Dean A, Venkataramani A, Kimmel S.
Mortality rates from COVID-19 are lower in unionized nursing homes. Health Aff (Millwood). 2020;39(11).

APPENDIX

This appendix consists of three parts:

- The appendix to the final published version of the article
- The Fast Track Ahead Of Print version of the article, which was published online September 10, 2020
- The appendix published online with that article, containing the tables and figures that now appear in the final published version of the article (*Health Affairs,* vol. 39, no. 11, November 2020)

Appendix

Exhibit A1 reports descriptive statistics for the cohort of nursing homes used in our secondary analysis on access to personal protective equipment.

We performed eight sensitivity analyses of our main results, each of which is reported below.

First, we used OLS regression to model the predictors of whether or not the NYSDOH reported Covid-19 death data from nursing homes (Exhibit A2). Importantly, the presence of a healthcare workers union is not a significant predictor of the NYSDOH reporting data for a nursing home. This suggests that nursing homes with labor unions are not systematically withholding data from facilities with high Covid-19 mortality rates. This therefore decreases our concerns that our main results could be driven by selection bias among the nursing homes for which the NSYDOH reported data. Instead, facility-level occupied beds, county-level population and confirmed Covid-19 cases per capita were all positively associated with reporting, while higher levels of the CMS 5-star rating were negatively associated with reporting.

Second, we used inverse probability weighting to adjust for selection bias due to missing data. Exhibit A3 reports the OLS regression results based on the inverse probability weights estimated with logistic regression.

Third, we computed 95% confidence intervals derived from commuting zone-level wild cluster bootstrap robust standard errors, which account for the possibility that Covid-19 deaths are correlated across nursing homes in the same labor market area. Exhibit A4 reports the coefficient (-1.289) for the presence of a healthcare worker union along with confidence interval [-3.152, 0.767], and p-value (0.074).

Fourth, we estimated our main OLS model with the addition of region-level fixed effects and calculated standard errors clustered at the county level. The fixed effects adjust for regional variation in Covid-19 risk factors while the clustered standard errors take into account the possibility that Covid-19 deaths may have been correlated across nursing homes within the same counties. Exhibit A5 reports the coefficient (-1.213) for the presence of a healthcare worker union along with confidence interval [-2.222, -0.204], and p-value ($p<0.019$).

Fifth, we estimated our main OLS model using the extreme assumption that all nursing homes for which the NYSDOH did not report data experienced zero Covid-19 deaths. Exhibit A6 reports our results, which are substantively similar despite this assumption likely biasing against our hypothesis (95% CI: -1.53, 0.09; p=0.08)

Sixth, we performed Oster's (2019) coefficient stability test, to assess the robustness of the substantive finding to other unmeasured confounders. Exhibit A7 shows that simulating the potential effect of additional unmeasured confounders did not reverse the substantive finding.

Seventh, we estimated our secondary analysis on PPE using only the subset of our original cohort nursing homes that reported data on access to PPE. Exhibit A8 reports the results, which are substantively similar to results using the largest possible sample of nursing homes.

Eighth, we estimated our secondary analysis on Covid-19 infection rates using only the subset of our original cohort nursing homes that reported data on access to PPE and Covid-19 infection rates. Exhibit A9 reports the results, which are substantively similar to the results reported in our paper using a larger sample of nursing homes.

Exhibit A1: Secondary Analysis—Characteristics of nursing homes with and without reported data on personal protective equipment and cohort nursing homes with and without healthcare worker unions.

	All Nursing Homes N=621			Nursing Homes in Cohort N=399		
Variable mean (SD)	**Reported N=418**	**Not Reported N=203**	**Difference statistically significant?**	**Unionized N=200**	**Non-Unionized N=199**	**Difference statistically significant?**
Population (County)	978,284 (815,099)	878,984 (790,926)	no	1,337,099 (799,729)	608,304 (652,102)	yes
Covid-19 Cases per capita (County)	0.02 (0.01)	0.02 (0.01)	no	0.02 (0.01)	0.01 (0.01)	yes
Average Age of Residents (Nursing Home)	80.97 (7.62)	78.17 (10.07)	yes	79.00 (8.79)	83.13 (5.31)	yes
Medicaid % (Nursing Home)	58.69 (20.84)	61.04 (20.56)	no	62.99 (17.65)	54.19 (22.25)	yes
Medicare % (Nursing Home)	13.01 (11.4)	13.42 (15.29)	no	14.71 (11.05)	11.13 (11.33)	yes
RN Ratio (Nursing Home)	0.49 (0.36)	0.55 (0.69)	no	0.50 (0.38)	0.47 (0.29)	no
LPN Ratio (Nursing Home)	0.83 (0.33)	0.87 (0.28)	no	0.74 (0.29)	0.94 (0.33)	yes
CNA Ratio (Nursing Home)	2.36 (0.62)	2.30 (0.60)	no	2.28 (0.52)	2.43 (0.69)	yes
5-Star Rating (Nursing Home)	3.40 (1.38)	2.97 (1.5)	yes	3.46 (1.31)	3.35 (1.43)	no
Resident Acuity (Nursing Home)	1.22 (0.15)	1.21 (0.19)	no	1.24 (0.17)	1.20 (0.12)	yes
Occupied Beds (Nursing Home)	176.9 (114.36)	152.72 (106.84)	yes	204.09 (114.46)	152.07 (110.11)	yes
White % (Nursing Home)	75.48 (27.38)	72.03 (29.38)	no	64.70 (27.45)	86.54 (22.44)	yes
For-Profit (Nursing Home)	0.59 (0.49)	0.67 (0.47)	yes	0.74 (0.44)	0.45 (0.5)	yes
Chain (Nursing Home)	0.16 (0.37)	0.16 (0.36)	yes	0.06 (0.25)	0.25 (0.43)	yes
Occupancy Rate (Nursing Home)	0.90 (0.13)	0.86 (0.22)	no	0.90 (0.12)	0.89 (0.12)	no

SOURCE: New York State Department of Health, 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, Communication Workers of America, Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS. **NOTES:** T-tests calculated to compare the means across union and non-union facilities for all other continuous measures. Z-tests calculated for the binary measures of *For-Profit* and *Chain*. For both tests, the threshold for statistical significance was $p < 0.05$. Non-cohort nursing homes have missing data for the nursing home-level variables, therefore the means and standards deviations for Reported and Not Reported nursing homes are calculated using less than 418 and 203 observations, respectively.

Exhibit A2: OLS regression results modeling the predictors of the New York State Department of Health reporting Covid-19 death data from nursing homes

	Model 1
(Intercept)	-0.849 [-1.811, 0.114], p<0.085
Union	0.009 [-0.069, 0.087], p<0.822
For-Profit	0.047 [-0.023, 0.117], p<0.19
Population (county)	0.102**** [0.059, 0.145], p<0.001
Covid-19 cases per capita (county)	14.708**** [11.043, 18.372], p<0.001
Average Age	0.000 [-0.007, 0.006], p<0.940
Chain	0.001 [-0.102, 0.103], p<0.990
Medicaid %	0.001 [-0.001, 0.003], p<0.392
Medicare %	0.003 [0.000, 0.006], p<0.0330
RN Ratio	-0.122 [-0.246, 0.001], p<0.053
LPN Ratio	-0.025 [-0.158, 0.107], p<0.708
CNA Ratio	0.004 [-0.064, 0.072], p<0.902
2-Star Rating	-0.066 [-0.181, 0.049], p<0.260
3-Star Rating	-0.114** [-0.217, -0.011], p<0.031
4-Star Rating	-0.173**** [-0.277, -0.07], p<0.001
5-Star Rating	-0.128** [-0.241, -0.015], p<0.027
Occupancy Rate	0.154 [-0.156, 0.463], p<0.331
Obese %	-0.004 [-0.009, 0.001], p<0.146
Resident Acuity	-0.142 [-0.372, 0.087], p<0.225
Occupied Beds	0.001**** [0.000, 0.001], p<0.001
White %	0.000 [-0.001, 0.002], p<0.499
N	543
R^2	0.511
Adj. R^2	0.492
Resid. Sd	0.400

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A3: OLS regression results using inverse probability weighting.

