

# Admissions of COVID-positive patients to US nursing homes with personal protective equipment or staffing shortages

Diane M. Gibson PhD  | Jessica Greene PhD

Marxe School of Public and International Affairs, Baruch College—City University of New York, New York, New York, USA

## Correspondence

Diane Gibson, Marxe School of Public and International Affairs, Baruch College—City University of New York, 135 East 22nd Street, Box D-901, New York, NY 10010, USA.  
Email: [diane.gibson@baruch.cuny.edu](mailto:diane.gibson@baruch.cuny.edu)

## Abstract

**Background:** US nursing homes are required to follow Centers for Disease Control guidance for COVID-19 transmission-based precautions (TBP) when admitting COVID-positive patients.

**Objective:** To assess how frequently nursing homes had shortages of personal protective equipment (PPE) or staffing in weeks when they admitted COVID-positive patients, which likely made it more difficult to follow TBP, and to compare facility characteristics by admissions practices.

**Design and Setting:** Facility-level data from the Nursing Home COVID-19 Public File for the period between June 7, 2020 and March 7, 2021 was combined with additional data. The percentages of nursing homes that admitted COVID-positive patients and that had shortages when admitting were calculated for each week. Descriptive statistics and logistic regression models were used to examine the relationship between facility characteristics and the likelihood of admitting COVID-positive patients.

**Measurements:** Facilities were categorized as having admitted COVID-positive patients in a week if one or more admissions requiring TBP were reported for that week. Facilities that reported having less than a 1-week supply of any type of PPE or being short any type of staff in a week were defined, respectively, as having a PPE shortage or staffing shortage in that week.

**Results:** Over the 40-week study period, 39% of US nursing homes admitted COVID-positive patients in at least 1 week in which they were experiencing PPE or staffing shortages. Facilities that admitted COVID-positive patients with shortages generally had lower Centers for Medicare and Medicaid Services overall five-star ratings than other facilities. Only a small percentage of facilities that admitted COVID-positive patients while facing shortages were located in counties with severe shortages of PPE or staffing. In logistic regression models, shortages were not associated with COVID-positive admissions.

**Conclusion:** The widespread practice of admitting COVID-positive patients while facing shortages may have put nursing home residents and staff at heightened risk of COVID-19 infection.

**KEYWORDS**

COVID-19, nursing homes, personal protective equipment, staffing

**INTRODUCTION**

As of April 2021, 23% of deaths due to COVID-19 in the United States had occurred among nursing home residents.<sup>1,2</sup> Recent research has found that nursing homes located in communities with a higher prevalence of COVID-19 were more likely to have COVID-19 infections among residents, suggesting that nursing home staff members who contracted COVID-19 in the community have been the primary source of transmission to nursing home residents.<sup>3-7</sup> Admissions of COVID-positive patients to nursing homes from hospitals or other facilities may also have increased the spread of COVID-19 in nursing homes and led to additional resident cases and deaths.<sup>8,9</sup>

The Centers for Medicare and Medicaid Services (CMS) issued guidance to nursing homes in March 2020 stating that, “A nursing home can accept a patient diagnosed with COVID-19 and still under transmission-based precautions for COVID-19 as long as it can follow CDC guidance for transmission-based precautions. If a nursing home cannot, it must wait until these precautions are discontinued.”<sup>10</sup> The Centers for Disease Control’s (CDC) transmission-based precautions require that healthcare personnel wear personal protective equipment (PPE) during all interactions involving contact with patients or their environments and require that healthcare personnel change and properly discard of used PPE after moving patients or visiting patients or their rooms.<sup>11</sup> Transmission-based precautions also include staff time-intensive requirements such as frequent disinfection of equipment and facilities.

The ability of nursing homes to implement transmission-based precautions has been complicated by widespread shortages of PPE and staffing during the pandemic. Using the most recent week of information available for each nursing home for the period between June 24, 2020 and July 19, 2020, McGarry et al. found that 19.1% of nursing homes reported less than a 1-week supply of one or more types of PPE and 21.9% reported staff shortages.<sup>12</sup> Gibson and Greene found that nearly half of US nursing homes faced a shortage of PPE or staff during at least 1 week over a 5-week period between June and July 2020.<sup>13</sup>

In this study, we assess how frequently nursing homes had shortages of PPE or staffing at the start of weeks in which they admitted COVID-positive patients, which likely made it difficult to follow CDC transmission-based precautions. To provide context for this analysis, we examine the extent of shortages of PPE and staffing over the course of the pandemic, and

**Key Points**

- A total of 39% of US nursing homes admitted COVID-positive patients when they had PPE or staffing shortages.
- Facilities admitting with shortages generally had lower quality ratings.

**Why Does this Paper Matter?**

COVID-positive admissions by facilities with shortages may have increased the risk of infection for residents and staff.

we assess whether nursing homes were more likely to admit COVID-positive patients while facing shortages if a high concentration of facilities located in the same county were experiencing shortages. Descriptive statistics were used to examine the characteristics of nursing homes that admitted COVID-positive patients with and without shortages and cross-sectional logistic regression models estimated at different points in the study period were used to further explore whether having a shortage was related to the likelihood that a facility accepted COVID-positive patients.

