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Larger Nursing Home Staff Size Linked To Higher Number Of COVID-19 Cases In 2020

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Abstract

Staff in skilled nursing facilities (SNFs) are essential health care workers, yet they can also be a source of COVID-19 transmission. We used detailed staffing data to examine the relationship between a novel measure of staff size (i.e., number of unique employees working daily), conventional measures of staffing quality, and COVID-19 outcomes among SNFs without confirmed COVID-19 cases by June 2020. By the end of September 2020, sample SNFs in the lowest quartile of staff size had 6.2 resident cases and 0.9 deaths per 100 beds compared to 11.9 resident cases and 2.1 deaths per 100 beds among facilities in the highest quartile. Staff size, including staff not involved in resident care, was strongly associated with SNFs' COVID-19 outcomes, even after accounting for facility size. Conventional staffing quality measures, including direct care staff to resident ratios and skill mix, were not significant predictors of COVID-19 cases or deaths. Reducing the number of unique staff members without decreasing direct-care hours, such as by relying on full-time rather than part-time staff, could help prevent outbreaks.

Nursing homes have suffered greatly during the COVID-19 pandemic.(1) Although less than 1% of US population lives in long-term care facilities, roughly 5% of cases and nearly 32% of fatalities have been in these facilities.(2) Because nursing homes, also known as skilled nursing facilities (SNFs), have spent much of 2020 closed to visitors, the primary way in which COVID-19 enters a nursing home is through staff.(3–5) Especially given widespread shortages of personal protective equipment and poor availability of rapid testing for SNF staff,(6, 7) if COVID-19 is in the community where staff live, it is soon to be in the nursing home where they work.

Multiple studies have found that higher direct care staffing levels per resident are associated with more limited COVID-19 outbreaks among residents in a facility.(8, 9) Other evidence has added nuance to these findings, suggesting that the relationship between SNF staffing

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and COVID-19 spread is more complex. For instance, one study found that facilities with more staff were more likely to have a COVID-19 case, but conditional on having a case, SNFs with higher staffing levels were less likely to have a major outbreak than those with fewer staff.(4) The mechanisms behind these results remain unclear.

An important limitation of the literature on the relationship between direct-care staffing and outbreaks is that studies largely used the traditional lens that hours of staffing care per resident-day reflects quality of care and thus a facility's potential for infection control. However, this traditional lens does not account for staff as an important mechanism by which COVID-19 enters a facility. There are many places a SNF's staff members can acquire infections outside the facility, such as their household, community, or even other SNFs where they work.(10) Therefore, each additional staff member, even those not providing direct care, has the potential to asymptomatically introduce COVID-19 to the facility. Correspondingly, the number of unique staff members entering the facility each day may be a crucial determinant of the frequency and size of COVID-19 outbreaks at SNFs. For example, holding all else constant, we would expect a facility with many part-time staff to be at higher risk than a facility providing a similar amount of care using only full-time staff because the former would be using more unique staff members.

We examined how the number of unique staff members might influence the likelihood of COVID-19 cases and deaths in SNFs, the first such study to our knowledge. We hypothesized that the number of unique staff members entering a facility daily will be predictive of COVID-19 cases in SNFs beyond other measures of staffing.

Methods

Study Design and Data Sources

We conducted a retrospective cohort study examining nursing homes from June 1, 2020 to September 27, 2020 to understand the association between facilities' staff size (i.e., unique number of employees working in a nursing home on a given day) and COVID-19 outcomes.

We obtained information on COVID-19 outcomes from the Centers for Medicare and Medicaid Services (CMS) COVID-19 Nursing Home Data database.(11) These publicly available data provide weekly information submitted by SNFs, including COVID-19 cases and deaths among residents and staff. We computed measures of unique employee counts (i.e., staff size) at each facility from daily employee-level records submitted by SNFs as part of CMS's payroll-based journal (PBJ) electronic staffing reporting system in quarter 4 of 2019, the most recent quarter of data available at the time of this study.(12, 13) All CMS-certified SNFs are required to submit daily staffing information on a quarterly basis, including the number of hours worked by each employee, based on payroll or other verifiable and auditable data. The PBJ encompasses a wide variety of nursing home staff types, including clinical (e.g., nurses, nursing assistants), administrative, and other (e.g., social workers, housekeeping) staff, and includes full-time employees, part-time employees, and contract workers.