	Model 1
(Intercept)	-25.245**** [-35.382, -15.108], p<0.001
Union	-1.707*** [-2.785, -0.629], p<0.005
For-Profit	0.399 [-1.187, 1.985], p<0.588
Population (county)	0.726 [-0.022, 1.473], p<0.056
Covid-19 cases per capita (county)	43.876 [-49.945, 137.697], p<0.322
Average Age	0.196*** [0.063, 0.329], p<0.008
Chain	-1.382 [-3.534, 0.770], p<0.183
Medicaid %	0.031 [-0.009, 0.071], p<0.114
Medicare %	0.065** [0.014, 0.116], p<0.017
RN Ratio	1.304 [-1.921, 4.529], p<0.389
LPN Ratio	1.239 [-1.187, 3.665], p<0.282
CNA Ratio	-1.524*** [-2.425, -0.623], p<0.004
2-Star Rating	-1.142 [-2.592, 0.308], p<0.110
3-Star Rating	-0.863 [-2.684, 0.957], p<0.316
4-Star Rating	-0.141 [-2.688, 2.406], p<0.905
5-Star Rating	0.064 [-1.435, 1.564], p<0.926
Occupancy Rate	2.236 [-2.21, 6.682], p<0.289
Obese %	0.084 [-0.007, 0.174], p<0.066
Resident Acuity	-0.648 [-5.184, 3.888], p<0.757
Occupied Beds	-0.003 [-0.008, 0.003], p<0.308
White %	0.032 [-0.008, 0.072], p<0.101
N	355
R^2	0.210
Root MSE	4.474

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A4: Wild cluster bootstrapped standard errors for main OLS model

	Based on Model 2 from Exhibit 3
Union	-1.289 [-3.152, 0.767], p<0.0741

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A5: OLS regression results including region-level fixed effects and standard errors clustered at the county level.

	Based on Model 2 from Exhibit 3
Union	-1.213** [-2.222, -0.204], p<0.019
White %	0.017 [-0.004, 0.039], p<0.107

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A6: OLS regression results modeling association between presence of healthcare worker union and facility Covid-19 mortality rate in nursing homes, assuming non-reported facilities had zero deaths.

	Model 1
(Intercept)	-19.944**** [-29.65, -10.239], p<0.001
Union	-0.72 [-1.527, 0.086], p<0.081
For-Profit	-0.183 [-0.911, 0.544], p<0.621
Population (county)	0.757*** [0.26, 1.254], p<0.003
Covid-19 cases per capita (county)	106.121**** [60.741, 151.502], p<0.001
Average Age	0.076** [0.014, 0.138], p<0.017
Chain	1.136 [-0.135, 2.407], p<0.08
Medicaid %	0.015 [-0.004, 0.033], p<0.115
Medicare %	0.05** [0.006, 0.095], p<0.028
RN Ratio	0.451 [-0.768, 1.669], p<0.469
LPN Ratio	0.789 [-0.529, 2.107], p<0.241
CNA Ratio	-0.822*** [-1.353, -0.29], p<0.003
2-Star Rating	-0.868 [-1.815, 0.079], p<0.073
3-Star Rating	-0.963** [-1.849, -0.076], p<0.034
4-Star Rating	-0.899 [-1.851, 0.053], p<0.065
5-Star Rating	-0.143 [-1.244, 0.958], p<0.800
Occupancy Rate	1.604 [-1.122, 4.330], p<0.249
Obese %	0.018 [-0.048, 0.083], p<0.600
Resident Acuity	0.510 [-1.453, 2.473], p<0.611
Occupied Beds	0.002 [-0.001, 0.005], p<0.254
White %	0.034**** [0.017, 0.052], p<0.001
N	543
R^2	0.198
Adj. R^2	0.168
Resid. Sd	3.804

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A7: Coefficient stability test

Unadjusted Coefficient	Adjusted Coefficient	Bounds if $R_{max} = 1.3*R_{adj}$	Bounds if $R_{max} = 2*R_{adj}$
-1.80	-1.29	(-1.29, -0.97)	(-1.29, -0.26)

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.

Exhibit A8: Secondary Analysis - OLS regression results modeling association between presence of healthcare worker union and facility access to personal protective equipment, using subset of original cohort that reported data on personal protective equipment

	N95 Masks	Eye Shields	Surgical Masks
Union	0.139** [0.009, 0.269] p<0.038	0.059 [-0.028, 0.146] p<0.18	0.024 [-0.052, 0.100] p<0.531
N	238	238	238
***R*²**	0.108	0.079	0.096
Adj. *R*²	0.031	-0.001	0.017
Resid. sd	0.393	0.265	0.226
	Gowns	**Gloves**	**Hand Sanitizer**
Union	0.075 [-0.044, 0.194] p<0.300	-0.005 [-0.069, 0.059] p<0.875	-0.011 [-0.093, 0.071] p<0.798
N	238	238	238
***R*²**	.081	0.128	0.078
Adj. *R*²	0.001	0.052	-0.002
Resid. sd	0.371	0.214	0.2719

SOURCE: Authors' analysis of data on availability of personal protective equipment from Centers for Medicare & Medicaid Services (CMS), union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America and covariates from CMS, the New York State Department of Health, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A9: OLS regression results modeling association between presence of healthcare worker union and nursing home Covid-19 infection rates using subset of original cohort that reported data on personal protective equipment and Covid-19 infection rates

	Model 1
Union	-89.484*** [-156.261, 22.707] p<0.009
N	237
R^2	0.189
Adj. R^2	0.114
Resid. sd	207.3

SOURCE: Authors' analysis of data on Covid-19 infection rates from Centers for Medicare & Medicaid Services (CMS), union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America and covariates from CMS, the New York State Department of Health, Brown University's Long-term Care: FOCUS project, and USAFACTS. **NOTES:** 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** p < .01; **** p < .001.

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Mortality Rates From COVID-19 Are Lower In Unionized Nursing Homes

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ABSTRACT More than 40% of all reported coronavirus disease 2019 (COVID-19) deaths in the United States have occurred in nursing homes. As a result, health care worker access to personal protective equipment (PPE) and infection control policies in nursing homes have received increased attention. However, it is not known if the presence of health care worker unions in nursing homes is associated with COVID-19 mortality rates. Therefore, we used cross-sectional regression analysis to examine the association between the presence of health care worker unions and COVID-19 mortality rates in 355 nursing homes in New York State. Health care worker unions were associated with a 1.29 percentage point mortality reduction, which represents a 30% relative decrease in the COVID-19 mortality rate compared to facilities without health care worker unions. Unions were also associated with greater access to PPE, one mechanism that may link unions to lower COVID-19 mortality rates. [Editor's Note: *This Fast Track Ahead Of Print article is the accepted version of the peer-reviewed manuscript. The final edited version will appear in an upcoming issue of* Health Affairs.]