**Data**

Since May 2020, nursing homes certified by Medicare and/or Medicaid (“nursing homes”) have been required to submit weekly COVID-19 reports to the CDC, which are made public in the Nursing Home COVID-19 Public File.<sup>1</sup> Facility-level data from these reports for the 40-week period between June 7, 2020 and March 7, 2021 was combined with facility-level data from Nursing Home Compare (data released April, 2020) and Brown University’s LTCFocus.org (2018 data) and county-level data from the 2019 Area Health Resources File, Johns Hopkins Coronavirus Resource Center, and CMS COVID-19 test positivity rates.<sup>14-17</sup> Reports from May 2020 were excluded because of reporting inconsistencies in the early weeks of data collection; and reports after March 7, 2021 were

not considered because questions about PPE shortages were not asked after this date.<sup>1</sup>

## Measures

Nursing homes reported weekly the number of “residents admitted or readmitted from another facility who were previously diagnosed with COVID-19 and continue to require transmission-based precautions” since the last report. We categorized facilities as having admitted a COVID-positive patient in the past week if one or more admissions requiring transmission-based precautions were reported.

Each week facilities also reported whether they had less than a one-week supply of five types of PPE (N95 masks, surgical masks, gowns, gloves, and eye protection) and whether they had shortages of four types of staff (nursing staff, clinical staff, healthcare aides, and other types of staff). We defined a facility as having a PPE shortage in a week if it reported lacking a 1-week supply of any type of PPE and a facility was defined as having a staffing shortage in a week if it reported any type of staffing shortage. A nursing home’s report of shortages at the start of the week was matched with the following week’s report of COVID-positive admissions over the past week to create a measure of whether a facility reported a PPE or staffing shortage at the start of a week in which the facility then admitted COVID-positive patients. Direct care (nursing staff, clinical staff, healthcare aides) staffing shortages were examined in sensitivity analyses.

Facility reports were also used to create county-level weekly measures of the percentage of nursing homes with an occupancy rate  $\geq 100\%$  (number of occupied beds/number of certified beds), with a PPE shortage, and with a staffing shortage. The county-level 7-day rolling average of new COVID-19 cases per capita on the Sunday of each CMS reporting week from the Johns Hopkins Coronavirus Resource Center was merged with the weekly CMS data. Time-invariant variables included facility size ( $>150$  certified beds—“large”,  $\geq 50$  and  $\leq 150$  beds—“medium”,  $<50$  beds—“small”), ownership (nonprofit, for-profit, government-owned), whether the facility was part of a chain of nursing homes (yes/no), whether  $>85\%$  of facility revenue was from Medicaid (yes/no), whether  $>25\%$  of residents were black (yes/no), the CMS overall five-star rating (1–5, missing), and whether  $>75\%$  of a county’s population resided in an urban area (yes/no).<sup>18–20</sup>

## Statistical analyses

We examined trends in the data over the 40-week study period and examined relationships between facility

characteristics and the likelihood of admitting COVID-positive patients when experiencing shortages using cross-sectional data from three points in the 40-week study period. For the trend analysis, we calculated the percentage of facilities that admitted COVID-positive patients, the percentage that had a PPE shortage, and the percentage that had a staffing shortage each week. A facility was included in the analysis in any week in which admission and shortage information was reported by the facility; weekly sample sizes ranged from  $n = 14,937$  to  $n = 15,148$ . The number of nursing homes reporting any information to the CDC varied over the weeks of the study period, ranging from 15,330 to 15,371 facilities each week.

Three additional sets of weekly trends were calculated. In the first set, the sample in each week was limited to facilities that accepted COVID-positive patients in that week and the percentages of these facilities that had a PPE shortage and that had a staffing shortage in that week were calculated. In the second set, the sample in each week was limited to facilities that had a PPE shortage and accepted COVID-positive patients in that week and the percentage of facilities that were located in a county where  $>50\%$  of facilities also had a PPE shortage in that week (“counties with a severe shortage of PPE”) was calculated; the third set created a parallel series for staffing shortages. In additional analyses, these descriptives were calculated separately by county-level COVID-19 test positivity rate categories ( $<5\%$ —“low”,  $\geq 5\%$  and  $<10\%$ —“medium”,  $\geq 10\%$ —“high”) for August 23, 2020 through the end of the study period. CMS started releasing weekly county-level data on COVID-19 test positivity rates on August 19, 2020.

Descriptive statistics were used to examine whether characteristics differed between three groups of facilities: those that never admitted COVID-positive patients, those that admitted COVID-positive patients but never when they had shortages, and those that admitted COVID-positive patients in at least 1 week when they had a shortage. PPE and staffing shortages were considered separately. A facility was included in this analysis if it reported information on COVID-positive admissions and PPE and staffing shortages in more than 36 weeks of the 40 week the study period ( $n = 14,998$ ). Characteristics of facilities included and excluded from the sample were compared.

Cross-sectional logistic regression models of the likelihood that a facility had any COVID-positive admissions in a week were estimated at three points in the study period (June 14, 2020—“early”, October 18, 2020—“middle”, February 14, 2021—“late”) with robust standard errors clustered at the county level. PPE shortages and staffing shortages at the start of the week were the key

independent variables, and the facility and county-level variables described above (except for the variables for the percentage of facilities in a county with a shortage) as well as state fixed effects were included as explanatory variables. These models were also estimated separately for facilities located within and outside of high shortage counties.

