Appendix

I.   Auxiliary Data Sources

We obtained nursing facility level characteristics four sources. First, the Certification and Survey Provider Enhanced Reporting (CASPER) database includes information on nursing home organizational characteristics (e.g., bed size, payer mix) collected from annual surveys as well as location (state and county). Second, we used rural-urban continuum codes available from the U.S. Department of Agriculture (https://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx) to classify nursing homes as rural or urban based on the county they are located in. Third, data on resident characteristics were obtained from the Long-Term Care: Facts on Care in the U.S. (LTCfocus) website (www.ltcfocus.org). LTCfocus is maintained by Brown University and includes hundreds of facility-level measures based on Minimum Data Set resident assessments. Fourth, the Nursing Home Compare website (www.medicare.gov/nursinghomecompare) contains many nursing home quality measures (e.g. hospital admission rates) that are also aggregated and summarized as star-ratings (scored from 1 to 5 stars [higher is better]).

II.   Calculation of Community Case Fatality Rates

We compared the trend in case fatality rates for the analytic sample to the trend for surrounding communities. To calculate the community-level case fatality rate, we first identified the counties that the nursing homes in our sample are located in. We then defined the county-level case fatality rate for any given semimonthly period as the number of deaths during next period divided by the number of incident cases during the current period. We did not use deaths and cases from the same time interval due to the gap between diagnosis and death. We also subtracted nursing home deaths in our analytic sample from this calculation. Finally, we computed the median case fatality rate of the selected counties for each semimonthly period. We applied the proportion of nursing home residents residing in each county at each time point as sampling weights.

III.   Appendix Exhibit A1. Distribution of Analytic Sample by State

| State	No. Residents	% Residents	No. Facilities	% Facilities
PA	2111	17	29	10
NJ	1915	16	29	10
MA	1449	12	25	9
CT	1247	10	18	6
MD	1244	10	25	9
NM	945	8	24	9
CO	523	4	9	3
WV	480	4	26	9
NH	345	3	18	6
KY	339	3	15	5
RI	308	3	8	3
NC	244	2	7	2
AL	211	2	7	2
DE	202	2	6	2
FL	197	2	5	2
AZ	188	2	4	1
ME	164	1	9	3
VT	51	0	5	2
CA	48	0	4	1
IN	25	0	1	0
VA	25	0	2	1
TN	5	0	2	1
ID	3	0	2	1
WA	2	0	2	1

Notes: No. = number of.

IV. Appendix Exhibit A2. Characteristics of Nursing Homes in the Analytic Sample versus Other U.S. Nursing Homes

Characteristic, Median (IQR) or %	Sample Nursing Homes (n=282)	Other Nursing Homes (n=15161)
Total no. beds	120 (94 to 142)	99 (64 to 126)
Total no. beds		
Small (0-60)	4	24
Average (61-99)	25	27
Large (100 or more)	71	49
For-profit	100	70
Chain member	100	58
Resident characteristics		
% Black	5 (1 to 16)	5 (0 to 17)
% Hispanic	2 (0 to 5)	0 (0 to 4)
% Dementia	43 (35 to 53)	45 (33 to 57)
Payer mix		
% Medicare	10 (7 to 17)	10 (5 to 17)
% Medicaid	73 (61 to 82)	64 (47 to 76)
% Private pay	15 (10 to 23)	23 (13 to 37)
Quality		
Overall rating (/5)	3 (2 to 4)	3 (2 to 4)
Staffing rating (/5)	3 (2 to 4)	3 (2 to 4)
Infection control citation	45	42
Area-level characteristics		
Rural	15	29
Bureau of Economic Analysis Region		
Far west	2	11
Rocky mountain	4	3
Southwest	10	12
Plains	0	14
Southeast	23	23
Great Lakes	0	20
Mideast	32	12
New England	30	5

Notes: Nursing homes were classified as rural or urban based on the rural-urban continuum code of their county. Quality ratings refer to 5-star ratings published on the Medicare Nursing Home Compare webstie. See Appendix Section I for details.