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Amidst the coronavirus disease 2019 (COVID-19) global pandemic, the severe respiratory syndrome coronavirus 2 (SARS-CoV-2) has caused infections in more than 5 million people and more than 163,000 deaths in the United States.[1] Nursing home residents have been disproportionately affected and account for 43% of documented deaths in the country.[2,3] New York state has suffered over 6,500 COVID-19 deaths in nursing homes, more than any state besides New Jersey.[3]

Investigations into outbreaks in individual nursing homes have identified several factors leading to increased risk of infection and resulting death among nursing home residents.[4–7] First, nursing homes care for elderly individuals with medical comorbidities who have an increased risk of death from COVID-19 infection. Second, nursing home residents live close together and staff have direct contact with residents and each other. These staff provide direct care to multiple residents and may work in multiple facilities or provide homecare to earn additional income.[8,9] These cumulative direct contacts may increase risk for SARS-CoV-2 infection and spread. Third, asymptomatic spread of SARS-CoV-2 eluded early infection control strategies, which focused on isolating only staff and residents with symptoms.

Centers for Medicare and Medicaid (CMS) guidelines now recommend personal protective equipment (PPE), including N95 masks and eye shields for staff as well as universal testing in facilities with confirmed COVID-19 infections.[10] However, equipment and test shortages, as well as challenges with implementing infection control plans limited adoption of these recommendations.[11] Under such circumstances, labor unions representing health care workers per-

form several functions that may reduce SARS-CoV-2 transmission. Unions generally demand high staff-to-patient ratios, paid sick leave, and higher wage and benefit levels that reduce staff turnover.[12–14] They educate workers about their health and safety rights, work to ensure that such rights are enforced, demand that employers mitigate known hazards, and give workers a collective voice that can improve communication with employers.[14–17] In the specific context of the COVID-19 pandemic in New York, labor unions advocated for access to PPE and new infection control policies.[18]

Though health care worker unions have been shown to improve the occupational safety of health care workers and, in some cases, overall patient outcomes,[14,19] it is not known how the presence of health care worker unions affected COVID-19 mortality rates among residents in nursing homes. We hypothesized that labor union representation among health care workers in nursing homes would be associated with reduced resident mortality rates. Although labor unions may influence COVID-19 mortality rates in numerous ways, we hypothesized that two important mechanisms were successful demands for PPE and reduced COVID-19 infection rates. By increasing access to PPE, labor unions may reduce the spread of COVID-19 between health care workers and nursing home residents, thus reducing COVID-19 mortality rates for residents.

Study Data And Methods

STUDY DESIGN AND DATA SOURCES We conducted cross-sectional regression analyses to estimate the association between the presence of a health care worker union and COVID-19 mortality rates in nursing homes in New York State during the 2020 COVID-19 pandemic. We used publicly available data from the New York State Department of Health (NYSDOH) on COVID-19 mortality. We used proprietary data from 1199SEIU United Healthcare Workers East (1199SEIU), the International Brotherhood of Teamsters, and the Communication Workers of America (CWA), as well as publicly-available data from the New York State Nurses Association (NYSNA) to determine if a labor union represented health care workers in each facility.

STUDY SAMPLE We included all New York State nursing homes for which the NYSDOH reported data on confirmed COVID-19 deaths. Nursing homes that reported zero deaths were included in the cohort, while facilities for which NYSDOH did not report data were excluded. Facilities for which there was missing data on key covariates were also excluded.

MAIN OUTCOME The main outcome was the percentage of nursing home residents who died from COVID-19. To calculate this percentage, we used nursing home-level data on confirmed COVID-19 deaths made available by the NYSDOH for the period March 1 through May 31, 2020. This data includes all COVID-19 deaths that occurred inside of the facility, but not deaths that occurred after a resident was discharged to a hospital. The denominator was the total number of beds in each facility as a proxy for the number of residents in the facility.[20]

SECONDARY OUTCOMES The two secondary outcomes were nursing home access to PPE and nursing home COVID-19 infection rates. We obtained data from CMS on whether or not each facility reported having a one-week supply of N95 masks, eye shields, surgical masks, gowns, gloves, and hand sanitizer on May 24 and May 31, 2020 (the earliest two weeks available). Facilities were defined as having access to a given type of PPE if they reported having a one-week supply both weeks. We also obtained nursing home-level data on confirmed COVID-19 infections per 1,000 residents from CMS for the dates January 1 through May 31, 2020.

PRIMARY EXPLANATORY VARIABLE Facilities with NYSNA, 1199SEIU, Teamster, or CWA unions representing health care workers were defined as having a union in our cohort. NYSNA only represents registered nurses (RN), while the other unions represent workers throughout nursing homes, including nurse aides, dieticians, and sanitation workers. In every nursing home organized by 1199SEIU, the union represents certified nursing assistants (CNA) who provide direct care to residents (personal interview with 1199SEIU Regional Communications Director Mindy Berman, July 5, 2020). We gathered data on the union status of nursing homes through interviews with labor union representatives conducted between May 6 and July 8, 2020. The union status of all nursing homes remained constant throughout our period of study.

COVARIATES To address potential confounders, we gathered data on nursing home and area-level characteristics previously associated with poor outcomes from COVID-19.

We obtained nursing home-level data on the average age of residents, percent of residents who are obese, Resource Utilization Group Nursing Case Mix Index of resident acuity, total bed, occupied beds, occupancy rates, staff-hours-to-resident-days ratios (for RN, CNA, and licensed practical nurses (LPN)), percent of residents whose primary support comes from Medicaid or Medicare, Overall 5-Star Rating, and chain and for-profit status.

We gathered data on total and occupied beds

from the NYSDOH Nursing Home Profiles, based on the most recent occupancy reports (85% reported on March 25, 2020).[20] CMS provides data on the 5-Star Quality Rating (updated April 1, 2020), and all other nursing home-level characteristics are available from Brown University's Long-term Care: FOCUS project, which was last updated in 2017.[21]

We also obtained county-level data on confirmed cases of COVID-19 and population from USAFACTS (updated through May 31, 2020).[22]

STATISTICAL ANALYSES We first estimated descriptive statistics for the main outcome, primary explanatory variable, and all covariates, for four groups: facilities for which NYSDOH reported data, facilities for which NYSDOH did not report data, cohort facilities with unions, and cohort facilities without unions. Statistical differences by reporting and union status were ascertained using T-tests and Z-tests.

To examine the association between the proportion of residents who died from COVID-19 and the presence of health care worker unions, we then estimated cross-sectional ordinary least squares (OLS) regression models, with and without adjustment for county and facility-level variables.

In adjusted models, we included county-level confirmed COVID-19 cases per capita to adjust for the prevalence of disease in the surrounding county, and population to account for the possibility that more populous counties may contain more unidentified infections. Since COVID-19 mortality rates are known to increase along with age and comorbidities, we included the average age of residents, the percent of residents who are obese, average resident acuity, and the percent of residents whose primary support comes from Medicare, thus representing individuals receiving care following an acute in-patient hospitalization. Since COVID-19 has disproportionately affected low income individuals, we also adjust for the percent of residents whose primary source of insurance is Medicaid.

