Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.

eTable 1. Comparison of outbreak status classification between Medicare claims and National Healthcare Safety Network data, August-November, 2020

		Claims-Based Classification (n, SNF-months)		
		Never-SNF	Active-SNF	Former-SNF
NHSN Classification (n, SNF-months)	Never-SNF	5549	8732	3214
	Active-SNF	1083	25775	1461
	Former-SNF	680	12548	2065

This table compares the classification of SNF-months using the main definition in the analysis based on Medicare claims compared to classifications using the National Healthcare Safety Network (NHSN) publicly reported SNF COVID-19 data. The NHSN data did not accurately capture new COVID-19 cases prior to June 2020 so we examined August-November 2020. Based on claims-based classification, we classify 12.0% of SNF-months as never-SNFs, 77.0% as active, and 11.0% as former. Based on NHSN in the same period, we classify 28.6% as never-SNFs, 46.3% as active and 25.0% as former.

eTable 2. Characteristics of SNFs in 2018-2019 vs. 2020

	2018-2019	2020
SNF Characteristics		
SNF-Years (n)	29,722	14,592
For Profit	20,865 (70.2%)	10,229 (70.1%)
Not-for-Profit	6,955 (23.4%)	3,415 (23.4%)
Public	1,902 (6.4%)	948 (6.5%)
Urban[a]	21,459 (72.2%)	10,521 (72.1%)
Number of Beds (Median)	108.7	108.0
Part of a Chain	17,150 (57.7%)	8,420 (57.7%)
Hospital-Based	1,248 (4.2%)	642 (4.4%)
Region		
Northeast	5,112 (17.2%)	2,510 (17.2%)
West	4,547 (15.3%)	2,233 (15.3%)
South	10,403 (35.0%)	5,078 (34.8%)
Midwest	9,660 (32.5%)	4,772 (32.7%)
Overall Medicare Star Rating[b]	3.33	3.32
LTC Resident Characteristics		
Residents (n)	1,988,446	997,418
Age (median, IQR)	82 (73-90)	81 (71-88)
Age 64 and under	204,810 (10.3%)	100,739 (10.1%)
Age 65-79	691,979 (34.8%)	327,153 (32.8%)
Age 80+	1,091,657 (54.9%)	569,526 (57.1%)
Male	684,025 (34.4%)	337,127 (33.8%)
Female	1,304,421 (65.6%)	660,291 (66.2%)
Medicaid Dual Eligible	1,256,698 (63.2%)	639,345 (64.1%)
Disabled without ESRD	200,833 (10.1%)	98,744 (9.9%)
Frail[c]	393,712 (19.8%)	198,486 (19.9%)
Dementia[d]	1,115,518 (56.1%)	587,479 (58.9%)
Number of Chronic Conditions (median, IQR)[e]	5 (2-7)	5 (1-7)
Race and Ethnicity		
White	1,501,277 (75.5%)	755,045 (75.7%)
Black	290,313 (14.6%)	144,626 (14.5%)
Hispanic	123,284 (6.2%)	61,840 (6.2%)
Other	71,584 (3.6%)	35,907 (3.6%)

Abbreviations: end-stage renal disease (ESRD), long-term care (LTC), skilled nursing facility (SNF)

Abbreviations: end-stage renal disease (ESRD), long-term care (LTC), skilled nursing facility (SNF)

[a] Urban location defined using the Health Resources and Service Administration rural-urban commuting area code database (http://depts.washington.edu/ uwruca/index.php). Urban was defined as a patient residing in a metropolitan ZIP code.

[b.]Medicare star ratings range from 1 (much below average) to 5 (much above average). This score is a composite ranking of individual SNFs that incorporates multiple measures of SNF quality, staffing, and health inspection performance.

[c] Frailty was defined using a previously validated claims-based frailty index from Kim et al.[25,40] Patients in the top 10% of the frailty index over the entire population of SNF admissions were classified as frail.

Dementia was defined using ICD-9 codes described in Goodman et al.[26] Patients with "not otherwise specified" dementia diagnoses were included because routine use of non-specific diagnoses codes is common, such that leaving them out would result in omission of many affected individuals.