V. Appendix Exhibit A3 Lowess Estimated Trends in Crude 30-Day COVID-19-related Mortality
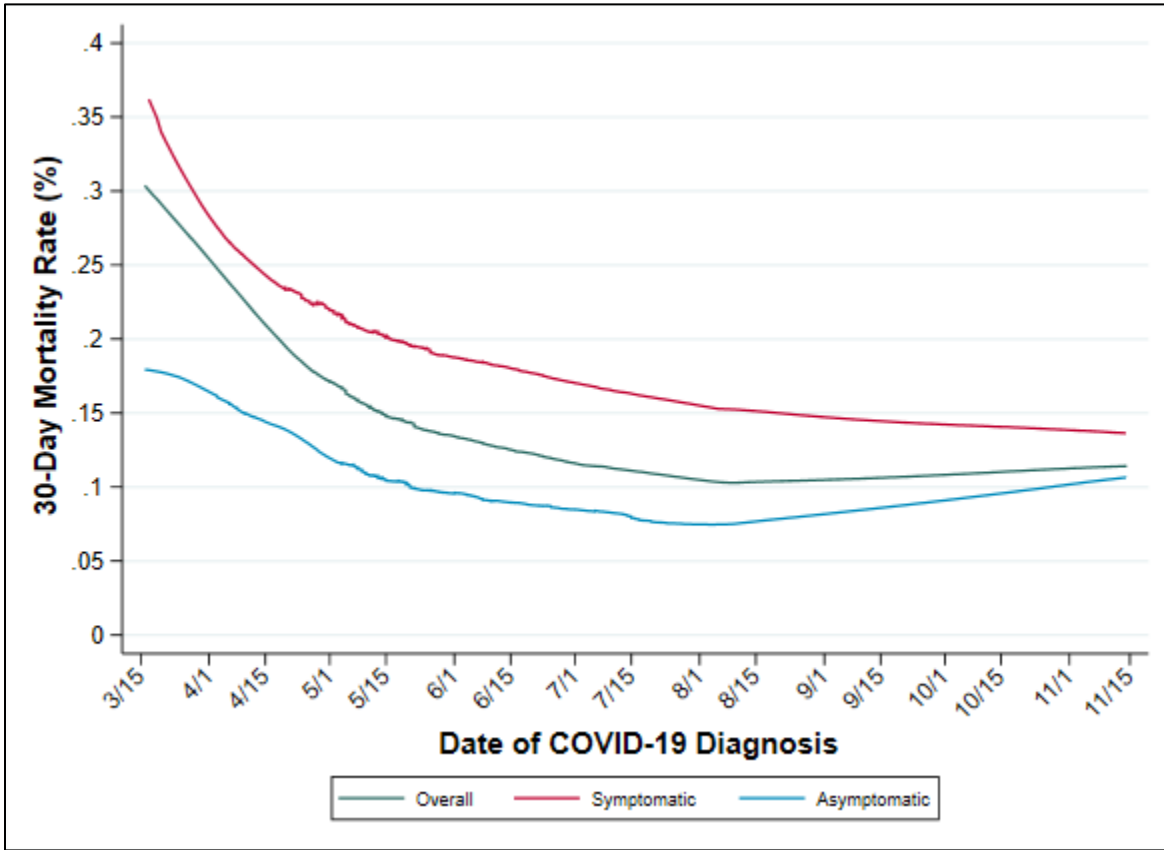
Notes: COVID-19was identified via reverse transcriptase polymerase chain reaction testing for SARS-CoV-2. Trend lines were estimated with Lowess (locally weighted scatterplot smoothing) using all data points from the analytic sample.

VI. Appendix Exhibit A4. Semimonthly Trends in 30-Day COVID-19-related Mortality among Residents with and without Functional Impairment

