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Original Study

# Assessment of Coronavirus Disease 2019 Infection and Mortality Rates Among Nursing Homes With Different Proportions of Black Residents



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## A B S T R A C T

### Keywords:

Racial/ethnic disparities  
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**Objective:** Coronavirus disease 2019 (COVID-19) has disproportionately impacted nursing homes (NHs) with large shares of Black residents. We examined the associations between the proportion of Black residents in NHs and COVID-19 infections and deaths, accounting for structural bias (operationalized as county-level factors) and stratifying by urbanicity/rurality.

**Design:** This was a cross-sectional observational cohort study using publicly available data from the LTCfocus, Centers for Disease Control and Prevention Long-Term Care Facility COVID-19 Module, and the NYTimes county-level COVID-19 database. Four multivariable linear regression models omitting and including facility characteristics, COVID-19 burden, and county-level fixed effects were estimated.

**Setting and Participants:** In total, 11,587 US NHs that reported data on COVID-19 to the Centers for Disease Control and Prevention and had data in LTCfocus and NYTimes from January 20, 2020 through July 19, 2020.

**Measures:** Proportion of Black residents in NHs (exposure); COVID-19 infections and deaths (main outcomes).

**Results:** The proportion of Black residents in NHs were as follows: none = 3639 (31.4%), <20% = 1020 (8.8%), 20%–49.9% = 1586 (13.7%), ≥50% = 681 (5.9%), not reported = 4661 (40.2%). NHs with any Black residents showed significantly more COVID-19 infections and deaths than NHs with no Black residents. There were 13.6 percentage points more infections and 3.5 percentage points more deaths in NHs with ≥50% Black residents than in NHs with no Black residents ( $P < .001$ ). Although facility characteristics explained some of the differences found in multivariable analyses, county-level factors and rurality explained more of the differences.

**Conclusions and Implications:** It is likely that attributes of place, such as resources, services, and providers, important to equitable care and health outcomes are not readily available to counties where NHs have greater proportions of Black residents. Structural bias may underlie these inequities. It is imperative that support be provided to NHs that serve greater proportions of Black residents while considering the rurality of the NH setting.

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Black older adults are the largest minority group receiving care in nursing homes, and this population has increased dramatically over the last 2 decades.<sup>1</sup> This growth has enabled a more rigorous examination of the health outcomes of Black older adults living in nursing homes and disparities in care.<sup>2</sup> Prior to coronavirus disease 2019 (COVID-19), researchers have found that Black nursing home residents 65 years of age or older have limited access to vaccinations and higher incidence of pressure ulcers and restraint use than White residents.<sup>3–5</sup> The proportion of Black residents in a nursing home has largely accounted for the differences in care seen in this setting.<sup>5,6</sup>

Nursing home residents have been disproportionately suffering from the impact of the COVID-19 pandemic,<sup>7</sup> and leaders seek to understand nursing home factors that increase vulnerability to COVID-19 infections and deaths.<sup>7</sup> Similar to other disparities described above,<sup>5,6</sup> the proportion of racial/ethnic minority groups segregated within nursing homes is associated with greater COVID-19 infections and deaths.<sup>8–11</sup> Although these findings help characterize the scope of the pandemic's impact on our most vulnerable population, the National Institute on Aging Health Disparities Research Framework suggests that geographical and political factors beyond residential segregation, such as urbanicity/rurality and structural bias, disproportionately influence the health of minority populations.<sup>12</sup> Examining these issues may inform COVID-19 response efforts.

We sought to examine whether structural bias (operationalized as county-level factors) and urbanicity/rurality explained the association between proportions of Black residents in a nursing home and COVID-19 infections and deaths. We define structural bias synonymously to structural racism: “macrolevel systems, social forces, institutions, ideologies, and processes that interact with one another to generate and reinforce inequities among racial and ethnic groups.”<sup>13</sup>

## Methods

This study linked data from 3 sources. First, the 2017 LTCfocus. This is a publicly available dataset that characterizes all Medicare- and Medicaid-certified nursing homes from the Minimum Data Set (MDS), the Certification and Survey Provider Enhanced Reports system, Medicare claims, Nursing Home Compare, and other sources.<sup>14</sup> The year 2017 was used because it was the most recent data available. Second, the 2020 Centers for Disease Control and Prevention's (CDC) National Healthcare Safety Network Long-Term Care Facility COVID-19 Module. This module includes data on nursing home resident COVID-19 infections and deaths along with nursing home supplies and staff.<sup>15</sup> Since early May 2020, the Centers for Medicare and Medicaid Services (CMS) have required that all nursing homes report to the CDC COVID-19 module every 7 days and back-report infections since January 2020.<sup>15</sup> Third, the real-time NYTimes county-level COVID-19 infections and deaths. These data were first collected from the beginning of January 2020 (<https://github.com/nytimes/covid-19-data>). We used data that were last updated on July 31, 2020 in the CDC COVID-19 module and included nursing homes and the NYTimes data that were reported through July 19, 2020. We excluded data that did not pass the quality assurance checks by CMS and those that did not have complete records in LTCfocus or the CDC COVID-19 module. Because these data were publicly available, in aggregate, and deidentified, the methods of this study did not warrant Institutional Review Board approval. This report follows the STROBE reporting guidelines for cross-sectional studies.<sup>16</sup>

Our primary outcomes were (1) number of confirmed COVID-19 infections and (2) number of confirmed or suspected COVID-19 deaths among nursing home residents. Both outcomes were reported at the nursing home level as proportions of the total number of occupied beds. In these data, confirmed resident infections were defined as positive laboratory tests for COVID-19, regardless of

symptomatology. Deaths were defined as persons with suspected or laboratory-positive COVID-19 who died.

Our primary exposure variable was the proportion of Black residents in nursing homes. LTCfocus reports percentage of Black residents from aggregated MDS assessments. Race is selected by the MDS coordinator using information provided by the resident or the family.<sup>17</sup> Similar to prior research, we categorized proportions of Black residents in nursing homes as none, <20%, 20%–49.9%, ≥50%, or not reported.<sup>3,18</sup> We combined the 50%–79.9% group (n = 558), 80%–94.9% group (n = 109), and the 95%–100% group (n = 14) to provide sufficient power. Not reported denotes nursing homes that had missing data for their percentage of racial/ethnic minorities. Because the most recently available LTCfocus data are from 2017, we examined 2011–2017 LTCfocus data to assess the stability of the percentages of Black residents in nursing homes and we found they remained stable during the period. Therefore, we used the 2017 data to characterize the proportion of Black residents in a nursing home.