We obtained county-level measures of weekly community COVID-19 case rates from the New York Times COVID-19 database.(14) We also obtained information on facilities' characteristics and quality from the 2017 Certification and Survey Provider Enhancement Reports (CASPER) system and 2017 Minimum Data Set (MDS) assessments, both through the National Institute on Aging-funded LTCFocus.org website.(15) Additional information was obtained from the 2020 Nursing Home Compare Provider Information dataset.(16)

Study Sample

The primary study sample comprised CMS-certified SNFs that had not yet experienced a COVID-19 case among its residents as of the week ending June 7, 2020. This restriction excludes facilities that were directly impacted by the initial COVID-19 outbreak that occurred during the spring of 2020. We imposed this restriction because the CMS COVID-19 Nursing Home data were not collected prior to mid-May of 2020. We examined outcomes from the week ending June 7, 2020 to the week ending September 27, 2020 and excluded facilities missing data in any of these weeks. We ended our sample in September in order to exclude cases related to the widespread national surge in COVID-19 cases that began in October as our staffing measure (captured during the fourth quarter of 2019) may be less associated with actual staffing patterns experienced during later phases of the pandemic.

Main Exposure: Total Staff Size

We used daily individual-level PBJ data to construct a measure of the number of employees, both clinical (e.g. nurses) and non-clinical (e.g. housekeeping), entering and leaving each facility each day. For each facility, we compute the average number of unique employees at that facility each day in quarter 4 of 2019, the latest quarter of data available before CMS temporarily suspended the PBJ submission requirement during the pandemic. Importantly, these represent facilities' typical staff sizes and do not reflect changes due to outbreaks. We categorize facilities into quartiles of staff size based on the distribution of this measure in the full sample of 15,071 SNFs and then apply these categories to the study sample of SNFs (which results in a non-uniform distribution of sample SNFs across quartiles).

Outcomes

Our main outcomes were weekly counts of confirmed COVID-19 cases among SNF residents and staff, as well as weekly COVID-19 deaths among residents. All three outcomes were expressed as a rate per 100 beds within the facility to account for exposure risk related to facility size. In addition to weekly rates of new cases and deaths, we also examined cumulative outcomes rates (e.g. total cases from June 1-September 27, 2020) per SNF at the end of the study window.

Facility Characteristics

From the CASPER and MDS data, we ascertained the percent of SNF residents who were Medicaid-eligible (categorized into quartiles among all nursing homes), the percent of residents who were non-white race (categorized into quartiles), and whether the facility was part of a chain. From the Nursing Home Compare data, we obtained measures of facility

size (operationalized as deciles of bed count), profit-status, and CMS's overall 5-star quality score.

Other Staffing Measures

We also included a number of alternate metrics of SNF staffing beyond our main exposure measure. First, using PBJ data we calculated the number of hours of direct care provided per resident per day by summing the number of hours of nurse (registered and licensed) and nursing assistant hours and then dividing by the facility's daily census. Second, we measured staffing skill mix by calculating the share of total direct care hours per resident day provided by licensed and registered nurses. Daily values were averaged within the quarter and both measures were categorized into quartiles across the national sample of SNFs.

Additionally, we constructed two measures to characterize SNFs' use of contracted therapy and direct care staff (i.e., staff working under contract or provided through another agency). We calculated the proportion of total therapy hours within a quarter provided by contracted therapy staff (categorized as 0%-10% and >10% of hours) and the proportion of total direct care hours within a quarter provided by contracted staff (categorized as <1%; 1-10%; 10.1-50%; and >50% of hours). Finally, we constructed measures of direct care staff turnover, measured as the percent of direct care hours in the fourth quarter of 2019 that were provided by staff employed by the facility in quarters 1-3, and of direct care staff experience, measured as median tenure in quarters of direct care staff members within a facility categorized in quartiles (see Appendix Section 1 for details).(17)

Statistical Analysis

We expected our main exposure variable, staff size, to be correlated with facility size, because larger facilities will naturally need more staff. To examine variation in staff size across facilities with similar numbers of beds, we plotted the distribution of staff size across 10 deciles SNFs by bed count. We modeled the association between staff size and weekly COVID-19 outcomes using SNF-week level linear regressions that included an interaction between staff size quartiles and indicators for each week in our study window, facility controls, county rates of new COVID-19 cases weekly, and county fixed effects. See Appendix Exhibit A1 for a list of facility controls. (17) Models also included indicators for bed count deciles to control for the role of facility size in outbreaks. All together, these regression models estimate the relationship between COVID-19 outcomes and staff size using only variation within each decile of similarly sized facilities.

