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## RESEARCH ARTICLE

# Dementia, nurse staffing, and health outcomes in nursing homes

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## Abstract

**Objective:** To estimate and contrast the relationships between nurse staffing and health outcomes in nursing homes with low and high dementia census, to understand the association of staffing hours with dementia care quality.

**Data Sources and Study Setting:** A national sample of nursing homes during 2017–2019 (pre-COVID). Data included the Payroll-Based Journal, Medicare Claims, Nursing Home Care Compare, and Long-Term Care Focus.

**Study Design:** Retrospective, regression analyses. We estimated separate linear models predicting six long-term facility-level outcomes. Independent variables included staffing hours per resident-day (HPRD) interacted with the facility percentage of dementia residents, controlling for other resident and facility characteristics.

**Data Collection/Extraction Methods:** Hospital-based nursing homes, those with fewer than 30% dementia residents, and missing data were excluded.

**Principal Findings:** We found that registered nurses and certified nurse assistants HPRDs were likely to exhibit positive returns in terms of outcomes throughout most of the range of HPRD for both high and low-census dementia facilities, although, high- and low-dementia facilities differed in most outcome rates at all staffing levels. Average predicted antipsychotics and activities of daily living as functions of HPRD were worse in higher dementia facilities, independent movement, and hospitalizations did not differ significantly, and Emergency Rooms and pressure sores were worse in

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lower dementia facilities. Average marginal effects were not statistically different [CI included zero] between the high and low dementia facilities for any outcome.

**Conclusions:** These findings suggest that increasing staffing will improve outcomes by similar increments in both low- and high-dementia facilities for all outcomes. However, at any given level of staffing, absolute differences in outcomes between low- and high-dementia facilities remain, suggesting that additional staffing alone will not suffice to close these gaps. Further studies are required to identify opportunities for improvement in performance for both low- and high-dementia census facilities.

#### KEYWORDS

dementia, nursing homes, outcomes, policy, quality, staffing

#### What is known on this topic

- Studies to-date compared the health outcomes of nursing home residents with dementia cared for in special care units to residents with dementia in general care.
- The findings of these studies were mixed, with no clear indication that residents with dementia are faring better in one setting compared to the other.
- There are no studies comparing health outcomes in nursing homes caring for large numbers or residents with dementia to nursing homes caring for small numbers of residents with dementia.

#### What this study adds

- This study examines the relationship between nursing homes staffing and outcomes in general care.
- It compares this relationship between nursing homes with a large percentage of residents with dementia and nursing homes with a small percentage of residents with dementia.
- Findings indicate that increased staffing improves outcomes in most cases, for all patients. Staffing impact on outcomes differs by percentage of residents with dementia and depends on the specific outcome.

## 1 | INTRODUCTION

Over 40% of nursing home residents have been estimated to have Alzheimer's disease, related dementias or cognitive impairment (ADRD-CI).<sup>1</sup> These individuals require specialized care to assess their symptoms and manage their functional and behavioral needs compared with residents without ADRD-CI.<sup>2,3</sup> Persons with ADRD-CI have difficulty communicating their symptoms and needs, thus requiring staff experienced in understanding non-verbal cues and able to invest the time to learn each resident's particular way of expressing him or herself. Staff needs to employ methods to create rapport with residents with dementia, put them at ease, and minimize the anxiety that these residents often experience, anxiety that if not addressed may lead to behavioral issues and aggression. Furthermore, the nursing home needs to create a safe, familiar, and simple to navigate, least-confusing environment that would enhance the sense of security and physical safety of the ADRD-CI resident. Thus, providing appropriate, high-quality care to residents with ADRD-CI is not only a matter of employing more staff but also employing staff that is trained with techniques that have been shown to be efficacious in caring for

individuals with ADRD-CI.<sup>3,4</sup> Staff consistency and predictability are also important, as these allow staff to become familiar with the residents, better understand them and create rapport. Yet consistency and predictability are in short supply in most nursing homes, due to the high prevalence of turnover<sup>5</sup> and labor instability.<sup>6</sup>

The recognition that ADRD-CI might require special care has motivated the creation of special care units for dementia in the past. Studies examining their effectiveness in providing superior care to the care received by residents with ADRD-CI in the general nursing home population offer mixed evidence. For example, Gruneir et al. found that there was no difference in the use of physical restraints between residents with ADRD-CI in or outside the special care unit, that those in the special care unit were less likely to have bed rails or feeding tubes but more likely to be on antipsychotic drugs.<sup>7</sup> A study by Cadi-gan et al. found in addition that while residents with ADRD in special care units were more likely to have do-not-hospitalize orders and be treated for dyspnea, they were less likely to be treated for pain than those in the general beds.<sup>8</sup> There is, however, reason to believe that there are substantial differences in the severity of dementia between residents in the general population and those in the special care

units,<sup>9</sup> and most studies have not addressed these differences when comparing care processes and outcomes. The one study that used instrumental variable methods to address selection bias did find that all outcome measures tested in that study, including antipsychotic drug use, were lower among ADRD residents in the special care unit compared with ADRD residents outside the special care unit.<sup>10</sup> So, it might seem that, at least with respect to some outcomes, residents with dementia might have better outcomes in special care units.