Date of Diagnosis	CFS < 3, ADL < 19		CFS < 3, ADL ≥ 19		CFS ≥ 3, ADL < 19		CFS ≥ 3, ADL ≥ 19	
	No. Patients	30d Death Rate (%)	No. Patients	30d Death Rate (%)	No. Patients	30d Death Rate (%)	No. Patients	30d Death Rate (%)
3/16 to 3/31	103	18.4	65	16.9	36	41.7	61	41.0
4/1 to 4/15	674	17.2	471	18.9	211	26.1	400	35.2
4/16 to 4/30	961	9.7	610	15.1	373	19.3	609	32.2
5/1 to 5/15	821	8.8	598	13.0	350	15.1	715	24.5
5/16 to 5/31	260	3.9	190	11.1	101	15.8	171	29.2
6/1 to 6/15	159	3.8	106	6.6	48	12.5	75	23.0
6/16 to 6/30	156	5.1	100	5.0	57	15.8	128	18.8
7/1 to 7/15	213	4.7	119	5.9	82	8.5	147	15.6
7/16 to 7/31	144	6.9	129	5.4	57	12.3	133	19.5
8/1 to 8/15	140	2.1	95	2.1	31	9.7	78	20.5
8/16 to 8/31	130	4.6	104	7.7	65	16.9	125	20.0
9/1 to 9/15	87	4.6	83	8.4	42	11.9	80	21.3
9/16 to 9/30	110	3.6	84	7.1	46	23.9	55	29.1
10/1 to 10/15	106	3.8	78	10.3	30	6.7	75	22.7
10/16 to 10/31	212	5.7	125	8.1	82	17.1	102	22.8
11/1 to 11/15	123	8.1	112	6.3	40	15.0	76	15.8

Notes: No.= Number of. COVID-19 was identified via reverse transcriptase polymerase chain reaction testing for SARS-CoV-2. The CFS (Cognitive Function Scale) score ranges from 1 to 4; scores of 3 and 4 indicate moderate and severe cognitive impairment, respectively. The Activities of Daily Living (ADL) score signifies the extent to which residents are dependent on 7 activities of daily living, denoted by a higher score. An ADL score of 19 represents the 75th percentile value of the analytic sample, and reflects a substantial level of functional impairment.