Since the quality of care may influence COVID-19 mortality rates, we also adjusted for staff-hours-to-resident-days ratios for RNs, CNAs, and LPNs.[23] We also adjusted for the Overall 5-Star Quality Rating, which is based on health inspections, staffing, and 15 different physical and clinical measures for nursing home residents, as previous research suggests that COVID-19 death rates may be lower in higher-rated facilities.[2,10] Similarly, we adjusted for chain and for-profit status, as previous research associates these ownership characteristics with the quality of care.[24,25] We also adjusted for each facility's occupancy rate, as empty beds may have facilitated the isolation of COVID-19 positive residents. Finally, we adjusted for the number of occupied beds, as unionization and COVID-19 infection may both be more likely in large facilities. Even with these adjustments, the available data and observational research strategy preclude strong causal interpretations due to bias from unmeasured confounders and selection into our study sample.

SECONDARY ANALYSES As secondary analyses, we used cross-sectional OLS regression analyses to explore two mechanisms that may link labor unions to lower COVID-19 mortality rates in nursing homes: access to PPE and reduced COVID-19 infection rates. First, we examined the association between facility union-status and access to six types of PPE: N95 masks, eye shields, surgical masks, gowns, gloves, and hand sanitizer. We adjusted for the same county and facility-level variables as the main analysis, with the exception of resident obesity, which is unlikely to confound access to PPE.

Second, we examined the association between union-status and COVID-19 infection rates while adjusting for the same county and facility-level variables as the main analysis.

We computed 95% confidence intervals derived from heteroscedasticity-robust standard errors for all regression models. All analyses were conducted using R version 1.0.153 and Stata 15.0.

SENSITIVITY ANALYSES Prior research suggests that there may be COVID-19 deaths in nursing homes for which the NYSDOH did not report data, raising concerns about selection bias in our cohort.[2,26] To address these concerns, we conducted two robustness checks. First, we used an OLS model to assess for factors associated with reporting COVID-19 death data to the NYSDOH. Second, we used inverse probability weighting to adjust for selection bias in the data from nursing homes that did report data on COVID-19 deaths. Specifically, we used estimates of the predicted probability of reporting to NYSDOH from logistic regression models in constructing inverse probability weights in our main regression model.

We also considered the possibility that nonreporting facilities did not have any COVID-19 deaths by coding these facilities to have zero deaths. This is likely a conservative assumption given that facilities were mandated to report to the state, even if they had no deaths from COVID-19.

To account for the possibility that COVID-19 deaths were correlated across nursing homes in the same labor market, we calculated commuting zone-level wild cluster bootstrap robust standard errors.[27] To address concerns about regional variation in COVID-19 risk factors, as well as to

account for the possibility that COVID-19 deaths were correlated across facilities within the same county, we included region-level fixed effects and calculated standard errors clustered at the county level. We also performed Oster's coefficient stability test, to assess the robustness of our results to other unmeasured confounders.[28] Last, we estimated the models from our secondary analyses using only the nursing homes from our original cohort that reported data on PPE and COVID-19 infection rates. These sensitivity analyses are further described in the online appendix.[29]

LIMITATIONS Our study has several limitations that motivate future work. First, even with the inclusion of a rich set of covariates and sensitivity analyses, the observational study design precludes causal interpretations. Second, our study was conducted during an early phase of the COVID-19 pandemic and the estimated associations may change over time. Similarly, our findings may not be generalizable to unions and other patient outcomes before or after the pandemic. Third, our study was limited by missing data on confirmed COVID-19 deaths in many nursing homes in the State of New York.[30] Data collection during the pandemic faces many obstacles, and it is not possible to know how many COVID-19 deaths occurred in facilities excluded from the NYSDOH data. Fourth, NYSDOH data only includes confirmed COVID-19 deaths that occurred inside facilities. We are therefore unable to adjust for the possibility that unionized health care workers may transfer residents to hospitals earlier and thereby reduce their facility's COVID-19 mortality rate.

Fifth, while our data on unionized facilities covers the largest health care worker unions in New York, a small number of facilities may have been misclassified. Sixth, due to the lack of data on PPE early in the pandemic we were unable to adjust our main results for access to PPE. Seventh, we were unable to gather data on the race and ethnicity of individuals who died from COVID-19 or for health care workers, thus limiting our ability to examine racial disparities.

Eighth, many of the nursing home-level covariates were last measured in 2017, which may introduce measurement error. Our main outcome also may suffer potential measurement error due to our reliance on total beds to proxy for nursing home residents. Measurement error in both cases may bias estimates of the association between unionization and COVID-19 death rates either downwards or upwards. Last, this study may not be generalizable outside of the State of New York.

Study Results

DESCRIPTIVE STATISTICS We identified 621 nursing homes in New York state, 385 of which are included in the NYSDOH's report on COVID-19 mortality. Thirty facilities were excluded due to missing data on covariates, resulting in a study sample of 355 nursing homes.

Health care worker unions were present in 246 out of 355 nursing homes in our sample (239 affiliated with 1199SEIU, 4 affiliated with NYSNA, 1 affiliated with the Teamsters, and 2 affiliated with both 1199SEIU and NYSNA). Facilities with health care worker unions had residents who were younger, less obese, with higher acuity scores, less likely to be white, and more likely to be insured by Medicare or Medicaid (supplemental exhibit 1).[29] Unionized facilities were also more likely to be for-profit, less likely to be associated with a chain, had lower LPN-to-resident ratios, and were located in more populous counties with higher per capita rates of confirmed COVID-19 cases (supplemental exhibit 1).[29] At the county-level, the percent of nursing homes that were unionized ranged from zero to 100 (supplemental exhibit 2).[29]

There were 3,298 confirmed COVID-19 fatalities in nursing homes in the state of New York through May 31, 2020. The facility with the highest number of confirmed COVID-19 deaths had 82 deaths and the highest proportion of deaths among residents was 62 of 160, or 38.8%. Eleven nursing homes in our sample reported 0 confirmed COVID-19 deaths. At the county-level, average COVID-19 mortality rates in nursing homes varied from a low of 0.0 to a high of 12.9 (supplemental exhibit 3).[29] In the 246 unionized nursing homes, 3.72% of residents died from COVID-19 while in the 109 non-unionized facilities 5.53% of residents died.

MAIN REGRESSION RESULTS In regression analyses, we found that the presence of a labor union representing health care workers was associated with a 1.29 percentage point reduction (95% Confidence Interval (CI): -2.405, -0.172; $p = 0.024$) in the proportion of facility residents who die from COVID-19. Estimated coefficients were similar in models with and without covariates (supplemental exhibit 4)[29] and the statistical significance of our findings were substantively unchanged regardless of how confidence intervals were calculated. Since the mean proportion of facility residents who died from COVID-19 during our study period was 4.279 percent, the covariate-adjusted estimates suggest that the presence of a labor union was associated with a 30% relative decrease in the COVID-19 mortality rate compared to facilities without health care worker unions.

SECONDARY ANALYSES

▶ **PPE:** In our secondary analysis on PPE access, we use data from a larger cohort of nursing homes. Of 418 facilities reporting data on PPE, 19 were excluded due to missing data on covariates, resulting in a sample of 399 nursing homes. In the resulting sample of facilities, 83% reported having N95 masks, 92% eye shields, 84% gowns, 95% hand sanitizer, 96% gloves, and 96% surgical masks (appendix exhibit A1).[29]

In regression analyses, we found that the presence of a labor union is associated with an 11.5 percentage point increase (95% CI: 2.1, 20.9; $p = 0.017$) in the probability of a facility having access to N95 masks and a 6.7 percentage point increase (95% CI: 0.3, 13.0; $p = 0.039$) in the probability of having access to eye shields. Unions were therefore associated with a 13.8% relative increase in access to N95 masks and a 7.3% relative increase in access to eye shields. Labor union status was not a significant predictor of access to other types of PPE (supplemental exhibit 5).[29]

▶ **COVID-19 INFECTION RATES:** In our secondary analysis of COVID-19 infection rates we use data from the 371 nursing homes in this cohort that reported data on COVID-19 infection rates. In the resulting sample, the average COVID-19 infection rate was 119.4 per 1,000 residents. 148 of these nursing homes had infection rates of zero, thus minimizing concerns that CMS dropped facilities without COVID-19 infections.