We plotted weekly adjusted outcome rates obtained from these regressions stratified by quartiles of staff size. The association between staff size and cumulative outcomes at the end of September were estimated using SNF-level linear models that included county fixed effects and facility controls. Adjusted cumulative rates by staff size quartiles were plotted alongside adjusted cumulative rates by direct care hours per resident day quartiles and quartiles of skill mix to facilitate comparisons of the relative influence of these facility characteristics on outcomes compared to our main exposure.

In supplemental analyses, we used similar regression models to examine the association between unique employees in particular staff roles and cumulative COVID-19 outcomes. Specifically, we examined counts of unique employees who were direct care staff, therapy staff (e.g. physical, occupational, or speech therapy), and other staff (i.e., social workers, housekeeping, administrators). Additionally, we examined associations between quartiles of full-time (i.e., working at least 35 hours per week on average) and part-time (i.e., less than 35 hours worked per week on average) staff sizes and COVID-19 outcomes.

We assessed the robustness of our results through a series of sensitivity analyses. To ensure that staff size did not simply reflect variation in facility size, we repeated our cumulative outcome analyses after excluding the smallest (60 or fewer beds) and largest (140 or more beds) facilities from the sample. We also estimated models using an alternate measure of staff size normalized to facility size (staff size per bed). Furthermore, we tested the sensitivity of our results to the categorization of the staff size measure by using alternate cut-points of quartiles within the study sample. Finally, we tested the sensitivity of our results to our sample inclusion criterion by repeating our analyses after including SNFs that had resident COVID-19 cases prior to the first week of June.(17)

Limitations

Due to data limitations, our measure of staff size does not capture actual counts of unique employees during the COVID-19 pandemic and may therefore not fully reflect nursing home traffic patterns during this time period. However, our measure is well-suited to describing baseline differences between facilities in the number of unique employees that work there on an average day. Furthermore, this measure is not subject to bias that could result from changes to staffing patterns that are caused by COVID-19 outbreak in a facility (i.e., outbreaks cause staff shortages or lead to the use of more part-time staff). Due to data limitations, we are also unable to account for other factors that could be related to both staff size and COVID-19 outcomes, including the extent to which employees work in more than one nursing home. Also, this study estimates the association between staff size and COVID-19 outcomes in SNFs but is not able to account for all sources of potential confounding bias from unobserved differences across SNFs by staff size. Therefore, these results should not be interpreted as causal estimates.

Results

Our primary analytic sample of facilities without resident cases by the end of the first week in June included 7,154 SNFs, or 49.6% of the 14,425 SNFs without missing data in any of the weeks of our study window. For details, see Exhibit 1 and Appendix Exhibit A1.(17) There was wide variation in the average number of unique employees within a facility each day. In the lowest staff size quartile, facilities had on average 27 employees, while facilities in the highest quartile had on average 101 employees per day. Staff size had a clear relationship with facility size. For instance, 85% of facilities in the highest staff size quartile had more than 100 beds compared with just 8.3% of facilities in the lowest quartile. However, there was considerable variation in the number of unique employees even when looking within facilities of similar size (Exhibit 2). There was overlap in the

distribution of average staff size across all 10 categories of bed count, but this overlap was most pronounced within the 3rd through 8th deciles of bed count. This variation shows that staff size is not purely a function of the bed count of the facility.

Adjusting for facility size, direct care staffing patterns, other facility characteristics, community COVID-19 rates, and the geographic location of facilities, we found that SNFs in different quartiles of staff size had diverging trends in resident COVID-19 cases over the course of the study window (Exhibit 3). By the end of July 2020, there was a clear gradient in resident cases by quartiles of staff size, with facilities in the highest quartile having the highest case rates. Similar trends were noted in staff COVID-19 cases and resident COVID-19 deaths, as shown in Appendix Exhibit A2.(17) The associations between facility size and outcome trends were substantively similar without adjustment for facility and geographic factors, as shown in Appendix Exhibit A3.(17)

These trends were reflected in regression analyses examining cumulative outcomes at the end of the study window. Facilities in the fourth quartile of staff size experienced 11.9 resident cases per 100 beds (95% Confidence Interval [CI]: 10.1, 13.6) compared with 6.2 cases among facilities in the first quartile (95% CI: 5.2, 7.2), or 92% more cases. (Exhibit 4) Similarly, facilities in the fourth quartile were estimated to have 11.8 staff cases per 100 beds (95% CI: 10.6, 13.1) by the end of the study window in comparison to 7.0 staff cases per 100 beds (95% CI: 6.2, 7.8) among first quartile facilities, as shown in Appendix Exhibit A4, Panel A. This translates to 69% more staff cases in the fourth than in the first quartile of staff size .(17) Resident deaths were also significantly higher among high staff size facilities: facilities in the fourth quartile had 2.1 resident deaths per 100 beds (95% CI: 1.7, 2.5) compared to 0.9 deaths per 100 beds (95% CI: 0.7, 1.2), 133% higher. See Appendix Exhibit A4, Panel B for details.(17) There were no significant differences at the 95% confidence level for any of the three outcomes across quartiles of direct care staffing levels (relative to the lowest quartile) or the share of direct care hours provided by nurses. See Exhibit 4 and Appendix Exhibits A4 and A5.(17)

