homes in these areas observe fewer that two COVID-19 death per 100 beds. By September 13th, this figure is still in excess of 30 percent. Moreover, a disproportionately small share of nursing homes account for the majority of COVID-19 deaths. As of September 13th, the top 5 (1) percent of nursing homes, which is just 754 (151) homes or 8.2 (2.3) percent of the nation's beds, accounts for 40 (14) percent of all COVID-19 deaths in nursing homes.

II.C. Analysis Sample

The goal of this project is to explore whether observed nursing home characteristics can explain low COVID-19 death rates in high-risk areas. In particular, we test whether high-quality nursing homes, as measured by the CMS five-star ratings, did a better job of preventing deaths from COVID-19. Our initial sample contains 15,115 nursing homes reporting data to CMS on September 13th. We lose a few observations from incomplete data. Summary statistics for these data are shown in Table 2.[8]

Several variables require explanation. Data on nursing home characteristics comes from "Long-term Care: Facts on Care in the US", which is provided by a research center at Brown University.[9] Sample statistics are reported for observations with non-missing data. The acuity index ranges from zero to 23 in the data and is a measure of the amount of care needed by the average nursing home residents (higher values suggest more care). For the three variables – share of

[8] Both COVID-19 and non-COVID deaths counts are implausibly large in some homes. We make the following corrections: First, we identify 186 counties where the sum of nursing home COVID-19 deaths reported in CMS exceeds the CDC's count of total COVID-19 deaths for the county. For the 16 counties where the former exceeds the latter by more than 10 deaths, we use web sources to identify the nursing home with erroneous reporting and corrected the data (this is almost always limited to one home in the county). For the remaining 170 counties, we reduced deaths at each nursing home by a common factor to ensure total COVID-19 deaths in nursing homes exactly equals total COVID-19 deaths in the county. Furthermore, a total of 147 (6) nursing homes had non-COVID (COVID-19) deaths that exceed three quarters of the total beds in the home. We re-coded deaths in these homes to equal three quarters of the total beds.
[9] More information can be found at http://ltcfocus.org/.

residents using Medicaid, acuity index, and for-profit status – the data contains values for all or none of them.

Nursing home star ratings come from data.medicare.gov. There are three separate ratings – inspection, quality measures (QM), and staffing – which are aggregated by CMS into an overall rating. All three ratings, as well as the overall rating, measure quality in integer "star" values, where 5-star is the best possible rating and 1-star is the worst. The inspection rating is based on results from the home's three most recent state health inspections in a three-year period, with more weight given to the most recent inspections, as well as investigations stemming from formal complaints. The QM rating is based on a home's self-reported ability to manage and prevent certain negative health outcomes (e.g., bedsores, ED visits, chronic pain, major injuries resulting from falls, urinary tract infections, etc.). The staff rating is a function of the reported number of registered nurses and total staffing hours relative to the number of residents.

As the inspection rating is the only measure calculated from data that is not self-reported, it is viewed as the most objective and, thus, is given greater weight in the calculation of the overall star rating (Williams et al. 2010).[10] Numerous authors have shown that the inspection rating is the most predictive of better health outcomes and resident/family satisfaction among the four. For example, Fuller et al. (2019) show that the overall rating is not associated with lower emergency department visits or hospital admissions. Neuman et al. (2014) study the ratings separately and show that only the inspection rating is statistically associated with a lower likelihood of hospital readmission and death. Çalikoglu et al. (2011) show that family satisfaction is positively correlated with the inspection and staff rating, but not the QM rating. Perraillon et al. (2017) suggest that the QM and staff ratings, which are calculated from information reported by nursing homes, are easily manipulated. As a

[10] More details, as well as the methods for calculating the overall rating can be found at https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/CertificationandComplianc/downloads/brieffivestartug.pdf

result, although we will report results for all four measures initially, we will focus more heavily on the inspection results.

All case and death measures should be interpreted as cumulative, since January 1st, 2020. Resident and staff case variables measure confirmed cases reported to CMS. Nursing homes report both total deaths (from any cause) and COVID-19 deaths each week, which allows us to calculate deaths not from COVID-19.[11] Note that case (and death) rates are calculated as (cases/total beds)*100. County-level COVID-19 cases and death totals comes from the same source used by the CDC (USAFacts, 2020).

In Table 3, we present nursing home characteristics and relevant COVID-19 summary statistics for nursing homes with different inspection star ratings. Compared to residents at lower-quality homes, high-quality home residents are younger and are more likely to be white and female. The homes also have fewer beds, are less likely to be for-profit, and have a smaller share of Medicaid residents. Regarding COVID-19, high-quality homes have lower resident case rates, but higher staff case rates. Moreover, these homes have notably smaller COVID-19 death rates, but higher non-COVID death rates. On average, higher-quality homes have experienced fewer staff shortages and PPE outages than lower-quality homes since May 24th. High-quality homes also seem to conduct more COVID-19 tests.

[11] Homes are to report all deaths regardless of location, e.g., in the home or in a hospital (CMS, 2020c). The module instructions (CDC, 2020b) define a COVID-19 death as "a resident with suspected or a positive COVID-19 test result who died in the facility or another location as a result of COVID-19 related complications." The instructions state the following regarding the reporting of marginal COVID-19 deaths: (i) suspected deaths are those that are being managed for COVID-19 symptoms, but do not have a positive test, and these symptoms play a role in their death; (ii) someone without a positive test or symptoms who dies from complications associated with COVID-19 and later has COVID-19 diagnosed in autopsy, should be coded (retrospectively) as a COVID-19 death; (iii) someone previously diagnosed or suspected to be COVID-19 positive, who dies after recovery should *not* be counted as a COVID-19 death.

III. Statistical Model and Results

We estimate the effect of nursing home quality on the total number of nursing home deaths due to COVID-19 using a negative binomial model. That is, we write the probability of nursing home i having COVID-19 deaths Y_i as

$$\Pr(Y_i) = \frac{\Gamma(Y_i + \gamma_i)}{\Gamma(Y_i + 1)\Gamma(\gamma_i)} \left(\frac{\theta}{1+\theta}\right)^{Y_i} \left(\frac{1}{1+\theta}\right)^{\gamma_i} \quad (1)$$

where $\Gamma(\cdot)$ is a gamma function and γ_i and θ are the shape and scale parameters, respectively, of a gamma distribution. We allow γ_i to vary with nursing home and county characteristics, X_i, such that $\ln(\gamma_i) = X_i\beta$. The parameters (θ, β) are estimated via maximum likelihood. All models include state fixed effects and standard errors are clustered at the state level.

We are primarily interested in the impact that nursing home quality has on COVID-19 deaths; however, we also control for the following: (logged) total number of beds; percent female, under 65 years old, black, Hispanic, and on Medicaid; whether the homes is for profit; acuity index;[12] (logged) county population; and county COVID-19 cases per 1,000 residents.[13]

III.A. COVID-19 Mortality Results

As discussed above, nursing home quality is measured using 3 ratings (home inspection, QM, and staff), as well as an aggregate (overall) rating, each of which is measured on a 1-5 scale – 5 indicating highest quality. We estimate equation (1) four times, once for each quality metric. Parameter estimates are presented in Table 4. In the top third of the table, we report results as of September 13th and in the middle third, we report results as of May 24th.

[12] Nursing home characteristics are missing for some homes; thus, we include missing variable indicators as well.
[13] County-level COVID-19 cases are included as a measure of the intensity of the virus locally. As death occurs on average 18.5 days after symptom onset (Zhou et al. 2020) and the incubation period is 4-5 days on average (CDC, 2020c) we measure cases 23 days prior to death. All models are robust to controlling for the non-nursing home death rate, as measured on September 13th, rather than the case rate.

Our results show that higher-quality nursing homes have experienced fewer deaths from COVID-19; however, this relationship is highly dependent on the quality metric used. The QM rating, which is determined using data that is self-reported by nursing homes, has no impact on COVID-19 deaths at either point in time. The staff rating, which is also determined via self-reported data, yields mixed results. Relative to 1-star homes, 2-star homes have significantly *more* COVID-19 deaths, while 5-star homes have significant fewer; this last result grew considerably as the pandemic aged. The inspection rating is strongly associated with lower death counts with a high degree of statistical precision. For example, nursing homes with a 5-star inspection rating have a COVID-19 death rate that is 24.2 percent lower than those with a 1-star inspection rating as of September 13th. As the overall rating is an agglomeration of the three sub-categories, it is not surprising that it is negatively associated with COVID-19 deaths, but less-so than the inspection rating.[14]

We discuss above that the CMS data likely under counts the true number of COVID-19 deaths in nursing homes, as homes were given the choice on May 24th to report deaths from the prior week or cumulative deaths since January 1st. To show that our results are not somehow driven by this measurement error, we change the dependent variable to deaths since May 24th, which should be measured accurately in the CMS data. These results are presented in the final third of Table 4. Again, these results are similar to our main findings, though nearly all quality effects are notably larger. For example, we estimate that homes with a 5-star inspection rating have had 34 percent fewer COVID-19 deaths since May 24th than observationally similar 1-star homes. Using cumulative deaths, this difference was 24 percent.

Overall, estimated quality effects as of May 24th are very similar to the results for mid-September for the overall, inspection, and QM ratings. The impact of the staff rating became much

[14] Across the four specifications, we find that homes with more beds, larger black populations, and located in larger cities with higher case rates have more COVID-19 deaths, while homes with younger populations have fewer deaths. We also find that for-profit homes have significantly more deaths. These results are available upon request.

stronger over time, especially for 5-star establishments. Finally, home quality is most predictive of COVID-19 deaths since May 24th. These results contrast with the work of Abrams et al. (2020), who found no relationship between a nursing home's overall star rating and the probability of any COVID-19 *case* (as well as outbreak size) as measured on May 11th. The difference is at least partly explained by the authors' use of the overall star rating, which we find to be less predictive than the inspection rating. Moreover, as we find home quality to be most predictive of deaths after May 24th, it is possible that high-quality homes were simply caught off guard by the unpredicted and unprecedented nature of the virus but adjusted with time.