In regression analyses, we found that the presence of a labor union is associated with a 50.1-point decrease in the number of COVID-19 infections per 1,000 residents (95% CI: −96.2, −3.9; $p = 0.034$). Since the mean COVID-19 infection rate during our study period was 119.4, the covariate-adjusted estimates suggest that the presence of a labor union was associated with a 42% relative decrease in the COVID-19 infection rate (supplemental exhibit 5).[29]

SENSITIVITY ANALYSES In OLS models examining predictors of whether or not the NYSDOH reported data on COVID-19 deaths for a given facility, the presence of a health care worker union, was not found to be a statistically significant (appendix exhibit A2).[29] Analyses using inverse probability weighting to address potential non-random selection into reporting COVID-19 deaths yielded similar estimates of the association between COVID-19 deaths and unionization (−1.71, $p = 0.005$) (appendix exhibit A3).[29]

Our results remained statistically significant when estimating commuting zone-level wild cluster bootstrap robust standard errors (95% CI: −3.152, 0.767; $p = 0.074$) (appendix exhibit A4).[29] Findings were also robust when adjusting for region-level fixed effects and clustering standard errors at the county level (95% CI: −2.222, −0.204; $p = 0.019$) (appendix exhibit A5).[29] Our results are similar even when using the conservative assumption that all non-reported nursing homes experienced zero COVID-19 deaths (95% CI: −1.53, 0.09; $p = 0.08$) (appendix exhibit A6).[29] Simulating the potential effect of additional unmeasured confounders did not reverse the substantive finding (appendix exhibit A7).[29] Last, the results of our secondary analyses are similar when only using the nursing homes from our original cohort that also reported data on PPE and COVID-19 infection rates (appendix exhibits A8 & A9).[29]

Discussion

Among 355 nursing homes in New York State for which data on COVID-19 mortality rates were available, the presence of a health care worker union was associated with a 30% lower mortality rate from COVID-19 among nursing home residents. The findings were robust to adjustment for a range of covariates and specification checks for bias from missing data. We also found that nursing homes with labor unions had greater access to PPE and lower COVID-19 infection rates, two important mechanisms that may link unions to lower COVID-19 mortality rates.

Specifically, unions were associated with a 13.8% relative increase in access to N95 masks and a 7.3% relative increase in access to eye shields. We also found that unions were associated with a 42% relative decrease in COVID-19 infection rates among nursing home residents. However, more research is needed to understand the numerous mechanisms through which unions may influence COVID-19 mortality rates, such as staff training, reducing use of part-time workers, implementing infection protocols, and giving workers a collective voice in the workplace.[9,14–17,31]

As more than 40% of all COVID-19 deaths have occurred in nursing homes, there is an urgent need to understand factors that protect residents and staff. Amidst the COVID-19 pandemic, unions advocated for supplies and policies that protect staff and residents from SARS-CoV-2 infection. While our study design precludes causal interpretations, our results suggest that unions may have reduced COVID-19 deaths among nursing home residents by successfully demanding PPE for health care workers. These are especially important contributions given that early research on COVID-19 in nursing homes found that only facility size and location—rather than quality metrics—were associated with COVID-19 outbreaks.[2,11]

Our finding that unions are associated with reduced COVID-19 mortality rates in nursing homes is consistent with previous findings that unions improve safety and health standards for workers,[15,16,32] help to co-enforce those standards with employers,[33] and also reduce workplace injuries[34,35] and accidental deaths.[36] Health care worker unions, in particular, are also associated with improved patient outcomes.[14,19,37]

Our study also identified other individual and facility factors associated with increased COVID-19 mortality rates in nursing homes. COVID-19 mortality rates were negatively associated with CNA staffing ratios and positively associated with the average age of residents and the percent of facility residents that are white. However, this finding regarding race is not statistically significant when we include region-level fixed effects (appendix exhibit A5).[29] This suggests that the result may be driven by unmeasured confounders that vary across regions. Unfortunately, missing race and ethnicity data for individuals that died from COVID-19 limits our ability to further examine racial disparities. We also found that chain nursing homes were associated with higher COVID-19 mortality rates. Previous research similarly finds that nursing home chains are associated with lower quality care.[16,17,38]

Our study has three main strengths that improve our understanding of the relationship between labor unions, access to PPE, and COVID-19 infection and mortality in nursing homes. First, we combined several data sources in order to identify unionized nursing homes in New York while also adjusting for facility and community covariates. Second, we performed important sensitivity analyses to address NYSDOH's selective reporting of COVID-19 deaths in nursing homes. We found that the presence of a union was not associated with NYSDOH reporting data on COVID-19 deaths. Our results were also robust when using inverse probability weighting to address potential non-random selection and accounting for potential unmeasured confounders. Third, to our knowledge this study is the first to demonstrate that labor unions are associated with reduced COVID-19 infections and deaths in an essential industry. Lack of data on COVID-19 infections by occupation has thus far hindered research on whether unions can protect workers and the public.

Our results have significant implications for stakeholders concerned with COVID-19 mortality in nursing homes. Health care worker unions were associated with reduced mortality rates in the initial COVID-19 surge in the United States. Future surges of COVID-19 infections in regions with fewer unionized nursing homes are therefore particularly worrisome.

Conclusion

Residents in nursing homes have been disproportionately affected by COVID-19. The presence of a health care worker labor union was associated with a 30% relative decrease in the COVID-19 mortality rate compared to facilities without unions in the State of New York. Health care worker unionization may play an important role in ensuring access to appropriate PPE and implementing infection control policies that protect vulnerable nursing home residents. ■

Simeon Kimmel consulted for Abt Associates on a Massachusetts Department of Public Health–funded project to improve access to medications for opioid use disorder in skilled nursing facilities. [*Published online September 10, 2020.*]

NOTES

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Appendix

Exhibit A1 reports descriptive statistics for the cohort of nursing homes used in our secondary analysis on access to personal protective equipment.

We performed eight sensitivity analyses of our main results, each of which is reported below.

First, we used OLS regression to model the predictors of whether or not the NYSDOH reported Covid-19 death data from nursing homes (Exhibit A2). Importantly, the presence of a healthcare workers union is not a significant predictor of the NYSDOH reporting data for a nursing home. This suggests that nursing homes with labor unions are not systematically withholding data from facilities with high Covid-19 mortality rates. This therefore decreases our concerns that our main results could be driven by selection bias among the nursing homes for which the NSYDOH reported data. Instead, facility-level occupied beds, county-level population and confirmed Covid-19 cases per capita were all positively associated with reporting, while higher levels of the CMS 5-star rating were negatively associated with reporting.

Second, we used inverse probability weighting to adjust for selection bias due to missing data. Exhibit A3 reports the OLS regression results based on the inverse probability weights estimated with logistic regression.

Third, we computed 95% confidence intervals derived from commuting zone-level wild cluster bootstrap robust standard errors, which account for the possibility that Covid-19 deaths are correlated across nursing homes in the same labor market area. Exhibit A4 reports the coefficient (-1.289) for the presence of a healthcare worker union along with confidence interval [-3.152, 0.767], and p-value (0.074).