## RESULTS

Figure 1A shows the percentage of nursing homes admitting COVID-positive patients over the 40-week study period. In the first week of the study period, 12.4% of nursing homes admitted COVID-positive patients and the rate dropped to a low of 7.4% on September 27, 2020. The rate then increased until January 10, 2021, when it reached a high of 20.3% before declining again through the remainder of the study period. Facilities located in counties with higher county-level COVID-19 test positivity rates were generally more likely to have COVID-positive admissions over the study period (Figure 2A). The percentage of facilities with a weekly PPE shortage remained near 20% from the beginning of the study period through August 2020 and subsequently declined substantially over the remainder of the study period (Figure 1A). In contrast, close to 20% of facilities had a staffing shortage in each week of the study period.

The percentages of nursing homes that reported a PPE or staffing shortage in a week they admitted COVID-positive patients are shown across the study period in Figure 1B. PPE shortages in weeks in which COVID-positive patients were admitted were highest early in the study period, with around 20% of admissions-accepting facilities reporting a PPE shortage during the middle of July 2020 through the beginning of September 2020, and decreased over the remainder of the study period, with around 5% of admissions-accepting nursing homes reporting a PPE shortage during the last 4 weeks of the study period. In contrast, staffing shortages among admissions-accepting facilities remained above 20% until late January 2021 before beginning to decline slightly at the end of the study period.

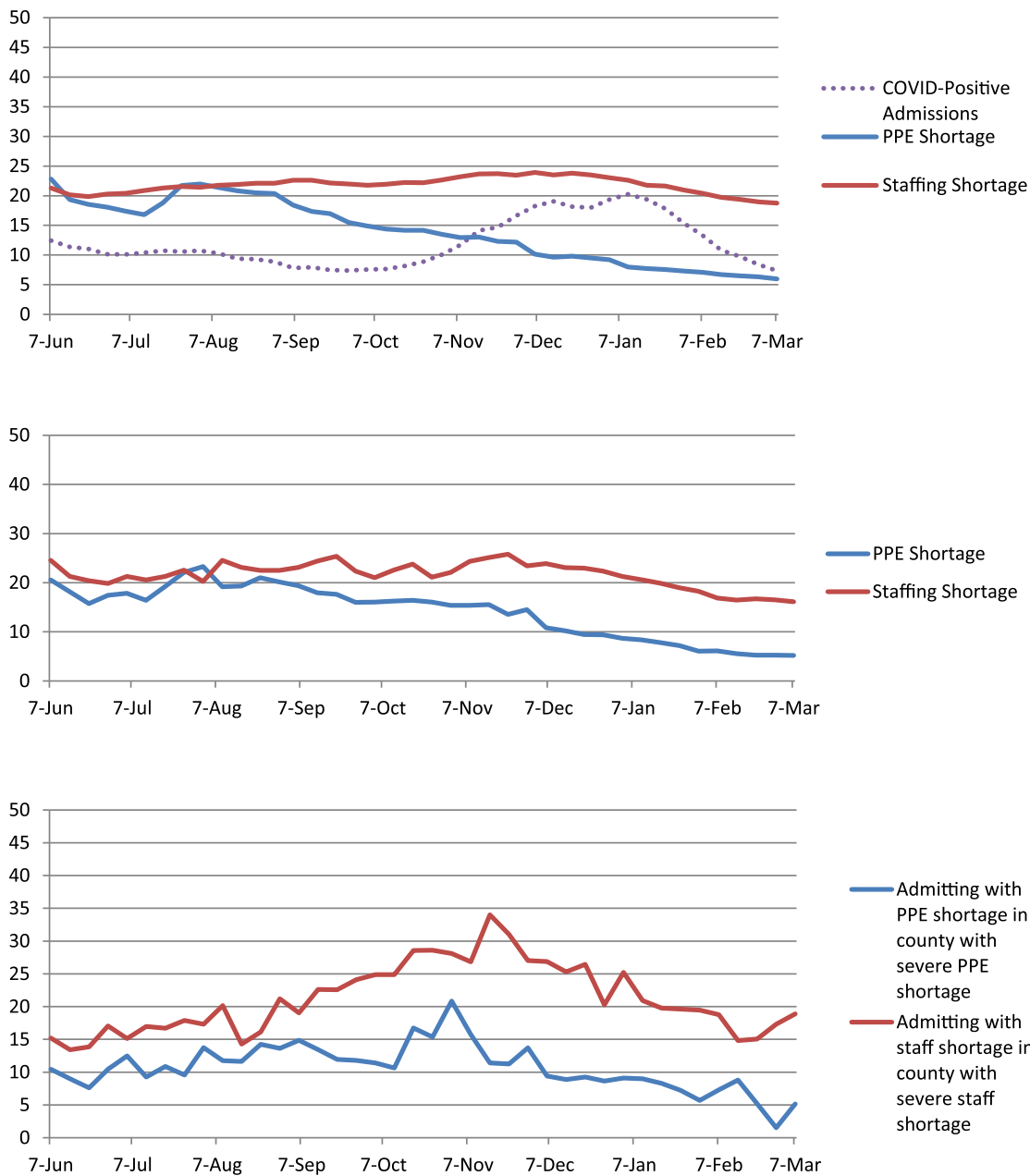
There were not consistent differences over the study period between groups of facilities categorized by county-level COVID-19 test positivity rates in the percentage of facilities that accepted admissions when they had PPE shortages (Figure 2B). However, facilities located in counties with higher county-level COVID-19 test positivity rates were generally more likely to have staffing shortages when accepting admissions from August 2020 through December 2020, with a less consistent pattern during the remainder of the study period (Figure 2C).

Figure 1C shows that in each week of the study period that less than 21% of facilities that admitted COVID-positive patients when they had a PPE shortage were located in a county with a severe shortage of PPE and that less than 34% of facilities that admitted COVID-positive patients when they had a staffing shortage were located in a county with a severe shortage of staff.

