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COVID-19 Mortality Rates Among Nursing Home Residents Declined From March To November 2020

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Abstract

Improved therapeutics and supportive care in hospitals have helped reduce mortality from COVID-19. However, there is limited evidence as to whether nursing home residents, who account for a disproportionate share of COVID-19 deaths and are often managed conservatively in the nursing home instead of being admitted to the hospital, have experienced similar mortality

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Residents infected in later months had a significantly lower probability of dying within thirty days of diagnosis compared with those infected in earlier months.

reductions. In this study we examined changes in thirty-day mortality rates between March and November 2020 among 12,271 nursing home residents with COVID-19. We found that adjusted mortality rates significantly declined from a high of 20.9 percent in early April to 11.2 percent in early November. Mortality risk declined for residents with both symptomatic and asymptomatic infections and for residents with both high and low clinical complexity. The mechanisms driving these trends are not entirely understood, but they may include improved clinical management within nursing homes, improved personal protective equipment supply and use, and genetic changes in the virus.

The COVID-19 pandemic has had devastating effects on nursing homes and other long-term care facilities, causing roughly 1.2 million infections and 147,000 deaths in this sector in the US as of early February 2021.¹ The communal living environment combined with the overall frailty of residents, who generally must be in regular close proximity with staff for personal care, make this population extremely susceptible to adverse outcomes from COVID-19.²⁻⁴ Since the start of the COVID-19 pandemic, long-term care residents have consistently accounted for roughly 40 percent of total US deaths.¹

COVID-19 mortality rates have declined in the general population as a result of factors that may have limited, if any, influence on mortality rates for nursing home residents. For example, more widespread testing has allowed for increased detection of SARS-CoV-2 in younger people, who are less susceptible to severe disease.⁵ Yet this phenomenon would not affect mortality rates in the nursing home population, which is primarily composed of frail older adults. Advances in therapeutics and supportive care have improved survival in hospitalized patients with severe infections. These include systemic corticosteroids, remdesivir, monoclonal antibodies, and prone positioning, as well as advanced non-invasive oxygen therapy.⁶⁻⁸ However, such therapies are generally not available outside of the hospital setting and have not been systematically tested or widely used in medically frail older adults.^{7,8} Because of the poor survival of this population after hypoxemic respiratory failure and prolonged intensive care unit admission, the mainstay of clinical management for nursing home residents with COVID-19 has been conservative care within the nursing home.⁸

Given these significant differences between the nursing home population and the general population, there is a need to examine changes in mortality risk over time for nursing home residents specifically. A state-level analysis by the Kaiser Family Foundation found that the average number of new COVID-19 deaths in long-term care facilities declined from April through August 2020.⁹ However, factors influencing underlying resident-level mortality risk cannot be measured in publicly reported, aggregate data.

To address this evidence gap, we used detailed, resident-level data from a large, multistate nursing home operator to examine the association of calendar time with short-term mortality after COVID-19 diagnosis. Our analysis tested two hypotheses that may explain changes in mortality risk over time in this population. First, we assessed whether increased detection of asymptomatic cases, which would add residents with less severe infection to the denominator, has led to reduced mortality rates for the population overall. Second, we examined whether differences in the case-mix of residents infected in earlier versus later

months resulted in lower mortality. Findings from this study will improve understanding of mortality risk in this vulnerable population and help identify both intrinsic and extrinsic factors that may have contributed to changes in mortality risk over time.

Study Data And Methods

DATA SOURCES

Clinical data were obtained for 282 nursing homes in twenty-four states, owned by a large provider of postacute and long-term care services. All facilities had at least one COVID-19 resident case as of November 15, 2020. The main data sources for this analysis included electronic medical records (EMRs), facility infection tracking logs, and Minimum Data Set resident assessments. Auxiliary data sources used in secondary analyses are described in the online appendix.¹⁰ EMRs were the source for daily resident census data and relevant nursing documentation including vital sign records and structured notes documenting changes in condition. Infection tracking logs are maintained by each facility and include all SARS-CoV-2 testing dates and results. Minimum Data Set assessments are administered to all residents of Medicare- or Medicaid-certified nursing homes (including the studied facilities) both on admission and serially thereafter until discharge. The Minimum Data Set captures resident demographics and a variety of clinical elements including active diagnoses and validated measures of functional and cognitive status.