Fourth, we estimated our main OLS model with the addition of region-level fixed effects and calculated standard errors clustered at the county level. The fixed effects adjust for regional variation in Covid-19 risk factors while the clustered standard errors take into account the possibility that Covid-19 deaths may have been correlated across nursing homes within the same counties. Exhibit A5 reports the coefficient (-1.213) for the presence of a healthcare worker union along with confidence interval [-2.222, -0.204], and p-value ($p<0.019$).

Fifth, we estimated our main OLS model using the extreme assumption that all nursing homes for which the NYSDOH did not report data experienced zero Covid-19 deaths. Exhibit A6 reports our results, which are substantively similar despite this assumption likely biasing against our hypothesis (95% CI: -1.53, 0.09; p=0.08)

Sixth, we performed Oster's (2019) coefficient stability test, to assess the robustness of the substantive finding to other unmeasured confounders. Exhibit A7 shows that simulating the potential effect of additional unmeasured confounders did not reverse the substantive finding.

Seventh, we estimated our secondary analysis on PPE using only the subset of our original cohort nursing homes that reported data on access to PPE. Exhibit A8 reports the results, which are substantively similar to results using the largest possible sample of nursing homes.

Eighth, we estimated our secondary analysis on Covid-19 infection rates using only the subset of our original cohort nursing homes that reported data on access to PPE and Covid-19 infection rates. Exhibit A9 reports the results, which are substantively similar to the results reported in our paper using a larger sample of nursing homes.

Exhibit A1: Secondary Analysis—Characteristics of nursing homes with and without reported data on personal protective equipment and cohort nursing homes with and without healthcare worker unions.

	All Nursing Homes N=621			Nursing Homes in Cohort N=399		
Variable mean (SD)	**Reported N=418**	**Not Reported N=203**	**Difference statistically significant?**	**Unionized N=200**	**Non-Unionized N=199**	**Difference statistically significant?**
Population (County)	978,284 (815,099)	878,984 (790,926)	no	1,337,099 (799,729)	608,304 (652,102)	yes
Covid-19 Cases per capita (County)	0.02 (0.01)	0.02 (0.01)	no	0.02 (0.01)	0.01 (0.01)	yes
Average Age of Residents (Nursing Home)	80.97 (7.62)	78.17 (10.07)	yes	79.00 (8.79)	83.13 (5.31)	yes
Medicaid % (Nursing Home)	58.69 (20.84)	61.04 (20.56)	no	62.99 (17.65)	54.19 (22.25)	yes
Medicare % (Nursing Home)	13.01 (11.4)	13.42 (15.29)	no	14.71 (11.05)	11.13 (11.33)	yes
RN Ratio (Nursing Home)	0.49 (0.36)	0.55 (0.69)	no	0.50 (0.38)	0.47 (0.29)	no
LPN Ratio (Nursing Home)	0.83 (0.33)	0.87 (0.28)	no	0.74 (0.29)	0.94 (0.33)	yes
CNA Ratio (Nursing Home)	2.36 (0.62)	2.30 (0.60)	no	2.28 (0.52)	2.43 (0.69)	yes
5-Star Rating (Nursing Home)	3.40 (1.38)	2.97 (1.5)	yes	3.46 (1.31)	3.35 (1.43)	no
Resident Acuity (Nursing Home)	1.22 (0.15)	1.21 (0.19)	no	1.24 (0.17)	1.20 (0.12)	yes
Occupied Beds (Nursing Home)	176.9 (114.36)	152.72 (106.84)	yes	204.09 (114.46)	152.07 (110.11)	yes
White % (Nursing Home)	75.48 (27.38)	72.03 (29.38)	no	64.70 (27.45)	86.54 (22.44)	yes
For-Profit (Nursing Home)	0.59 (0.49)	0.67 (0.47)	yes	0.74 (0.44)	0.45 (0.5)	yes
Chain (Nursing Home)	0.16 (0.37)	0.16 (0.36)	yes	0.06 (0.25)	0.25 (0.43)	yes
Occupancy Rate (Nursing Home)	0.90 (0.13)	0.86 (0.22)	no	0.90 (0.12)	0.89 (0.12)	no

SOURCE: New York State Department of Health, 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, Communication Workers of America, Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS. **NOTES:** T-tests calculated to compare the means across union and non-union facilities for all other continuous measures. Z-tests calculated for the binary measures of *For-Profit* and *Chain*. For both tests, the threshold for statistical significance was $p < 0.05$. Non-cohort nursing homes have missing data for the nursing home-level variables, therefore the means and standards deviations for Reported and Not Reported nursing homes are calculated using less than 418 and 203 observations, respectively.

Exhibit A2: OLS regression results modeling the predictors of the New York State Department of Health reporting Covid-19 death data from nursing homes

	Model 1
(Intercept)	-0.849 [-1.811, 0.114], p<0.085
Union	0.009 [-0.069, 0.087], p<0.822
For-Profit	0.047 [-0.023, 0.117], p<0.19
Population (county)	0.102**** [0.059, 0.145], p<0.001
Covid-19 cases per capita (county)	14.708**** [11.043, 18.372], p<0.001
Average Age	0.000 [-0.007, 0.006], p<0.940
Chain	0.001 [-0.102, 0.103], p<0.990
Medicaid %	0.001 [-0.001, 0.003], p<0.392
Medicare %	0.003 [0.000, 0.006], p<0.0330
RN Ratio	-0.122 [-0.246, 0.001], p<0.053
LPN Ratio	-0.025 [-0.158, 0.107], p<0.708
CNA Ratio	0.004 [-0.064, 0.072], p<0.902
2-Star Rating	-0.066 [-0.181, 0.049], p<0.260
3-Star Rating	-0.114** [-0.217, -0.011], p<0.031
4-Star Rating	-0.173**** [-0.277, -0.07], p<0.001
5-Star Rating	-0.128** [-0.241, -0.015], p<0.027
Occupancy Rate	0.154 [-0.156, 0.463], p<0.331
Obese %	-0.004 [-0.009, 0.001], p<0.146
Resident Acuity	-0.142 [-0.372, 0.087], p<0.225
Occupied Beds	0.001**** [0.000, 0.001], p<0.001
White %	0.000 [-0.001, 0.002], p<0.499
N	543
R^2	0.511
Adj. R^2	0.492
Resid. Sd	0.400

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** p < .01; **** p < .001.

Exhibit A3: OLS regression results using inverse probability weighting.

	Model 1
(Intercept)	-25.245**** [-35.382, -15.108], p<0.001
Union	-1.707*** [-2.785, -0.629], p<0.005
For-Profit	0.399 [-1.187, 1.985], p<0.588
Population (county)	0.726 [-0.022, 1.473], p<0.056
Covid-19 cases per capita (county)	43.876 [-49.945, 137.697], p<0.322
Average Age	0.196*** [0.063, 0.329], p<0.008
Chain	-1.382 [-3.534, 0.770], p<0.183
Medicaid %	0.031 [-0.009, 0.071], p<0.114
Medicare %	0.065** [0.014, 0.116], p<0.017
RN Ratio	1.304 [-1.921, 4.529], p<0.389
LPN Ratio	1.239 [-1.187, 3.665], p<0.282
CNA Ratio	-1.524*** [-2.425, -0.623], p<0.004
2-Star Rating	-1.142 [-2.592, 0.308], p<0.110
3-Star Rating	-0.863 [-2.684, 0.957], p<0.316
4-Star Rating	-0.141 [-2.688, 2.406], p<0.905
5-Star Rating	0.064 [-1.435, 1.564], p<0.926
Occupancy Rate	2.236 [-2.21, 6.682], p<0.289
Obese %	0.084 [-0.007, 0.174], p<0.066
Resident Acuity	-0.648 [-5.184, 3.888], p<0.757
Occupied Beds	-0.003 [-0.008, 0.003], p<0.308
White %	0.032 [-0.008, 0.072], p<0.101
N	355
R^2	0.210
Root MSE	4.474

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A4: Wild cluster bootstrapped standard errors for main OLS model

	Based on Model 2 from Supplemental Exhibit 3
Union	-1.289 [-3.152, 0.767], p<0.0741

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** *p* < .05; *** p < .01; **** p < .001.