Over the whole study period, three-quarters of nursing homes (74.6%) admitted COVID-positive patients in at least 1 week, 20.1% of facilities admitted COVID-positive patients in at least 1 week when they had a PPE shortage, and 29.2% of facilities admitted COVID-positive patients in at least 1 week when they had a staffing shortage (Tables 1 and 2). Thirty-nine percent of facilities admitted COVID-positive patients in at least 1 week in which they had either a PPE or staffing shortage. Of facilities that admitted COVID-positive patients when they had a PPE shortage, 26.7% admitted with PPE shortages in four or more weeks; and of facilities that admitted COVID-positive patients when they had a staffing shortage, 30.5% admitted with staffing shortages in four or more weeks.

Facilities that admitted COVID-positive patients when they had a PPE shortage were more likely to be large, for-profit, and have lower CMS overall five-star ratings and a higher share of residents who were black compared to facilities that admitted COVID-positive patients without a PPE shortage or those that did not admit COVID-positive patients (Table 1). Facilities admitting COVID-positive patients when they had a PPE shortage reported substantially more weeks of PPE shortages and staff shortages overall than the other two groups of facilities, and more weeks admitting COVID-positive patients. There were minimal differences in the county characteristics between facilities with COVID-positive admissions by whether or not they had PPE shortages when admitting.

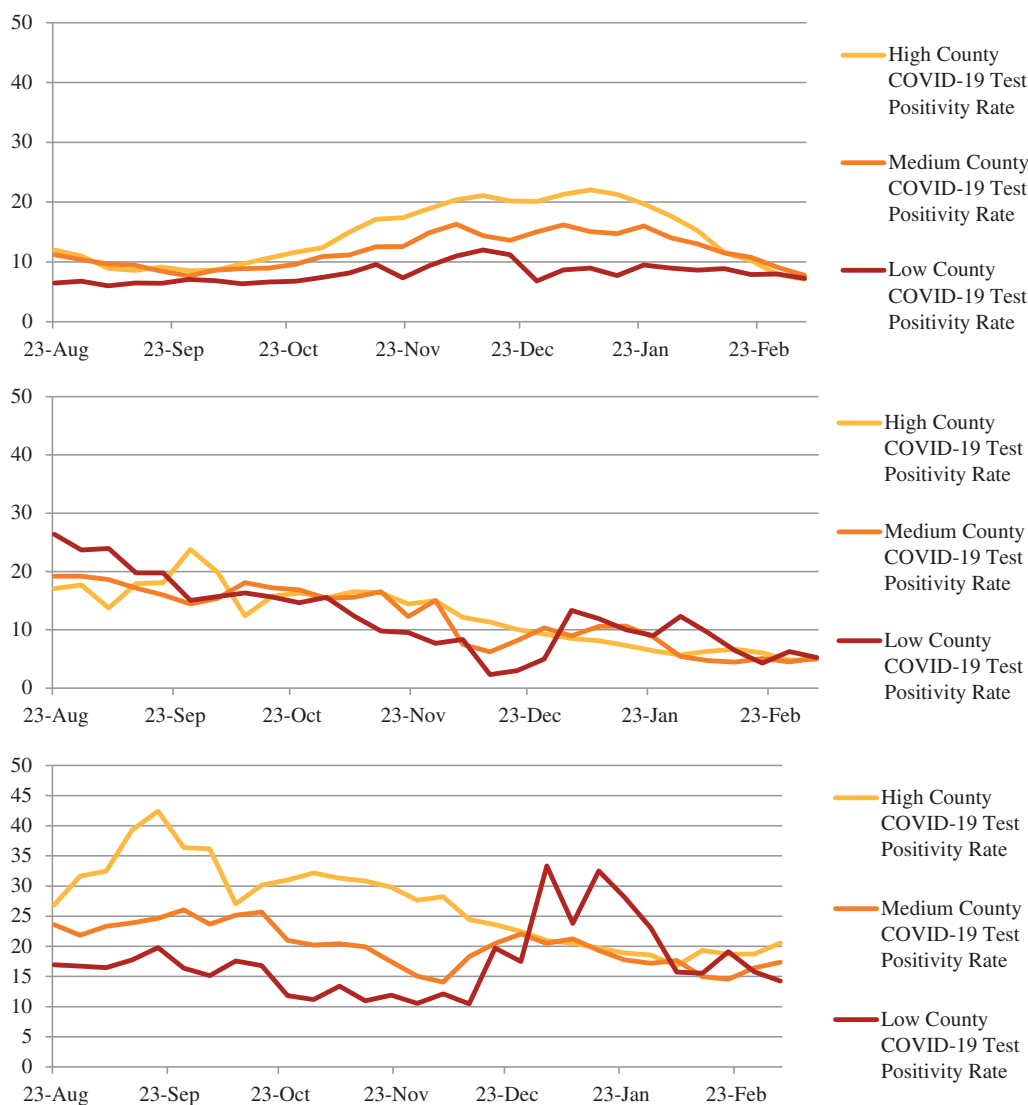
Similarly, facilities that admitted COVID-positive patients when they had a staffing shortage were more likely to be large and to have lower CMS overall five-star ratings and a higher share of residents who were black compared to facilities that admitted COVID-positive patients without a staffing shortage or those that did not admit COVID-positive patients (Table 2). Facilities admitting COVID-positive patients when they had staffing shortages reported substantially more weeks of PPE shortages and staff shortages overall than the other two groups of facilities, and more weeks admitting COVID-positive patients. Facilities that admitted COVID-positive patients but not when they had staffing shortages were more likely to be located in urban areas and in counties with more nursing homes than other facilities, but they had a similar total number of COVID-19 cases per capita as of March 7, 2021 as facilities that admitted when they had staffing shortages.