Supplemental analyses indicated that numbers of direct care employees and other employees, but not therapy employees, were associated with COVID-19 cases and deaths. Direct care staff sizes were more strongly associated with case rates in comparison to other staff, as shown in Appendix Exhibit A6.(17) Supplemental analyses also indicated that our main results are driven by both full- and part-time staff, with effect sizes being larger among full-time staff in comparison to part-time.See Appendix Exhibit A7.(17)

Results for the main analyses were similar when restricting the sample to facilities with between 61 and 139 beds, expanding the sample to include facilities that had resident cases prior to June, measuring exposure as the number of employees per bed, and using alternate categories to define high- and low-staff size facilities. These findings are shown in Appendix Exhibit A8.(17)

Discussion

The average number of unique individuals working in a facility on a given day was strongly associated with nursing homes' COVID-19 outcomes after controlling for several other measures of SNF staffing. By the end of September 2020, nursing homes with the largest number of unique employees had cumulative resident case rates that were 92% higher than that of facilities with the fewest employees. Likewise, facilities with the most unique staff had cumulative staff case rates and resident death rates that were 69% and 133% higher than facilities with the fewest unique staff members. These results are especially noteworthy because after controlling for staff size, there was no clear relationship between COVID-19 outcomes and more traditional measures of staffing: direct care staff hours to resident ratios or the skill mix of direct care hours. Our findings are robust to multiple sensitivity analyses that used alternate approaches to account for facility size and alternate cut points in the main exposure variable.

More staff predisposing SNFs to more COVID-19 cases conforms to expectations from basic principles of epidemiology. In the absence of a robust and rapid testing system to prevent asymptomatic COVID-19 infected staff from coming to work, increases in the number of unique individuals entering a nursing home increase the probability of SNF residents being exposed to the virus and subsequent outbreaks. The large effects noted among full-time staff suggest that these effects are not primarily due to part-time staff who work in more than one nursing home.(10) The absence of significant effects for therapy staff may reflect changes in actual therapy staffing levels during the pandemic. Because new admissions for short-stay rehabilitative residents who typically require the most therapy were substantially reduced early in the pandemic,(18) therapist staffing levels may have similarly been curtailed. Importantly, however, we do observe a significant relationship between numbers of non-clinical staff and COVID-19 outcomes. The number of unique non-clinical staff likely influences COVID-19 rates because staff from all disciplines share the same spaces and work together, highlighting the importance of vaccinating all SNF staff regardless of their proximity to residents.

The results of this study suggest that overall staff size is a more important predictor of COVID-19 outcomes than direct care staff to resident ratios and skill mix. Although these aspects of staffing may influence infection control in SNFs, our results suggest that any protective effect from these factors is small compared to the additional exposure risk created by a larger staff. This is more than a technical difference; staff interventions to prevent COVID-19 outbreaks could vary tremendously depending on which measure is most influential.

Our findings do not imply nursing homes should have lower staffing ratios per resident. Many SNFs are barely able to meet their staffing needs. Roughly one-in-five nursing homes reported severe staffing shortage during the pandemic over the summer of 2020 with little improvement over time.(6) Also, a large literature supports the importance of nursing home staff towards encouraging good care outcomes.(19–21)

Rather, our findings suggest that holding fixed hours of direct care, nursing homes that can provide those staff hours with fewer unique staff members will be better able to protect their residents from COVID-19. It is important to note that nursing homes are under a great deal of clinical and financial stress and may not be able to quickly make large-scale reductions to their overall staff size. Yet, several responses may be available to marginally reduce staff sizes. For example, limiting the use of part-time staff could provide a similar amount of labor with fewer unique individuals and may reduce the number of staff who work in more than one facility. Careful consideration should be given, however, to direct care workers' preferences for part time work,(22) as well as the need for adequate social supports, including affordable child care, to make full-time employment feasible for nursing home staff.(23) Shifting non-essential employees, even those who do not come in close contact with residents, to remote work is another temporary approach to reducing the traffic of staff members in nursing facilities.