Exhibit A5: OLS regression results including region-level fixed effects and standard errors clustered at the county level.

	Based on Model 2 from Supplemental Exhibit 3
Union	-1.213** [-2.222, -0.204], p<0.019
White %	0.017 [-0.004, 0.039], p<0.107

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A6: OLS regression results modeling association between presence of healthcare worker union and facility Covid-19 mortality rate in nursing homes, assuming non-reported facilities had zero deaths.

	Model 1
(Intercept)	-19.944**** [-29.65, -10.239], p<0.001
Union	-0.72 [-1.527, 0.086], p<0.081
For-Profit	-0.183 [-0.911, 0.544], p<0.621
Population (county)	0.757*** [0.26, 1.254], p<0.003
Covid-19 cases per capita (county)	106.121**** [60.741, 151.502], p<0.001
Average Age	0.076** [0.014, 0.138], p<0.017
Chain	1.136 [-0.135, 2.407], p<0.08
Medicaid %	0.015 [-0.004, 0.033], p<0.115
Medicare %	0.05** [0.006, 0.095], p<0.028
RN Ratio	0.451 [-0.768, 1.669], p<0.469
LPN Ratio	0.789 [-0.529, 2.107], p<0.241
CNA Ratio	-0.822*** [-1.353, -0.29], p<0.003
2-Star Rating	-0.868 [-1.815, 0.079], p<0.073
3-Star Rating	-0.963** [-1.849, -0.076], p<0.034
4-Star Rating	-0.899 [-1.851, 0.053], p<0.065
5-Star Rating	-0.143 [-1.244, 0.958], p<0.800
Occupancy Rate	1.604 [-1.122, 4.330], p<0.249
Obese %	0.018 [-0.048, 0.083], p<0.600
Resident Acuity	0.510 [-1.453, 2.473], p<0.611
Occupied Beds	0.002 [-0.001, 0.005], p<0.254
White %	0.034**** [0.017, 0.052], p<0.001
N	543
R^2	0.198
Adj. R^2	0.168
Resid. Sd	3.804

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A7: Coefficient stability test

Unadjusted Coefficient	Adjusted Coefficient	Bounds if $R_{max} = 1.3*R_{adj}$	Bounds if $R_{max} = 2*R_{adj}$
-1.80	-1.29	(-1.29, -0.97)	(-1.29, -0.26)

SOURCE: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.

Exhibit A8: Secondary Analysis - OLS regression results modeling association between presence of healthcare worker union and facility access to personal protective equipment, using subset of original cohort that reported data on personal protective equipment

	N95 Masks	Eye Shields	Surgical Masks
Union	0.139** [0.009, 0.269] p<0.038	0.059 [-0.028, 0.146] p<0.18	0.024 [-0.052, 0.100] p<0.531
N	238	238	238
***R*²**	0.108	0.079	0.096
Adj. *R*²	0.031	-0.001	0.017
Resid. sd	0.393	0.265	0.226
	Gowns	**Gloves**	**Hand Sanitizer**
Union	0.075 [-0.044, 0.194] p<0.300	-0.005 [-0.069, 0.059] p<0.875	-0.011 [-0.093, 0.071] p<0.798
N	238	238	238
***R*²**	.081	0.128	0.078
Adj. *R*²	0.001	0.052	-0.002
Resid. sd	0.371	0.214	0.2719

SOURCE: Authors' analysis of data on availability of personal protective equipment from Centers for Medicare & Medicaid Services (CMS), union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America and covariates from CMS, the New York State Department of Health, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.

Exhibit A9: OLS regression results modeling association between presence of healthcare worker union and nursing home Covid-19 infection rates using subset of original cohort that reported data on personal protective equipment and Covid-19 infection rates

	Model 1
Union	-89.484*** [-156.261, 22.707] p<0.009
N	237
R^2	0.189
Adj. R^2	0.114
Resid. sd	207.3

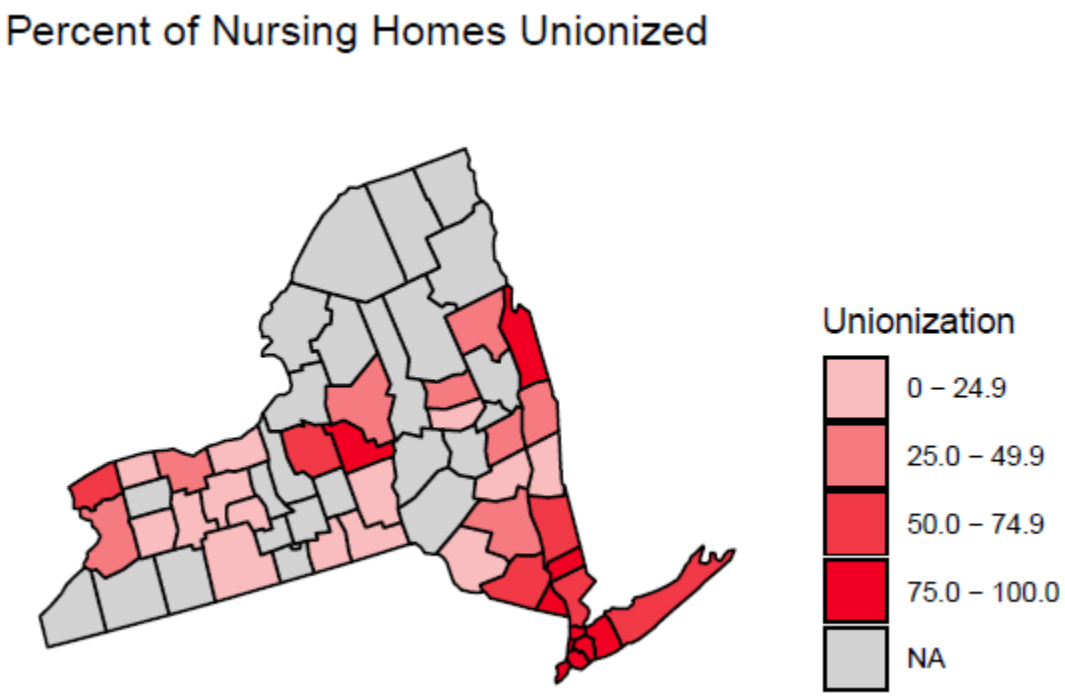
SOURCE: Authors' analysis of data on Covid-19 infection rates from Centers for Medicare & Medicaid Services (CMS), union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America and covariates from CMS, the New York State Department of Health, Brown University's Long-term Care: FOCUS project, and USAFACTS. **NOTES:** 95% confidence intervals calculated with robust standard errors. ** $p < .05$; *** p < .01; **** p < .001.