**FIGURE 1** (A) Percentages of nursing homes with COVID-positive admissions, personal protective equipment shortages, and staffing shortages, June 7, 2020–March 7, 2021. (B) Among nursing homes with COVID-positive admissions, percentages reporting shortages of personal protective equipment and staffing the week of admission, June 7, 2020–March 7, 2021. (C) Percentage of facilities admitting with personal protective equipment (PPE) shortages located in counties with a severe PPE shortage and the percentage of facilities admitting with staffing shortages located in counties with a severe staffing shortage, June 7, 2020–March 7, 2021

In comparison to facilities included in this descriptive analysis, facilities excluded (those with 36 or fewer weeks of observations on admissions and shortages) were less likely to report ever admitting COVID-positive patients or to have ever admitted patients with a PPE shortage, but were more likely to report having ever admitting patients with a staffing shortage and were more likely to be small and to have lower CMS overall five-star ratings (Table S1).

In the cross-sectional logistic regression models of COVID-positive admissions, staffing shortages at the start of a week were not significantly associated with the likelihood of COVID-positive admissions during the rest of the week in any of the three time periods; PPE shortages were not significantly associated with the likelihood of COVID-positive admissions in the early and late periods, but were positively and significantly associated with admissions in the middle period (Table 3). Associations



**FIGURE 2** (A) Percentage of nursing homes with COVID-positive admissions by county-level COVID-19 test positivity rate categories, August 23, 2020–March 7, 2021. (B) Among nursing homes with COVID-positive admissions, the percentage reporting shortages of personal protective equipment by county-level COVID-19 test positivity rate, August 23, 2020–March 7, 2021. (C) Among nursing homes with COVID-positive admissions, the percentage reporting shortages of staffing by county-level COVID-19 test positivity rate, August 23, 2020–March 7, 2021 [Color figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

between shortages and admissions did not differ when staffing shortages were defined using shortages of direct care staff and did not differ between facilities located inside or outside of high shortage counties (results not shown).

Larger facility size and an urban location were associated with a significant increase in the likelihood of admitting COVID-positive patients in all three time periods. Having a higher CMS overall five-star rating was associated with a lower likelihood of admitting COVID-positive patients in each time period, although the pattern of statistical significance differed somewhat across the three periods. In the early period, but not the later periods, the likelihood of admitting COVID-positive

patients was significantly higher for for-profit facilities and those with a higher percentage of black residents.

## DISCUSSION

Over the 40-week study period, 20% of nursing homes admitted COVID-positive patients in at least 1 week in which they had a PPE shortage and 29% admitted COVID-positive patients in at least 1 week in which they had a staffing shortage. In each week of the study period, a sizeable percentage of facilities that admitted COVID-positive patients did so with shortages. Although the rates of admitting with PPE shortages declined throughout the pandemic,

**TABLE 1** Characteristics of nursing homes based on whether they admitted COVID-positive patients between June 7, 2020–March 7, 2021 and whether they reported personal protective equipment shortages during a week with admissions, *n* = 14,839

| <b>Nursing home characteristics</b>                                   | <b>Never admitted COVID-positive patients</b> | <b>Admitted COVID-positive patients, but not with PPE shortage</b> | <b>Admitted COVID-positive patients with PPE shortage</b> | <b><i>p</i>-Value</b> |
|---|---|--|---|-----------------------|
| Total (%)   | 25.4  | 54.6   | 20.1  |                       |
| <b>Facility characteristics</b>                                       |   |  |   |                       |
| Nursing home size (%)   |   |  |   |                       |
| Small (<50 beds)  | 19.7  | 10.0   | 6.7   | 0.000                 |
| Medium (≥50 and ≤150 beds)  | 72.0  | 73.0   | 72.6  |                       |
| Large (>150 beds)   | 8.4   | 17.1   | 20.7  |                       |
| Ownership (%)   |   |  |   |                       |
| For-profit  | 65.2  | 70.4   | 75.7  | 0.000                 |
| Government  | 9.0   | 6.1  | 3.8   |                       |
| Nonprofit   | 25.8  | 23.5   | 20.5  |                       |
| Part of a chain (%)   | 59.0  | 58.3   | 62.6  | 0.000                 |
| Black residents >25% of all residents (%)                             | 12.0  | 16.6   | 20.4  | 0.000                 |
| Share of revenue from Medicaid >85% (%)                               | 11.7  | 9.2  | 10.3  | 0.000                 |
| CMS overall five-star rating (%)                                      |   |  |   |                       |
| 1 (lowest)  | 14.0  | 16.7   | 18.6  | 0.000                 |
| 2   | 17.6  | 19.4   | 21.9  |                       |
| 3   | 16.4  | 18.0   | 17.9  |                       |
| 4   | 21.2  | 21.3   | 20.3  |                       |
| 5 (highest)   | 29.2  | 23.3   | 20.3  |                       |
| Missing   | 1.6   | 1.3  | 1.1   |                       |
| Number of weeks with  |   |  |   |                       |
| PPE shortage (mean)   | 5.4   | 2.1  | 15.2  | 0.000                 |
| Staffing shortage (mean)  | 8.9   | 7.6  | 10.9  | 0.000                 |
| COVID-positive admissions (mean)                                      | 0.0   | 5.6  | 8.7   | 0.000                 |
| <b>County of facility location characteristics</b>                    |   |  |   |                       |
| Population per square mile (mean)                                     | 727.9   | 1053.7   | 1027.1  | 0.000                 |
| Population >75% urban (%)   | 45.0  | 59.1   | 62.2  | 0.000                 |
| Number of nursing homes (mean)  | 23.7  | 36.4   | 41.0  | 0.000                 |
| Total COVID-19 cases per 100,000 residents as of March 7, 2021 (mean) | 8578.1  | 9171.2   | 9110.5  | 0.000                 |