POPULATION

We identified all residents across the operator's nursing homes who were infected with SARS-CoV-2, as confirmed by reverse transcriptase polymerase chain reaction (PCR) testing between March 16 and November 15, 2020. Reasons for testing included new-onset symptoms, potential exposure, and surveillance during facilitywide or unit-based point prevalence surveys.

OUTCOME

The primary outcome was all-cause mortality within thirty days of confirming SARS-CoV-2 infection. We identified both resident deaths occurring in the nursing home from Minimum Data Set discharge assessments and deaths occurring outside the facility (for example, in a hospital) from the EMR resident census.

MAIN EXPLANATORY VARIABLE

The main explanatory variable was the date a resident first tested positive for SARS-CoV-2. To facilitate interpretation of adjusted analyses, we categorized diagnosis dates into sixteen semimonthly dummy variables capturing the set of diagnosis dates (from March 16 through November 15) in our study population.

ASYMPTOMATIC VERSUS SYMPTOMATIC CLASSIFICATION

Nurses conducted assessments including vital signs on all residents two to three times daily and documented any new symptoms in structured notes in the EMR documenting changes in condition. Relevant symptoms included cough, sore throat, nasal congestion, rhinorrhea,

fever (temperature of 100 degrees F or higher), shortness of breath, chest congestion, nausea, vomiting, diarrhea, anosmia, malaise, confusion, tachycardia, and hypoxia (oxygen saturation below 92 percent or a 3-percentage-point decline from baseline). We classified residents infected with SARS-CoV-2 as asymptomatic if they exhibited none of these symptoms from the five days before their first positive PCR test up to fourteen days after that test. Residents with symptoms in this window were classified as symptomatic.

COVARIATES

We controlled for factors known to be associated with COVID-19-related mortality that may vary in prevalence over time with fluctuations in nursing home case-mix. These factors included age, comorbidities, cognitive and functional impairment, postacute versus long-stay resident status, and symptomatic versus asymptomatic infection status. To capture illness severity, we also controlled for whether the resident experienced new-onset fever, tachycardia, shortness of breath, or hypoxia.¹¹ Additional demographic covariates included sex and race (classified as White, Black, and other).

We identified baseline chronic conditions from the Minimum Data Set assessment nearest to the initial positive SARS-CoV-2 test, including hypertension, diabetes mellitus, heart failure, coronary artery disease, chronic obstructive pulmonary disease or asthma, chronic kidney disease, and dementia. Functional and cognitive impairment were measured with the Morris activities of daily living (ADL) scale¹² and the Cognitive Function Scale (CFS),¹³ respectively. The ADL score ranges from 0 to 28 (higher values indicate greater functional impairment) and was divided into quartiles to facilitate interpretation. The CFS ranges from 1 (intact cognitive function) to 4 (highly impaired) and was operationalized as four dummy variables.

STATISTICAL ANALYSIS

We illustrated the distribution of COVID-19-related thirty-day mortality rates over time by dividing residents into semimonthly diagnosis date periods, which included the second half of March through the first half of November. We also graphically assessed the relationship of thirty-day mortality with the entire distribution of diagnosis dates using locally weighted scatterplot smoothing estimates of trend. This method computes the probability of mortality separately on each diagnosis date, using a mean of nearby data points with greater weight on the nearest points. Because we expected asymptomatic infection rates to increase over time, we estimated separate trend lines for symptomatic and asymptomatic cases. As with the prevalence of asymptomatic infection, resident case-mix may also vary with time, particularly as residents die. Accordingly, we estimated separate trend lines for residents with high and low levels of functional and cognitive impairment—known risk factors for COVID-19-related mortality that indicate clinical complexity—based on ADL and CFS scores.¹⁴ ADL scores of 19 and higher (the upper two quartiles of scores) and CFS scores of 3 and 4 were used to indicate advanced functional and cognitive impairment, respectively.