Beyond informing policy responses to COVID-19, our results suggest that smaller staff sizes my help limit the spread of other infectious diseases, including the seasonal flu. Policy reforms that support meeting staff-to-resident ratios with fewer unique individuals could help improve patient safety and improve nursing homes' preparedness for future pandemics. For example, policy makers could support the expansion of the small-home or Green House model, wherein around 8-12 residents reside in a home-like setting with smaller and more consistent staffing assignments. These models have been associated with better COVID-19 outcomes, in addition to better quality outcomes.(24–26) Better financial support for nursing homes, likely through higher Medicaid reimbursement rates, could also promote the increased use of full-time staff. Such a shift in staffing patterns would likely reduce infectious disease outbreak risk and may improve the quality of resident care by reducing staff turnover and promoting consistent staff assignment.(27, 28)

Conclusion

Measurements of the unique number of workers at nursing homes suggest a higher number of unique staff is associated with more COVID-19 cases, independent of the size of a facility itself. Moving forward, policymakers should encourage policies that promote the use of full-time, longitudinal staff while maintaining sufficient direct caregivers to provide safe and effective care for residents.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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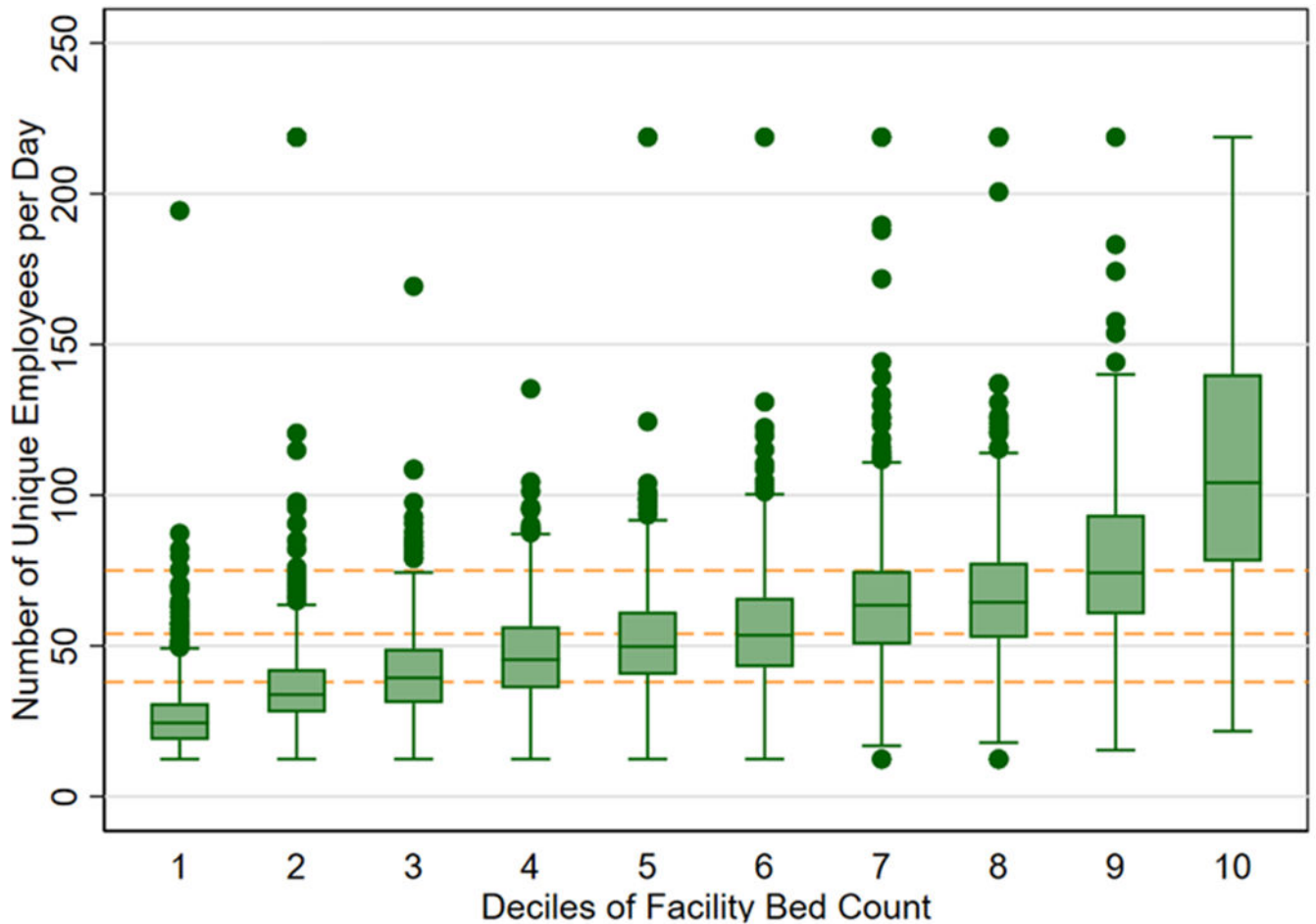
Exhibit 2-