However, even if special care units do provide more appropriate care in some instances, their numbers are small. Fewer than 15% of nursing homes have special care units<sup>1</sup> and those account for only 4.5% of the over 1.6 million beds nationally.<sup>10</sup> Thus, even if the evidence about the quality of care in special care units was overwhelming, only about 28,000 of the estimated 625,000 nursing home residents with dementia would benefit from it. In fact, recent findings indicate that the vast majority of nursing home residents with ADRD-CI reside in general nursing home beds, some in facilities in which they account for a relatively small fraction of the residents and others in facilities in which they account for a large majority.<sup>1</sup>

These facts motivated us to ask the following question: Is the relationship between staffing ratios and outcomes different in nursing homes with a high census of residents with ADRD-CI versus a low census of ADRD-CI? One might hypothesize that nursing homes serving a resident population made of mostly individuals with ADRD-CI would have adjusted their staffing and care processes to the needs of these residents. To answer this question, we investigated the relationships between staffing and health outcomes in nursing homes with low and high dementia census. Specifically, we present estimates of production functions for six long-stay health outcomes and compare the relationships between the average and marginal effects of staffing on these outcomes in nursing homes with 40% and 80% ADRD-CI census.

## 2 | METHODS

### 2.1 | Sample and data

The initial study sample included all 15,790 nursing homes nationally that submitted data to the Payroll-Based Journal (PBJ) dataset during the pre-COVID period: January 2017 through September 2019. We chose this period to avoid confounding by the COVID-19 pandemic which has affected nursing homes' staff, residents, and outcomes.<sup>11</sup> These data were merged, using the Medicare Provider Number, to the Minimum Data Set (MDS), Nursing Home Care Compare (NHCC), and the Long-Term Care (LTC) Focus dataset.<sup>12</sup> The PBJ reports for each nursing home and for each day the staffing hours worked, by staff type. The MDS provides assessment data for each individual residing in the nursing home at pre-specified intervals during their stay. Assessments include demographics, diagnoses, case-mix, activities of daily living (ADLs), the Brief Interview for Mental Status (BIMS), measures of long and short-memory loss, and treatments. NHCC reports the quality measures (QMs) calculated by the Centers for Medicare & Medicaid (CMS) and published quarterly

in its web-based report card.<sup>13</sup> LTC Focus includes information about the nursing home such as payer mix, the number of beds, occupancy, for-profit status, chain status, and whether the facility has an Alzheimer's Special Care Unit.

We excluded from the initial sample nursing homes that were hospital-based, were not in operation during any part of the study period based on the availability of MDS assessment data, or those with young residents, defined as having more than 30% of the residents younger than 65. We also excluded nursing homes with outlier staffing levels defined as the top or bottom 1% of the national distribution of hours per resident-day (HPRD) for either registered nurses (RNs), licensed practical nurses (LPNs), or certified nurses aides (CNAs). Lastly, we excluded facilities with an average daily rate of ADRD-CI patients of less than 30%. The latter were assumed to be primarily post-acute care facilities.<sup>1</sup> In addition, the number of nursing homes with QMs reported in NHCC varied substantially. Therefore, the final sample sizes varied for each estimated model, from 12,105 to 13,171. 13,256 (84% of the initial PBJ sample) facilities appeared in at least one model.

## 2.2 | Variables

### 2.2.1 | Dependent variables

We aimed to select, from the publicly reported QMs by CMS, a mix of claims-based utilization and MDS-based facility-reported process and outcomes measures that are particularly important for individuals with ADRD-CI. We selected these based on existing science on staffing and outcomes for the overall nursing home population while balancing the risk of reporting or detection bias for the QMs. These included four MDS-based measures defined as the percent of residents who: (1) received an antipsychotic medication, (2) whose need for help with ADLs increased, (3) whose ability to move independently in their room or hallway worsened, (4) who were at high risk for experienced pressure ulcers; and two claims-based measures defined as the number of (5) hospitalizations per 1000 resident days, and (6) emergency department visit per 1000 resident days.

### 2.2.2 | Independent variables

We identified residents as having Alzheimer's disease or related dementia (ADRD) or CI using the MDS assessments, as follows: (1) ADRD was based on diagnoses. (2) CI was identified as a BIMS score of less than or equal to 7, or if the residents were unable to complete the BIMS and had both a short-term memory problem and severely impaired daily decision-making. Other resident characteristics included the case-mix index based on the Resource Utilization Groups (RUGs) IV, age, White, Black or other race, and gender.

Staffing was measured as HPRD for RNs, LPNs, and certified nurse assistants (CNAs) for each nursing home and each day, using the PBJ data. Other facility characteristics included having an

Alzheimer special care unit, ownership, chain affiliation, payer mix and occupancy.

### 2.2.3 | Variables calculation

The MDS-based QMs are calculated by CMS quarterly and reflect resident characteristics and care during the past quarter. The claims-based measures are based on annual data and reflect care quality provided during a whole year. This required that all other variables be calculated over two time periods, a quarter or a year, to fit the specification of each estimated model. Thus, models where the dependent variables were MDS-based, which are quarterly, required 11 observations during the 2017–3rd Q 2019 period and all independent variables had to be defined for these 11 quarters. Models with the dependent variables being the claims-based annual measures had three observations, and all independent variables were defined for these three time periods.