We used Poisson regression with cluster-robust standard errors to calculate the adjusted risk of thirty-day mortality associated with COVID-19 diagnosis date.¹⁵ Instead of assuming linearity or a particular functional form for the relationship between diagnosis date and

mortality, we calculated mortality risk for all semi-monthly periods relative to the first half of April, an early time point that includes a large number of residents. The regression model was estimated separately for the overall cohort, residents with symptomatic SARS-CoV-2 infection, and residents with asymptomatic infection.

All regression models included standard errors clustered at the nursing home level. In addition to the relative risks, we derived adjusted mortality rates per diagnosis period from the Poisson model, using the marginal standardization form of predictive margins. Analyses were conducted using Stata MP, version 16.0. Null hypotheses were tested assuming a two-sided type I error rate of 0.05.

SECONDARY ANALYSES AND ROBUSTNESS CHECKS

As a robustness check, we added nursing home fixed effects to our primary regression model to obtain the within-facility association between diagnosis date and thirty-day COVID-19-related mortality. This approach effectively compared mortality risk between residents living in the same nursing home who were diagnosed in early versus later months and thus controlled for important baseline facility attributes (for example, general level of quality). For this analysis we used a linear probability model because the inclusion of fixed effects may bias point estimates derived from a nonlinear model such as Poisson regression.¹⁶

We conducted two secondary analyses. First, we examined the relationship between nursing home-level and community-level case fatality rates (the number of deaths among the diagnosed population) over time. We described how we calculated the community case fatality rates in the appendix.¹⁰ Second, we assessed trends in hospitalization rates to gauge potential changes in the clinical care of residents with COVID-19. We used Minimum Data Set discharge records to indicate whether residents were hospitalized within thirty days of the COVID-19 diagnosis date, mirroring the mortality follow-up window. We then estimated the hospitalization rate for each period with the same risk-adjustment model used for the main mortality analysis.

LIMITATIONS

This study had two primary limitations. First, our data came from a single, multifacility, long-term care provider with a particular concentration in the Northeast. Mortality trends in other samples of nursing home residents maybe dissimilar. Second, because of the observational study design, significant potential for residual confounding remains, and observed associations should not be interpreted as causal. The purpose of this analysis was to determine whether there were differences in COVID-19-related mortality rates over time and whether potential differences are accounted for by observable changes in resident case-mix and asymptomatic infection rates. However, it is possible that temporally different mortality risk may be due to unobserved changes in resident case-mix or survival bias. More generally, our analyses did not pinpoint potential mechanisms that may underlie temporal shifts in COVID-19-related mortality.

Study Results

The sample included 12,271 nursing home residents confirmed to have SARS-CoV-2 infection by PCR testing between March 16 and November 15, 2020. Residents' median age was seventy-nine (interquartile range: 69–88), and 61 percent of residents were female. The racial composition of the sample was 70 percent White, 16 percent Black, and 14 percent other (exhibit 1). The mean baseline ADL score was 16.7 (standard deviation: 6.2), 38 percent had advanced cognitive impairment (CFS score of 3 or 4), and 13 percent were receiving postacute care. The prevalence of heart failure, coronary artery disease, chronic obstructive pulmonary disease or asthma, and chronic kidney disease ranged between 22 percent and 26 percent. Almost half of residents exhibited one or more COVID-19-related symptoms, including 24 percent with fever, 8 percent with tachycardia, 8 percent with hypoxia, and 5 percent with shortness of breath.