VII. Appendix Exhibit A5. Multivariable Association between COVID-19 Diagnosis Date and 30-day Mortality

Covariate	Full Sample RR (95% CI)	Symptomatic RR (95% CI)	Asymptomatic RR (95% CI)
3/16 to 3/31	0.92 (0.73 1.16)	1.01 (0.82 1.24)	0.49 (0.21 1.15)
4/1 to 4/15	Referent	Referent	Referent
4/16 to 4/30	0.79 (0.68 0.93)	0.84 (0.73 0.96)	0.67 (0.49 0.92)
5/1 to 5/15	0.74 (0.57 0.97)	0.77 (0.65 0.93)	0.65 (0.39 1.09)
5/16 to 5/31	0.64 (0.47 0.86)	0.72 (0.56 0.94)	0.49 (0.29 0.82)
6/1 to 6/15	0.49 (0.30 0.79)	0.53 (0.30 0.91)	0.41 (0.20 0.86)
6/16 to 6/30	0.52 (0.36 0.76)	0.60 (0.43 0.84)	0.42 (0.19 0.93)
7/1 to 7/15	0.49 (0.37 0.65)	0.62 (0.47 0.82)	0.38 (0.24 0.59)
7/16 to 7/31	0.56 (0.37 0.87)	0.58 (0.36 0.94)	0.50 (0.27 0.92)
8/1 to 8/15	0.35 (0.26 0.47)	0.27 (0.18 0.41)	0.42 (0.23 0.75)
8/16 to 8/31	0.51 (0.35 0.75)	0.50 (0.35 0.72)	0.46 (0.26 0.82)
9/1 to 9/15	0.54 (0.35 0.84)	0.57 (0.35 0.93)	0.48 (0.26 0.91)
9/16 to 9/31	0.64 (0.43 0.95)	0.68 (0.47 0.99)	0.53 (0.32 0.89)
10/1 to 10/15	0.55 (0.30 0.98)	0.47 (0.22 1.01)	0.51 (0.27 0.96)
10/16 to 10/31	0.67 (0.47 0.94)	0.50 (0.32 0.79)	0.68 (0.44 1.04)
11/1 to 11/15	0.53 (0.36 0.80)	0.34 (0.19 0.62)	0.62 (0.39 0.98)
Age <65	0.34 (0.26 0.45)	0.32 (0.23 0.44)	0.38 (0.24 0.59)
Age, 65 to 69	0.69 (0.55 0.86)	0.64 (0.50 0.82)	0.77 (0.49 1.19)
Age, 70 to 74	0.80 (0.66 0.98)	0.80 (0.64 1.01)	0.77 (0.55 1.09)
Age, 75 to 79	Referent	Referent	Referent
Age, 80 to 84	1.25 (1.08 1.45)	1.27 (1.08 1.51)	1.15 (0.87 1.53)
Age, 85 to 89	1.36 (1.17 1.57)	1.32 (1.12 1.56)	1.41 (1.08 1.84)
Age, ≥90	1.74 (1.51 2.02)	1.61 (1.38 1.87)	1.96 (1.49 2.57)
Female sex	0.71 (0.66 0.77)	0.77 (0.70 0.85)	0.61 (0.53 0.71)
Race, White	Referent	Referent	Referent
Race, Black	0.78 (0.67 0.91)	0.80 (0.69 0.93)	0.78 (0.62 0.99)
Race, Other	0.75 (0.61 0.91)	0.74 (0.60 0.91)	0.77 (0.58 1.02)
CFS score, 1	Referent	Referent	Referent
CFS score, 2	1.09 (0.95 1.25)	1.05 (0.89 1.25)	1.13 (0.91 1.41)
CFS score, 3	1.62 (1.41 1.86)	1.57 (1.34 1.84)	1.67 (1.32 2.10)
CFS score, 4	1.95 (1.67 2.28)	1.84 (1.53 2.21)	2.02 (1.51 2.70)
ADL score, 0 to 13	Referent	Referent	Referent
ADL score, 14 to 18	1.08 (0.94 1.24)	1.00 (0.84 1.18)	1.30 (0.98 1.72)
ADL score, 19 to 20	1.32 (1.17 1.50)	1.36 (1.17 1.56)	1.35 (1.04 1.74)
ADL score, 21 to 28	1.61 (1.39 1.87)	1.45 (1.24 1.71)	1.97 (1.48 2.62)
Post-Acute patient	0.87 (0.75 1.00)	0.77 (0.64 0.91)	1.05 (0.82 1.33)
Dementia	1.24 (1.10 1.40)	1.18 (1.05 1.33)	1.36 (1.08 1.69)
Heart failure	1.14 (1.03 1.26)	0.97 (0.85 1.11)	1.48 (1.27 1.72)
Coronary artery disease	1.05 (0.96 1.15)	1.00 (0.89 1.13)	1.11 (0.95 1.31)
COPD/Asthma*	1.07 (0.98 1.18)	1.02 (0.91 1.15)	1.16 (1.01 1.34)
Chronic kidney disease†	1.16 (1.05 1.29)	1.21 (1.07 1.37)	1.05 (0.88 1.26)
Hypertension	0.92 (0.82 1.02)	0.87 (0.78 0.97)	1.00 (0.82 1.20)
Diabetes	1.13 (1.05 1.22)	1.13 (1.03 1.25)	1.11 (0.96 1.28)
Fever	1.36 (1.22 1.53)	1.37 (1.23 1.53)	-- --
Tachycardia	1.26 (1.05 1.52)	1.37 (1.14 1.65)	-- --
Hypoxia	1.62 (1.43 1.82)	1.57 (1.39 1.77)	-- --
Shortness of breath	1.75 (1.54 1.99)	1.78 (1.56 2.02)	-- --
Any COVID-19 symptom‡	1.22 (1.04 1.43)	-- --	-- --

Notes: Point estimates were obtained from robust Poisson regression (see methods for details). CFS=Cognitive function scale, ADL=Activities of daily living.

[*]Includes asthma, chronic obstructive pulmonary disease, chronic bronchitis, and restrictive lung diseases.

[†]Includes renal insufficiency, renal disease, or end-stage renal disease.

[‡]Residents were classified as symptomatic if any of the following symptoms were present during the five days prior to their first positive test or during the 14 days afterwards: cough, sore throat, nasal congestion, rhinorrhea, fever, shortness of breath, chest congestion, nausea, vomiting, diarrhea, anosmia, malaise, confusion, tachycardia, and hypoxia.

VIII. Appendix Exhibit A6. Multivariable Association between COVID-19Diagnosis Date and 30-day Mortality Estimated with Fixed Effects Linear Probability Model