[d] The presence of 27 conditions was gathered from the Chronic Condition Data Warehouse (CCW), which uses claims since 1999 to describe Medicare beneficiaries' accumulated chronic disease burden. Chronic conditions were defined as any condition present by the end of the calendar year prior to the LEJR episode. Conditions included Alzheimer's disease, Alzheimer's disease and related disorders or senile dementia, anemia, asthma, atrial fibrillation, benign prostatic hyperplasia, breast cancer, cataract, chronic kidney disease, chronic obstructive pulmonary disease, colorectal cancer, depression, diabetes, endometrial cancer, glaucoma, heart failure, hip or pelvic fracture, hyperlipidemia, hypertension, hypothyroidism, ischemic heart disease, lung cancer, osteoporosis, prostate cancer, acute myocardial infarction, rheumatoid arthritis, and stroke or transient ischemic attack.

[e] "Other" race includes American Indian or Alaska Native; Asian; Native Hawaiian or Pacific Islander; these are the four options for self-identified race in the Medicare enrollment file besides White and Black race or Hispanic/Latino. Less than 1% of beneficiaries are coded as "unknown" race.

eTable 3. SNF outbreak classification by month in 2020

Month in 2020	No-known-COVID-SNFs		Active-COVID SNFs		Former-COVID SNFs	
	N	% of SNFs in each month	N	% of SNFs in each month	N	% of SNFs in each month
January	15472	100.0%	5	0.0%	0	0.0%
February	15468	99.9%	9	0.1%	0	0.0%
March	14851	96.0%	621	4.0%	5	0.0%
April	11022	71.2%	4452	28.8%	3	0.0%
May	9225	59.6%	6240	40.3%	12	0.1%
June	7843	50.7%	7187	46.4%	447	2.9%
July	6334	40.9%	8145	52.6%	998	6.4%
August	5375	34.7%	8547	55.2%	1555	10.0%
September	4632	29.9%	8628	55.7%	2217	14.3%
October	3631	23.5%	9340	60.3%	2506	16.2%
November	2235	14.4%	11118	71.8%	2124	13.7%
December	1324	8.6%	12586	81.3%	1567	10.1%
Total	97412	52.4% of cumulative months	76878	41.1% of cumulative months	11,434	6.2% of cumulative months

This table shows the breakdown of SNF classifications as described in the Methods section for each month in 2020. By definition, there were 0 former-SNFs prior to March 2020 since that definition required 2 months of no COVID-19 diagnoses to qualify.

eTable 4. Characteristics of active- and never-SNFs in November 30, 2020

	No Outbreak by November 30, 2020 (Never-SNFs)	Active Outbreak in November 30, 2020 (Active-SNFs)
SNF Characteristics		
SNFs (n)	1,950	10,657
For Profit	58.7%	72.5%
Not-for-Profit	32.2%	21.3%
Public	9.1%	6.2%
Urban[a]	55.0%	74.3%
Number of Beds (Median, IQR)	60 (43-90)	108 (78-138)
Part of a Chain	53.7%	58.1%
Hospital-Based	10.7%	2.9%
Region		
Northeast	17.2%	17.2%
West	15.3%	15.3%
South	35.0%	34.8%
Midwest	32.5%	32.7%
Overall Medicare Star Rating[b]	3.61	3.25
County-level COVID-19 Prevalence per 1,000 Beneficiaries[c]	4.08 (2.30)	4.77 (2.95)
LTC Resident Characteristics		
Residents (n)	63,531	567,053
Age (median, IQR)	83 (74-90)	80 (71-88)
Age 64 and under	9.2%	11.4%
Age 65-79	31.4%	36.6%
Age 80+	59.4%	51.9%
Male	32.2%	34.3%
Female	67.8%	65.7%
Medicaid Dual Eligible	68.1%	74.0%
Disabled without ESRD	9.1%	11.2%
Frail[d]	20.4%	19.9%
Dementia[e]	52.9%	55.8%
Number of Chronic Conditions (median, IQR)[f]	4 (1-6)	5 (1-7)
Race and Ethnicity	87.4%	74.2%
White	5.5%	15.7%
Black	2.9%	6.6%
Hispanic	4.3%	3.5%

Abbreviations: end-stage renal disease (ESRD), long-term care (LTC), skilled nursing facility (SNF)

[a] Urban location defined using the Health Resources and Service Administration rural-urban commuting area code database (http://depts.washington.edu/ uwruca/index.php). Urban was defined as a patient residing in a metropolitan ZIP code.

[b.]Medicare star ratings range from 1 (much below average) to 5 (much above average). This score is a composite ranking of individual SNFs that incorporates multiple measures of SNF quality, staffing, and health inspection performance.

[c]COVID-19 cases were defined using publicly available data from the New York Times COVID-19 database (https://github.com/nytimes/covid-19-data). Cumulative county-level cases as of November, 2020 were tabulated and normalized per 100 residents in each county.