Our models included several explanatory variables, choice of which was supported by previous research.<sup>19,20</sup> First were the facility characteristics. They included bed size (categorized as 0–49, 50–149, and 150+ beds), percent of facilities that were part of a chain organization and percent of facilities that were for-profit; percent occupancy; percent Medicaid residents; mean case mix index; and nurse staffing ratios defined as hours per patient day for registered nurses (RNs), licensed practical nurses, and aides, all of which came from the LTCfocus database. We also included percentage of facilities reporting staffing shortages and percentage reporting a lack of personal protection equipment supply which originated from the CDC Module. nursing home-level staff shortages included nurse/clinician and aide and lack of a 1-week supply of personal protection equipment included any of the following: N95 masks, surgical masks, eye protection, gowns, gloves, and hand sanitizer.<sup>20</sup> We categorized nursing home location by urban/rural setting based on state and county Federal Information Processing Standard codes <https://www.census.gov/geographies/reference-files/2018/demo/popest/2018-fips.html>.

Another explanatory variable was county-level COVID-19 burden. County COVID-19 burden was measured by county-level cumulative COVID-19 infections and deaths through July 19, 2020 from the NYTimes dataset. The nursing home resident infections and deaths were subtracted from county infections and deaths, respectively, to avoid double counting. These were then presented as the infections or deaths per 100,000 people in the county.

Lastly, we included county-level fixed effects. This allowed us to account for unobserved fixed county-level factors that may also have contributed to structural bias.

County COVID-19 burden (county infection and death proportions), occupancy rates, percent Medicaid residents, case mix index, and nurse staffing ratios were all normalized by population standard deviation.

## Statistical Analysis

To provide a detailed characterization of potential structural biases associated with disparities in COVID-19 infections and deaths, we investigated the association between proportion of Black residents in nursing homes and nursing home infections and deaths using four linear regression models: model 1, including only proportion of Black residents; model 2, including proportion of Black residents and facility-level characteristics; model 3, including proportion of Black residents, facility-level characteristics, and county COVID-19 burden; and model 4, including proportion of Black residents, facility-level characteristics, and county-level indicators (fixed effects). If the disparities in COVID-19 infections and deaths by proportion of Black residents were attenuated or became insignificant after including county fixed effects, this would indicate that county-level factors are

explaining at least some of the disparities beyond the nursing home characteristics. Standard errors in models 2–4 were clustered at the county level.

To explore heterogeneity in our results in respect to geographical factors, we applied stratified analyses by urbanicity/rurality to models 1–3.

As a sensitivity analysis, we estimated a fractional response model using logit regressions to check whether our results varied with different estimation approaches.<sup>21,22</sup> Statistical significance was set at  $P < .05$ . Data were analyzed using STATA v 14 (StataCorp, College Station TX).

**Results**

*Descriptive Statistics*

A total of 11,587 nursing homes were included in this study. Approximately 681 (6%) of nursing homes had  $\geq 50\%$  Black residents, whereas nearly one-third reported no Black residents ( $n = 3639$ ). Nursing homes with  $\geq 50\%$  Black residents had the most COVID-19

infections per occupied bed (0.19), compared with nursing homes with  $< 50\%$  Black residents (range 0.06–0.17,  $P < .001$ ). Staffing shortages were most reported among nursing homes with  $\geq 50\%$  Black residents with 7% greater reports among these nursing homes than nursing homes with no Black residents for both nurses/clinicians and aides (22.7% vs 15.5% and 24.4% vs 17.7%, respectively.  $P < .001$ ). This was also reflected in the lower RN (0.33) and aide (2.13) hours per resident day among these nursing homes with  $\geq 50\%$  Black residents compared with the others. Nursing homes with no Black residents were least likely to be in urban settings and have Medicaid-funded residents (49.3% and 52.18%, respectively,  $P < .001$ ). Nursing homes with any proportion of Black residents had at least twice as many COVID-19 deaths per occupied bed as nursing homes with no Black residents (0.02,  $P < .001$ ). On the other hand, nursing homes with  $\geq 50\%$  Black residents were situated in counties with the greatest burden of COVID-19 infections and deaths (average = 1461 and 54, respectively, per 100,000 people), whereas nursing homes with no Black residents were situated in counties with the lowest burden of COVID-19 infections and deaths (average = 615 and 13, respectively, per 100,000 people). Additional descriptive statistics are summarized in Table 1.