| Covariate	Full Sample β (95% CI)	Symptomatic β (95% CI)	Asymptomatic β (95% CI)
3/16 to 3/31	2.2 (-4.9, 9.2)	2.8 (-4.4, 9.9)	-5.8 (-15.8, 4.2)
4/1 to 4/15	Referent	Referent	Referent
4/16 to 4/30	-6.5 (-10.2, -2.9)	-5.7 (-9.5, -1.9)	-8.3 (-14.5, -2.0)
5/1 to 5/15	-7.4 (-12.7, -2.0)	-6.2 (-11.2, -1.1)	-7.9 (-15.5, -0.3)
5/16 to 5/31	-8.7 (-14.1, -3.3)	-8.8 (-16.3, -1.2)	-9.6 (-16.5, -2.8)
6/1 to 6/15	-11.8 (-17.1, -6.6)	-15.8 (-23.6, -8.0)	-10.6 (-17.8, -3.5)
6/16 to 6/30	-10.6 (-15.6, -5.6)	-11.3 (-18.7, -4.0)	-9.7 (-16.3, -3.1)
7/1 to 7/15	-9.3 (-14.0, -4.6)	-7.4 (-14.8, 0.1)	-9.1 (-15.6, -2.6)
7/16 to 7/31	-10.4 (-15.6, -5.1)	-11.3 (-19.5, -3.0)	-9.8 (-16.8, -2.8)
8/1 to 8/15	-10.4 (-15.4, -5.3)	-18.9 (-27.5, -10.4)	-7.3 (-14.2, -0.4)
8/16 to 8/31	-9.9 (-15.0, -4.7)	-13.8 (-22.6, -5.0)	-9.4 (-16.3, -2.5)
9/1 to 9/15	-8.4 (-15.6, -1.1)	-10.3 (-23.4, 2.8)	-8.1 (-16.6, 0.4)
9/16 to 9/31	-7.9 (-14.1, -1.8)	-8.1 (-17.2, 0.9)	-9.8 (-17.5, -2.1)
10/1 to 10/15	-8.5 (-15.0, -2.0)	-13.0 (-24.9, -1.1)	-9.2 (-17.1, -1.2)
10/16 to 10/31	-7.1 (-12.5, -1.6)	-11.9 (-18.4, -5.4)	-7.2 (-15.0, 0.6)
11/1 to 11/15	-9.5 (-15.1, -3.9)	-19.4 (-30.8, -8.0)	-8.5 (-15.8, -1.1)
Age <65	-7.2 (-9.7, -4.8)	-11.1 (-14.5, -7.7)	-4.6 (-7.3, -2.0)
Age, 65 to 69	-4.0 (-6.3, -1.6)	-6.0 (-9.9, -2.2)	-2.6 (-5.6, 0.4)
Age, 70 to 74	-2.6 (-5.0, -0.2)	-3.3 (-7.1, 0.4)	-2.7 (-5.7, 0.2)
Age, 75 to 79	Referent	Referent	Referent
Age, 80 to 84	3.3 (1.0, 5.5)	5.5 (1.4, 9.6)	0.3 (-2.3, 2.9)
Age, 85 to 89	4.5 (2.1, 6.8)	5.6 (1.6, 9.5)	2.6 (-0.2, 5.4)
Age, ≥90	9.9 (7.5, 12.3)	11.5 (7.8, 15.3)	7.7 (4.5, 11.0)
Female sex	-5.3 (-6.7, -3.9)	-5.2 (-7.4, -3.0)	-4.9 (-6.5, -3.3)
Race, White	Referent	Referent	Referent
Race, Black	-1.3 (-3.0, 0.5)	-2.8 (-5.7, 0.1)	0.6 (-1.3, 2.6)
Race, Other	-2.7 (-5.3, -0.2)	-5.4 (-9.8, -0.9)	-0.8 (-3.4, 1.8)
CFS score, 1	Referent	Referent	Referent
CFS score, 2	-0.2 (-1.7, 1.3)	-0.1 (-2.8, 2.7)	-0.1 (-1.7, 1.5)
CFS score, 3	5.8 (3.9, 7.7)	7.9 (4.7, 11.1)	3.7 (1.5, 5.8)
CFS score, 4	10.8 (8.0, 13.5)	13.3 (8.7, 17.9)	8.2 (4.8, 11.5)
ADL score, 0 to 13	Referent	Referent	Referent
ADL score, 14 to 18	1.1 (-0.3, 2.5)	0.6 (-1.9, 3.1)	2.2 (0.3, 4.1)
ADL score, 19 to 20	4.3 (2.6, 6.0)	7.1 (4.3, 10.0)	2.3 (0.4, 4.2)
ADL score, 21 to 28	8.1 (6.1, 10.1)	8.8 (5.7, 11.9)	7.8 (5.3, 10.3)
Post-Acute patient	-1.9 (-4.0, 0.1)	-4.3 (-7.5, -1.2)	0.4 (-2.1, 2.9)
Dementia	2.9 (1.3, 4.6)	3.2 (0.7, 5.8)	2.6 (0.5, 4.8)
Heart failure	2.0 (0.2, 3.8)	-0.1 (-3.0, 2.9)	4.4 (2.5, 6.3)
Coronary artery disease	0.5 (-1.1, 2.0)	0.1 (-2.5, 2.6)	0.9 (-1.1, 3.0)
COPD/Asthma*	1.0 (-0.4, 2.5)	0.2 (-2.2, 2.7)	1.9 (0.3, 3.4)
Chronic kidney disease†	2.7 (0.9, 4.5)	4.4 (1.4, 7.3)	0.7 (-1.2, 2.6)
Hypertension	-1.6 (-3.2, -0.0)	-2.6 (-5.0, -0.2)	-0.4 (-2.2, 1.3)
Diabetes	1.7 (0.5, 2.9)	2.4 (0.3, 4.5)	1.4 (-0.1, 2.8)
Fever	5.2 (2.9, 7.6)	5.2 (2.6, 7.7)	-- --
Tachycardia	4.0 (0.1, 8.0)	7.0 (2.2, 11.7)	-- --
Hypoxia	12.5 (8.8, 16.3)	11.6 (7.7, 15.5)	-- --
Shortness of breath	16.6 (12.3, 20.9)	16.3 (12.0, 20.7)	-- --
Any COVID-19 symptom‡	0.9 (-1.0, 2.8)	-- --	-- --