To achieve this, we first calculated all dependent and independent variables for each resident in each nursing home for each day. Those variables that are not reported daily, for example, MDS variables, were assumed to keep their value until the next reporting update. For example, the RUGs score of a resident was assumed to be the same for all days between the first MDS assessment and the next assessment, at which time it may or may not have been updated. We then calculated the daily average of all residents staying in each nursing home on each day based on admission and discharge information. This resulted in daily average values for each nursing home for all variables, including daily averages of ADRD-CI percent of census, RN HPRD, LPN HPRD, and CNA HPRD, age, gender, and case-mix. Finally, these daily averages were further averaged to create the time-dependent independent variables corresponding to each of the QMs, such that each model would include a set of variables defined over time intervals coinciding with the time interval over which each dependent variable was defined, that is, quarterly or annually.

## 2.3 | Estimated models

We estimated six separate models, each with the following specifications:

$$\begin{aligned}
 QM_{i,j,t_i} = & \left( \sum_s \text{StfHPRD}_{s,j,t_i} + \sum_s \text{StfHPRD}_{s,j,t_i}^2 \right) \\
 & + \left( \% \text{ADRDCI}_j + \% \text{ADRDCI}_j^2 \right) + \left( \sum_s \text{StfHPRD}_{s,j,t_i} \right. \\
 & \left. + \sum_s \text{StfHPRD}_{s,j,t_i}^2 \right) * \left( \% \text{ADRDCI}_j + \% \text{ADRDCI}_j^2 \right) \\
 & + \sum_f \text{FacChr}_{f,j,t_i} + \sum_m \text{INTVL}_{m,t_i} + u_j + e_{i,j,t_i}
 \end{aligned}$$

These were estimated as ordinary least squares regressions with random facility effects and robust standard errors clustered at the

facility level.  $QM_{i,j,t_i}$  is the QM  $i$  for NH  $j$  and time interval (quarter or year)  $t_i$ .  $\text{StfHPRD}_{s,j,t_i}$  is the staffing HPRD for nursing staff type  $s$  in NH  $j$ , and time interval  $t_i$  associated with  $QM_i$  where staffing type  $s = \text{RN, LPN, CNA}$ .  $\% \text{ADRDCI}_j$  is the percent of residents with ADRD-CI in NH  $j$ .  $\text{FacChr}$  is the set of characteristics of NH  $j$  and its residents.  $\text{INTVL}$  is a set of indicator variables of the time interval specific to each  $QM_i$  controlling for a secular time trend.  $u_j$  represents the error term specific to the facility and  $e_{i,j,t_i}$  represents the idiosyncratic error term for each NH, time interval observation.

Note that this specification allows for non-linearities in both staffing and percent ADRD-CI (the squared terms), as well as interaction between all staffing types and percent ADRD-CI. Thus, this specification allows us to explore not only the relationship between staffing and outcomes but also whether these relationships differ when the nursing home has different concentrations of residents with ADRD-CI.

## 2.4 | Predictions and statistical tests

To answer the question we posed in the introduction we used each of the six estimated models to predict outcomes separately for nursing homes with a low and a high census of residents with ADRD-CI. Recall that we consider nursing homes with up to 30% ADRD-CI census to be primarily post-acute and excluded them from our sample. We, therefore, chose 40% ADRD census to represent the low ADRD-CI level. For the high level, we chose 80%. We also calculated and presented the 95% confidence interval for the average outcomes at the 10th, 25th, 50th, 75th, and 90th percentile of staffing in our sample.

We then tested whether the production functions for the high and the low-census ADRD-CI are the same by testing the hypotheses that (1) the average predicted values; and (2) the average marginal effects evaluated at the 25th and 75th percentiles for each staffing type are the same for a nursing home with a low (40%) and high (80%) ADRD-CI census can be rejected. In other words, we compared the intercept (the average predicted value of each outcome) and the slope (the average marginal effect of staffing) of the two production functions. Each production function related staff HPRD by type (e.g., RNs) to the same outcome, one for a nursing home with a low ADRD-CI census and one with a high ADRD-CI census.

We present our estimated production functions graphically for high and low ADRD-CI nursing homes. We focus on findings for RNs and CNAs, which, unlike the LPNs, were likely to exhibit positive or constant returns in terms of outcomes, as many prior studies have found.<sup>14–16</sup>

## 2.5 | Sensitivity analysis

We indicated above that our sample excluded nursing homes with outlier values for staffing—the top and bottom 1%. We repeated the analyses with a sample that includes these nursing homes as well. In addition, we conducted a sensitivity analysis using 90% to define high ADRD-CI instead of 80%.

### 3 | RESULTS

Table 1 presents descriptive statistics for nursing homes included and excluded from the analysis. For the analysis sample, the means of the QMs ranged from 1.0 for emergency room visits per 1000 resident

days to 18.1 for the percent of long-stay residents whose ability to move independently worsened. Average staffing ranged from 0.39 HRPD for RNs to 2.1 HRPD for CNAs. Average percent of residents with ADRD-CI was 58.8 and 14.8% of facilities had an Alzheimer special care unit. Case-mix averaged 1.6, 78.5% of residents were White,