Abbreviation: PPE, personal protective equipment.

more than 16% of facilities with COVID-positive admissions in a week admitted with staffing shortages in each week of the study period. These findings raise the concern that

many of the facilities that admitted COVID-positive patients over the study period did so at a time when it would have been more difficult for them to follow transmission-based

**TABLE 2** Characteristics of nursing homes based on whether they admitted COVID-positive patients between June 7, 2020 and March 7, 2021 and whether they reported staffing shortages during a week with admissions,  $n = 14,839$ 

| Nursing home characteristics  | Never admitted COVID-positive patients | Admitted COVID-positive patients, but not with staffing shortage | Admitted COVID-positive patients with staffing shortage | <i>p</i> -Value |
|---|--|--|---|-----------------|
| Total (%)   | 25.4                                   | 45.4   | 29.2  |                 |
| Facility characteristics  |  |  |   |                 |
| Nursing home size (%)   |  |  |   |                 |
| Small (<50 beds)  | 19.7                                   | 9.5  | 8.6   | 0.000           |
| Medium ( $\geq 50$ & $\leq 150$ beds)                                 | 72.0                                   | 73.0   | 72.6  |                 |
| Large (>150 beds)   | 8.4                                    | 17.6   | 18.8  |                 |
| Ownership (%)   |  |  |   |                 |
| For-profit  | 65.2                                   | 72.7   | 70.5  | 0.000           |
| Government  | 9.0                                    | 4.9  | 6.4   |                 |
| Nonprofit   | 25.8                                   | 22.5   | 23.0  |                 |
| Part of a chain (%)   | 59.0                                   | 60.1   | 58.5  | 0.242           |
| Black residents >25% of all residents (%)                             | 12.0                                   | 16.6   | 19.2  | 0.000           |
| Share of revenue from Medicaid >85% (%)                               | 11.7                                   | 9.2  | 9.9   | 0.000           |
| CMS overall five-star rating (%)                                      |  |  |   |                 |
| 1 (lowest)  | 14.0                                   | 15.2   | 20.3  | 0.000           |
| 2   | 17.6                                   | 19.3   | 21.4  |                 |
| 3   | 16.4                                   | 17.9   | 18.1  |                 |
| 4   | 21.2                                   | 21.8   | 19.8  |                 |
| 5 (highest)   | 29.2                                   | 24.7   | 19.2  |                 |
| Missing   | 1.6                                    | 1.2  | 1.3   |                 |
| Number of weeks with:   |  |  |   |                 |
| PPE shortage (mean)   | 5.4                                    | 5.0  | 6.7   | 0.000           |
| Staffing shortage (mean)  | 8.9                                    | 1.8  | 18.9  | 0.000           |
| COVID-positive admissions (mean)                                      | 0.0                                    | 5.9  | 7.4   | 0.000           |
| County of facility location characteristics                           |  |  |   |                 |
| Population per square mile (mean)                                     | 727.9                                  | 1199.6   | 809.6   | 0.000           |
| Population > 75% urban (%)  | 45.0                                   | 64.4   | 53.0  | 0.000           |
| Number of nursing homes (mean)  | 23.7                                   | 45.1   | 26.0  | 0.000           |
| Total COVID-19 cases per 100,000 residents as of March 7, 2021 (mean) | 8578.1                                 | 9128.8   | 9195.2  | 0.000           |

Abbreviation: PPE, personal protective equipment.

precautions. Furthermore, facilities that admitted COVID-positive patients when they had shortages were more likely to have lower CMS overall five-star ratings and to have

more persistent PPE and staffing shortages, raising further concerns about the ability of these facilities to implement transmission-based precautions effectively.



**TABLE 3** Logistic regression models of admission of any COVID-positive patients in a week by US nursing homes at “early,” “middle” and “late” points in the 40-week study period (June 7, 2020–March 7, 2021), *n* = 14,839