**Table 1**  
Characteristics of US Nursing Homes in Sample, Overall and by Proportion of Black Residents

Variables	Overall	Proportion of Black Residents					P
		None	Less than 20%	20%–49.9%	50% or More	Not reported*	
n (%)	11,587	3639 (31.40%)	1020 (8.80%)	1586 (13.69%)	681 (5.88%)	4661 (40.23%)	
<b>Outcomes</b>							
Proportion of confirmed COVID-19 infections/occupied beds, mean (SD)	0.11 (0.23)	0.06 (0.17)	0.17 (0.25)	0.17 (0.25)	0.19 (0.26)	0.11 (0.23)	<.0001
Proportion of confirmed or suspected COVID-19 deaths/occupied beds, mean (SD)	0.03 (0.08)	0.02 (0.07)	0.05 (0.09)	0.04 (0.08)	0.05 (0.09)	0.03 (0.09)	<.0001
<b>Facility Characteristics</b>							
<b>Bed size, %</b>							
0–49 beds	11.05%	22.62%	0.00%	1.07%	2.79%	9.05%	<.0001
50–149 beds	71.38%	72.90%	51.52%	67.97%	66.23%	76.47%	
150+ beds	17.56%	4.48%	48.48%	30.96%	30.98%	14.48%	
Part of chain organization, %	60.07%	55.32%	59.06%	64.12%	63.88%	62.05%	<.0001
For profit facility, %	68.58%	52.13%	77.18%	82.72%	85.76%	72.22%	<.0001
<b>Region, %</b>							
South	36.33%	54.84%	23.02%	17.47%	25.40%	32.82%	<.0001
West	17.76%	16.68%	25.56%	14.82%	12.78%	18.62%	
North	35.93%	14.87%	44.17%	64.12%	59.91%	37.47%	
Midwest	9.98%	13.61%	7.25%	3.59%	1.91%	11.09%	
<b>Urban rural location, %</b>							
Urban	69.57%	49.33%	90.78%	81.40%	85.02%	74.45%	<.0001
Rural	30.43%	50.67%	9.22%	18.60%	14.98%	25.55%	
Percent occupancy, mean (SD)	80.80 (14.62)	79.82 (15.26)	85.06 (11.47)	82.00 (13.78)	83.00 (12.45)	79.89 (15.08)	<.0001
Percent Medicaid, mean (SD)	59.55 (22.9)	52.18 (23.29)	65.36 (17.89)	70.12 (17.55)	74.39 (16.84)	58.28 (23.30)	<.0001
Case mix index, mean (SD)	1.29 (0.16)	1.26 (0.12)	1.32 (0.16)	1.31 (0.19)	1.31 (0.20)	1.30 (0.16)	<.0001
<b>Staff shortages, %</b>							
Nurse or clinician	16.82%	15.50%	15.48%	20.74%	22.74%	16.02%	<.0001
Aide	19.12%	17.70%	17.04%	23.08%	24.38%	18.58%	<.0001
<b>Lack of 1 wk availability of PPE, %</b>							
N95 mask	14.54%	15.53%	12.05%	14.56%	12.19%	14.65%	.03
Surgical mask	8.61%	9.40%	7.44%	8.20%	7.20%	8.60%	.15
Eye protection	8.08%	8.35%	7.25%	8.51%	7.20%	8.02%	.65
Gowns	11.18%	12.31%	9.89%	11.03%	10.13%	10.79%	.10
Gloves	4.21%	4.29%	4.02%	4.92%	5.29%	3.80%	.19
Hand sanitizer	4.22%	3.93%	4.51%	5.30%	5.58%	3.82%	.03
RN h per resident d, mean (SD)	0.48 (0.48)	0.54 (0.39)	0.41 (0.25)	0.37 (0.34)	0.33 (0.29)	0.51 (0.61)	<.0001
LPN h per resident d, mean (SD)	0.84 (0.45)	0.74 (0.38)	0.85 (0.31)	0.92 (0.32)	0.93 (0.30)	0.89 (0.55)	<.0001
Aide h per resident d, mean (SD)	2.31 (0.76)	2.42 (0.79)	2.22 (0.49)	2.23 (0.70)	2.13 (0.51)	2.30 (0.83)	<.0001
<b>County COVID-19 Burden</b>							
County infections excluding NH infections per 100,000 population, mean (SD)	926 (769)	615 (676)	1236 (769)	1368 (838)	1461 (641)	871 (692)	<.0001
County deaths excluding NH deaths per 100,000 population, mean (SD)	26 (43)	13 (22)	43 (59)	43 (64)	54 (65)	22 (32)	<.0001

LPN, licensed practical nurse; NH, nursing home; RN, registered nurse; SD, standard deviation.

\*Not reported denotes NHs that had <4500 NH days and no race/ethnicity information.

**Table 2** Association Between Proportion of Black Residents, Facility and County-Level Characteristics and Proportions of COVID-19 Infections and COVID-19 Deaths in US Nursing Homes\*

	Model 1: Crude			Model 2: Accounting for Facility Characteristics			Model 3: Accounting for Facility Characteristics and County COVID-19 Burden			Model 4: Accounting for Facility Characteristics and County FE			
	Coef.	SE	P	Coef.	SE	P	Coef.	SE	P	Coef.	SE	P	
<b>Infections</b>													
None	Reference			Reference			Reference			Reference			
Less than 20%	0.110	0.008	<.001	0.065	0.011	0.043	0.087	0.063	<.001	0.022	0.011	0.000	0.044
20% to 49.9%	0.108	0.007	<.001	0.081	0.011	0.059	0.102	0.068	<.001	0.028	0.011	0.006	0.050
50% or more	0.136	0.009	<.001	0.109	0.013	0.082	0.135	0.097	<.001	0.026	0.016	-0.005	0.058
Not reported	0.056	0.005	<.001	0.035	0.005	0.024	0.045	0.036	<.001	0.014	0.006	0.001	0.026
Constant	0.058	0.004	<.001	0.028	0.009	0.010	0.046	0.056	<.001	0.042	0.008	0.026	0.057
<b>Deaths</b>													
None	Reference			Reference			Reference			Reference			
Less than 20%	0.029	0.003	<.001	0.018	0.004	0.010	0.026	0.017	.014	0.001	0.004	-0.007	0.010
20% to 49.9%	0.025	0.003	<.001	0.023	0.004	0.015	0.030	0.017	.009	0.001	0.004	-0.007	0.009
50% or more	0.035	0.003	<.001	0.033	0.005	0.023	0.043	0.028	.002	0.003	0.006	-0.008	0.015
Not reported	0.015	0.002	<.001	0.011	0.002	0.007	0.015	0.012	<.001	0.003	0.003	-0.002	0.008
Constant	0.018	0.001	<.001	0.009	0.003	0.003	0.016	0.019	<.001	0.015	0.003	0.009	0.021

Coef., coefficient; CI, confidence interval; FE, fixed effects; SE, standard error.  
 \*Multivariable models (models 2-4) included bed size, urbanicity/rurality, region, occupancy rate, percent Medicaid, case mix index, nursing staffing ratios, staff shortages and lack of personal protective equipment (facility characteristics). County COVID-19 burden = proportion of county infections and deaths; County COVID-19 burden for each nursing home was measured by county-level cumulative COVID-19 infections and deaths.

Multivariable Analyses

Table 2 presents the results of the four models estimating the association between proportion of Black residents in nursing homes and nursing home infections and deaths. In models 1–3, nursing homes with any percentage of Black residents had more COVID-19 infections; the greatest COVID-19 infection prevalence was in nursing homes with ≥50% Black residents. Model 1 examines the strength of the relationship between greater proportions of Black residents and COVID-19 infections. This relationship attenuates modestly when including facility-level characteristics (model 2) and county COVID-19 burden (model 3), and it attenuates almost entirely with county-level fixed effects (model 4). For deaths, we see similar associations. Supplementary Figure 1 shows the gradient in these changes.