**TABLE 1** Descriptive statistics<sup>a</sup>.

|   | Analysis sample |           |         | Sample excluded from analysis |           |         | p-value <sup>b</sup> |
|---|-----------------|-----------|---------|-------------------------------|-----------|---------|----------------------|
|   | N               | Mean      | SD      | N                             | Mean      | SD      |                      |
| <b>Long-stay quality measures</b>   |                 |           |         |                               |           |         |                      |
| Percentage of residents whose need for help with activities of daily living has increased | 13,065          | 14.8      | 5.3     | 1540                          | 14.7      | 6.5     | 0.265                |
| Percentage of residents who received an antipsychotic medication                          | 13,171          | 14.6      | 8.4     | 1623                          | 15.5      | 12.3    | <0.001               |
| Percentage of residents whose ability to move independently worsened                      | 12,842          | 18.1      | 6.6     | 1415                          | 17.5      | 7.8     | 0.005                |
| Percentage of high-risk residents with pressure ulcers 2017–3rd Quarter 2018              | 12,527          | 5.5       | 3.3     | 1435                          | 6.8       | 4.9     | <0.001               |
| Number of hospitalizations per 1000 resident days   | 12,409          | 1.7       | 0.6     | 1440                          | 1.5       | 0.7     | <0.001               |
| Number of outpatient emergency department visits per 1000 resident days                   | 12,105          | 1.0       | 0.6     | 1332                          | 1.0       | 0.7     | 0.738                |
| <b>Staffing levels</b>  |                 |           |         |                               |           |         |                      |
| Average hours per resident-day: Registered nurses   | 13,256          | 0.39      | 0.23    | 2482                          | 0.93      | 0.98    | <0.001               |
| Average hours per resident-day: Licensed practical nurses                                 | 13,256          | 0.78      | 0.25    | 2482                          | 0.96      | 0.67    | <0.001               |
| Average hours per resident-day: Certified nurse practitioners                             | 13,256          | 2.1       | 0.4     | 2482                          | 2.5       | 0.8     | <0.001               |
| % of residents with ADRD-CI   | 13,256          | 58.8      | 11.9    | 2481                          | 42.7      | 22.1    | <0.001               |
| <b>Other facility characteristics</b>   |                 |           |         |                               |           |         |                      |
| Case-mix index based on resource utilization groups (RUGs) IV                             | 13,256          | 1.6       | 0.3     | 2480                          | 1.8       | 0.7     | <0.001               |
| % residents below age 65  | 13,256          | 15.1      | 12.5    | 2481                          | 19.4      | 22.9    | <0.001               |
| % residents age 65–74   | 13,256          | 18.5      | 7.8     | 2481                          | 18.4      | 8.9     | 0.539                |
| % residents age 75–84   | 13,256          | 27.1      | 6.1     | 2481                          | 26.5      | 10.1    | <0.001               |
| % residents age 85 and above  | 13,256          | 39.3      | 17.5    | 2481                          | 35.7      | 20.5    | <0.001               |
| % male residents  | 13,256          | 35.2      | 11.3    | 2481                          | 38.4      | 14.2    | <0.001               |
| % female residents  | 13,256          | 64.8      | 11.3    | 2481                          | 61.6      | 14.2    | <0.001               |
| % white residents   | 13,256          | 78.5      | 23.8    | 2481                          | 78.7      | 24.3    | 0.641                |
| % black residents   | 13,256          | 12.5      | 18.3    | 2481                          | 9.9       | 16.0    | <0.001               |
| % other race residents  | 13,256          | 9.1       | 15.3    | 2481                          | 11.4      | 17.9    | <0.001               |
| <b>Resident census</b>  |                 |           |         |                               |           |         |                      |
| % residents with payer: Medicare  | 13,256          | 90.7      | 51.9    | 2480                          | 57.2      | 47.8    | <0.001               |
| % residents with payer: Medicaid  | 13,256          | 12.0      | 8.6     | 1707                          | 23.2      | 27.2    | <0.001               |
| % residents with payer: Other   | 13,256          | 61.8      | 19.5    | 1707                          | 47.7      | 35.5    | <0.001               |
| Nursing home occupancy  | 13,256          | 26.2      | 17.1    | 1707                          | 29.1      | 22.2    | <0.001               |
| <b>Nursing home characteristics</b>   |                 |           |         |                               |           |         |                      |
|   | N               | Frequency | Percent | N                             | Frequency | Percent | p-value <sup>c</sup> |
| Nursing home is for-profit  | 13,256          | 9620      | 72.6    | 1707                          | 865       | 50.7    | <0.001               |
| Nursing home is part of a chain   |                 | 7831      | 59.1    | 1707                          | 837       | 49.0    | <0.001               |
| Nursing home has Alzheimer special care unit  | 13,256          | 1956      | 14.8    | 1707                          | 86        | 5.0     | <0.001               |

Abbreviations: ADRD-CI, Alzheimer disease and related dementias–cognitive impairment; N, sample size; SD, standard deviation.

<sup>a</sup>The values for staffing, % ADRD-CI, and facility characteristics are the averages of the quarterly observations over the study period. The values for the quality measures are calculated for the appropriate time window for each measure as described in the methods section.