Residents were disproportionately located in Northeastern states (appendix exhibit A1);¹⁰ about 65 percent of the sample resided in New Jersey, Pennsylvania, Massachusetts, Connecticut, or Maryland. The facilities of the nursing home operator were also disproportionately located in New England and Mideastern states compared with nursing homes nationally (appendix exhibit A2).¹⁰ In addition, the sample facilities were larger (120 versus 99 median beds), more heavily financed by Medicaid (73 percent versus 64 percent), and less likely to be located in rural counties (15 percent versus 29 percent).

Exhibit 2 lists trends in crude thirty-day mortality rates for the overall sample, stratified according to asymptomatic versus symptomatic infection status (locally weighted scatterplot smoothing estimated trend lines are in appendix exhibit A3).¹⁰ Also included in the exhibit is the proportion of residents who were asymptomatic across semimonthly diagnosis periods. For the overall sample, crude mortality rates fell from 26.4 percent in the second half of March to 10.0 percent during the first half of November. Concurrently, the proportion of residents with an asymptomatic infection rose from 24.9 percent in the second half of March to 69.2 percent in the first half of November. However, although mortality rates were higher among residents with symptomatic infections, for both groups, diagnosis date was inversely correlated with thirty-day mortality. Among residents with symptomatic infections, the mortality rate in the second half of March was 32.2 percent and fell to 10.2 percent in the first half of November. Among residents with asymptomatic infections, the mortality rate in the second half of March was 9.1 percent, rose to 16.7 percent in the first half of April, and fell to 9.9 percent in the first half of November.

Exhibit 3 illustrates trends in thirty-day COVID-19-related mortality among residents with and without advanced functional impairments (corresponding point estimates are in appendix exhibit A4).¹⁰ Although residents with greater cognitive and ADL impairment had higher mortality rates compared with residents who were less impaired, diagnosis date was inversely correlated with thirty-day mortality across all groups. Among the most impaired group of residents (CFS = 3, ADL = 19), the thirty-day mortality rate fell from 41.0 percent in the second half of March to 15.8 percent in the first half of November. Among the group of residents with the lowest levels of impairment (CFS <3, ADL <19), mortality rates fell from 18.4 percent in the second half of March to 8.1 percent in the first half of November.

exhibit 4 presents adjusted thirty-day mortality rates and the adjusted relative risk of mortality associated with semimonthly diagnosis date period. Point estimates for regression model covariates are in appendix exhibit A5.¹⁰ In the overall cohort, the mortality rate among residents diagnosed with COVID-19 in the second half of March was 19.3 percent. In the following period, the first half of April, the adjusted mortality rate (20.9 percent) did not significantly differ. However, COVID-19-related mortality risk was significantly lower in all subsequent semimonthly periods. Among residents diagnosed with COVID-19 in the first half of November, the adjusted thirty-day mortality rate was 11.2 percent, and their mortality risk was almost 50 percent lower than that of residents diagnosed in the first half of April (relative risk: 0.53). In stratified analyses, adjusted mortality rates also declined significantly for residents with either asymptomatic or symptomatic infections in almost all periods after the first half of April (exhibit 4). Trends in adjusted mortality rates were similar when derived from within-facility linear probability models with nursing home fixed effects, indicating that even within facilities, residents diagnosed in later versus earlier months had lower mortality risk (appendix exhibit A6).¹⁰

Case fatality rates of the surrounding communities were substantially lower than the case fatality rate of the sample (appendix exhibit A7).¹⁰ However, the community and sample case fatality rates were highly correlated during the study period. Analyses of thirty-day hospitalization revealed no significant changes in adjusted hospitalization rates in the majority of semimonthly periods compared with the first half of April (appendix exhibit A8).¹⁰ This finding was consistent in analyses stratified by asymptomatic infection status.