Distribution of Staff Size by Facility Size

Source: Authors' calculations using the Centers for Medicare and Medicaid Services (CMS)Payroll-Based Journal Staffing data and Nursing Home Compare Provider Information dataset.

Notes: Box-and-whisker plots of the distribution of nursing home staff size within 10 deciles of bed counts among sample nursing homes without a resident case as of June 7, 2020. Employee counts are winsorized at the 1st and 99th percentiles to account for outliers. Horizontal dashed lines indicate cut-points for 4 quartiles of staff size.
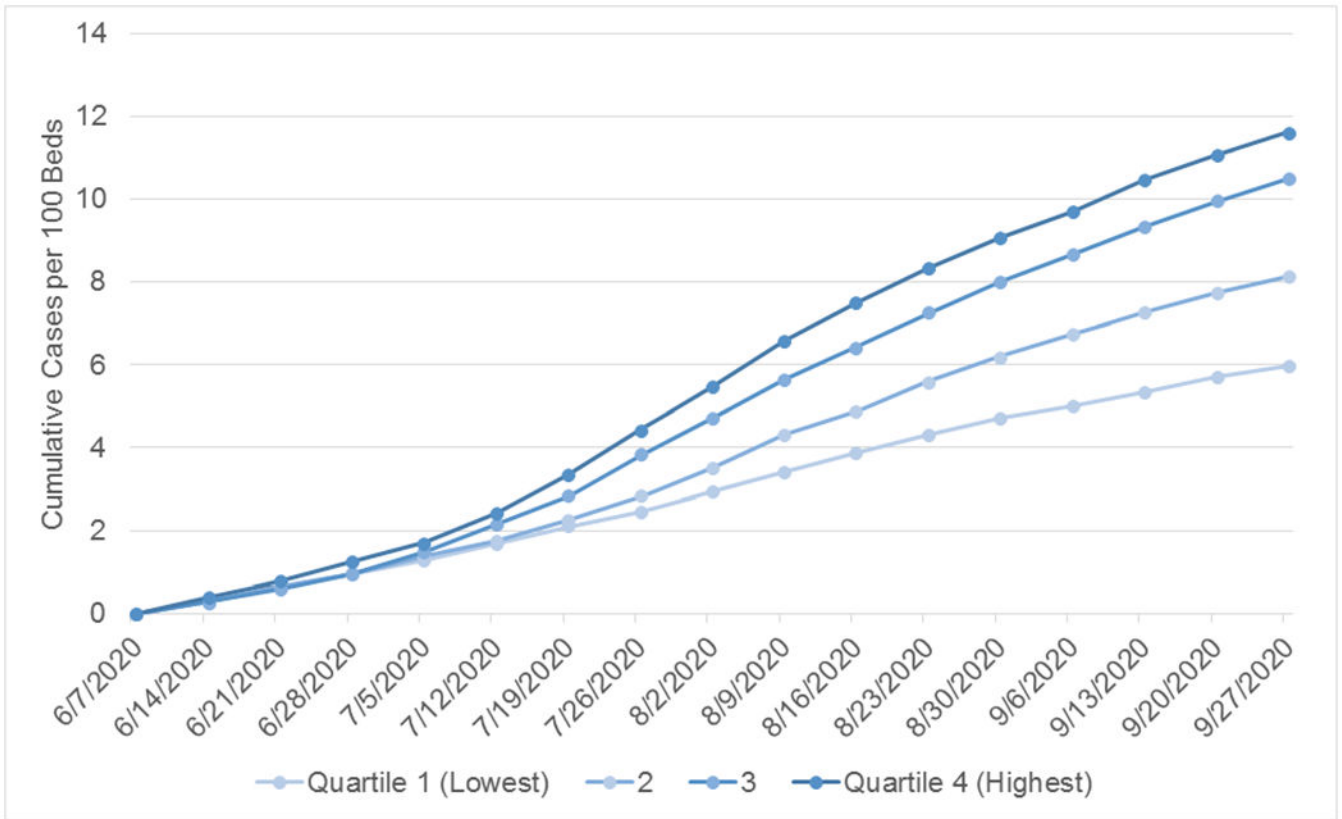
Exhibit 3-