[d] Frailty was defined using a previously validated claims-based frailty index from Kim et al.[25,40] Patients in the top 10% of the frailty index over the entire population of SNF admissions were classified as frail.

Dementia was defined using ICD-9 codes described in Goodman et al.[26] Patients with "not otherwise specified" dementia diagnoses were included because routine use of non-specific diagnoses codes is common, such that leaving them out would result in omission of many affected individuals.

[e] The presence of 27 conditions was gathered from the Chronic Condition Data Warehouse (CCW), which uses claims since 1999 to describe Medicare beneficiaries' accumulated chronic disease burden. Chronic conditions were defined as any condition present by the end of the calendar year prior to the LEJR episode. Conditions included Alzheimer's disease, Alzheimer's disease and related disorders or senile dementia, anemia, asthma, atrial fibrillation, benign prostatic hyperplasia, breast cancer, cataract, chronic kidney disease, chronic obstructive pulmonary disease, colorectal cancer, depression, diabetes, endometrial cancer, glaucoma, heart failure, hip or pelvic fracture, hyperlipidemia, hypertension, hypothyroidism, ischemic heart disease, lung cancer, osteoporosis, prostate cancer, acute myocardial infarction, rheumatoid arthritis, and stroke or transient ischemic attack.

[f] "Other" race includes American Indian or Alaska Native; Asian; Native Hawaiian or Pacific Islander; these are the four options for self-identified race in the Medicare enrollment file besides White and Black race or Hispanic/Latino. Less than 1% of beneficiaries are coded as "unknown" race.

eTable 5. Adjusted Differential Change in Health and Quality of Life Outcome for LTC Residents in former-SNFs, 2020 vs. 2018-2019

	Outcome	Dec 2019 Mean	Former Outbreak	95% CI	
Health and Utilization Outcomes	Monthly Mortality	2.1%	-0.13%	-0.18%	-0.08%
	Monthly Hospitalization	2.3%	-0.95%	-1.00%	-0.90%
	Monthly ED Visits	2.9%	-0.87%	-0.92%	-0.81%
Quality of Life Outcomes – Change from Prior MDS Assessment	# ADLs Requiring Assistance	0.85	0.14	0.05	0.23
	Change in Weight (lbs)	-1.6	-2.6	-3.0	-2.2
	% with worse PHQ-9	30.0%	2.2%	1.1%	3.3%

Abbreviations: activities of daily living (ADLs), confidence interval (CI), emergency department (ED), Minimum Data Set v3.0 (MDS), long term care (LTC) Patient Health Questionnaire-9 (PHQ-9)

Adjusted differences are the coefficients on an indicator for the year 2020 (health and utilization) or an interaction term between year 2020 and November (quality of life) for each outcome. Each adjusted difference is estimated using separate linear regression models at the resident-month level. Each model controls for SNF fixed effects and beneficiary characteristics (age, sex, race, Medicaid eligibility, indicators for 27 chronic conditions).

eTable 6. Adjusted Differential Change in Health and Quality of Life Outcome for LTC Residents in SNFs with Alternate Group Definitions, 2020 vs. 2018-2019[a]

	Outcome	Main Analysis (Table 2)			Never/Ever Grouping[b]			Modified Active Group (Excluding ≤1 Case Months)[b]		
		Active Outbreak	95% CI		"Ever" Outbreak	95% CI		Active Outbreak, Excluding ≤1 Case Months	95% CI	
Health and Utilization Outcomes[c]	Monthly Mortality	1.60%	1.58%	1.62%	1.35%	1.33%	1.37%	1.54%	1.52%	1.56%
	Monthly Hospitalization	-0.10%	-0.12%	-0.09%	-0.21%	-0.23%	-0.19%	-0.02%	-0.04%	0.00%
	Monthly ED Visits	-0.57%	-0.59%	-0.55%	-0.63%	-0.65%	-0.61%	-0.58%	-0.60%	-0.56%
Quality of Life Outcomes (Change from Prior MDS Assessment)[c]	Change in # ADLs Requiring Assistance	0.36	0.34	0.38	0.34	0.32	0.36	0.36	0.34	0.38
	Change in Weight (lbs)	-3.1	-3.2	-3.0	-3.1	-3.2	-3.0	-3.1	-3.2	-2.9
	% with worse PHQ-9	4.4%	4.1%	4.7%	4.2%	4.0%	4.5%	4.5%	4.2%	4.7%