When stratifying by urbanicity/rurality, we found that COVID-19 infections and deaths increased with increasing proportions of Black residents in both settings (Table 3). This association was strongest in nursing homes with ≥50% Black residents in rural settings and these associations were stronger than those observed in the nonstratified models. Changes across models were similar to those reported in the nonstratified models (Supplementary Figure 2).

Findings when using the fractional response model estimating logit regressions remained similar to those obtained when using our main estimation approach (data not shown).

Discussion

In this national study, we sought to examine whether structural bias (operationalized as county-level factors) and urbanicity/rurality explained the association between proportion of Black residents in a nursing home and nursing home COVID-19 infections and deaths based on the National Institute on Aging Health Disparities Framework. Nursing homes with any proportion of Black residents had more COVID-19 infections and deaths than nursing homes with no Black residents. Although these disparities largely remained after including both facility-level characteristics and county COVID-19 burden in the models, the county in which the nursing home was located largely explained the associations. Disparities were present in both urban and rural settings but were larger in rural settings. We consider how various attributes of place, compositional and contextual, likely rooted in structural bias, might shape the care delivered by segregated nursing homes in urban and potentially more importantly, rural settings.<sup>23</sup>

The composition of individuals residing in the nursing homes were found to be related to the burden of COVID-19. These individual characteristics consisted of the percentage of Black residents in a nursing home. We found that on average, nursing homes with the greatest proportions of Black residents were more likely to be for-profit, report staffing shortages, have the highest percentage of Medicaid residents (~75%), and have the least amount of RN and aide hours per resident day. Indeed, Medicaid-dependent nursing homes are typically more financially restrained, compromising staffing and quality of care<sup>10,20,24</sup> and likely contributing to the disparities in infections and deaths that we found. Conversely, nursing homes with no Black residents had on average just 50% Medicaid residents. These nursing homes have higher revenues, operating costs, and profit margins along with better resident outcomes.<sup>25</sup>

In addition to the compositional effect of the individuals residing in the nursing home, there were overwhelming contextual county effects that may underlie COVID-19 infection and death disparities in nursing homes. Particularly, although county COVID-19 burden is important for explaining the disparities in infections and deaths, through the use of county-level fixed effects we found that other unobserved county characteristics, potentially rooted in structural bias, are more important in explaining these disparities.<sup>26</sup> For

**Table 3**  
Association Between Proportion of Black Residents, Facility and County-Level Characteristics and Proportions of COVID-19 Infections and COVID-19 Deaths in US Nursing Homes Stratified by Urban and Rural Setting\*

Prop. of Black Residents	Model 1: Crude				Model 2: Accounting for Facility Characteristics				Model 3: Accounting for Facility Characteristics and County COVID-19 Burden						
	Coef.	SE	CI	P	Coef.	SE	CI	P	Coef.	SE	CI	P			
<b>Urban</b>															
<b>Infections</b>															
None	Reference				Reference				Reference						
Less than 20%	0.089	0.010	0.070	0.108	<.001	0.063	0.013	0.038	0.088	<.001	0.043	0.012	0.019	0.067	<.001
20% to 49.9%	0.085	0.009	0.067	0.102	<.001	0.075	0.013	0.049	0.101	<.001	0.048	0.013	0.023	0.072	<.001
50% or more	0.105	0.012	0.082	0.127	<.001	0.098	0.015	0.069	0.127	<.001	0.064	0.016	0.033	0.095	<.001
Not reported	0.047	0.007	0.033	0.060	<.001	0.039	0.007	0.025	0.053	<.001	0.030	0.007	0.016	0.044	<.001
Constant	0.088	0.006	0.077	0.100	<.001	0.004	0.013	-0.020	0.029	.731	0.016	0.012	-0.008	0.041	.184
<b>Deaths</b>															
None	Reference				Reference				Reference						
Less than 20%	0.022	0.004	0.015	0.029	<.001	0.018	0.005	0.009	0.027	<.001	0.011	0.004	0.002	0.020	.015
20% to 49.9%	0.017	0.003	0.011	0.024	<.001	0.022	0.005	0.013	0.031	<.001	0.012	0.005	0.003	0.021	.01
50% or more	0.022	0.004	0.014	0.031	<.001	0.028	0.006	0.017	0.039	<.001	0.015	0.006	0.004	0.027	.008
Not reported	0.012	0.003	0.006	0.017	<.001	0.013	0.003	0.008	0.018	<.001	0.010	0.003	0.004	0.015	<.001
Constant	0.029	0.002	0.024	0.033	<.001	0.006	0.005	-0.003	0.015	.214	0.010	0.005	0.001	0.019	.031
<b>Rural</b>															
<b>Infections</b>															
None	Reference				Reference				Reference						
Less than 20%	0.053	0.018	0.018	0.088	.003	0.038	0.024	-0.009	0.086	.113	0.022	0.023	-0.023	0.068	.336
20% to 49.9%	0.107	0.011	0.086	0.128	<.001	0.087	0.018	0.052	0.121	<.001	0.048	0.018	0.012	0.083	.009
50% or more	0.171	0.017	0.138	0.205	<.001	0.152	0.034	0.085	0.219	<.001	0.091	0.033	0.026	0.156	.006
Not reported	0.025	0.006	0.013	0.037	<.001	0.016	0.007	0.002	0.030	.025	0.010	0.007	-0.004	0.023	.154
Constant	0.029	0.004	0.022	0.037	<.001	0.019	0.008	0.004	0.034	.015	0.051	0.009	0.033	0.070	<.001
<b>Deaths</b>															
None	Reference				Reference				Reference						
Less than 20%	0.007	0.006	-0.006	0.020	.271	0.004	0.005	-0.005	0.013	.334	-0.001	0.005	-0.010	0.008	.861
20% to 49.9%	0.022	0.004	0.015	0.030	<.001	0.018	0.006	0.007	0.030	.002	0.006	0.006	-0.006	0.018	.322
50% or more	0.058	0.006	0.046	0.070	<.001	0.054	0.015	0.024	0.084	<.001	0.037	0.016	0.006	0.068	.019
Not reported	0.005	0.002	0.001	0.009	.026	0.002	0.003	-0.002	0.007	.324	0.001	0.002	-0.004	0.005	.827
Constant	0.008	0.001	0.006	0.011	<.001	0.004	0.002	0.000	0.009	.039	0.013	0.003	0.008	0.018	<.001

Coef., coefficient; CI, confidence interval; FE, fixed effects; SE, standard error.