Discussion

In this study of more than 12,000 US nursing home residents with COVID-19, we found that both unadjusted and adjusted thirty-day mortality rates declined from late March to early November 2020. Concurrently, the proportion of COVID-19 cases that were asymptomatic increased over time as a result of improvements in surveillance testing. However, even after adjusting for whether residents were symptomatic and whether they had symptoms of more severe infection, we still found that residents infected in later months had a significantly lower probability of dying within thirty days of diagnosis compared with those infected in earlier months. In addition, stratified analyses of symptomatic versus asymptomatic residents revealed that mortality risk declined for both groups over the course of the pandemic. This suggests that the overall decline in mortality rates was not driven by the increased detection of asymptomatic, less severe cases.

Residents with significant cognitive and functional impairment had higher mortality rates than those with less impairment across all months. However, mortality rates declined both for residents who were significantly impaired and for those who were not. Had we seen larger differences between the most and least clinically complex groups in earlier versus later months, it would have suggested that more vulnerable residents were more likely to have died during the early months of the pandemic, leaving a less at risk population in later months. We did not find this to be the case. In analyses adjusted for multiple resident characteristics capturing clinical complexity, a later diagnosis date was associated with a 21–

65 percent reduction in thirty-day mortality risk in all semimonthly periods from mid-April onward.

A number of other factors could explain temporal changes in mortality rates. Early COVID-19 outbreaks overwhelmed the long-term care sector and health care systems overall, potentially leading to excessively high mortality at the beginning of the pandemic. After initial outbreaks, the freeing up of resources, increased knowledge of and experience with COVID-19, and reduced burden on nursing homes may have led to better outcomes for residents. In some areas of the country not well represented in our sample, such as the Rocky Mountain and Plains states, severe COVID-19 outbreaks first occurred during the late summer and early fall. There is recent evidence demonstrating high initial nursing home resident death rates corresponding to outbreak timing in these areas.¹⁷

There is also the potential for temporal variation in infection severity and case fatality due to different SARS-CoV-2 variants.^{18–20} A study examining genomic variation across the US found a positive correlation between fatality rates and circulating levels of two variants that were highly prevalent in the Northeastern states—the predominant location of residents of the present study—and less prevalent in Southern, Central, and Western states.²⁰ Community COVID-19 prevalence highly correlates with the probability and severity of nursing home outbreak;^{18,21} thus, higher prevalence of a more lethal variant in the community would increase the likelihood of that variant being introduced into the nursing homes in that area. Relatedly, we found that the case fatality rates of our nursing home sample corresponded with the case fatality rates of the surrounding communities over time.

Given the geographic concentration of the sample population in the Northeast, lower mortality risk among residents with later exposure may suggest some influence of advances in the management of COVID-19 in nursing homes. Yet current evidence regarding the influence of changes in clinical and operational management on mortality in this population remains limited. Therapeutics such as remdesivir, monoclonal antibodies, and systemic intravenous corticosteroids are primarily administered to hospitalized patients and have not been systematically tested or used in nursing home or other frail older adult populations.^{7,8} Clinical management of nursing home residents with COVID-19 has primarily focused on supportive treatment within the facility,²² and no available evidence suggests that such care substantially changed between March and November 2020. In our sample we found that risk-adjusted hospitalization rates did not significantly change over the course of the study period.

Personal protective equipment (PPE) supply, another potential explanatory factor, has improved since March. During the early months of the pandemic, PPE shortages were widespread, and most nursing home providers were forced to rely on federal crisis standard guidelines for extended use and reuse of gowns and masks.²³ Reuse of PPE could relate to the viral load at time of infection, a metric shown to correlate with mortality,²⁴ but further work is needed to examine this hypothesis. Similarly, the evidence regarding staffing levels and resident COVID-19 outcomes is also evolving. A recent cross-sectional analysis provided some evidence that higher nurse staffing levels were associated with fewer cases

and deaths once a case was already confirmed in a facility,²⁵ but there have been no studies to date examining the impact of longitudinal changes in staffing on resident outcomes.