Adjusted Cumulative COVID-19 Resident Cases by Quartiles of Staff Size, June 1, 2020 – September 27, 2020

Source: Authors' calculations using the Centers for Medicare and Medicaid Services (CMS) COVID-19 Nursing Home Data database, Payroll-Based Journal Staffing data, Nursing Home Compare Provider Information dataset, and the LTCFocus.org database.

Notes: Weekly estimates obtained from regressions that include interactions between weekly indicators and indicators for staff size quartiles. The regression models also adjust for facility characteristics, weekly county COVID-19 new case rates, and county fixed effects. Negative adjusted rate estimates are represented as 0 in the graphs. See Appendix Exhibit A2 for similar estimates for staff cases and resident deaths.
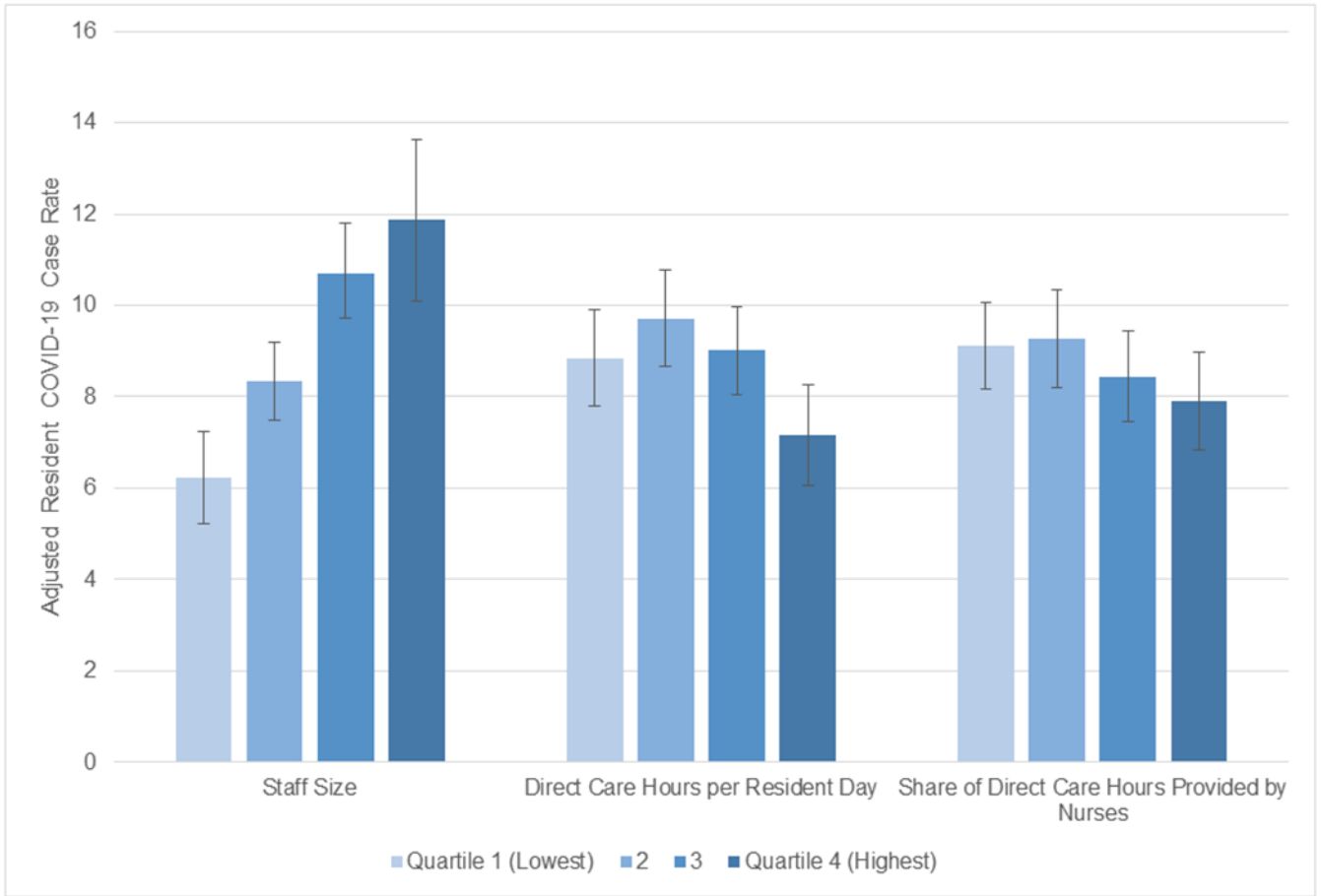
Exhibit 4-