Notes: Point estimates were obtained from a linear probability model with nursing home fixed effects. CFS=Cognitive function scale, ADL=Activities of daily living.

*Includes asthma, chronic obstructive pulmonary disease, chronic bronchitis, and restrictive lung diseases.

†Includes renal insufficiency, renal disease, or end-stage renal disease.

‡Residents were classified as symptomatic if any of the following symptoms were present during the five days prior to their first positive test or during the 14 days afterwards: cough, sore throat, nasal congestion, rhinorrhea, fever, shortness of breath, chest congestion, nausea, vomiting, diarrhea, anosmia, malaise, confusion, tachycardia, and hypoxia.

IX.   Appendix Exhibit A7. Correspondence between Crude Community and Nursing Home Level COVID-19Case Fatality Rates
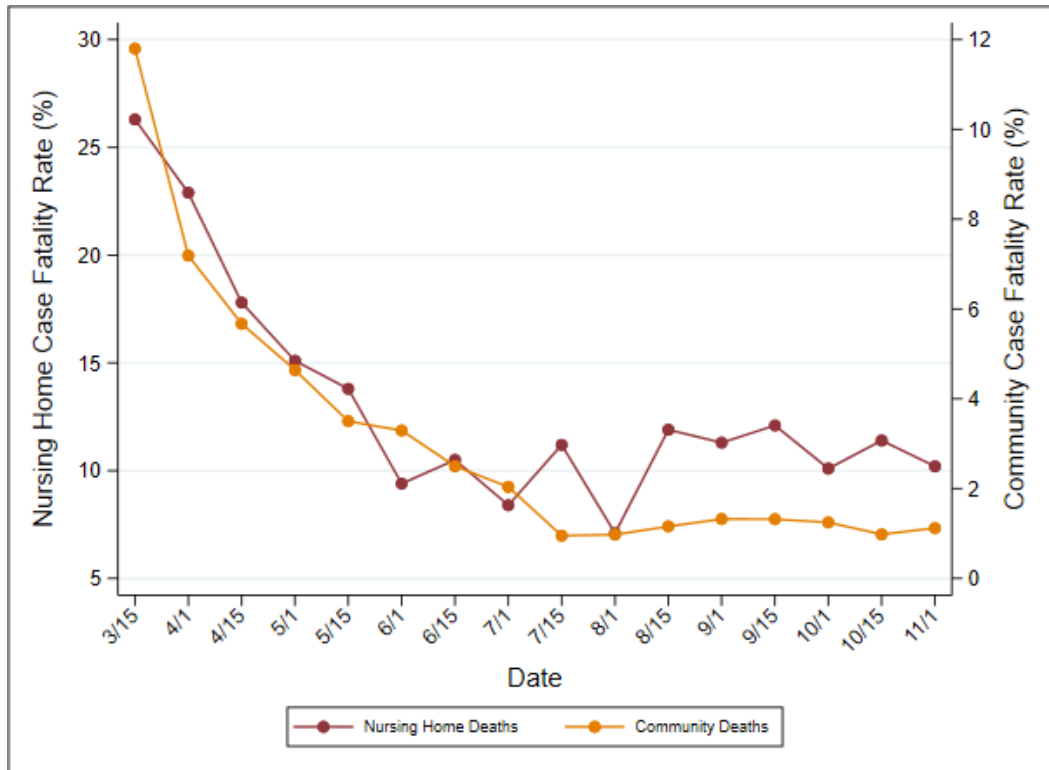
Notes: The calculation of community level case fatality rates are described in Section II of this appendix.