\*Multivariable models (models 2–4) included bed size, urbanicity/rurality, region, occupancy rate, percent Medicaid, case mix index, nursing staffing ratios, staff shortages and lack of personal protective equipment (facility characteristics). County COVID-19 burden = proportion of county infections and deaths; County COVID-19 burden for each nursing home was measured by county-level cumulative COVID-19 infections and deaths.

example, counties with greater proportions of Black citizens may experience scarcity of resources and service availability (eg, transportation, health services), mistrust in the healthcare system among community members, and low socioeconomic indicators (eg, education, income).<sup>27</sup> Moreover, resources are provided to communities in the context of a history of racial bias in which communities with higher proportions of Black members generally receive fewer resources.<sup>28</sup> These county-level consequences are unfolding during the pandemic in the form of greater excess deaths unattributed to COVID-19 in counties with high income inequality, low homeownership, and high percentages of Black individuals.<sup>29</sup> Disproportionate excess deaths in segregated counties could translate to fewer workers available to perform services necessary for nursing home operations.

Urban/rural disparities remain an understudied area, especially for nursing homes.<sup>30</sup> Our findings confirm that disparities in COVID-19 infections and deaths are stronger in the presence of both rurality and higher proportion of Black residents than in the presence of either of these characteristics alone. This could be because residents in rural nursing homes tend to have poorer overall health and more chronic conditions than urban nursing homes.<sup>31</sup> Previous investigators have reported that rural nursing homes are associated with lower quality of care and higher likelihood of staffing shortages, Medicaid residents, and in-hospital deaths.<sup>32,33</sup> Moreover, differences between urban and rural nursing homes, such as differing organizational structures (eg, ownership) and funding sources (eg, Medicaid-dependency), have accounted for 10%–22% of disparities in quality of care between rural

nursing homes and urban nursing homes.<sup>34</sup> Rural racial/ethnic minorities have been described as a “forgotten population,” and attention during the COVID-19 pandemic has been focused on urban settings. Thus, our findings highlight the critical need for attention to rural nursing homes as well.<sup>35</sup>

Despite its strengths in examining the structural bias associated with COVID-19 infections and deaths in nursing homes with high proportions of Black residents, there are several limitations in our data and analyses. In terms of data limitations, the CDC data have gaps in reporting by some nursing homes and inconsistencies in how data were reported before May 2020.<sup>36</sup> In addition, the availability and use of testing may affect the number of true COVID-19 infections and deaths nursing homes report. Because nursing homes with greater proportions of Black residents have fewer resources and, in this case, poorer access to testing for COVID-19, it is likely that the disparities reported in this study are underestimated. These data may change as more rural settings are experiencing increases in infections. Moreover, it is expected that these data will stabilize as nursing homes become more familiar with submitting data and testing becomes more widespread. Despite limitations, these data point to a need for national surveillance of COVID-19 infections and deaths among the most vulnerable populations.

In terms of analytic limitations, we excluded all nursing homes that did not pass CMS’s quality assurance checks, but it is possible that this exclusion may have limited our sample to better performing nursing homes. In addition, we calculated the proportion of infections and

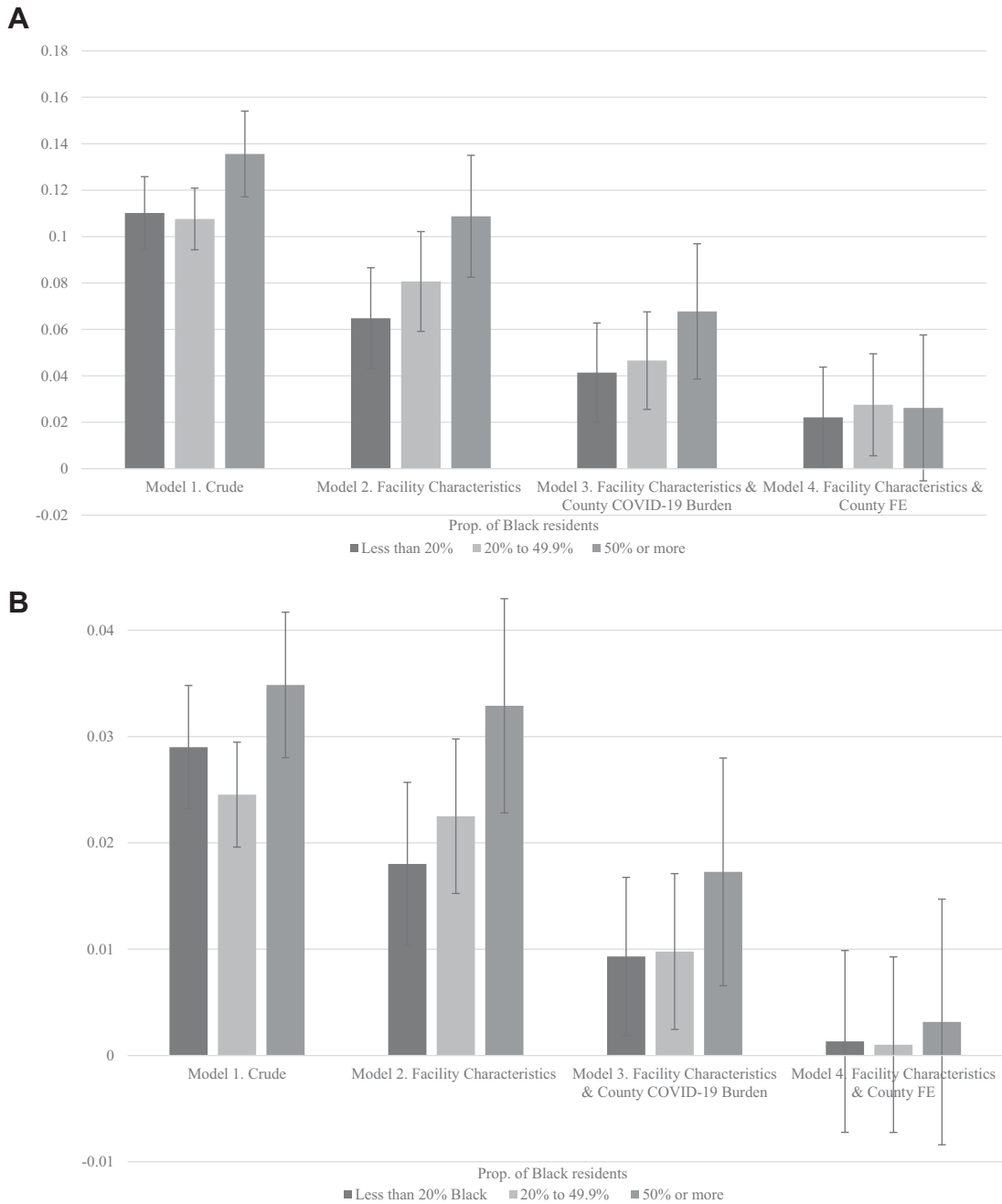
deaths per occupied bed, but occupation rates may have been affected broadly by the pandemic and specifically by infections and deaths in nursing homes. We were also unable to build a model 4 in our stratified analysis. The reason for this is we could not account for county fixed effects in these analyses because of the limited number of nursing homes in a rural county. In regard to our sample, 40% of the nursing homes were missing information on their proportion of Black residents and thereby classified as not reported. A sensitivity analysis that excluded these nursing homes and estimated the models again revealed similar results (data not shown). Although we were able to situate the disparities in COVID-19 infections and deaths within potential structural bias in counties, it is important to note that our access to COVID-19 data were limited to the county level, and county-level analyses lack specificity when drawing conclusions about racial disparities. Future research should consider these issues in more depth when census block data become available. Finally, we examined differences in COVID-19 infections and deaths across nursing homes by proportions of Black residents, but future studies should consider whether these differences exist within nursing homes.