Conclusion

In this large, multistate sample of nursing home residents with COVID-19, we observed significant declines in thirty-day mortality rates between March and November 2020. Neither improved detection of asymptomatic cases nor changes in observed case-mix explained these trends. Understanding the dynamic risk for mortality from COVID-19 among nursing home residents is critical for identifying the mechanisms affecting outcomes in this vulnerable population. Future research is needed to explore the impact of other extrinsic factors affecting COVID-19 mortality in nursing homes, including improvements in PPE supply, staff adoption of and skill with PPE, specific changes in the clinical management of COVID-19, and potential SARS-CoV-2 genetic variants. Furthermore, it will be critical to monitor infection and mortality rates with the rollout of the SARS-CoV-2 vaccines, which are the most urgent and effective interventions available to protect this vulnerable population. ■

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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NOTES

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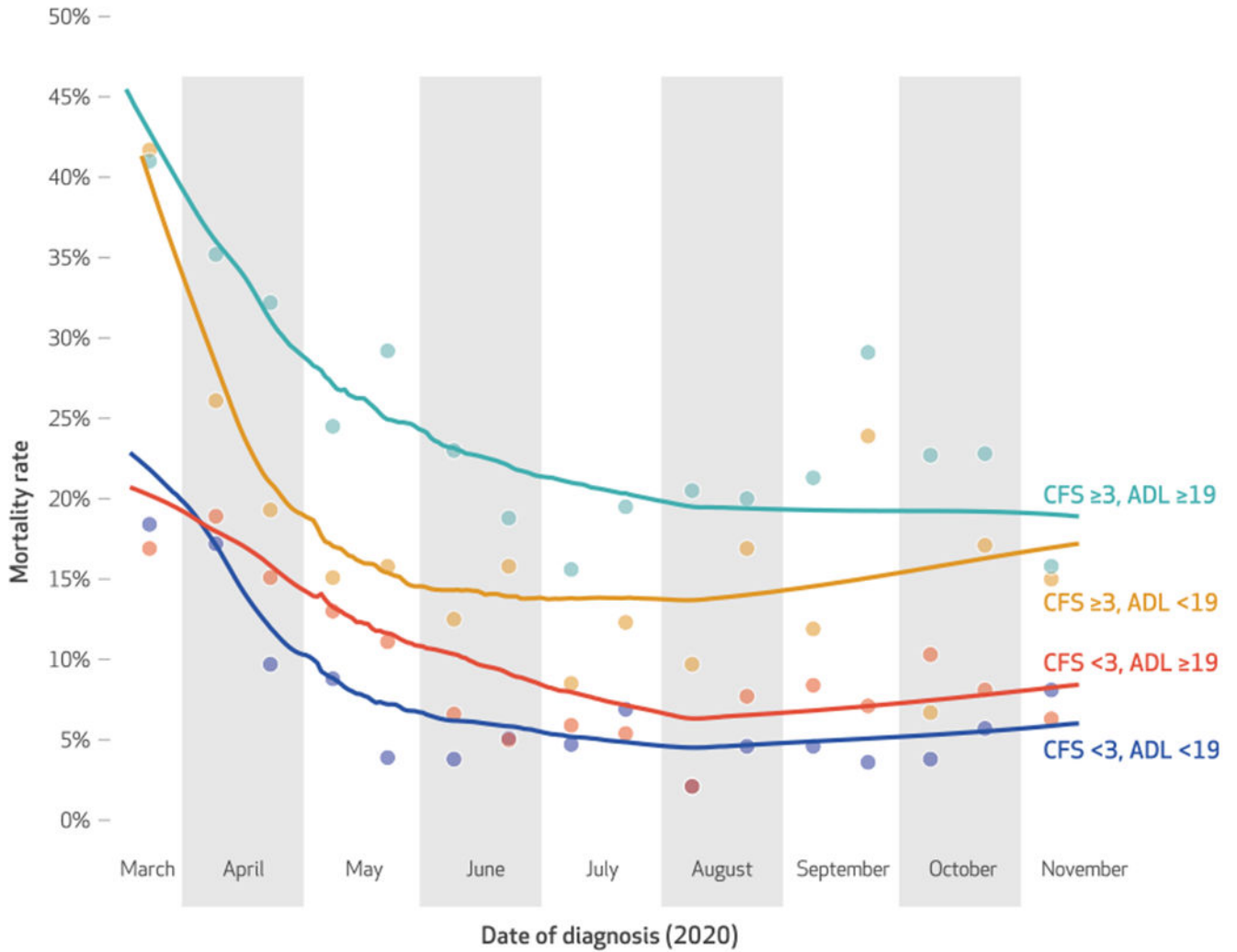