X. Appendix Exhibit A8. Adjusted Trends in 30-Day Hospitalization Rates among Residents with COVID-19

Date of Diagnosis	Full Sample Adj. Hospitalization Rate (95% CI)	p	Symptomatic Residents Adj. Hospitalization Rate (95% CI)	p	Asymptomatic Residents Adj. Hospitalization Rate (95% CI)	p
3/16 to 3/31	21.2 (16.2, 26.2)	0.25	24.9 (18.2, 31.6)	0.46	23.9 (14.2, 33.7)	0.17
4/1 to 4/15	18.0 (14.8, 21.2)	Ref.	22.3 (19.0, 25.6)	Ref.	16.4 (10.5, 22.3)	Ref.
4/16 to 4/30	16.8 (14.4, 19.1)	0.48	21.2 (18.2, 24.2)	0.60	13.4 (10.8, 16.0)	0.32
5/1 to 5/15	13.8 (11.6, 16.1)	0.05	22.5 (19.1, 25.9)	0.93	7.4 (5.6, 9.1)	<0.01
5/16 to 5/31	12.6 (8.8, 16.3)	0.028	21.0 (14.4, 27.6)	0.73	6.1 (3.4, 8.8)	0.001
6/1 to 6/15	16.3 (11.3, 21.2)	0.57	23.5 (14.6, 32.3)	0.81	10.4 (6.6, 14.3)	0.10
6/16 to 6/30	17.6 (12.7, 22.5)	0.89	22.0 (14.2, 29.9)	0.96	13.8 (8.5, 19.0)	0.47
7/1 to 7/15	13.9 (10.3, 17.4)	0.09	15.8 (10.1, 21.5)	0.06	10.8 (7.4, 14.3)	0.09
7/16 to 7/31	16.2 (11.6, 20.8)	0.54	24.9 (17.3, 32.5)	0.53	9.4 (5.3, 13.5)	0.047
8/1 to 8/15	11.1 (7.7, 14.4)	0.004	15.7 (10.1, 21.2)	0.05	7.8 (3.5, 12.1)	0.017
8/16 to 8/31	19.2 (14.2, 24.1)	0.70	25.3 (18.5, 32.1)	0.43	14.0 (8.6, 19.3)	0.55
9/1 to 9/15	19.9 (15.3, 24.4)	0.53	30.2 (22.1, 38.2)	0.08	12.2 (7.9, 16.5)	0.27
9/16 to 9/30	23.1 (17.5, 28.7)	0.11	30.5 (24.8, 36.3)	0.01	17.1 (10.7, 23.5)	0.85
10/1 to 10/15	19.3 (14.4, 24.2)	0.68	25.0 (14.7, 35.4)	0.62	14.3 (10.1, 18.5)	0.59
10/16 to 10/31	16.2 (11.5, 20.9)	0.54	25.7 (14.9, 36.4)	0.56	9.9 (5.9, 13.8)	0.06
11/1 to 11/15	16.6 (12.9, 20.4)	0.59	23.5 (16.9, 30.1)	0.74	11.3 (7.7, 14.9)	0.14

Notes: Adjusted hospitalization rates were derived from a robust Poisson regression model. Covariates were age, sex, race (categorized as White, Black, and Other), activities of daily living score, Cognitive Function Scale score, baseline comorbidities, post-acute vs. long-stay status, and presence of COVID-19 related symptoms (see methods for details). The *p* values indicate whether the adjusted hospitalization rate for a given period significantly differs from that of the reference period (4/1 to 4/15).