|  | Early (week of June 14, 2020) |                 | Middle (week of October 18, 2020) |                 | Late (week of February 14, 2021) |                 |
|--|-------------------------------|-----------------|-----------------------------------|-----------------|----------------------------------|-----------------|
|  | OR                            | <i>p</i> -Value | OR                                | <i>p</i> -Value | OR                               | <i>p</i> -Value |
| Facility characteristics   |                               |                 |                                   |                 |                                  |                 |
| PPE shortage at start of week  | 0.92                          | 0.41            | 1.22                              | 0.04            | 0.90                             | 0.38            |
| Staffing shortage at start of week   | 1.11                          | 0.14            | 1.12                              | 0.16            | 0.99                             | 0.90            |
| Nursing home size  |                               |                 |                                   |                 |                                  |                 |
| Small (<50 beds)   | (1.00)                        |                 | (1.00)                            |                 | (1.00)                           |                 |
| Medium (≥50 and ≤150 beds)   | 2.24                          | 0.00            | 1.47                              | 0.01            | 2.12                             | 0.00            |
| Large (>150 beds)  | 4.27                          | 0.00            | 2.39                              | 0.00            | 3.41                             | 0.00            |
| Ownership  |                               |                 |                                   |                 |                                  |                 |
| For-profit   | (1.00)                        |                 | (1.00)                            |                 | (1.00)                           |                 |
| Government   | 0.54                          | 0.00            | 1.05                              | 0.70            | 0.85                             | 0.22            |
| Nonprofit  | 0.68                          | 0.00            | 0.95                              | 0.54            | 0.93                             | 0.36            |
| Part of a chain  | 0.91                          | 0.11            | 1.03                              | 0.68            | 1.03                             | 0.63            |
| CMS overall five-star rating   |                               |                 |                                   |                 |                                  |                 |
| 1 (lowest)   | (1.00)                        |                 | (1.00)                            |                 | (1.00)                           |                 |
| 2  | 0.92                          | 0.35            | 0.91                              | 0.35            | 1.07                             | 0.43            |
| 3  | 0.92                          | 0.46            | 0.81                              | 0.04            | 0.92                             | 0.37            |
| 4  | 0.75                          | 0.01            | 0.77                              | 0.01            | 0.86                             | 0.11            |
| 5 (highest)  | 0.68                          | 0.00            | 0.83                              | 0.08            | 0.77                             | 0.01            |
| Missing  | 0.66                          | 0.20            | 0.69                              | 0.26            | 0.85                             | 0.55            |
| Black residents >25% of all residents  | 1.49                          | 0.00            | 1.10                              | 0.36            | 0.94                             | 0.47            |
| Share of revenue from Medicaid >85%  | 0.90                          | 0.23            | 0.75                              | 0.01            | 0.54                             | 0.00            |
| County of facility location characteristics                                      |                               |                 |                                   |                 |                                  |                 |
| Percent of nursing homes in county with full occupancy at start of week          | 1.00                          | 0.56            | 1.00                              | 0.84            | 1.01                             | 0.55            |
| Seven-day average daily new COVID-19 cases per capita in county at start of week | 1.02                          | 0.07            | 1.01                              | 0.00            | 1.00                             | 0.23            |
| Population >75% urban  | 2.43                          | 0.00            | 1.57                              | 0.00            | 1.60                             | 0.00            |

*Notes:* The logistic regression models were estimated using robust standard errors clustered at the county level. State fixed effects were included in each model. Information from Brown University’s LTCfocus.org (chain status, Medicaid revenue share, black resident share) was missing for 1038 facilities. Facilities missing LTCfocus information were assigned a value of zero for these variables and the models included an indicator variable for missing LTCfocus information.

Abbreviations: OR, odds ratio; PPE, personal protective equipment.

In each week of the study period, less than 21% of facilities that admitted COVID-positive patients with a PPE shortage were located in counties with a severe PPE shortage and less than 34% of facilities that admitted COVID-positive patients with a staffing shortage were located in counties with a severe staffing shortage. This suggests that the location of a facility in a county with a severe shortage of PPE or staffing, where options for admitting patients at local facilities without shortages may have been extremely limited,

was not the primary factor explaining admissions with shortages.

If nursing homes were trying to ensure that they could follow transmission-based precautions when accepting COVID-positive patients, we would expect that having a PPE or staffing shortage in a given week would be associated with a lower likelihood that a facility admitted COVID-positive patients. This was not the case in the cross-sectional logistic regression models of COVID-positive admissions that also controlled for the

location of facilities and the local course of the pandemic for any of the three time periods, nor in supplemental models estimated separately for facilities located within and outside of high shortage counties. This suggests that facilities did not take shortages into consideration when making admissions decisions. With data currently available, it is not possible to determine the extent to which the admission of COVID-positive patients while facing shortages contributed to the spread of COVID within nursing homes.<sup>8</sup> Actions taken by facilities such as setting up dedicated areas for the isolation of COVID-positive patients, prioritizing the allocation of available PPE and staffing to the implementation of transmission-based precautions in the care of COVID-positive patients, and encouraging and offering COVID vaccinations to residents and staff may have mitigated the impact of shortages on the spread of COVID within nursing homes.

A limitation of this study is that information about whether facilities took these types of mitigating actions is not available. Further limitations are that the study used nursing home-reported data and that the CDC did not define what constituted a staffing shortage or request information on the extent of PPE or staffing shortages in its weekly questionnaire for nursing homes. Additionally, we are not able to observe whether COVID-positive patients admitted by a facility were former residents of the facility who were returning to the facility or whether they were new admissions.

## CONCLUSIONS

Nearly 40% of US nursing homes admitted COVID-positive patients in at least 1 week in which they were experiencing PPE or staffing shortages. Shortages would have made it more difficult for facilities to follow CDC transmission-based precautions and admissions with shortages may have put nursing home residents and staff at heightened risk for COVID-19 infection. Additionally, facilities that admitted COVID-positive patients when they had shortages were more likely to have lower CMS overall five-star ratings and more consistent shortages, raising further concerns about the ability of these facilities to implement transmission-based precautions. Finally, despite widespread shortages of PPE and staffing during the pandemic, only a small percentage of facilities admitting COVID-positive patients while facing shortages were located in counties with severe shortages of PPE or staffing, suggesting that in many locations that admitting COVID-positive patients while facing shortages was not a foregone conclusion.