Abbreviations: activities of daily living (ADLs), confidence interval (CI), emergency department (ED), Minimum Data Set v3.0 (MDS), long term care (LTC) Patient Health Questionnaire-9 (PHQ-9)

[a]Adjusted differences are the coefficients on an indicator for the year 2020 (health and utilization outcomes) or an interaction term between an indicator for year 2020 and November (quality of life outcomes, which are cumulative over the year) for each outcome. Each adjusted difference is estimated using separate linear regression models at the resident-month level. Each model controls for SNF fixed effects (which control for all observable and unobservable SNF characteristics that are time invariant) and beneficiary characteristics (age, sex, race and ethnicity, Medicaid eligibility, indicators for 27 chronic conditions).

[b] "Never/ever" grouping shows the "active" SNF group reported in the main analysis, but instead grouping SNFs as those who ever had a COVID-19 case vs. those with no case (identical to the "never" group in the main analysis). The "modified active group" shows a version of the active group in which all SNF-months with ≤1 case of COVID-19 were not included, with the never group remaining the same.

[c]For the "health and utilization" outcomes, this is the mean unadjusted monthly rate across all months in 2018-2019. For the "quality of life" outcomes, the 2018-2019 baseline is the average within-individual change for all assessments in 2018 and 2019 vs. the prior year.

eTable 7. Adjusted Differential Change in Health and Quality of Life Outcome for LTC Residents in SNFs with Constant Membership Groups, 2020 vs. 2018-2019[a]

	Outcome	Never Outbreak[b]	95% CI		SNFs with 1-5 Months Active Outbreak[b]	95% CI		SNFs with ≥6 Months Active Outbreak[b]	95% CI	
Health and Utilization Outcomes[c]	Monthly Mortality	-0.17%	-0.27%	-0.06%	0.15%	0.13%	0.18%	0.69%	0.67%	0.70%
	Monthly Hospitalization	-0.92%	-1.01%	-0.82%	-0.88%	-0.91%	-0.86%	-0.64%	-0.65%	-0.62%
	Monthly ED Visits	-1.03%	-1.14%	-0.92%	-0.94%	-0.96%	-0.91%	-0.64%	-0.65%	-0.62%
Quality of Life Outcomes (Change from Prior MDS Assessment)[c]	Change in # ADLs Requiring Assistance	-0.10	-0.19	0.00	0.27	0.24	0.31	0.36	0.33	0.38
	Change in Weight (lbs)	-1.7	-2.2	-1.3	-2.5	-2.7	-2.4	-3.3	-3.5	-3.2
	% with worse PHQ-9	2.6%	1.3%	4.0%	4.1%	3.6%	4.5%	4.3%	4.0%	4.6%

Abbreviations: activities of daily living (ADLs), confidence interval (CI), emergency department (ED), Minimum Data Set v3.0 (MDS), long term care (LTC) Patient Health Questionnaire-9 (PHQ-9)

[a]Adjusted differences are the coefficients on an indicator for the year 2020 (health and utilization outcomes) or an interaction term between an indicator for year 2020 and November (quality of life outcomes, which are cumulative over the year) for each outcome. Each adjusted difference is estimated using separate linear regression models at the resident-month level. Each model controls for SNF fixed effects (which control for all observable and unobservable SNF characteristics that are time invariant) and beneficiary characteristics (age, sex, race and ethnicity, Medicaid eligibility, indicators for 27 chronic conditions).

[b] In this analysis, SNFs are divided into 3 mutually exclusive groups with *constant* membership throughout each year in 2018-2020. The groups are defined based on the number of months meeting the main definition of "active SNF" in the manuscript, either never (0 active months), 1-5 active months and ≥6 active months in 2020.

[c]For the "health and utilization" outcomes, this is the mean unadjusted monthly rate across all months in 2018-2019. For the "quality of life" outcomes, the 2018-2019 baseline is the average within-individual change for all assessments in 2018 and 2019 vs. the prior year.

eTable 8. Adjusted Differential Change in Health and Quality of Life Outcome for LTC Residents in SNFs by US Census Region, 2020 vs. 2018-2019[a]