In Table 5 we show that our main findings are robust to a number of alternative empirical specifications, including (i) using a Poisson model with clustered standard errors, as suggested by Cameron and Trivedi (2005) (row 2); (ii) dropping the six states shown in Figure 4 to display the most measurement error in the CMS data (i.e., NY, NJ, MA, PA, FL, IL) (row 3 and 10); and (iii) using linear models with ln(deaths+1) or the inverse hyperbolic sine of COVID-19 deaths as the dependent variable, both estimated with and without county fixed effects (rows 4-7).

III.B. Mechanisms

How did high-quality nursing homes managed to prevent COVID-19 deaths? CMS first offered nursing homes and assisted living facilities guidelines for preventing and managing COVID-19 cases on March 13th. Since then, these guidelines have been updated and expanded repeatedly as the public health community has learned more about the virus. The CDC's advice is expansive but is linked by several common themes: First, keep COVID-19 out by limiting visitors and encouraging staff to stay home when ill. Second, clean hands, surfaces, and equipment thoroughly and repeatedly. Third, staff should closely monitor residents for signs of the virus, test symptomatic individuals and

close contacts, and isolate those who are symptomatic. Fourth, staff should use personal protective equipment (PPE) at all times (CDC, 2020d).

These recommendations guide our exploration of the potential mechanisms that enabled higher-quality nursing homes to prevent COVID-19 deaths. First, we examine whether higher-quality nursing homes were better able to prevent COVID-19 from entering the home at all. In Table 6 we report results from linear probability models that regress an indicator of whether a home has a single COVID-19 case among its staff (column 1) or among its residents (column 3) on the home's 5-star inspection rating and the same set of covariates from our earlier analysis. These results show that higher-quality nursing homes, despite lowering the death rate, were not able to prevent COVID-19 from entering the home.[15] Second, we test whether higher-quality nursing homes were able to prevent the spread of the virus, conditional on having at least one case. In columns 2 (4) of Table 5, we report estimates from a linear regression of log staff (resident) cases on inspection rating and covariates, only for homes with at least one staff (resident) case. The results show that while high-quality nursing homes were not effective in preventing the spread of COVID-19 among their staff, these homes were effective at preventing the virus' spread among their residents – e.g., conditional on having at least one case, all else equal, 5-star homes saw roughly 23 percent fewer cases than 1-star homes. As of September 13th, among homes with at least one case, the average home has 20.5 cases per 100 beds, meaning this difference amounts to about 4.7 cases per 100 beds.[16]

[15] 4-star homes are statistically less likely to have a resident case than 1-star homes (p-value=0.02); however, the effect size (0.018) is small relative to share of homes experiencing any resident cases (0.626). Moreover, the effect is not statistically different from zero when county fixed effects are included.

[16] We explored one additional mechanism – that higher-quality nursing homes provided better care conditional on infections, leading to a lower death rate. To do so, we returned to Equation 1, but controlled (separately) for whether any staff or residents were COVID positive, as well as the total number of staff and resident cases. If high-quality facilities only prevent death by reducing cases, then we would expect quality to have no impact on death counts in this model. Estimates can be found in Table 5, row 8. Conditional on cases, higher-quality facilities have fewer deaths, but the effect sizes are modest and are only marginally significant.

If high-quality nursing homes prevented deaths not by keeping COVID-19 out of the nursing home entirely, but by preventing its spread within the home, the next obvious question is: how? We test several plausible theories. First, both identifying and isolating residents with COVID-19 symptoms requires a capable staff that is of an adequate size; thus, we first test whether high-quality nursing homes have had fewer staffing shortages during the pandemic, which may explain their ability to prevent COVID-19 cases among their residents. In Panel A of Table 7, we present results from three linear probability models that regress indicators for self-reported staffing shortages (nurses, aides, and clinical staff) at any point between May 24th and September 13th on 5-star inspection rating and other controls. Row 1 shows that, all else equal, 5-star facilities were 7.8 percentage points less likely to have a nursing shortage over this time period than a 1-star facility. The gap is 8.4 percentage points for aides (row 2) and 2.5 percentage points for clinical staff (row 3) and both results are statistically significant. These estimates range from 13 to 19 percent of the sample mean for the outcomes.

Nursing homes may also prevent the spread of COVID-19 by following the CDC recommendation that all nursing home staff use PPE and wash their hands frequently. While these behaviors cannot be observed in our data, we are able to measure shortages in PPE (n95 masks, surgical masks, eye protection, gowns, gloves) and hand sanitizer; thus, we test whether higher-quality facilities were less likely to have experienced such shortages between May 24th and September 13th. We again use linear probability models and control for the same set of potential confounders. Results are presented in Panel B of Table 7. For all five forms of PPE and hand sanitizer, we find that the likelihood of a shortage is falling monotonically in nursing home quality. These results for five-star homes relative to one-star homes are large relative to the sample mean, ranging from 18 percent for PPE masks, about 35 percent for surgical masks, eye protection and gown outages, and greater than 50 percent for glove and hand sanitizer outages.

Finally, we test whether higher-quality homes simply do a better job of testing residents for the virus. In particular, the CMS data allows us to generate four measures of testing intensity and speed. First, nursing homes report for the week ending September 13th that receiving test results takes "less than a day", "between one and two days", "three-to-seven days", or "more than seven days." Second, nursing homes report whether they tested any asymptomatic residents during the week ending September 13th *in response to* a new positive case.[17] Third, homes report whether they have *ever* tested asymptomatic staff or residents when there is no knowledge of exposure. Finally, homes report whether they have their own testing machine.

In Panel C of Table 7, we present estimates of the effect of nursing home quality on these testing measures. Results are mixed. Higher-quality homes receive test results faster than 1-star homes (row 1) but these effects are not precisely estimated. Higher-quality homes are not statistically more likely to test asymptomatic residents following a new case (row 2) but they are more likely to test staff after a new case. Somewhat in contrast to the prior finding, higher-quality homes are statistically more likely to have ever tested non-exposed residents but are no more likely to test non-exposed staff. Finally, 2-4 star homes are between 1.8 and 2.3 percentage points more likely than 1-star homes have their own testing machine, but these effects are only of marginal statistical significance.

Overall, higher-quality nursing homes prevent COVID-19 deaths, not by preventing the disease from entering the home, but by preventing its spread. Moreover, the methods by which they prevent the spread are consistent with CDC guidelines. High-quality homes have significantly fewer staff shortages and PPE outages. We also provide some evidence that higher-quality facilities get test

[17] Note that nursing homes can only report such testing if a new positive case arises; thus, we condition our analysis on facilities with a new positive case, as higher-quality facilities have already been shown to have fewer positive cases.

results quicker, potentially because they have their own testing machines, and are more likely to test non-exposed asymptomatic residents, though these relationships are less precisely estimated.

Finally, in an effort to understand exactly how much of the inverse relationship between COVID-19 deaths and nursing home quality is explained by higher-quality nursing homes avoiding staff and PPE shortages, we return to our baseline model, but add controls for shortages. In particular, among the nine staff and PPE measures, we calculate for each nursing home the number of shortages experienced between May 24th and September 13th (e.g., if a home experienced a nursing shortage and an n95 mask shortage over this period, we would measure their total as 2). The original results from Table 4 are presented in the first column 1 of Table 8 and the results adding the counts of shortages as a control are reported in the second column. First, note that for each additional shortage reported, the nursing home's COVID-19 death rate increases by 3.3 percent. Second, compared to the original model without these controls, the estimated quality effects are 6-12 percent smaller, suggesting that in addition to avoiding staff and PPE shortages, high-quality nursing homes are taking other precautions to prevent the spread of the virus. We discuss the last two columns of Table 8 below.

III.C. Isolation and Non-Covid Deaths

In addition to PPE use, adequate staffing, and robust testing, an early prevention method used by virtually all nursing homes was to refuse all outside visitors. On March 13th, CMS issued memorandum QSO-20-14-NH recommending that all facilities nationwide "should restrict visitation of all visitors and non-essential health care personnel, except for certain compassionate care situations, such as an end-of-life situation" (CMS 2020a). The memorandum also advised cancelling "communal dining and all group activities, such as internal and external group activities." On May 18th, CMS issued memorandum QSO-20-30-NH, that provided a three-phase reopening plan for

nursing homes (CMS, 2020d). The plan did not allow for outside visitors until a nursing home entered phase three, which (loosely) requires (i) that COVID-19 cases in the outside community have declined for 14 consecutive days, (ii) no new cases within the nursing home for 28 days, (iii) no staff or PPE shortages, and (iv) homes have the capacity and supplies to test residents and staff weekly. In light of the continued spread of the virus and the strict reopening criteria, many nursing homes were still closed to visitors months later.

An unfortunate downside of these guidelines is that residents have experienced extreme isolation. In the introduction, we used data on excess deaths among the over 65 population and among individuals with Alzheimer's to argue that this isolation may be deadly. Thus, we now aim to test whether high-quality nursing homes, in their efforts to prevent the spread of COVID-19, also managed the non-COVID risks created by isolation.