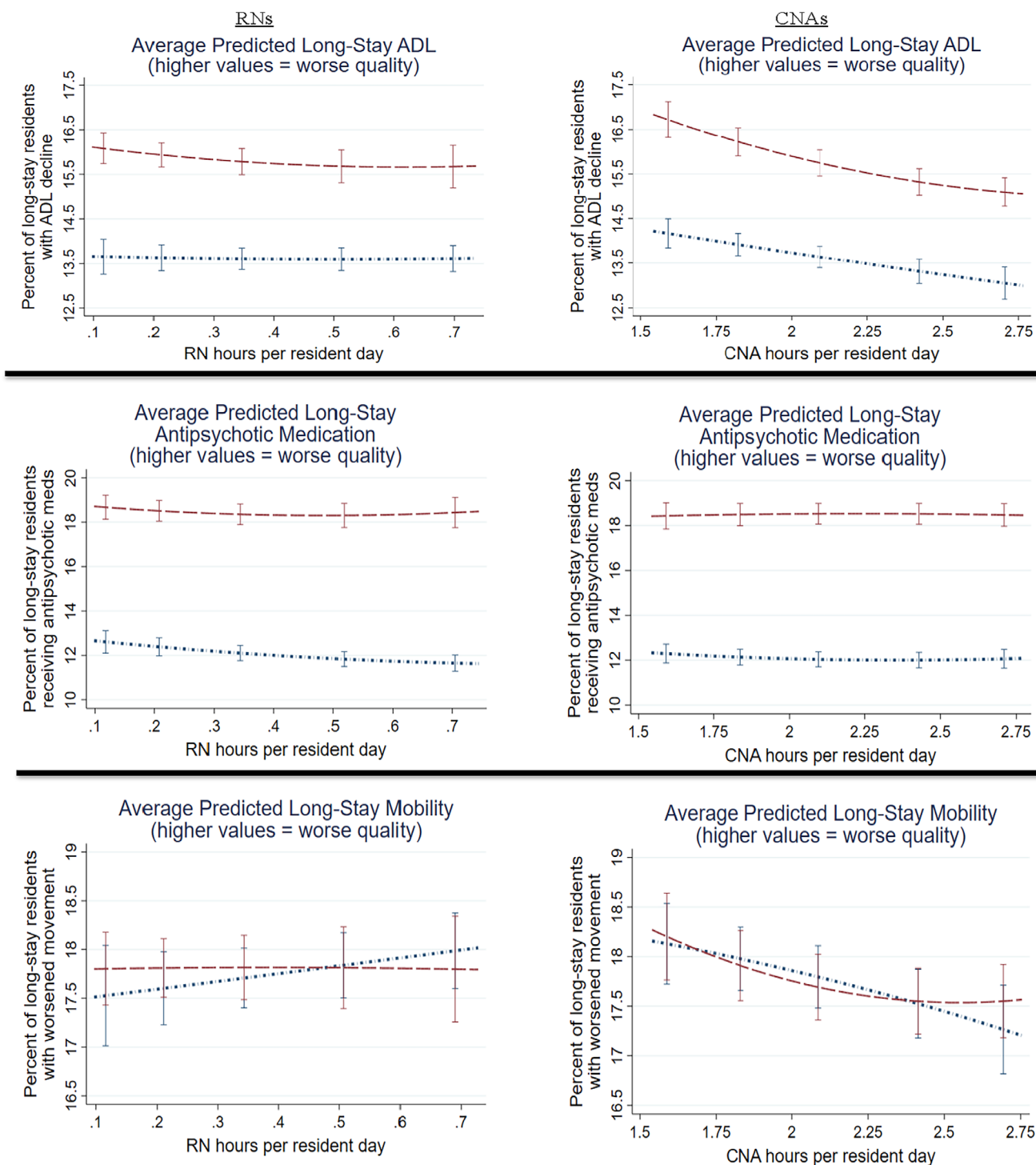
<sup>b</sup>Based on t-test where  $H_0$ : Mean for analysis sample–Mean for excluded sample = 0.

<sup>c</sup>Based on chi-square test where  $H_0$ : There is no relationship between the independent variable and the analysis sample status.

and 12.5 were Black. 72.6% of nursing homes were for-profit and 59.1% were part of a chain. Most variables were significantly different ( $p < 0.001$ ) between the two samples. This is not surprising because our exclusion criteria were designed to exclude nursing homes based on specific criteria, including the likelihood of post-acute care

based on patient care and percent ADRD-CI and outlier staffing levels.

The estimated models are presented in the Appendix. Figure 1 presents the predicted production functions, based on the estimated models. Because we are interested in the relationship between



**FIGURE 1** Long-stay outcomes as functions of registered nurses (RNs) or certified nurses assistants (CNAs) hours per resident-day for Low (40% blue, dotted lines) and High (80% red, dashed lines) Alzheimer disease or related dementias (ADRD)-cognitive impairment census. Solid vertical lines represent the 95% confidence intervals at the 10th, 25th, 50th, 75th and 90th percentiles of the hours per resident-day. [Correction added on 25 January 2024, after first online publication: Figure 1's legend has been updated to mention 'blue, dotted lines' and 'red, dashed lines' for clarity.]



staffing and outcomes, the graphs display each outcome as a function of either RN or CNA HPRD. Each chart presents two functions, one for high- (80%-red dashed lines) and one for a low- (40%-blue dotted line) ADRD-CI census nursing home. All other variables are set to the sample average values. The graphs also indicate the 95% confidence intervals for staff HPRD at 10th, 25th, 50th, 75th, and 90th

percentiles for the sample, offering a perspective of where the mass of the sample with respect to staffing is located on the X scale. Because all QMs are adverse events, lower values on the Y-axis indicate better quality. On the left side of the page, we present predictions as functions of RN HPRD and on the right predictions as functions of CNA HPRD, both for the same QM.