## Conclusions and Implications

As disparities in COVID-19 infections and deaths among nursing homes with higher proportions of Black residents are potentially rooted in long-standing issues related to structural bias within counties, it is important that we dismantle the bias and discriminatory structures that continue to fuel these disparities. Some suggestions based on prior research are as follows: Invest in Black communities where these nursing homes are located. Investment is needed in infrastructure, social services, healthcare, education, housing, and neighborhoods.<sup>30,37</sup> In addition, increase Medicaid reimbursement to nursing homes and ensure monies are allocated toward resident care and increase the availability of qualified medical and non-medical staff, especially in rural settings.<sup>38</sup> In a recent article by Li et al,<sup>19</sup> the authors suggest structural problems as a cause of the disparities found in nursing homes. Our findings bring us closer to understanding the relationship between county, urbanicity/rurality, and disparities in nursing homes, along with likely roots in structural bias. It is imperative that support is provided to nursing homes serving greater proportions of Black residents while considering the rurality of the nursing home setting.

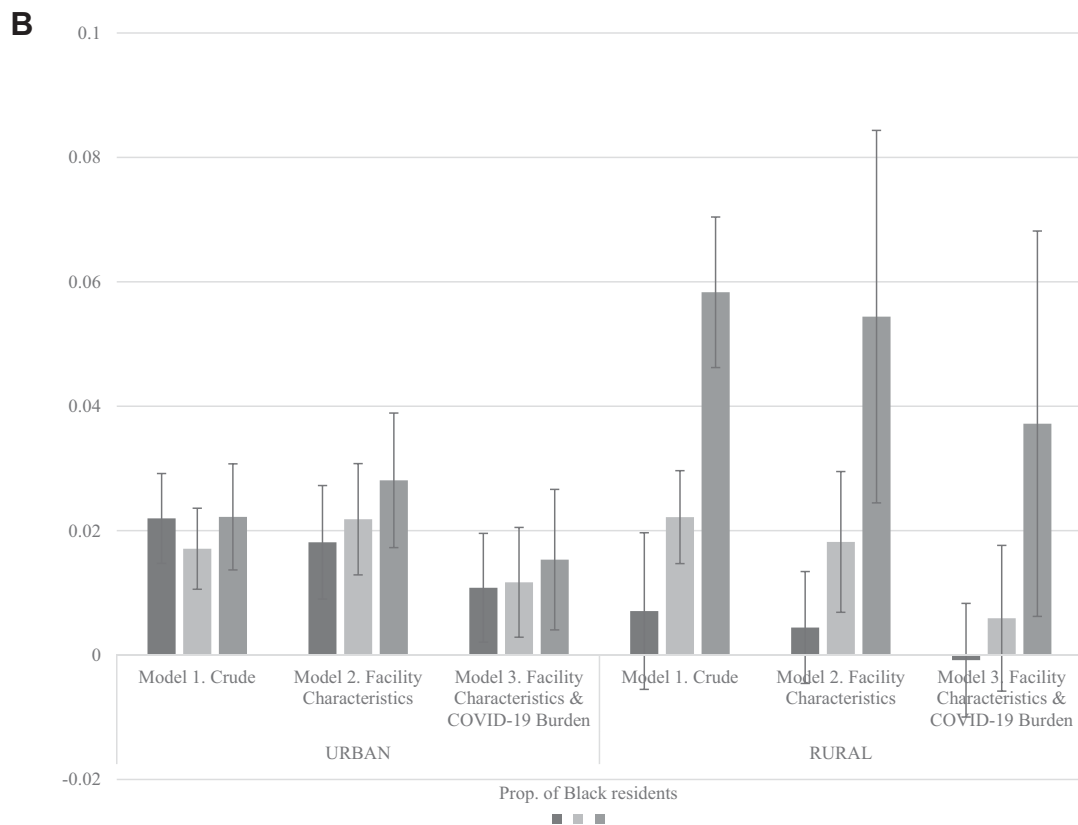
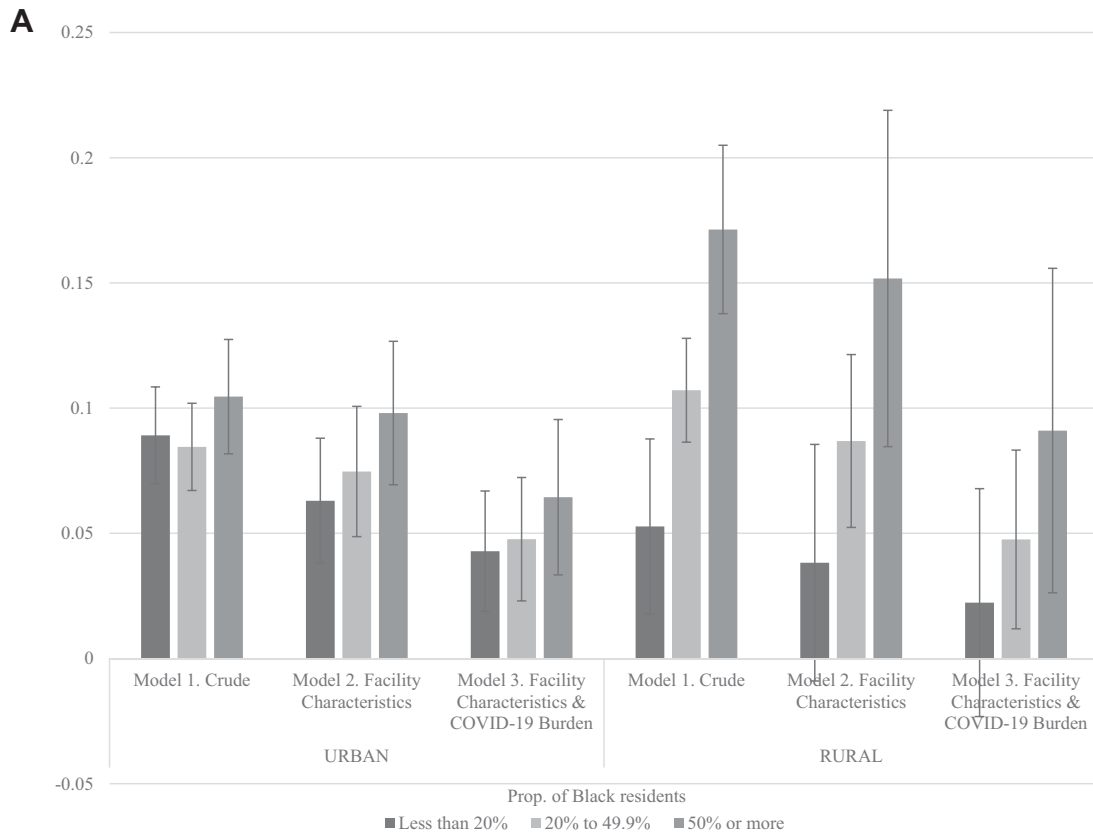
## References