Supplemental EXHIBIT 1 Characteristics of nursing homes with and without reported data on Covid-19 deaths and cohort nursing homes with and without health care worker unions.

	All Nursing Homes N=621		Nursing Homes in Cohort N=355	
Variable mean	**Reported N=385**	**Not Reported N=236**	**Unionized N=246**	**Non-Unionized N=109**
Population (County)	1,285,134	392,288**	1,446,815	863,978**
Covid-19 Cases per capita (County)	0.02	0.01**	0.03	0.02**
Average Age of Residents	79.59	80.96**	78.35	81.59**
Medicaid %	60.88	56.94**	63.82	57.19**
Medicare %	14.39	10.96**	15.07	11.72**
RN Ratio	0.48	0.57	0.47	0.47
LPN Ratio	0.79	0.95**	0.74	0.90**
CNA Ratio	2.30	2.41**	2.26	2.33
5-Star Rating	3.33	3.15	3.35	3.21
Obese %	23.89	29.73**	23.53	25.08**
Resident Acuity	1.23	1.20**	1.24	1.20**
Occupied Beds	203.47	112.76**	215.31	199.45
White %	65.12	90.79**	58.39	77.58**
For-Profit	0.69	0.49**	0.78	0.51**
Chain	0.11	0.24**	0.08	0.18**
Occupancy Rate	0.91	0.85**	0.92	0.90

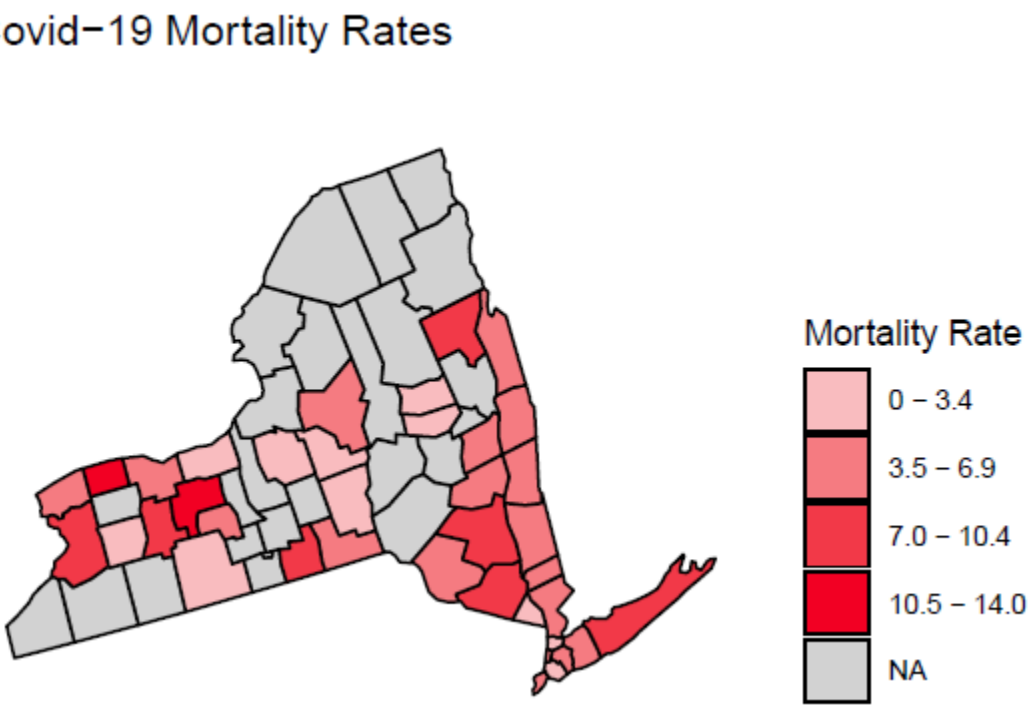
Source: New York State Department of Health, 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, Communication Workers of America, Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES: All variables are for nursing homes except where county is indicated. T-tests calculated to compare the means across union and non-union facilities for all other continuous measures. Z-tests calculated for the binary measures of *For-Profit* and *Chain*. Non-cohort nursing homes have missing data for the nursing home-level variables, therefore the means and standards deviations for Reported and Not Reported nursing homes are calculated using less than 385 and 236 observations, respectively. ** $p < 0.05$

Supplemental EXHIBIT 2 County-level Unionization Rates in New York Nursing Homes



Source: SOURCE 1199SEIU United Healthcare Workers East, New York State Nurses Association, and Teamsters.

Supplemental EXHIBIT 3 County-level Covid-19 Mortality Rates in New York Nursing Homes



Source: SOURCE New York State Department of Health.

Supplemental EXHIBIT 4 Association between the presence of health care worker unions and Covid-19 mortality rates in nursing homes

	Multivariate Model (model 2)
(Intercept)	-22.116***
Union	-1.289**
For-Profit	-0.462
Population (county)	0.503
Covid-19 cases per capita (county)	41.960
Average Age	0.166****
Chain	2.429**
Medicaid %	0.016
Medicare %	0.050
RN Ratio	0.411
LPN Ratio	1.128
CNA Ratio	-1.301***
2-Star Rating	-0.819
3-Star Rating	-0.462
4-Star Rating	-0.028
5-Star Rating	0.671
Occupancy Rate	2.135
Obese %	0.067
Resident Acuity	1.301
Occupied Beds	-0.001
White %	0.027***
N	355
R^2	0.300
Adj. R^2	0.284
Resid. Sd	4.067

Source: Authors' analysis of data on confirmed Covid-19 deaths in nursing homes from the New York State Department of Health, union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from Centers for Medicare & Medicaid Services, Brown University's Long-term Care: FOCUS project, and USAFACTS.
NOTES Results based on ordinary least squares regression. Univariate model (model 1) regressed Covid-19 mortality rates against union status. Key regression statistics for the univariate model: Intercept, 5.529[4.436, 6.622], p<0.001; coefficient on "union", -1.805 [-2.988, -0.621], p=0.003; N = 355; R^2 = 0.033; Adj. R^2 = 0.030; Residual SD = 4.733. 95% confidence intervals for the model were calculated with robust standard errors. ** $p <$ .05; *** p < .01; **** p < .001.

Supplemental EXHIBIT 5 Association between the presence of health care worker unions and facility access to personal protective equipment and facility Covid-19 infection rates

	N95 Masks (N = 399)	Eye Shields (N = 399)	Surgical Masks (N = 399)	Gowns (N = 399)	Gloves (N = 399)	Hand Sanitizer (N = 399)	Covid-19 Infection Rate (N = 371)
Union	0.115**	0.067**	-0.010	0.030	-0.021	0.000	-50.089**
R^2	0.102	0.082	0.056	0.049	0.066	0.070	0.154
Adj. R^2	0.057	0.036	0.009	0.001	0.019	0.023	0.106
Resid. sd	0.368	0.267	0.201	0.370	0.189	0.221	185.5

Source: Authors' analysis of data on availability of personal protective equipment and Covid-19 infection rates from Centers for Medicare & Medicaid Services (CMS), union representation from 1199SEIU United Healthcare Workers East, New York State Nurses Association, Teamsters, and Communication Workers of America, and covariates from CMS, the New York State Department of Health, Brown University's Long-term Care: FOCUS project, and USAFACTS.

NOTES Results based on ordinary least squares regression. 95% confidence intervals for the model were calculated with robust standard errors. ** $p < .05$; *** $p < .01$; **** $p < .001$.