In particular, we estimate equation (1) above, but with non-COVID deaths as our dependent variable. In Table 9 (column 1 panel A), we again present results from column 2 of Panel A from Table 4 demonstrating that the nursing home inspection rating is negatively associated with COVID-19 deaths. In Panel B, we show that homes with a higher inspection rating experienced significantly *more* non-COVID deaths. In other words, high-quality homes, who presumably did the best job of following CDC guidelines, were successful in their efforts to prevent COVID-19 deaths, but in doing so, saw significantly more non-COVID deaths than low-quality homes. These effects are monotonic in nursing home quality and are large. Five-star homes saw 8.9 percent more non-COVID deaths than one-star homes. As non-COVID deaths out-number COVID deaths three to one, it is no surprise that in Panel C, where we use total deaths as the outcome, we show that the impact of inspection ratings on *total* deaths is small and positive but statistically insignificant.[18]

[18] A full set of results is available upon request. Note, these estimates suggest that a 5-star home saw 23.3 percent fewer COVID-19 deaths than a 1-star home. As the mean number of COVID-19 deaths in this sample is 3.96, this amounts to 0.92 COVID-19 deaths prevented. The same 5-star home saw 10.7 percent more non-COVID deaths than a 1-star

In Columns 2 and 3 of Table 9, we repeat our analysis, but divide the sample by the number of COVID-19 cases per 1,000 residents in the county where the nursing home is located. Column 2 contains results for nursing homes in counties with a COVID-19 case rate that is greater than the sample median – i.e., high-risk counties – while column 3 has results for low-risk counties. Panel A show that high-quality nursing homes in both sets of counties managed to lower the number of COVID-19 deaths. Five-star homes in high-risk counties had 25.6 percent lower deaths while the same number in low-risk counties is 16 percent. The results differ considerably when we consider non-COVID mortality. We find no statistically significant impact of quality on non-COVID mortality in the high-risk counties but a large positive and statistically precise impact in low-risk counties.[19] In part C of the table, we show that the total death rate is not associated with nursing home quality in high-risk counties but aggregate mortality increases in low-risk counties by a substantial margin. The coefficients in column 3 of Panel C are increasing monotonically and 3- to 5- star ratings are all statistically significant.

There is some concern that our results can be explained by higher-quality nursing homes intentionally misreporting COVID-19 deaths as non-COVID deaths in an effort to protect their reputation. This concern is somewhat mitigated by the fact that the quality / non-COVID mortality gradient is strongest in low-risk areas – i.e., where nursing home residents are least likely to have died as a result of COVID-19. We further address this concern by examining the relationship between nursing home quality and *total* nursing home deaths in the very lowest-risk counties; namely, those that have yet to record a single COVID-19 death. Were quality not positively associated with total deaths in these counties (where the likelihood of COVID-19 death is very low,

home. The mean number of non-COVID deaths is 11.09, meaning 5-star homes had 1.2 additional non-COVID deaths on average. This explains why the parameter estimates in Panel C are positive.

[19] It is possible that isolation would have also significantly increased mortality in high risk areas were it not for harvesting – i.e., the most fragile patients, who are the most susceptible to death by loneliness, are also the most likely to die upon contracting COVID-19.

meaning misreporting is of little concern), we may be concerned that our earlier findings are impacted by misreporting.

Our results using non-COVID deaths reported September 13th, in counties with no COVID-19 deaths as of September 13th, are reported in Column 1 of Table 10. We find that among the 698 homes in these counties, 5-star homes have 35.4 percent fewer deaths than 1-star homes; this difference is statistically significant. We do not find consistently positive effects for 2-4 star homes; however, this is at least partly explained by the fact that so few counties have yet to experience a COVID-19 death six months into the pandemic. To relax this power constraint, we repeat this analysis for cumulative deaths as of August 16th, July 19th, and June 21st, each time limiting the sample to nursing homes located in counties with zero COVID-19 deaths as of that date. Results can be found in columns 2-4 of Table 10. For all three dates, 2-5 star homes consistently have more deaths than 1 star homes and the difference between 5-star and 1-star homes is always large and statistically significant. Moreover, in late June, where the sample size is the largest, non-COVID deaths are increasing monotonically in nursing home quality.

Non-COVID deaths may be measured with error for the same reason as COVID-19 deaths. Thus, in Table 11, we show that the results from Table 9 are robust to (i) dropping the 6 states with the most substantial measurement error, i.e., NY, NJ, PA, MA, IL, FL (column 2) and (ii) measuring non-COVID deaths since May 24th (column 3).

Finally, if it were the case that non-COVID deaths were truly misreported COVID-19 deaths, we would expect homes experiencing more staff and PPE shortages to also have more non-COVID deaths. Similar to analysis above, we re-estimate our non-COVID death model, controlling for the number of staff and PPE shortages experienced between May 24th and September 13th. Results are presented in Column 4 of Table 8. Here, we find that shortages have no impact on non-

COVID deaths (a precisely estimated zero) and the impact of quality on non-COVID deaths is unaffected by the inclusion of this variable.

IV. Conclusion

Over the past six months, high-quality nursing homes have successfully prevented the spread of COVID-19 and deaths caused by COVID-19. We show that high-quality facilities are more likely to follow several CDC recommended guidelines – namely, avoiding staff shortages, maintaining adequate PPE, and regularly testing staff and residents – and that, even conditional on pre-pandemic facility quality, homes following these guidelines experienced fewer COVID-19 deaths. That said, we also provide evidence that high-quality nursing homes have witnessed significantly more non-COVID deaths. Our hypothesis is that the latter represent deaths of loneliness – i.e., that in following CDC guidelines, these homes exposed their residents to severe isolation in an attempt to prevent infection, subsequently leading to premature death by other causes. Furthermore, we show that the relationship between home quality and non-COVID deaths is driven almost entirely by homes located in counties where the risk of infection is low.

These results are sobering. Despite efforts by nursing staff and administrators to protect seniors during the pandemic, the very best nursing homes have experienced no fewer total deaths than the worst ones. In low-risk areas the picture is even more bleak, as the best homes have witnessed the most death. This latter result suggests a need for more nuanced guidelines. Specifically, were isolation guidelines more closely aligned with infection rates at the local level, nursing homes facing little COVID-19 risk may avoid exposing their residents to extreme isolation. A September 17th memo suggest that CMS has recently reached a similar conclusion. Citing resident distress from isolation, the memo outlines new policies that allow for outdoor visitation and relaxed policies for indoor visitation in lower-risk settings such as counties with low positivity rates in the general population.

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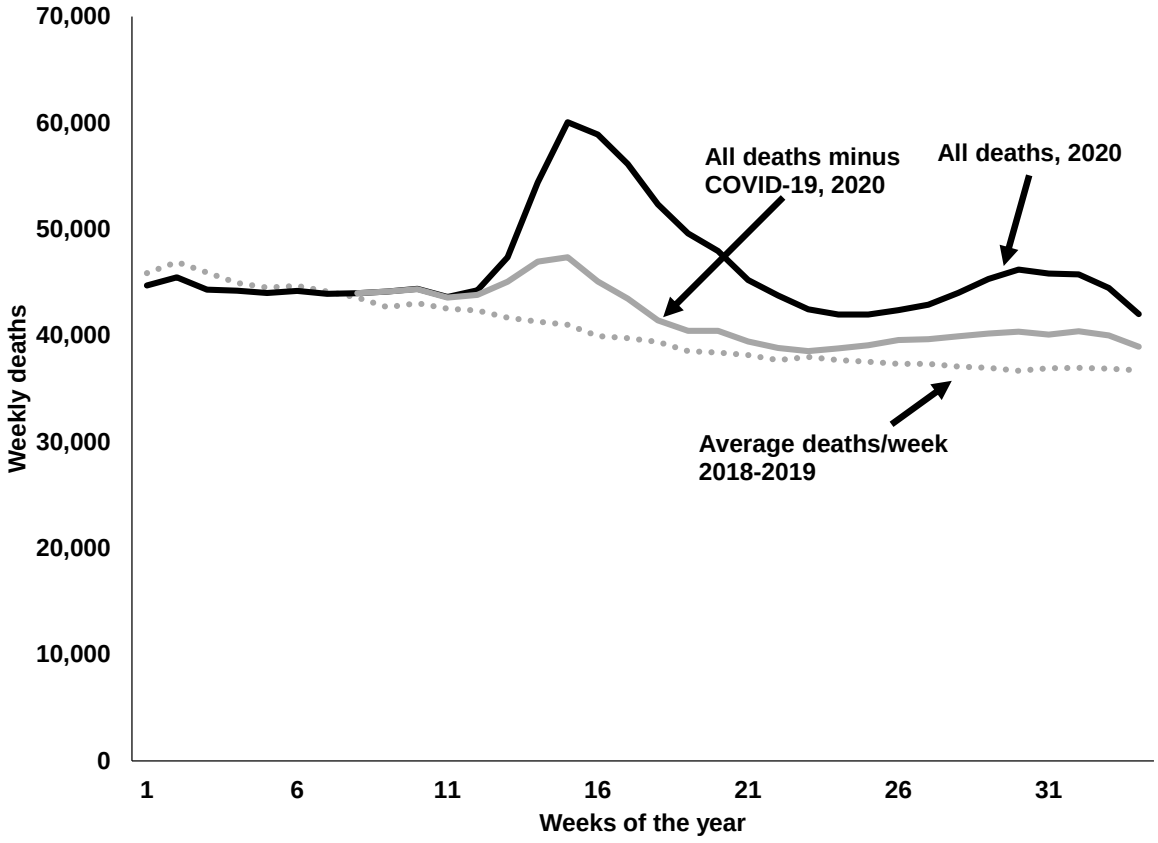
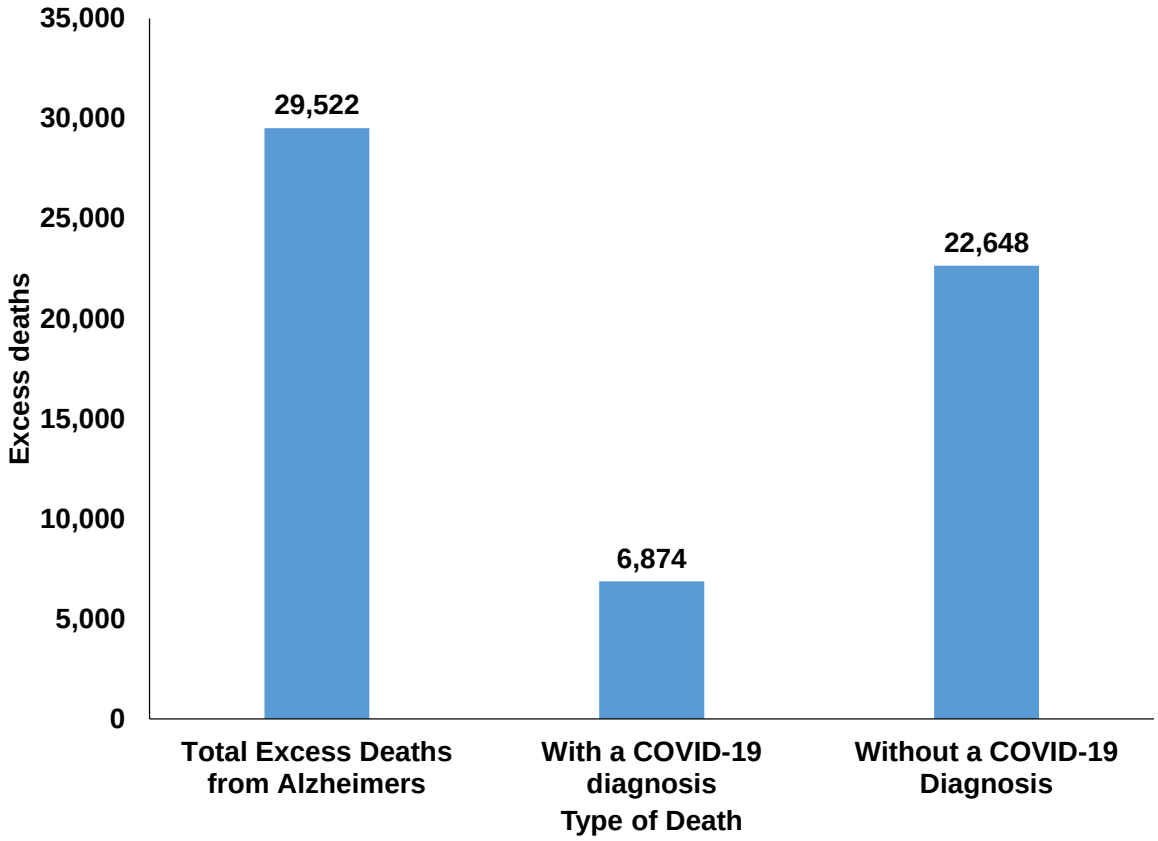
Figure 1
Deaths by Week for Ages 65 and Over, Average of 2018-2019 and 2020,
Provisional Data, CDC