- Feng Z, Fennell ML, Tyler DA, et al. Growth of racial and ethnic minorities in US nursing homes driven by demographics and possible disparities in options. *Health Affairs* 2011;30:1358–1365.
- Fashaw SA, Thomas KS, McCreedy E, Mor V. Thirty-year trends in nursing home composition and quality since the passage of the Omnibus Reconciliation Act. *J Am Med Dir Assoc* 2020;21:233–239.
- Travers JL, Dick AW, Stone PW. Racial/ethnic differences in receipt of influenza and pneumococcal vaccination among long-stay nursing home residents. *Health Services Res* 2018;53:2203–2226.
- Li Y, Yin J, Cai X, et al. Association of race and sites of care with pressure ulcers in high-risk nursing home residents. *JAMA* 2011;306:179–186.
- Konetzka RT, Werner RM. Disparities in long-term care: Building equity into market-based reforms. *Med Care Res Rev* 2009;66:491–521.
- Travers JL, Schroeder KL, Blaylock TE, Stone PW. Racial/ethnic disparities in influenza and pneumococcal vaccinations among nursing home residents: A systematic review. *Gerontologist* 2018;58:e205–e217.
- The New York Times. More than 40% of US Coronavirus deaths are linked to nursing homes. *New York Times* 2020;2020. Available at: <https://www.nytimes.com/interactive/2020/us/coronavirus-nursing-homes.html>. Accessed March 26, 2021.
- Abrams HR, Loomer L, Gandhi A, Grabowski DC. Characteristics of US nursing homes with COVID-19 cases. *J Am Geriatr Soc* 2020;68:1653–1656.
- He M, Li Y, Fang F. Is there a link between nursing home reported quality and COVID-19 cases? Evidence from California skilled nursing facilities. *J Am Med Dir Assoc* 2020;21:905–908.
- Li Y, Temkin-Greener H, Gao S, Cai X. COVID-19 infections and deaths among Connecticut nursing home residents: Facility correlates. *J Am Geriatr Soc* 2020;68:1899–1906.
- Gebeloff R, Ivory D, Richtel M, et al. Striking racial divide: How COVID-19 has hit nursing homes. *New York Times*; 2020.
- Hill CV, Pérez-Stable EJ, Anderson NA, Bernard MA. The National Institute on Aging health disparities research framework. *Ethnicity Dis* 2015;25:245.
- Powell JA. Structural racism: Building upon the insights of John Calmore. *NCL Rev* 2007;86:791.
- Brown University School of Public Health. LTCfocus: Long-term care: Facts on care in the US Brown University School of Public Health. Available at: <http://ltafocus.org>. Published n.d. Accessed June 25, 2020.
- National Healthcare Safety Network of the Centers for Disease Control and Prevention. LTCF COVID-19 Module. Available at: <https://www.cdc.gov/nhsn/ltafocus/2019/index.html>. Published n.d. Accessed June 25, 2020.
- Vandenbroucke JP, Von Elm E, Altman DG, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): Explanation and elaboration. *PLoS Med* 2007;4:e297.
- Saliba D, Jones M, Streim J, et al. Overview of significant changes in the Minimum Data Set for nursing homes version 3.0. *J Am Med Dir Assoc* 2012;13:595–601.
- Bardenheier B, Wortley P, Ahmed F, et al. Racial inequities in receipt of influenza vaccination among long-term care residents within and between facilities in Michigan. *Med Care* 2011;49:371–377.
- Li Y, Cen X, Cai X, Temkin-Greener H. Racial and ethnic disparities in COVID-19 infections and deaths across US nursing homes. *J Am Geriatr Soc* 2020;68:2454–2461.
- McGarry BE, Grabowski DC, Barnett ML. Severe staffing and personal protective equipment shortages faced by nursing homes during the COVID-19 pandemic: Study examines staffing and personal protective equipment shortages faced by nursing homes during the COVID-19 pandemic. *Health Aff (Millwood)* 2020;39:1812–1821.
- Papke LE, Wooldridge JM. Econometric methods for fractional response variables with an application to 401 (k) plan participation rates. *J Appl Econometr* 1996;11:619–632.
- Papke LE, Wooldridge JM. Panel data methods for fractional response variables with an application to test pass rates. *J Econometr* 2008;145:121–133.
- Collins J, Ward BM, Snow P, et al. Compositional, contextual, and collective community factors in mental health and well-being in Australian rural communities. *Qual Health Res* 2017;27:677–687.
- Mor V, Zinn J, Angelelli J, et al. Driven to tiers: Socioeconomic and racial disparities in the quality of nursing home care. *Milbank Q* 2004;82:227–256.
- Chisholm L, Weech-Maldonado R, Laberge A, et al. Nursing home quality and financial performance: Does the racial composition of residents matter? *Health Serv Res* 2013;48:2060–2080.
- Weaver C, Mathews A, Kamp J. Covid-19 cases jump in sunbelt nursing homes. *Wall Street Journal*; 2020. Available at: <https://www.wsj.com/articles/covid-19-cases-jump-in-sun-belt-nursing-homes-11594468980>. Accessed March 26, 2021.
- Macintyre S, Maciver S, Sooman A. Area, class and health: Should we be focusing on places or people? *J Soc Policy* 1993;22:213–234.
- Assari S. Unequal gain of equal resources across racial groups. *Int J Health Policy Manage* 2018;7:1.
- Stokes AC, Lundberg DJ, Hempstead K, et al. Assessing the Impact of the Covid-19 pandemic on US mortality: A county-level analysis. Preprint. Posted online September 2, 2020. *MedRxiv*. <https://doi.org/10.1101/2020.08.31.20184036>.
- Kang Y, Meng H, Miller NA. Rurality and nursing home quality: Evidence from the 2004 National Nursing Home Survey. *Gerontologist* 2011;51:761–773.
- Agency for Healthcare Research and Quality. National Healthcare Disparities Report, 2009. Agency for Healthcare Research and Quality: Rockville, MD; 2010.
- Lutfiyya MN, Gessert CE, Lipsky MS. Nursing home quality: A comparative analysis using CMS Nursing Home Compare data to examine differences between rural and nonrural facilities. *J Am Med Dir Assoc* 2013;14:593–598.
- Temkin-Greener H, Zheng NT, Mukamel DB. Rural–urban differences in end-of-life nursing home care: Facility and environmental factors. *Gerontologist* 2012;52:335–344.
- Bowblis JR, Meng H, Hyer K. The urban-rural disparity in nursing home quality indicators: The case of facility-acquired contractures. *Health Serv Res* 2013;48:47–69.
- Probst JC, Moore CG, Glover SH, Samuels ME. Person and place: The compounding effects of race/ethnicity and rurality on health. *Am J Public Health* 2004;94:1695–1703.
- Data.CMS.gov. COVID-19 nursing home dataset. Centers for Medicare and Medicaid Services. Available at: <https://data.cms.gov/Special-Programs-Initiatives-COVID-19-Nursing-Home/COVID-19-Nursing-Home-Dataset/s2uc-8wpx>. Published 2020. Accessed August 1, 2020.
- Jenkins D. What does it really mean to invest in Black communities? *The Nation*; 2020.
- Vann A. Reducing COVID deaths in assisted living residences and nursing homes. *Ann Long-Term Care*; 2020. Available at: <https://www.thenation.com/article/society/invest-divest-police/>. Accessed March 26, 2021.