Exhibit 3. Trends in daily and semimonthly crude 30-day COVID-19 mortality rates, by cognitive and functional status, among residents of a sample of US nursing homes, 2020
SOURCE Authors’ analysis of resident-level data from 282 nursing homes operated by a large, long-term care provider. **NOTES** Trend lines were estimated with locally weighted scatterplot smoothing, using all data points from the analytic sample (daily from March 16 through November 15). A scatterplot of unadjusted semimonthly mortality rates is superimposed. Cognitive Function Scale (CFS) scores range from 1 to 4; scores of 3 and 4 indicate advanced cognitive impairment. The Morris activities of daily living (ADL) score signifies the extent to which residents are dependent in seven activities of daily living, denoted by a higher score. An ADL score of 19 represents the seventy-fifth-percentile value of the analytic sample and reflects a substantial level of functional impairment.

EXHIBIT 1

Characteristics of residents with COVID-19 in a sample of US nursing homes, March 16-November 15, 2020

Characteristics	Number/median/ mean ^a	Percent/ IQR/SD ^b
Median age, years (IQR)	79	69–88
Age, years		
Less than 65	1,916	16
65–69	1,239	10
70–74	1,538	13
75–79	1,611	13
80–84	1,726	14
85–89	1,814	15
90 or older	2,304	19
Female sex	7,538	61
Race		
White	8,586	70
Black	1,978	16
Other	1,707	14
Mean ADL score (SD) ^c	16.7	6.2
ADL dependency score quartile		
0–13	3,069	25
14–18	3,057	25
20–21	2,766	23
22–28	3,379	28
CFS score		
1	4,761	39
2	2,796	23
3	3,558	29
4	1,064	9
Postacute patient	1,631	13
Chronic conditions		
Dementia	5,599	46
Heart failure	2,691	22
Coronary artery disease	2,816	23
COPD or asthma ^d	2,987	24
Chronic kidney disease ^e	3,155	26
Hypertension	9,526	78

Characteristics	Number/median/ mean ^a	Percent/ IQR/SD ^b
Diabetes	4,775	39
Symptoms at presentation		
Any symptom ^f	5,645	46
Fever	2,936	24
Tachycardia	959	8
Hypoxia	974	8
Shortness of breath	567	5

SOURCE Authors' analysis of resident-level data from 282 nursing homes operated by a large long-term care provider.

NOTES *N* = 12,271 residents. IQR is interquartile range. SD is standard deviation. ADL is activities of daily living. CFS is Cognitive Function Scale. COPD is chronic obstructive pulmonary disease.

^aNumber unless otherwise indicated.

^bPercent unless otherwise indicated.

^cRange: 0–28.

^dClassified in the Minimum Data Set as “asthma, chronic obstructive pulmonary disease, chronic bronchitis, and restrictive lung diseases.”

^eClassified in the Minimum Data Set as “renal insufficiency, renal disease, or end-stage renal disease.”