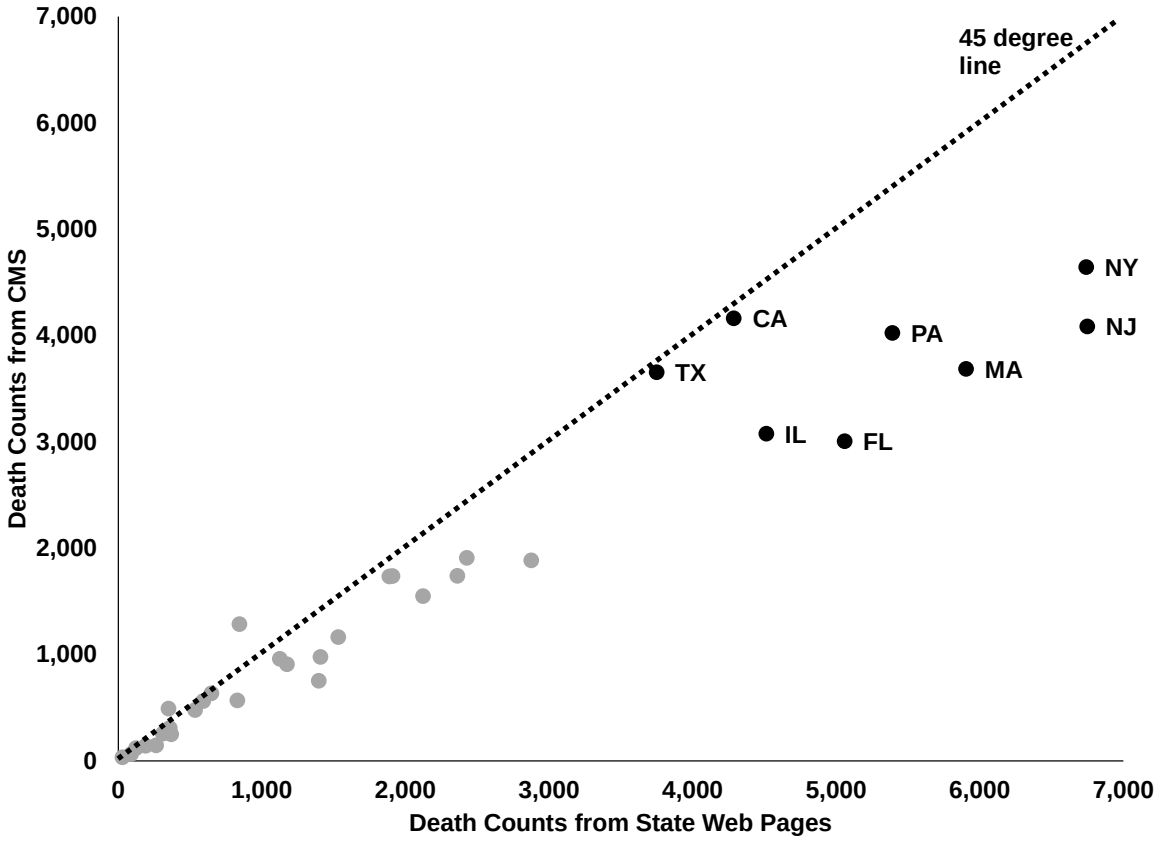
Data is from the CDC available at
https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm

Figure 2
CDC Provisional Estimates of Excess Deaths Among Alzheimer's Patients, With and Without a COVID-19 Diagnosis, Through September 26th, 2020



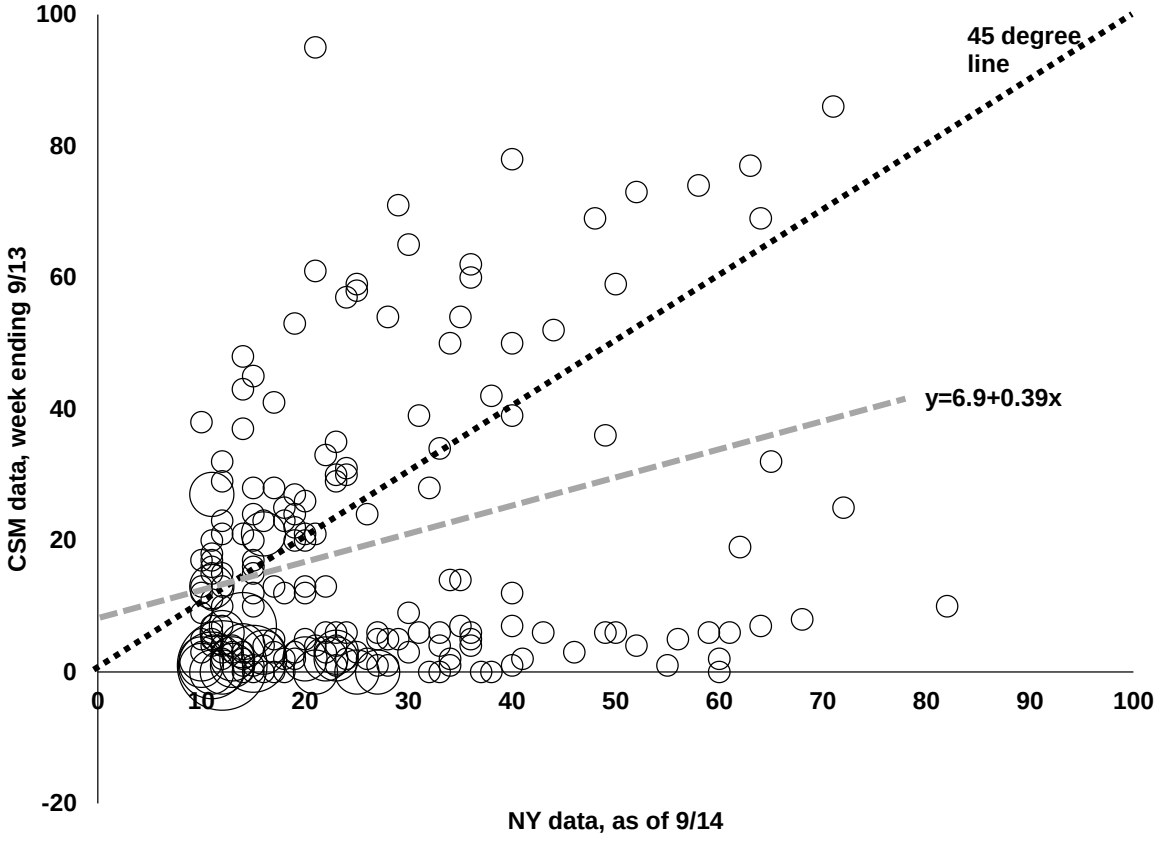
Data is from the CDC available at
https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm

Figure 3
Counts of COVID-19 Deaths in Nursing Homes for 33 States,
From States Reports and CMS Data, As of September 13th, 2020



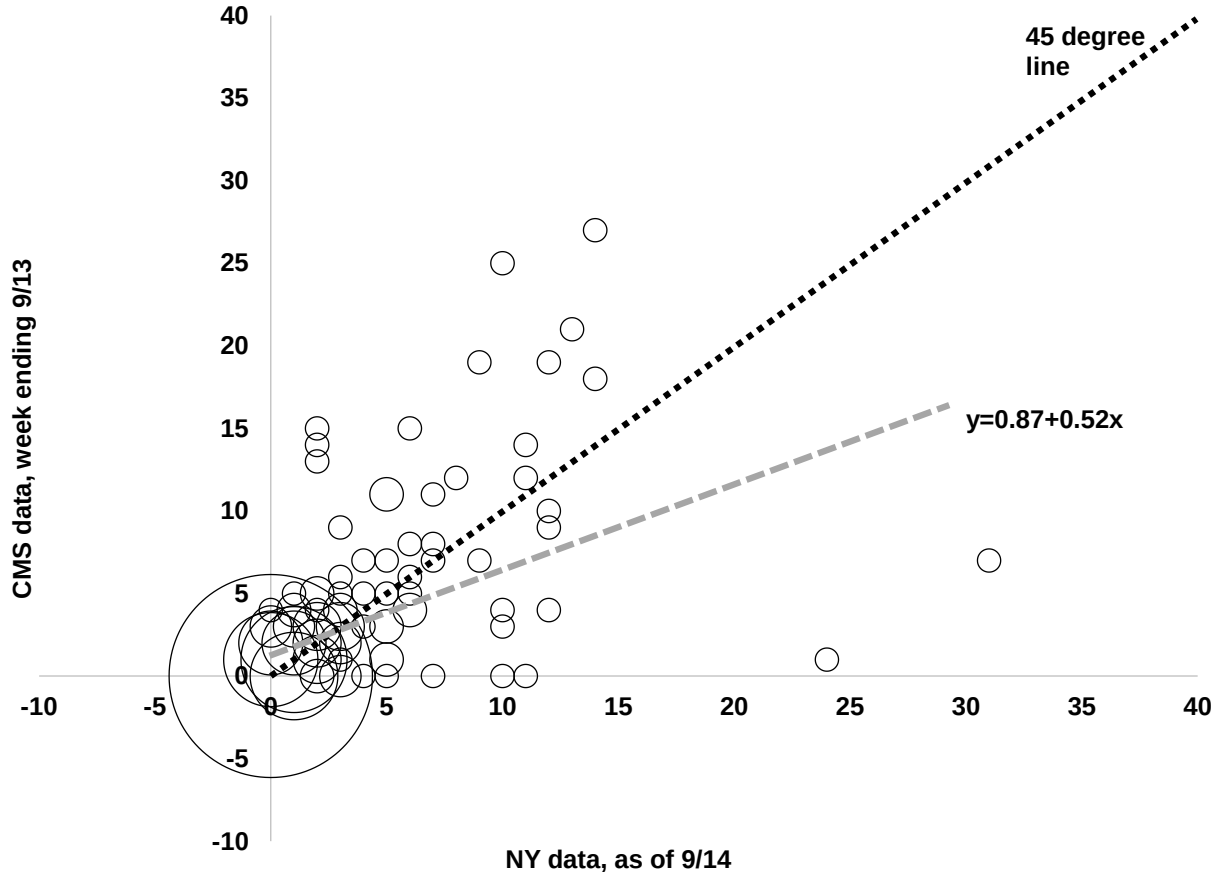
Data is from authors' calculations from CMS nursing home data and state web pages.

Figure 4
Scatter Plot of Cumulative Deaths in Nursing Homes as of September 13th
from New York and CMS Data



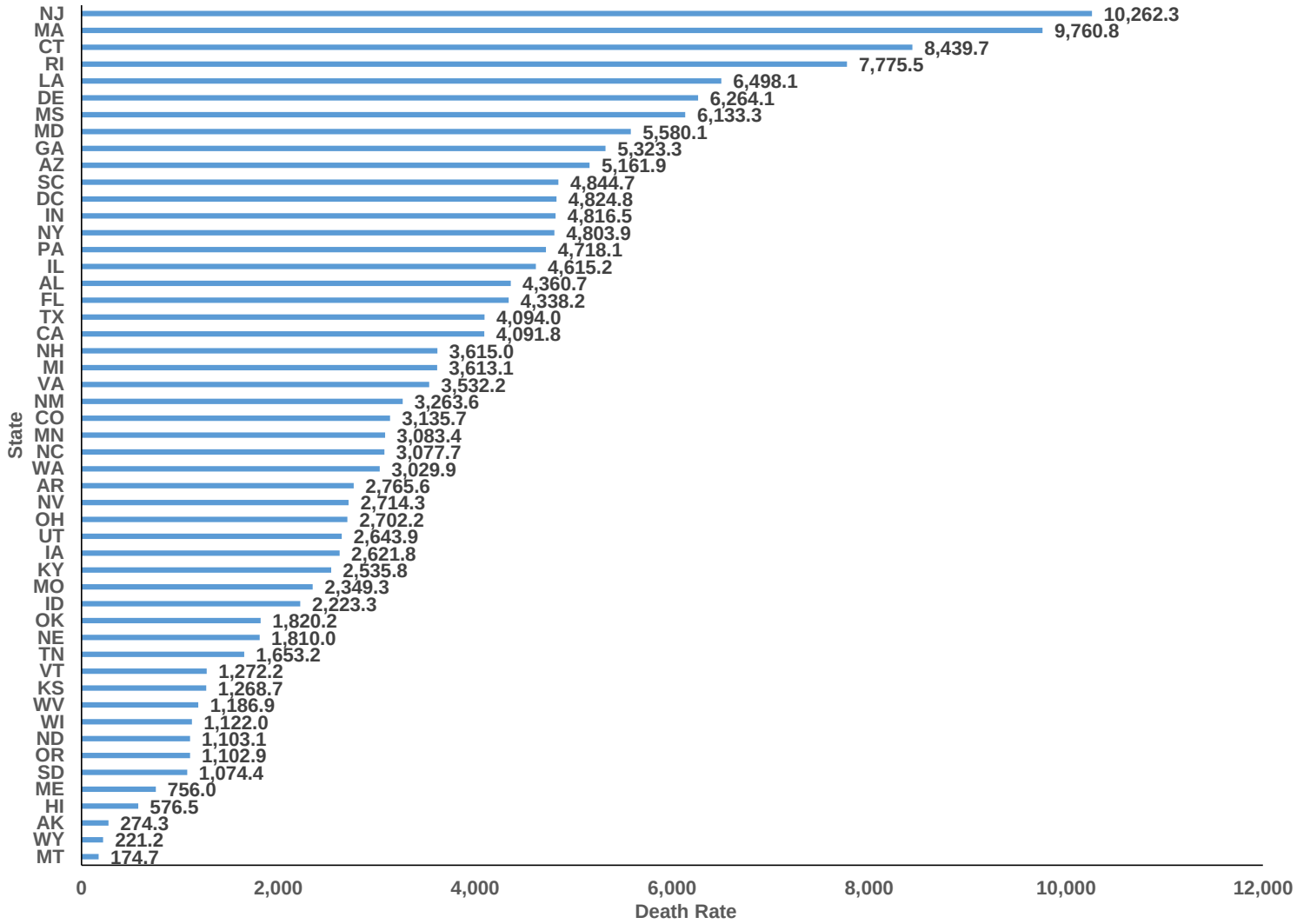
Data is from authors' calculations comparing CMS nursing home data with data provided by the state of New York.

Figure 5
Scatter Plot of Change in Deaths in Nursing Homes Between May 24th and September 13th from New York and CMS Data



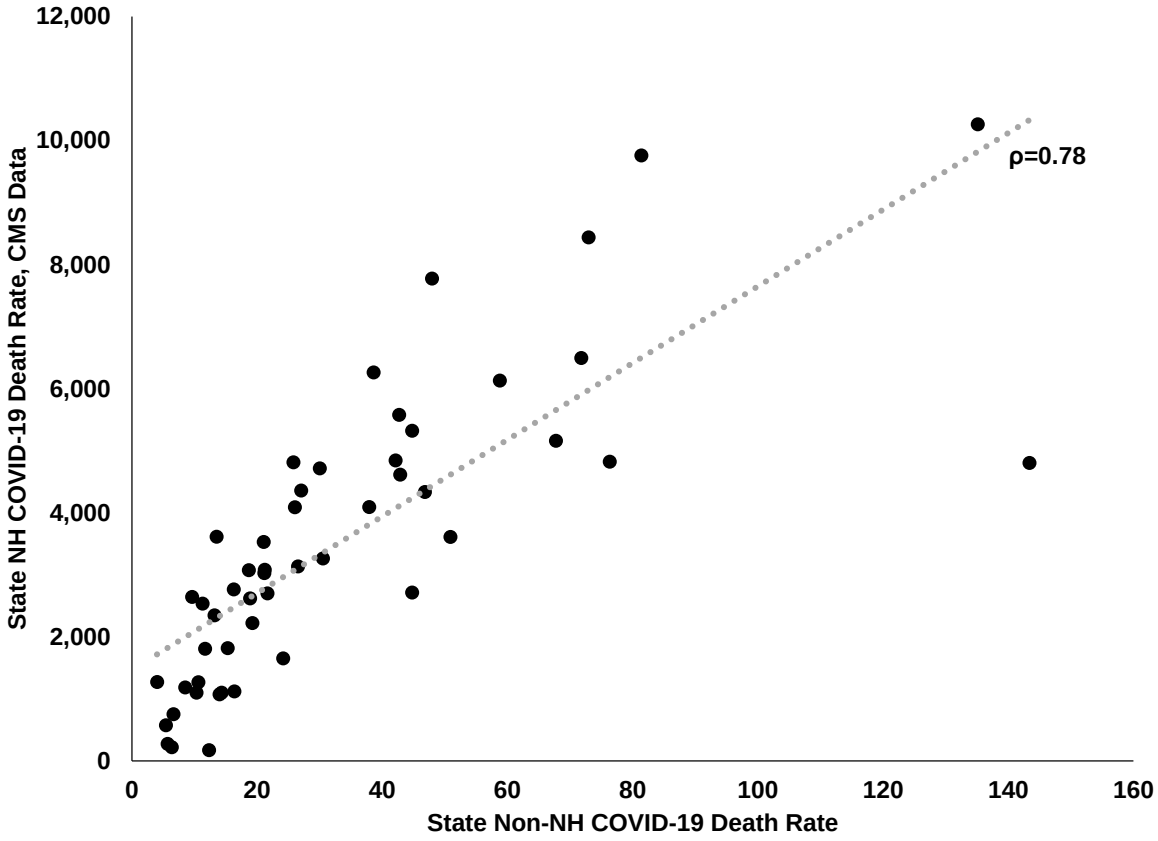
Data is from authors' calculations comparing CMS nursing home data with data provided by the state of New York.