Adjusted Cumulative Resident COVID-19 Cases by Select Staffing Characteristics

Source: Authors' calculations using the Centers for Medicare and Medicaid Services (CMS) COVID-19 Nursing Home Data database, Payroll-Based Journal Staffing data, Nursing Home Compare Provider Information dataset, and the LTCFocus.org database.

Notes: Cumulative case rates from June 1, 2020 – September 27, 2020. Estimates are obtained from regressions controlling for facility characteristics and county fixed effects. Error bars reflect 95% confidence intervals given standard errors clustered at the county level. See Appendix Exhibit A4 for similar estimates for staff cases and resident deaths. See Appendix Exhibit A5 for full regression results.

Exhibit 1-

Sample Description

	Nursing Home Staff Size (Average Number of Unique Employees per Day)			
	1st Quartile[a,b] (Lowest)	2[a,c]	3[a,d]	4th Quartile[a,e] (Highest)
	Mean/%	Mean/%	Mean/%	Mean/%
Average Number of Employees per Day (standard deviation)	27.1 (6.9)	45.6 (4.7)	63.5 (6.0)	101.2 (29.4)
Direct Care Hours per Resident Day (quartiles)				
1	34.3	32.9	23.0	10.8
2	22.4	26.1	27.4	17.4
3	17.7	23.7	27.4	31.5
4	25.6	17.3	22.2	40.4
Share of Direct Care Hours Provided by Nurses (quartiles)				
1	28.2	25.2	25.0	24.9
2	21.3	25.3	25.3	28.4
3	23.6	25.1	24.1	24.9
4	26.9	24.3	25.6	21.8
Bed count				
1-50	45.5	8.2	1.9	1.0
51-100	46.2	63.2	38.5	13.6
101-150	7.9	26.6	52.7	50.2
151-200	0.4	2.0	6.0	26.2
201+	0.0	0.1	1.0	8.9
Profit Status				
Non-Profit	28.1	19.5	20.1	25.9
Government Owned	9.8	5.3	5.8	5.9
For Profit	62.1	75.2	74.1	68.2
Percent of Patients with Medicaid (quartiles)				
1	27.4	19.3	22.7	25.1
2	20.6	22.5	25.1	28.5
3	21.5	25.6	25.6	22.5
4	23.8	25.8	21.1	17.9
Percent of Residents who are Non-white (quartiles)				
1	33.2	26.0	23.0	21.6
2	24.6	23.6	23.3	20.5
3	18.6	23.5	23.7	26.0
4	11.1	18.8	22.8	24.3

	Nursing Home Staff Size (Average Number of Unique Employees per Day)			
	1st Quartile[a,b] (Lowest)	2[a,c]	3[a,d]	4th Quartile[a,e] (Highest)
	Mean/%	Mean/%	Mean/%	Mean/%
Overall Quality Rating				
1 star	14.7	18.4	18.4	12.1
2 stars	16.8	21.3	20.6	17.8
3 stars	17.3	17.8	17.5	18.1
4 stars	21.0	21.1	21.8	22.3
5 stars	29.0	20.4	20.9	29.0
Resident COVID-19 Cases per 100 beds(standard deviation)	5.4 (17.2)	8.9 (16.8)	11.5 (18.4)	11.5 (17.3)
Staff COVID-19 Cases per 100 beds(standard deviation)	7.2 (15.3)	8.9 (11.7)	11.0 (13.3)	11.6 (12.5)
Resident COVID-19 Deaths per 100 beds (standard deviation)	0.9 (4.5)	1.5 (4.4)	1.7 (3.6)	1.9 (3.8)

Source: Authors' calculations using the Centers for Medicare and Medicaid Services (CMS) COVID-19 Nursing Home Data database, Payroll-Based Journal Staffing data, Nursing Home Compare Provider Information dataset, and the LTCFocus.org database.

Notes:

[a]Quartiles defined in the full sample (15,071) of SNFs and applied to sample SNFs without a resident case as of June 7, 2020, resulting in the non-uniform distribution of facilities across quartiles.

[b]N=2,446

[c]N=1,993

[d]N=1,667

[e]N=1,048