^fResidents were classified as symptomatic if any of the following symptoms were present during the five days before their first positive test or during the fourteen days afterward: cough, sore throat, nasal congestion, rhinorrhea, fever, shortness of breath, chest congestion, nausea, vomiting, diarrhea, anosmia, malaise, confusion, tachycardia, and hypoxia. See the Study Data And Methods section for further details.

Trends in crude 30-day COVID-19-related mortality and asymptomatic infection rates among residents in a sample of US nursing homes, 2020

EXHIBIT 2

Date of diagnosis (2020)	No. of residents	30-day mortality rate (%)		Infections that were asymptomatic (%)	
		Asymptomatic	Symptomatic	Overall	Overall
March 16–31	265	9.1	32.2	26.4	24.9
April 1–15	1,756	16.7	25.4	22.8	29.0
April 16–30	2,553	11.4	22.3	17.7	41.8
May 1–15	2,483	12.1	20.9	15.2	64.2
May 16–31	721	7.8	21.5	13.5	58.9
June 1–15	386	7.1	12.8	9.3	61.9
June 16–30	441	6.4	16.5	10.4	60.1
July 1–15	561	5.8	14.8	8.4	71.1
July 16–31	463	7.8	15.6	10.8	61.1
August 1–15	344	5.9	8.5	7.0	58.7
August 16–31	424	8.8	16.2	11.8	59.2
September 1–15	292	8.0	16.4	11.3	60.3
September 16–30	295	8.9	22.0	12.5	72.2
October 1–15	288	9.0	15.4	10.8	73.3
October 16–31	519	10.6	13.2	11.4	69.7
November 1–15	351	9.9	10.2	10.0	69.2

SOURCE Authors' analysis of resident-level data from 282 nursing homes operated by a large long-term care provider.

NOTE Symptomatic and asymptomatic classifications are described in the Study Data And Methods section.

EXHIBIT 4

Adjusted relative risks (RRs) and adjusted semimonthly rates of 30-day COVID-19-related mortality among residents in a sample of US nursing homes, 2020

Date of diagnosis (2020)	Full sample		Symptomatic residents		Asymptomatic residents	
	30-day mortality rate	RR	30-day mortality rate	RR	30-day mortality rate	RR
March 16–31	19.3	0.92	27.3	1.01	8.3	0.49
April 1–15	20.9	Ref	27.0	Ref	16.8	Ref
April 16–30	16.5	0.79**	22.6	0.84**	11.2	0.67**
May 1–15	15.5	0.74**	20.9	0.77**	10.9	0.65
May 16–31	13.3	0.64**	19.5	0.72**	8.2	0.49**
June 1–15	10.2	0.49**	14.2	0.53**	6.9	0.41**
June 16–30	10.9	0.52**	16.2	0.60**	7.0	0.42**
July 1–15	10.3	0.49**	16.7	0.62**	6.3	0.38**
July 16–31	11.7	0.56**	15.7	0.58**	8.4	0.50**
August 1–15	7.2	0.35**	7.4	0.27**	7.0	0.42**
August 16–31	10.7	0.51**	13.5	0.5**	7.8	0.46**
September 1–15	11.4	0.54**	15.4	0.57**	8.1	0.48**
September 16–30	13.3	0.64**	18.4	0.68**	9.0	0.53**
October 1–15	11.4	0.55**	12.7	0.47	8.5	0.51**
October 16–31	14.0	0.67**	13.6	0.50**	11.4	0.68
November 1–15	11.2	0.53**	9.3	0.34**	10.4	0.62**

SOURCE: Authors' analysis of resident-level data from 282 nursing homes operated by a large long-term care provider.

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NOTES Adjusted mortality rates and relative risks were derived from a robust Poisson regression model. Covariates were age, sex, race (categorized as White, Black, and other), Morris activities of daily living score, Cognitive Function Scale score, baseline comorbidities, postacute versus long-stay status, and presence of COVID-19-related symptoms (see the Study Data And Methods for details). Referent = 1.00.

^{***} $p < 0.05$