Figure 6
Nursing Home COVID-19 Deaths per 100,000 Residents, CMS Data as of September 13th, 2020



Data is from authors' calculations using CMS nursing home data.

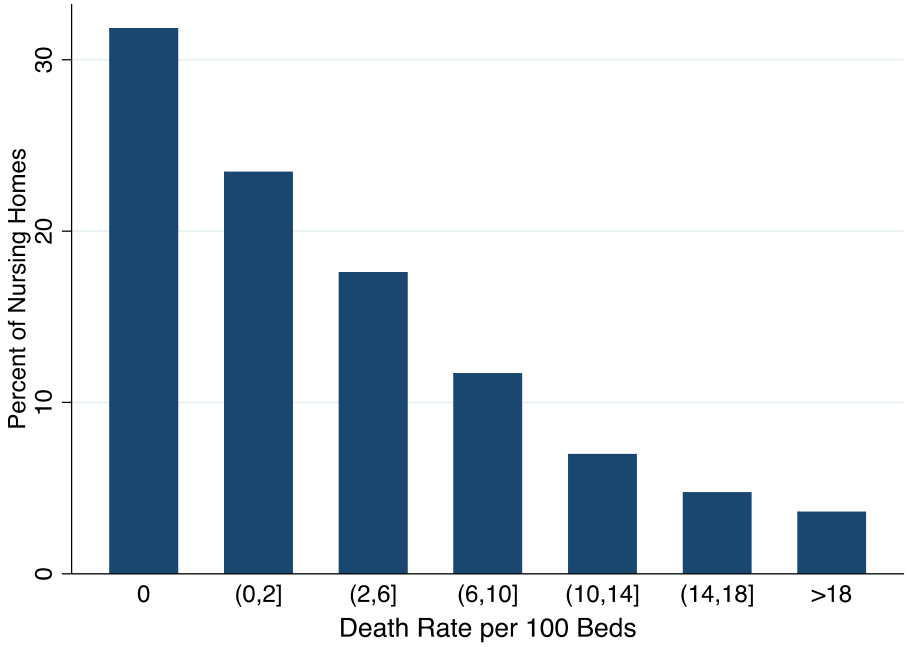
Figure 7
Scatter Plot, Non-Nursing Home COVID-19 Death Rate vs.
Nursing Home COVID-19 Death Rate, As of September 13th, 2020



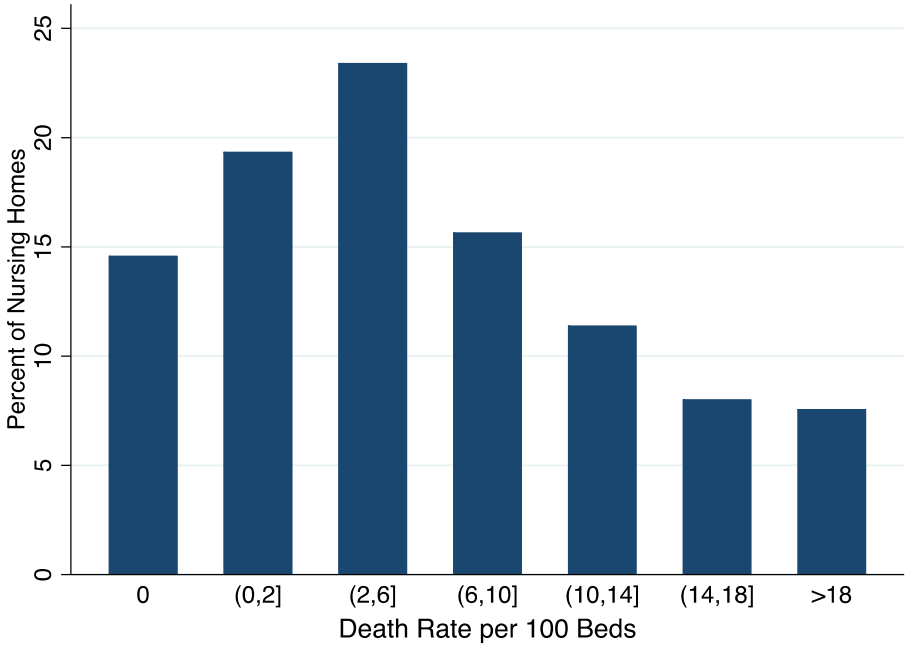
Data is from authors' calculations using CMS nursing home data and data from state web pages.

Figure 8
COVID-19 Death Rate Distribution in Nursing Homes that have More Than 100 Beds and are Located in Counties in the Top 10th Percentile for Total COVID-19 Deaths

Panel A: Distribution as of May 24th



Panel B: Distribution as of September 13th



Data is from authors' calculations using CMS nursing home data.

Table 1
COVID-19 Deaths as of September 13th, 2020
by Reporting Agency and Nursing Home Status

Total	Deaths in NH as reported by states	Deaths in NH as reported by CMS
33 States Reporting Separate Counts for Nursing Home Residents (% of total)		
173,694	68,180 (39.3%)	50,973 (29.3%)
18 States not Reporting Separate Counts for Nursing Home Residents		
18,525		4,856 (26.2%)
	All States	
192,221	73,949,* (38.5%)	55,829 (29.0%)

* Estimated by assuming that the 18 states NOT reporting numbers on webpages would report numbers at the same rate above CMS numbers as the 27 reporting states with the lowest death rates.

Table 2
Sample Characteristics, CMS Data on Nursing Homes, as of September 13th

Variable	mean	s.d.
Nursing home characteristics		
total beds	105.943	61.462
share of female residents	0.663	0.119
share of female residents, missing	0.085	0.280
share of residents < 65 years of age	0.225	0.178
share of residents < 65 years old, missing	0.547	0.498
share of black residents	0.164	0.220
share of black residents, missing	0.446	0.497
share of Hispanic residents	0.050	0.135
share of black residents, missing	0.420	0.494
share of residents on Medicaid	0.599	0.231
for profit	0.702	0.458
acuity index	12.188	1.488
Medicaid, profit, and acuity missing	0.062	0.241
Nursing home quality		
overall star rating		
2	0.196	0.397
3	0.179	0.383
4	0.216	0.412
5	0.256	0.436
Inspection star rating		
2	0.238	0.426
3	0.227	0.419
4	0.235	0.424
5	0.104	0.305
QM star rating		
2	0.128	0.334
3	0.198	0.398
4	0.256	0.436
5	0.368	0.482
Staff star rating		
2	0.267	0.442
3	0.297	0.457
4	0.231	0.422
5	0.124	0.330
Cases and Death rates (per 100 beds)		
resident COVID-19 case rate	12.837	19.225
staff COVID-19 case rate	11.037	13.029
resident COVID-19 death rate	2.891	5.695
resident non-COVID death rate	8.755	10.016
County Characteristics		
COVID-19 cases per 1,000 residents (8/21)	15.332	9.975
COVID-19 deaths per 1,000 residents	0.537	0.540
Population (x 1000)	816	1,745
Observations	15,115	