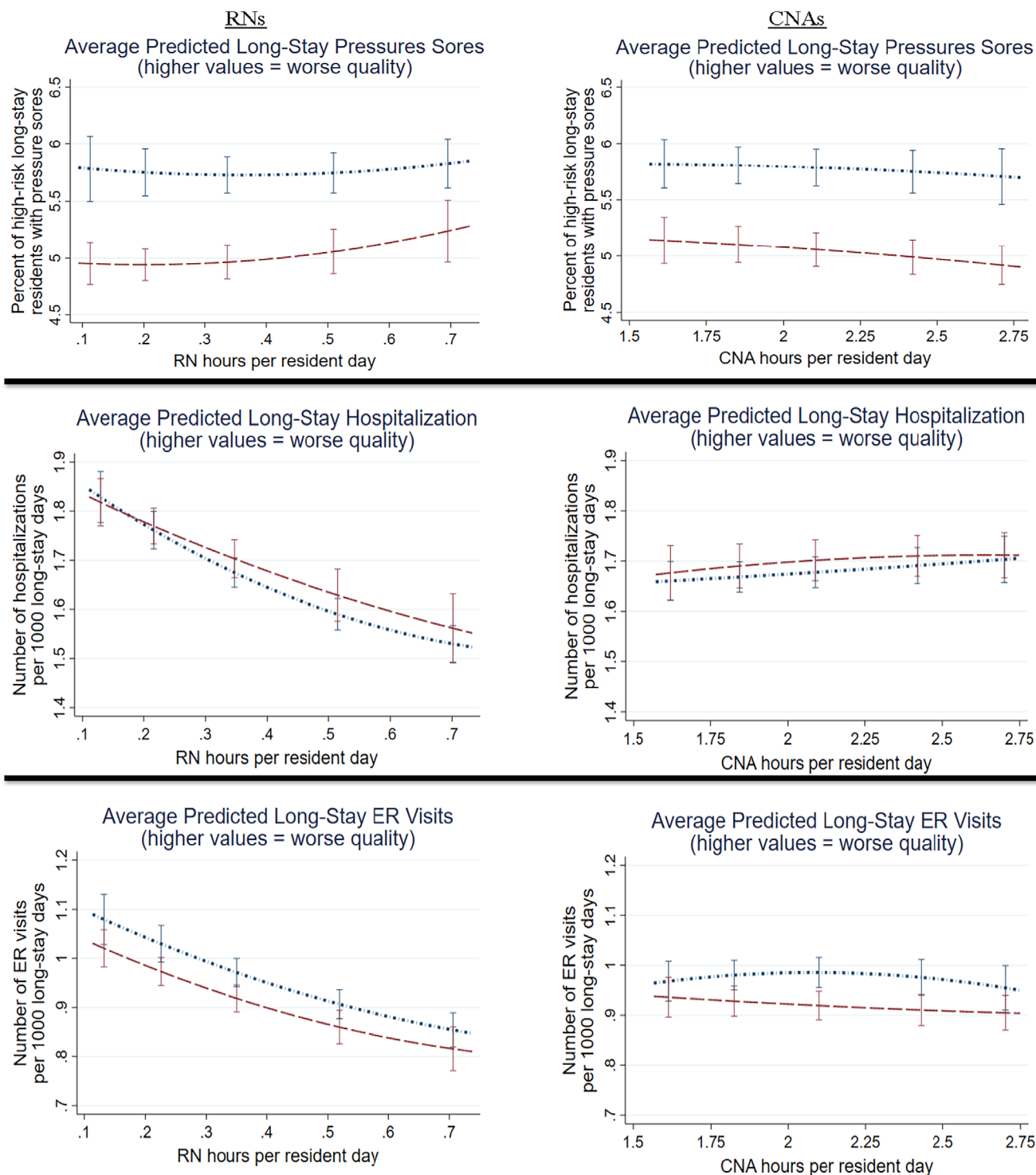


FIGURE 1 (Continued)



We first discuss the average predicted values, which can be determined by reading the values of each line off of the Y scale. Several observations are noteworthy. First, the average predicted values, that is, the position of the red and blue lines relative to each other, or in other words, the answer to the question “do the high or the low ADRD-CI nursing homes offer better outcomes?” is mixed. For two of the six outcomes (antipsychotics and ADLs for both RNs and CNAs) the low ADRD-CI facilities have better outcomes. For two outcomes (movement and hospitalization for both RNs and CNAs) there is no significant difference, and for the last two outcomes (pressure sores and ER visits) the high ADRD-CI facilities have generally better outcomes. For the ER visits the differences between the high and the low ADRD-CI curves are not significant at the extremes (for the 10th and the 90th percentiles for both RNs and CNAs). Second, the magnitude of the differences in outcomes between the high and the low ADRD-CI nursing homes as a function of staffing varies. We measured the percent difference between the average predicted outcomes of the high and the low ADRD-CI facilities at their 50th percentile HPRD relative to the better outcome curve (i.e., lowest curve). These percentages are about 8, 14, and 15 for the long-stay ER visits, pressure sores, and ADL outcomes respectively and about 53 for the antipsychotic medications. However, they are very similar for the RNs and CNAs within each outcome. Third, in many cases, the production functions exhibit positive returns from an increase in staffing HPRD,

that is, a decreasing slope as staffing increases, implying that as staff increases outcomes improve. An example is the ADL outcome, which declines throughout the range of HPRD, much more so for CNAs and RNs in the high ADRD-CI nursing homes than for RNs in the low ADRD-CI facilities.