		Northeast Region[b]						Midwest Region[b]					
	Outcome	Never Outbreak	95% CI		Active Outbreak	95% CI		Never Outbreak	95% CI		Active Outbreak	95% CI	
Health and Utilization Outcomes[c]	Monthly Mortality	-0.20%	-0.24%	-0.16%	1.67%	1.63%	1.70%	-0.13%	-0.16%	-0.10%	1.76%	1.72%	1.80%
	Monthly Hospitalization	-0.57%	-0.61%	-0.54%	-0.22%	-0.26%	-0.19%	-0.82%	-0.85%	-0.79%	-0.07%	-0.11%	-0.02%
	Monthly ED Visits	-0.43%	-0.47%	-0.40%	-0.55%	-0.58%	-0.51%	-0.80%	-0.84%	-0.77%	-0.49%	-0.53%	-0.44%
Quality of Life Outcomes (Change from Prior MDS Assessment)[c]	Change in # ADLs Requiring Assistance	0.05	-0.08	0.19	0.37	0.33	0.41	-0.14	-0.26	-0.03	0.33	0.28	0.37
	Change in Weight (lbs)	-1.6	-2.3	-0.9	-3.0	-3.2	-2.8	-1.9	-2.4	-1.4	-2.8	-3.0	-2.6
	% with worse PHQ-9	2.0%	0.0%	4.0%	4.7%	4.1%	5.2%	2.0%	0.5%	3.5%	3.7%	3.1%	4.3%

		South Region[b]						West Region[b]					
	Outcome	Never Outbreak	95% CI		Active Outbreak	95% CI		Never Outbreak	95% CI		Active Outbreak	95% CI	
Health and Utilization Outcomes[c]	Monthly Mortality	-0.13%	-0.16%	-0.10%	1.35%	1.32%	1.38%	-0.15%	-0.19%	-0.10%	1.26%	1.21%	1.31%
	Monthly Hospitalization	-1.00%	-1.04%	-0.97%	0.01%	-0.03%	0.05%	-0.78%	-0.83%	-0.73%	-0.37%	-0.44%	-0.31%
	Monthly ED Visits	-0.97%	-1.00%	-0.94%	-0.71%	-0.74%	-0.67%	-0.75%	-0.80%	-0.70%	-0.69%	-0.74%	-0.63%
Quality of Life Outcomes (Change from Prior MDS Assessment)[c]	Change in # ADLs Requiring Assistance	-0.02	-0.17	0.13	0.40	0.37	0.44	-0.05	-0.20	0.10	0.27	0.20	0.33
	Change in Weight (lbs)	-2.3	-2.9	-1.7	-3.4	-3.6	-3.2	-1.2	-1.9	-0.5	-2.7	-3.0	-2.4
	% with worse PHQ-9	2.7%	0.8%	4.5%	4.3%	3.9%	4.8%	8.2%	5.9%	10.5%	6.1%	5.3%	6.9%

Abbreviations: activities of daily living (ADLs), confidence interval (CI), emergency department (ED), Minimum Data Set v3.0 (MDS), long term care (LTC) Patient Health Questionnaire-9 (PHQ-9)