Table 3
Descriptive Statistics for Nursing Homes. As of September 13th

	1-star		2-star		3-star		4-star		5-star	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
NH characteristics										
total beds	121.69	60.53	115.20	66.89	105.56	60.52	94.33	54.07	81.83	52.17
share of female residents	0.629	0.116	0.651	0.121	0.672	0.115	0.683	0.116	0.699	0.114
share of residents < 65 years old	0.265	0.150	0.245	0.164	0.203	0.166	0.188	0.196	0.168	0.239
share of black residents	0.234	0.231	0.189	0.228	0.149	0.212	0.114	0.192	0.099	0.197
share of hispanic residents	0.067	0.152	0.064	0.153	0.046	0.130	0.036	0.117	0.024	0.093
share of residents on Medicaid	0.661	0.187	0.630	0.203	0.598	0.223	0.556	0.248	0.493	0.287
for profit	0.822	0.383	0.731	0.444	0.696	0.460	0.633	0.482	0.553	0.497
acuity index	12.20	1.32	12.19	1.42	12.19	1.36	12.20	1.52	12.12	2.08
Cumulative Cases and Deaths										
any resident COVID-19 cases	0.684	0.465	0.655	0.475	0.641	0.480	0.580	0.494	0.532	0.499
resident COVID-19 case rate/100 beds	14.70	20.04	13.86	19.65	12.95	19.24	11.69	18.69	9.821	17.56
any staff COVID-19 cases	0.867	0.340	0.852	0.356	0.847	0.360	0.836	0.370	0.821	0.383
staff COVID-19 case rate/100 beds	10.68	12.03	10.77	12.29	11.22	13.10	11.28	13.64	11.58	14.97
any resident COVID-19 deaths	0.490	0.500	0.446	0.497	0.421	0.494	0.381	0.486	0.311	0.463
resident COVID-19 death rate/100 beds	3.311	5.788	3.150	6.205	2.825	5.552	2.714	5.474	2.217	5.211
any resident deaths not from COVID-19	0.830	0.376	0.843	0.364	0.847	0.360	0.826	0.379	0.793	0.406
resident death rate not from COVID-19/100 beds	7.934	9.985	8.538	9.836	8.862	9.734	9.395	10.06	9.463	10.83
NH Staff (since week ending 5/24)										
any nursing staff shortage	0.461	0.499	0.415	0.493	0.393	0.488	0.373	0.484	0.356	0.479
any aide staff shortage	0.503	0.500	0.464	0.499	0.430	0.495	0.410	0.492	0.393	0.489
any clinical staff shortage	0.222	0.415	0.197	0.398	0.186	0.389	0.175	0.380	0.187	0.390
NH Supplies (since week ending 5/24)										
n95 mask outage	0.201	0.401	0.173	0.378	0.159	0.365	0.158	0.364	0.149	0.356
surgical mask outage	0.143	0.350	0.116	0.320	0.106	0.308	0.100	0.300	0.089	0.285
eye protection outage	0.148	0.355	0.122	0.327	0.108	0.311	0.103	0.303	0.085	0.279
gown outage	0.151	0.359	0.130	0.336	0.119	0.323	0.113	0.316	0.097	0.296
glove outage	0.102	0.303	0.075	0.263	0.064	0.245	0.063	0.242	0.061	0.239
hand sanitizer	0.106	0.308	0.073	0.260	0.064	0.245	0.064	0.244	0.059	0.235

Table 3 (continued)
Descriptive Statistics for Nursing Homes. As of September 13th

	1-star		2-star		3-star		4-star		5-star	
Variable	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
COVID-19 Testing (week ending 9/13)										
average time to test results										
<1 day	0.093	0.291	0.080	0.271	0.074	0.262	0.081	0.273	0.088	0.283
1-2 days	0.413	0.493	0.434	0.496	0.480	0.500	0.486	0.500	0.502	0.500
3-7 days	0.464	0.499	0.460	0.498	0.427	0.495	0.417	0.493	0.399	0.490
>7 days	0.030	0.170	0.027	0.161	0.018	0.134	0.016	0.125	0.012	0.108
any resident test in past week	0.448	0.497	0.479	0.500	0.477	0.500	0.464	0.499	0.446	0.497
any asymp. res. test this week | new case in home	0.357	0.479	0.382	0.486	0.404	0.491	0.390	0.488	0.384	0.487
any asymp. res. Test without exposure (ever)	0.271	0.445	0.292	0.455	0.275	0.447	0.284	0.451	0.260	0.439
any staff test in past week	0.654	0.476	0.655	0.475	0.658	0.475	0.639	0.480	0.651	0.477
any asymp. staff test this week | new case in home	0.309	0.462	0.331	0.471	0.362	0.481	0.349	0.477	0.363	0.482
any asymp. staff Test without exposure (ever)	0.512	0.500	0.499	0.500	0.498	0.500	0.497	0.500	0.494	0.500
testing machine on site	0.668	0.471	0.676	0.468	0.673	0.469	0.650	0.477	0.609	0.488
Observations	2,919		3,556		3,383		3,509		1,548	

Table 4
Negative Binomial Estimates, Death Counts in Nursing Homes,
as of May 24th, September 13th, and Cumulative Deaths Between Those Dates

Star Rating	Overall Rating	Inspection Rating	QM Rating	Staff Rating
A: Deaths as of September 13th (Mean deaths=3.52)				
2 stars	0.025	-0.100	0.003	0.103
	(0.039)	(0.048)	(0.066)	(0.062)
3 stars	-0.061	-0.098	0.033	0.001
	(0.053)	(0.048)	(0.046)	(0.058)
4 stars	-0.064	-0.107	-0.003	-0.095
	(0.047)	(0.040)	(0.055)	(0.070)
5 stars	-0.150	-0.242	-0.026	-0.242
	(0.056)	(0.065)	(0.052)	(0.089)
-2 LL	-26,768.1	-26,767.5	-26,756.0	-25,439.6
Observations	14,915	14,915	14,898	13,988
B: Deaths as of May 24th (Mean deaths=1.61)				
2 stars	-0.007	-0.143	0.058	0.133
	(0.053)	(0.065)	(0.087)	(0.100)
3 stars	-0.125	-0.168	0.046	0.034
	(0.074)	(0.069)	(0.097)	(0.107)
4 stars	-0.101	-0.170	0.077	-0.057
	(0.083)	(0.068)	(0.098)	(0.125)
5 stars	-0.155	-0.289	0.063	-0.105
	(0.074)	(0.092)	(0.094)	(0.132)
-2 LL	-13,639.6	-13,635.6	-13,637.9	-13,121.7
Observations	14,195	14,915	14,719	13,352
C: Deaths between May 24th and September 13th (Mean deaths=1.95)				
2 stars	-0.014	-0.104	-0.090	0.118
	(0.044)	(0.044)	(0.067)	(0.041)
3 stars	-0.079	-0.122	-0.031	0.000
	(0.061)	(0.059)	(0.047)	(0.041)
4 stars	-0.128	-0.165	-0.100	-0.093
	(0.054)	(0.054)	(0.060)	(0.055)
5 stars	-0.261	-0.343	-0.150	-0.298
	(0.064)	(0.078)	(0.064)	(0.084)
-2 LL	-20,364.5	-20,366.1	-20,361.5	-19,373.5
Observations	14,079	14,079	14,068	13,257

Standard errors allow for arbitrary correlation across observations within a state. Other controls in the models include logged total beds; percent of residents that are female, under 65, black, Hispanic, on Medicaid (along with corresponding indicators for missing variables); for-profit status; acuity index; county-level COVID-19 cases per 1,000 residents (measured 23 days prior to death); logged county population; and a full set of state fixed effects.

Table 5
Sensitivity of Basic Estimates

Model characteristics	Mean of dep. var.	Obs.	R^2/ -2 LL	Coefficient (Standard error) on Inspection rating dummy variables			
				2-star	3-star	4-star	5-star
(1) Baseline model, Table 4, Panel A, Col. 2 (included for comparison)	3.52	14,915	-26,767.5	-0.100	-0.098	-0.107	-0.242
				(0.048)	(0.048)	(0.040)	(0.065)
(2) Model (1) but Poisson specification	3.52	14,915	-57,179.5	-0.088	-0.160	-0.118	-0.201
				(0.058)	(0.051)	(0.038)	(0.083)
(3) Model (1) but drop NY, NJ, PA, MA, FL, IL	2.70	10,990	-8,040.0	-0.014	-0.031	-0.024	-0.176
				(0.046)	(0.043)	(0.036)	(0.066)
(4) Model (1) but OLS with ln(deaths+1)	0.78	14,915	0.291	-0.050	-0.056	-0.061	-0.098
				(0.029)	(0.030)	(0.024)	(0.034)
(5) Model (4) but add county FE	0.78	14,915	0.423	-0.042	-0.070	-0.088	-0.118
				(0.034)	(0.030)	(0.030)	(0.041)
(6) Model (1) but OLS with inverse hyperbolic sine of deaths	0.98	14,915	0.290	-0.062	-0.068	-0.076	-0.125
				(0.036)	(0.037)	(0.029)	(0.041)
(7) Model (6) but add county FE	0.98	14,915	0.425	-0.052	-0.085	-0.108	-0.150
				(0.042)	(0.037)	(0.037)	(0.049)
(8) Model (1) but add controls for any staff and resident cases, as well as counts	3.52	14,915	-21,731.5	-0.046	-0.072	-0.022	-0.089
				(0.034)	(0.036)	(0.027)	(0.047)
(9) Deaths between 5/24 and 9/13, Table 4, Panel C, Col. 2 (included for comp.)	1.95	14,079	-20,366.1	-0.104	-0.122	-0.165	-0.343
				(0.044)	(0.059)	(0.054)	(0.078)
(10) Model (9) but drop NY, NJ, PA, MA, FL, IL	1.81	10,915	-14,892.8	-0.046	-0.050	-0.080	-0.296
				(0.043)	(0.051)	(0.045)	(0.081)

Standard errors allow for arbitrary correlation across observations within a state. Other controls in the models include logged total beds; percent of residents that are female, under 65, black, Hispanic, on Medicaid (along with corresponding indicators for missing variables); for-profit status; acuity index; county-level COVID-19 cases per 1,000 residents (measured 23 days prior to death); logged county population; and a full set of state fixed effects.

Table 6
OLS Estimates of Within-Nursing Home Incidence of Staff and Resident Cases, Using Deaths as of September 13th, 2020

Inspection Star Rating	Any staff cases	Ln(staff cases | staff cases>0)	Any resident cases	Ln(resident cases | resident cases>0)
2 stars	-0.006	-0.006	-0.004	-0.057
	(0.009)	(0.023)	(0.009)	(0.036)
3 stars	0.003	0.040	0.011	-0.090
	(0.010)	(0.026)	(0.009)	(0.043)
4 stars	0.005	0.026	-0.018	-0.064
	(0.010)	(0.021)	(0.008	(0.039)
5 stars	0.008	-0.001	-0.025	-0.230
	(0.015)	(0.035)	(0.013)	(0.0650
Mean of Dep. Var.	0.847	2.041	0.626	2.374
R^2	0.193	0.355	0.271	0.171
Observations	14,915	12,630	14,915	8,766

Standard errors allow for arbitrary correlation across observations within a state. Other controls in the models include logged total beds; percent of residents that are female, under 65, black, Hispanic, on Medicaid (along with corresponding indicators for missing variables); for-profit status; acuity index; county-level COVID-19 cases per 1,000 residents (measured 23 days prior to death); logged county population; and a full set of state fixed effects.