**Supplementary Fig. 1.** (A) COVID-19 infections by proportions of black residents in a nursing home, relative to none (95% CI reported). All coefficients expressed relative to the reference group (ie, No black residents in a nursing home). Models 2, 3, and 4 are clustered on county and include: bed size, urbanicity/rurality, region, occupancy rate, percent Medicaid, case mix index, nursing staffing ratios, staff shortages and lack of personal protective equipment (facility characteristics). Model 3 includes County COVID-19 burden which = proportion of county infections and deaths; County COVID-19 burden was measured by county-level cumulative COVID-19 infections and deaths. Model 4 includes county fixed effects (FE). (B) COVID-19 deaths by proportions of black residents in a nursing home, relative to none (95% CI reported). All coefficients expressed relative to the reference group (ie, No black residents in a nursing home). Models 2, 3, and 4 are clustered on county and include: bed size, urbanicity/rurality, region, occupancy rate, percent Medicaid, case mix index, nursing staffing ratios, staff shortages and lack of personal protective equipment (facility characteristics). Model 3 includes County COVID-19 burden which = proportion of county infections and deaths; County COVID-19 burden was measured by county-level cumulative COVID-19 infections and deaths. Model 4 includes county fixed effects (FE).





**Supplementary Fig. 2.** (A) COVID-19 infections by proportions of Black residents in a nursing home, relative to none by urban/rural (95% CI reported). All coefficients expressed relative to the reference group (ie, No black residents in a nursing home). Models 2 and 3 are clustered on county and include bed size, urbanicity/rurality, region, occupancy rate, percent Medicaid, case mix index, nursing staffing ratios, staff shortages and lack of personal protective equipment (facility characteristics). Model 3 additionally includes County COVID-19 burden which = proportion of county infections and deaths; County COVID-19 burden was measured by county-level cumulative COVID-19 infections and deaths. (B) COVID-19 deaths by proportions of Black residents in a nursing home, relative to none by urban/rural (95% CI reported). All coefficients expressed relative to the reference group (ie, No black residents in a nursing home). Models 2 and 3 are clustered on county and include bed size, urbanicity/rurality, region, occupancy rate, percent Medicaid, case mix index, nursing staffing ratios, staff shortages and lack of personal protective equipment (facility characteristics). Model 3 additionally includes County COVID-19 burden which = proportion of county infections and deaths; County COVID-19 burden was measured by county-level cumulative COVID-19 infections and deaths.