[a]Adjusted differences are the coefficients on an indicator for the year 2020 (health and utilization outcomes) or an interaction term between an indicator for year 2020 and November (quality of life outcomes, which are cumulative over the year) for each outcome. Each adjusted difference is estimated using separate linear regression models at the resident-month level. Each model controls for SNF fixed effects (which control for all observable and unobservable SNF characteristics that are time invariant) and beneficiary characteristics (age, sex, race and ethnicity, Medicaid eligibility, indicators for 27 chronic conditions).
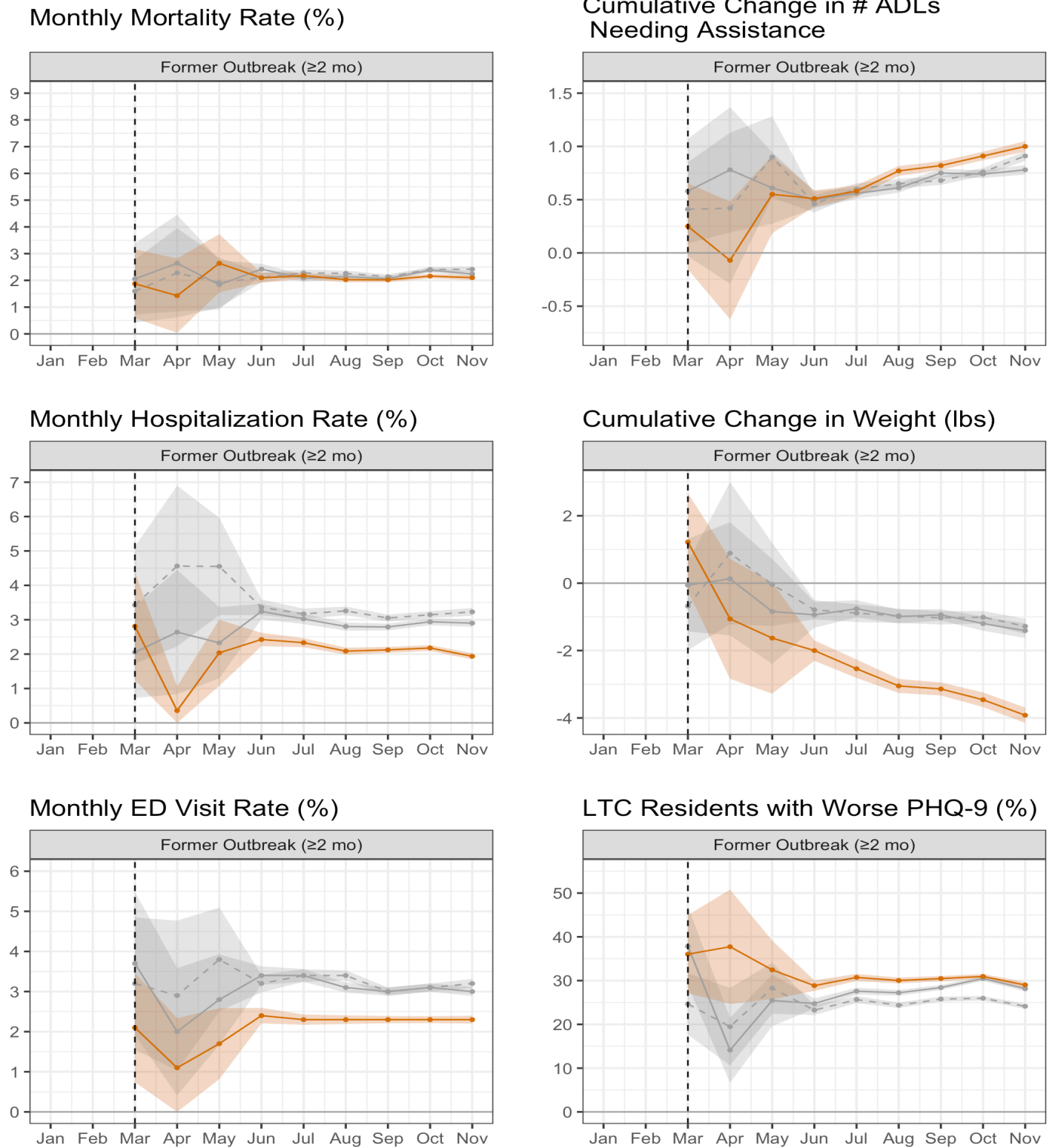
[b] US Census Regions with State Code:
    Northeast (Connecticut (09) Maine (23) Massachusetts (25) New Hampshire (33) Rhode Island (44) Vermont (50) New Jersey (34) New York (36) Pennsylvania (42));
    Midwest (Indiana (18) Illinois (17) Michigan (26) Ohio (39) Wisconsin (55) Iowa (19) Nebraska (31) Kansas (20) North Dakota (38) Minnesota (27) South Dakota (46)

Missouri (29));

South (Delaware (10) District of Columbia (11) Florida (12) Georgia (13) Maryland (24) North Carolina (37) South Carolina (45) Virginia (51) West Virginia (54)

Alabama (01) Kentucky (21) Mississippi (28) Tennessee (47) Arkansas (05) Louisiana (22) Oklahoma (40) Texas (48));

West (Alaska (02) California (06) Hawaii (15) Oregon (41) Washington (53) Arizona (04) Colorado (08) Idaho (16) New Mexico (35) Montana (30) Utah (49) Nevada

(32) Wyoming (56)).

cFor the "health and utilization" outcomes, this is the mean unadjusted monthly rate across all months in 2018-2019. For the "quality of life" outcomes, the 2018-2019 baseline is the average within-individual change for all assessments in 2018 and 2019 vs. the prior year.

eFigure 1. Health and quality of life outcomes in former-SNFs

Each panel shows monthly outcomes for SNFs in the study sample for "former outbreak" SNFs (≥2 months without any COVID-19 diagnosis) in 2018 (gray dashed), 2019 (gray solid), and 2020 (orange solid) with 95% confidence interval assuming normal distribution of mean outcome estimates. By this definition, there were no former-SNFs in January and February of 2020. The dotted vertical line denotes March 2020, the month when SNF "lockdown" policies went into effect in the US.