The other property of the production function that is of importance is the slope of the function. We discussed it above in terms of the positive returns from HPRD increases. But here we are interested in the question of whether the slopes, or the average marginal effects at different levels of staffing for nursing homes with high and low ADRD-CI census are the same or not. In other words, as the two types of nursing homes increase staff by the same amount, is the gain in improvement the same in both the low and the high ADRD-CI census nursing homes? Table 2 addresses this question. It presents the differences in average marginal effects between the high and the low ADRD-CI nursing homes at the 25th and the 75th percentile staff level for both RNs and CNAs and the confidence intervals for the test that these differences are different from zero. As the table shows, in none of these comparisons do we find that the average marginal effects between the high- and the low-dementia nursing homes are significantly different.

The sensitivity analyses with respect to the inclusions of nursing homes with staffing data at the top and bottom 1% staffing and defining the high ADRD-CI as those facilities with 90% census dementia residents led to similar results.

**TABLE 2** Differences between the average marginal effects (Change in outcomes associated with an increase of one unit of HPRD in staffing) for facilities with High (80%) ADRD-CI and Low (40%) ADRD-CI census<sup>a</sup>.

|   | RN HRPD average marginal effect                                      |  | CNA HRPD average marginal effect                                     |  |
|---|--|--|--|--|
|   | Difference <sup>b</sup> at the 25th percentile of staffing [95th CI] | Difference <sup>b</sup> at the 75th percentile of staffing [95th CI] | Difference <sup>b</sup> at the 25th percentile of staffing [95th CI] | Difference <sup>b</sup> at the 75th percentile of staffing [95th CI] |
| Long-stay outcomes  |  |  |  |  |
| Percentage of residents whose need for help with activities of daily living has increased | -1.16 [-3.38, 1.06]  | -0.36 [-1.72, 1.00]  | -0.91 (0.05) [-1.81, -0.01]  | -0.08 [-0.80, 0.64]  |
| Percentage of residents who received an antipsychotic medication                          | 0.78 [-1.76, 3.33]   | 1.45 [-0.21, 3.11]   | 0.73 [-0.21, 1.67]   | -0.15 [-0.92, 0.61]  |
| Percentage of residents whose ability to move independently worsened                      | -0.73 [-0.35, 2.07]  | -0.85 [-2.48, 0.78]  | -0.38 [-1.46, 0.69]  | 0.67 [-0.20, 1.55]   |
| Percentage of high-risk residents with pressure ulcers 2017–3rd Quarter 2018              | 0.30 [-1.18, 1.77]   | 0.48 [-0.41, 1.37]   | -0.10 [-0.66, 0.46]  | -0.10 [-0.54, 0.35]  |
| Number of hospitalizations per 1000 resident days   | 0.19 [-0.13, 0.51]   | 0.02 [-0.17, 0.21]   | 0.02 [-0.11, 0.14]   | -0.03 [-0.13, 0.07]  |
| Number of outpatient emergency department visits per 1000 resident days                   | 0.03 [-0.24, 0.29]   | 0.04 [-0.12, 0.19]   | -0.08 [-0.20, 0.05]  | 0.03 [-0.05, 0.12]   |

Abbreviations: ADRD-CI, Alzheimer disease and related dementias–cognitive impairment; CI, Confidence interval; CNA, certified nurse assistant; HPRD, hours per resident day; RN, registered nurse.

<sup>a</sup>ADRD-CI means Alzheimer disease and related dementia and/or cognitive impairment.

<sup>b</sup>Difference is defined as the average marginal effect at high ADRD-CI nursing home minus the average marginal effect at the low ADRD-CI nursing home.

## 4 | DISCUSSION

This paper was motivated by the fact that most nursing home residents with ADRD-CI reside in general nursing home beds, some in facilities in which they comprise a relatively small fraction of the residents and others in facilities in which they are a large majority, but very few in dementia special care units.<sup>1</sup> This led us to hypothesize that nursing homes serving a large percentage of ADRD-CI residents might have adjusted their operations to the unique needs of these individuals and provide care using different production processes and technologies than nursing homes with a low census of ADRD-CI residents. To examine this possibility, we estimated six production functions, focusing on the relationship between staffing HPRD, the most important input into care for these residents, and long-stay health outcomes that are relevant for this population.

The production functions we estimated have several properties of interest. The first is the return to increases in staffing. As staffing HPRD increases, do outcomes improve, remain the same, or deteriorate? In most cases, we find that outcomes either improve or remain the same as RN and CNA HPRDs increase, either for all levels of staffing or most. This is the case for both the low and the high ADRD-CI facilities, suggesting that residents in both facility types would benefit from increasing staffing at all staffing levels, whether they are currently staffed at a low or a high level of HPRD.

Second, we found that there are no differences for any of the outcomes in the marginal effects between the high and the low ADRD-CI facilities at either the low staffing level (25th percentile) or a high staffing level (75th percentile). This means, that as each facility type increases staffing, at the margin each remains on its own trajectory (of outcome vis a vis HPRD), which are basically parallel, and do not intersect. In other words, if the high ADRD-CI nursing home started on a production function that is at a higher level than the low ADRD-CI nursing home, as is, for example, the case with ADLs, it will remain on that trajectory (the red line) and while improving its performance, its range of improvement will be limited to improvement on its own trajectory, and will not cross over to the lower line/trajectory exhibited by the better outcomes achieved by the low ADRD-CI census facility.