## ACKNOWLEDGMENTS

### CONFLICT OF INTEREST

The authors have no conflicts.

### AUTHOR CONTRIBUTIONS

Both authors contributed equally to the study concept and design, acquisition of data, analysis and interpretation of data, and preparation of the manuscript.

### SPONSOR'S ROLE

This study did not receive financial support.

### ORCID

Diane M. Gibson  <https://orcid.org/0000-0002-3140-3510>

## REFERENCES

- Centers for Medicare and Medicaid Services. COVID-19 nursing home data. 2021. <https://data.cms.gov/stories/s/COVID-19-Nursing-Home-Data/bkwz-xpvg/>
- Centers for Disease Control and Prevention. CDC COVID data tracker. 2020. [https://covid.cdc.gov/covid-data-tracker/#cases\\_casesper100klast7days](https://covid.cdc.gov/covid-data-tracker/#cases_casesper100klast7days). Accessed November 11, 2020.
- White EM, Kosar CM, Feifer RA, et al. Variation in SARS-CoV-2 prevalence in U.S. skilled nursing facilities. *J Am Geriatr Soc.* 2020;68(10):2167-2173. <https://doi.org/10.1111/jgs.16752>
- Gorges RJ, Konetzka RT. Staffing levels and COVID-19 cases and outbreaks in U.S. nursing homes. *J Am Geriatr Soc.* 2020; 68(11):2462-2466. <https://doi.org/10.1111/jgs.16787>
- Abrams HR, Loomer L, Gandhi A, Grabowski DC. Characteristics of U.S. nursing homes with COVID-19 cases. *J Am Geriatr Soc.* 2020;68:1653-1656. <https://doi.org/10.1111/jgs.16661>
- Konetzka RT, Gorges RJ. Nothing much has changed: COVID-19 nursing home cases and deaths follow fall surges. *J Am Geriatr Soc.* 2021;69:46-47. <https://doi.org/10.1111/jgs.16951>
- Bui DP, See I, Hesse EM, et al. Association between CMS quality ratings and COVID-19 outbreaks in nursing homes—West Virginia, March 17–June 11, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69(37):1300-1304. <https://doi.org/10.15585/mmwr.mm6937a5>
- James L. Nursing home response to COVID-19 pandemic. 2021. <https://ag.ny.gov/sites/default/files/2021-nursinghomesreport.pdf>
- New York State Department of Health. Factors associated with nursing home infections and fatalities in New York state during the COVID-19 global health crisis. 2021. [https://www.health.ny.gov/press/releases/2020/docs/nh\\_factors\\_report.pdf](https://www.health.ny.gov/press/releases/2020/docs/nh_factors_report.pdf)
- Wright DR. Dear State Survey Agency Directors, Ref: QSO-20-14-NH. Centers for Medicare and Medicaid Services. 2020. <https://www.cms.gov/files/document/3-13-2020-nursing-home-guidance-covid-19.pdf>
- Centers for Disease Control and Prevention. Transmission-based precautions. 2020. <https://www.cdc.gov/infectioncontrol/basics/transmission-based-precautions.html>
- McGarry BE, Grabowski DC, Barnett ML. Severe staffing and personal protective equipment shortages faced by nursing homes during the COVID-19 pandemic. *Health Aff.* 2020;39(10):1812-1821. <https://doi.org/10.1377/hlthaff.2020.01269>

13. Gibson DM, Greene J. State actions and shortages of personal protective equipment and staff in U.S. nursing homes. *J Am Geriatr Soc*. 2020;68(12):2721-2726. <https://doi.org/10.1111/jgs.16883>
14. Centers for Medicare and Medicaid Services. Nursing home compare datasets. 2021. <https://data.cms.gov/provider-data/search?theme=Nursinghomesincludingrehabservices>
15. Brown University. Shaping Long Term Care in America Project at Brown University, funded in part by the National Institute on Aging (1P01AG027296). LTCFocus.org. 2020.
16. Johns Hopkins University and Medicine. Coronavirus Resource Center. COVID-19 United States Cases by County. 2021. <https://coronavirus.jhu.edu/>
17. Centers for Medicare and Medicaid Services. COVID-19 test positivity rates. 2021. <https://data.cms.gov/stories/s/q5r5-gjyu>
18. Mor V, Zinn J, Angelelli J, Teno JM, Miller SC. Driven to tiers: socioeconomic and racial disparities in the quality of nursing home care. *Milbank Q*. 2004;82(2):227-256. <https://doi.org/10.1111/j.0887-378X.2004.00309.x>
19. Boccuti C, Casillas G, Neuman T. Reading the stars: nursing home quality star ratings, nationally and by state. 2015. <https://www.kff.org/medicare/issue-brief/reading-the-stars-nursing-home-quality-star-ratings-nationally-and-by-state/>
20. You K, Li Y, Intrator O, et al. Do nursing home chain size and proprietary status affect experiences with care? *Med Care*. 2016; 54(3):229-234. <https://doi.org/10.1097/MLR.0000000000000479>

## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

**Table S1.** Characteristics of nursing homes by completeness of data on COVID-positive admissions, personal protective equipment shortages and staffing shortages over the period from 6/7/20–3/7/21 ( $n = 15,343$ )

**How to cite this article:** Gibson DM, Greene J. Admissions of COVID-positive patients to US nursing homes with personal protective equipment or staffing shortages. *J Am Geriatr Soc*. 2021;69(9): 2393–2403. <https://doi.org/10.1111/jgs.17302>