Table 7
OLS and Maximum Likelihood where Outcomes are Different Measures of Nursing Home Quality, As of September 13th

Dependent variable	Mean of dependent variable	Obs.	R^2/ -2 LL	Coefficient (Standard error) on Inspection rating dummy variables			
				2-star	3-star	4-star	5-star
A: Staff shortage (any 5/24 – 9/13)							
Any nursing shortage?	0.403	14,915	0.073	-0.040	-0.059	-0.071	-0.078
				(0.009)	(0.013)	(0.015)	(0.015)
Any aide shortage?	0.444	14,915	0.079	-0.034	-0.066	-0.077	-0.084
				(0.010)	(0.015)	(0.016)	(0.015)
Any clinical staff shortage?	0.193	14,915	0.029	-0.022	-0.032	-0.040	-0.025
				(0.008)	(0.013)	(0.012)	(0.012)
B: PPE shortage (any 5/24 – 9/13)							
N95 outage?	0.169	14,915	0.056	-0.020	-0.030	-0.028	-0.031
				(0.011)	(0.013)	(0.013)	(0.017)
Surgical mask outage?	0.113	14,915	0.049	-0.020	-0.026	-0.029	-0.037
				(0.010)	(0.012)	(0.012)	(0.016)
Eye protection outage?	0.116	14,915	0.055	-0.019	-0.030	-0.032	-0.045
				(0.009)	(0.011)	(0.012)	(0.012)
Gown outage?	0.124	14,915	0.048	-0.015	-0.024	-0.028	-0.040
				(0.011)	(0.012)	(0.012)	(0.017)
Glove outage?	0.074	14,915	0.026	-0.024	-0.033	-0.034	-0.037
				(0.007)	(0.009)	(0.009)	(0.009)
Hand sanitizer outage?	0.074	14,915	0.030	-0.030	-0.038	-0.038	-0.044
				(0.008)	(0.009)	(0.009)	(0.010)
C: Testing procedures (week ending 9/13)							
Time to test	2.397	12,483	-12,065.8	0.016	-0.078	-0.105	-0.089
				(0.068)	(0.066)	(0.064)	(0.081)
Test asymptomatic residents after a new resident case?	0.385	3,699	0.054	0.022	0.047	0.030	0.023
				(0.026)	(0.024)	(0.030)	(0.030)
Test asymptomatic staff after a new resident case?	0.340	3,699	0.058	0.024	0.066	0.045	0.060
				(0.023)	(0.023)	(0.026)	(0.029)
Ever test non-exposed resident?	0.279	14,915	0.054	0.029	0.026	0.044	0.031
				(0.014)	(0.013)	(0.015)	(0.020)
Ever test non-exposed staff?	0.500	14,915	0.117	-0.007	-0.004	0.001	0.004
				(0.011)	(0.014)	(0.013)	(0.016)
Have in-home testing machine?	0.660	14,915	0.114	0.018	0.023	0.019	0.002
				(0.012)	(0.013)	(0.015)	(0.017)

Standard errors allow for arbitrary correlation across observations within a state. Other controls in the models include logged total beds; percent of residents that are female, under 65, black, Hispanic, on Medicaid (along with corresponding indicators for missing variables); for-profit status; acuity index; county-level COVID-19 cases per 1,000 residents (measured 23 days prior to death); logged county population; and a full set of state fixed effects.

Table 8
Negative Binomial Estimates, Death Counts in Nursing Homes from COVID-19 and non-COVID-19 Causes, as of September 13th

	COVID-19 Deaths		Non-COVID-19 Deaths	
Covariate	(1)	(2)	(3)	(4)
Inspection star rating				
2 stars	-0.100	-0.091	0.024	0.026
	(0.048)	(0.047)	(0.029)	(0.029)
3 stars	-0.098	-0.086	0.066	0.067
	(0.048)	(0.049)	(0.026)	(0.026)
4 stars	-0.107	-0.096	0.089	0.091
	(0.040)	(0.040)	(0.036)	(0.036)
5 stars	-0.242	-0.228	0.089	0.091
	(0.065)	(0.065)	(0.047)	(0.047)
Counts of PPE and staff shortages		0.033		0.005
		(0.006)		(0.005)
Mean of dep. variable	3.52	3.52	9.14	9.14
-2 LL	-26,767.5	-26,715.2	-46,530.7	-46,529.8
Observations	14,915	14,915	14,915	14,915

Standard errors allow for arbitrary correlation across observations within a state. Other controls in the models include logged total beds; percent of residents that are female, under 65, black, Hispanic, on Medicaid (along with corresponding indicators for missing variables); for-profit status; acuity index; county-level COVID-19 cases per 1,000 residents (measured 23 days prior to death); logged county population; and a full set of state fixed effects.

Table 9
Negative Binomial Estimates, Death Counts in Nursing Homes as of September 13th

		Nursing home by County COVID-19 Case Rate	
Inspection star Rating	All Nursing Homes	Above Median	At or below Median
A: COVID-19 Deaths			
2 stars	-0.100	-0.096	-0.038
	(0.048)	(0.049)	(0.079)
3 stars	-0.098	-0.117	0.010
	(0.048)	(0.047)	(0.085)
4 stars	-0.107	-0.128	-0.028
	(0.040)	(0.047)	(0.080)
5 stars	-0.242	-0.256	-0.160
	(0.065)	(0.066)	(0.089)
Mean of Dep. Var.	3.52	5.35	1.69
-2 LL	-26,767.5	-17,920.8	-8,502.4
B: Non-COVID Deaths			
2 stars	0.024	-0.021	0.089
	(0.029)	(0.041)	(0.042)
3 stars	0.066	0.036	0.116
	(0.026)	(0.034)	(0.033)
4 stars	0.089	0.045	0.158
	(0.036)	(0.041)	(0.044)
5 stars	0.089	0.007	0.197
	(0.047)	(0.054)	(0.055)
Mean of Dep. Var.	9.14	9.43	8.85
-2 LL	-46,530.7	-23,404.6	-23,078.5
C: All Deaths			
2 stars	0.003	-0.025	0.063
	(0.030)	(0.041)	(0.040)
3 stars	0.031	-0.002	0.095
	(0.027)	(0.034)	(0.033)
4 stars	0.048	0.005	0.128
	(0.032)	(0.036)	(0.040)
5 stars	0.015	-0.069	0.151
	(0.052)	(0.058)	(0.056)
Mean of Dep. Var.	12.66	14.78	10.54
-2 LL	-50544.7	-26,284.9	-24,145.4
Observations	14,915	7,431	7,484

Standard errors allow for arbitrary correlation across observations within a state. Other controls in the models include logged total beds; percent of residents that are female, under 65, black, Hispanic, on Medicaid (along with corresponding indicators for missing variables); for-profit status; acuity index; county-level COVID-19 cases per 1,000 residents (measured 23 days prior to death); logged county population; and a full set of state fixed effects.

Table 10
Negative Binomial Estimates, All Deaths in the Nursing Home by Various Dates
In Counties with Zero COVID-19 deaths

Inspection Star Rating	By Sept. 13th	By Aug. 16th	By July 19th	By June 21st
2 stars	0.033	0.096	0.034	0.092
	(0.145)	(0.137)	(0.129)	(0.129)
3 stars	0.006	0.103	0.134	0.163
	(0.164)	(0.143)	(0.097)	(0.109)
4 stars	-0.009	0.039	0.113	0.170
	(0.140)	(0.125)	(0.084)	(0.113)
5 stars	0.354	0.299	0.263	0.276
	(0.141)	(0.155)	(0.101)	(0.118)
Mean of Dep. Var.	5.24	4.68	4.06	3.24
-2 LL	-1,840.0	-2630.0	-3,899.9	-4350.3
Observations	698	1,038	1,629	2,025

Standard errors allow for arbitrary correlation across observations within a state. Other controls in the models include logged total beds; percent of residents that are female, under 65, black, Hispanic, on Medicaid (along with corresponding indicators for missing variables); for-profit status; acuity index; county-level COVID-19 cases per 1,000 residents (measured 23 days prior to death); logged county population; and a full set of state fixed effects.

Table 11
Negative Binomial Estimates, Non-COVID Deaths in the Nursing Home by Various Specifications

Inspection Star Rating	By Sept. 13th, All Data	By Sept. 13th, Drop 6 States	Since May 24th, All Data
2 stars	0.024	0.091	-0.007
	(0.029)	(0.132)	(0.025)
3 stars	0.066	0.119	0.048
	(0.026)	(0.128)	(0.019)
4 stars	0.089	0.035	0.055
	(0.036)	(0.119)	(0.029)
5 stars	0.089	0.284	0.063
	(0.047)	(0.145)	(0.035)
Mean of Dep. Var.	9.14	8.13	6.09
-2 LL	-46,530.7	-34935.0	-38663.7
Observations	14,915	11,522	14,079

Standard errors allow for arbitrary correlation across observations within a state. Other controls in the models include logged total beds; percent of residents that are female, under 65, black, Hispanic, on Medicaid (along with corresponding indicators for missing variables); for-profit status; acuity index; county-level COVID-19 cases per 1,000 residents (measured 23 days prior to death); logged county population; and a full set of state fixed effects.