In fact, we find that ADRD-CI high census facilities exhibit worse performance in two outcomes—antipsychotics and ADLs, have similar performance in two—independent walking in hallways and hospitalizations, and better performance in two—pressure sores and ER visits not followed by hospitalizations (except in the extremes, for low and high staffing levels). These findings suggest that both facility types might be able to improve their production function trajectories if they were able to shift to the production function of the other facility type. This shift might require changes in staff training, turnover, stability, or organization, all critical aspects of staffing that are not captured in HPRD. A study of the type we have performed, relying on large clinical data sets, is, however, limited in its ability to inform about the reasons underlying these findings and is unable to answer the question of what do nursing homes need to do in order to move to a different production function.

Different types of studies, looking at the clinical differences in the processes of care utilized by the facilities caring for the different populations are needed. We can only speculate on some of the reasons that might underlie the differences we observe. For example, one might speculate that the poor performance of the high ADRD-CI nursing homes regarding the antipsychotic medication outcome is a reflection of the high prevalence of behavioral issues, anxiety, and aggression among residents with ADRD that can be minimized by staff that have received specialized training in handling such behavioral issues. Lacking such training it is likely that facilities will resort to using antipsychotic medication. The need for using such medications is less likely to arise in nursing homes with a lower census of residents with ADRD. Similarly, the poor performance on ADL outcomes may reflect the nature of these outcomes that often require the resident's active participation, which is more likely to be obtained by staff that has been specifically trained in techniques designed to communicate with residents with ADRD. These are, however, only speculative explanations. Further research is required to better understand where the potential for improving care lies. While increasing staff is clearly beneficial, it does not seem to provide the full answer.

We also note that we intentionally examined pre-COVID 19 data in order to study “business as usual” patterns. However, the pandemic had a major impact on nursing homes, their staff and their residents, revealing stress points in the system.<sup>17</sup> While studies did not find a significant relationship between infection deficiencies and COVID-19 outcomes in nursing homes,<sup>18</sup> the pre-COVID CMS regulation addressing infection controls was considered inadequate and has been strengthened only recently.<sup>19–21</sup> And while the COVID-19 Public Health Emergency is officially over as of May 2023, significant shifts in patterns of admissions and staffing may persist. In particular, if the labor shortages plaguing the long-term care industry<sup>22,23</sup> continue for a significant period of time, residents' health outcomes may deteriorate further. And while the absolute levels of staffing and quality may have shifted post-pandemic, we doubt that the underlying relationships we reveal between staffing and outcomes in high-dementia and low-dementia facilities have significantly changed.

The Biden Administration has recently proposed federal minimum staffing regulations.<sup>24,25</sup> This initiative will invest \$75 million to help recruit, train, and transition workers into nursing home careers as nursing staff, in addition to existing programs<sup>17</sup> to increase the number of nurses entering the labor force, and hence might decrease the labor shortages observed in the industry. However, implementation of the regulation is not immediate. It is currently undergoing a public response period and will then have a two to 5-year implementation time frame.<sup>25</sup> Hence, it is unclear how soon or how completely this initiative will address nursing home labor issues and quality of care.

Several limitations of this study should be mentioned. First, as noted above, this study type can only identify opportunities for improvement, and suggest areas for further investigation. In particular, other staffing characteristics in addition to HPRD, such as turnover<sup>5</sup> and instability<sup>26</sup> that have been shown to be associated with outcomes should be investigated as should specialized training. Second, like all studies relying on administrative data of this type, this study is

limited in its ability to control for patient heterogeneity. While both the CMS QMs and our regression models adjusted for information about patient risks, this adjustment is never perfect and may not account completely for differences. Finally, our complex methodology, while it has the advantage of allowing us to investigate the differential impact of staffing HPRD on residents with ADRD-CI, it also has the limitation of being data intensive and limiting investigation of other potential factors of interest. For example, one might wonder whether, in nursing homes that have dementia special care units, there may be spill-over effects of better care practices, although the evidence-base about their performance is mixed.<sup>7,8</sup> Other areas that would be of interest is whether issues of racial disparities, which exist in nursing home quality care in general, or whether dementia severity matter in this context as well. Future studies of both large data sets focused on specific QMs and smaller, well-chosen samples that can rely on more detailed data, might be pursued to study these questions.

In conclusion, this is the first study to our knowledge to investigate the staffing/outcome relationship in the context of the ADRD-CI census of the nursing home. We have embarked on this study in order to offer insights into the complex, three-way relationship between outcomes, staffing, and ADRD-CI. We have shown that increasing staffing will generally be beneficial irrespective of ADRD-CI census, but that increasing staffing hours alone is likely not enough to dramatically reduce adverse outcomes. Furthermore, when it comes to outcome levels, individuals with ADRD-CI who reside in general nursing home beds, not part of a special care unit, experience better outcomes in some cases, the same outcomes in some, and worse outcomes in others. These differences suggest specific areas for improvement that can be targeted toward nursing home residents with ADRD-CI.

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## CONFLICT OF INTEREST STATEMENT

None of the authors have any conflict of interests.

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## SUPPORTING INFORMATION

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

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