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Original Study

Changes in Nursing Staff Levels and Injury-Related Emergency Department Visits among Assisted Living Residents with Alzheimers Disease and Related Dementias



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A B S T R A C T

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Objectives: To examine the relationship between changes in nursing staff-hours per resident-day and injury-related emergency department (ED) visits among assisted living (AL) residents with Alzheimer disease and related dementias (ADRD).

Design: Retrospective cohort study.

Setting and Participants: We leveraged a data set of AL community characteristics in Ohio linked to Medicare claims data from 2007 to 2015.

Methods: We estimated Poisson models examining the relationships of personal care aide, registered nurse (RN), licensed practical nurse (LPN), and total nursing hours with injury-related ED visits. Models were adjusted for resident characteristics (ie, age, race, sex, dual eligibility, presence and number of chronic conditions), AL community characteristics (percentage of residents on Medicaid, average resident acuity), year fixed effects, and assisted living fixed effects. We examined all injury-related ED visits and injury-related ED visits resulting in hospital admission as separate outcomes.

Results: The sample included 122,700 person-months, representing 12,144 fee-for-service Medicare beneficiaries with ADRD within 455 different AL communities in Ohio between 2007 and 2015. Median total nursing hours increased from 1.34 in 2007 to 1.69 in 2015. In the fully adjusted model, an increase in 1 RN-hour per resident-day was associated with a decrease in the risk of any injury-related ED visit (incidence rate ratio 0.59, 95% CI 0.36-0.96), representing a 53% decrease. Changes in RN-hours were not associated with injury-related inpatient hospitalizations. Changes in total nursing, LPN, and personal care aide hours were not associated with changes in the risk of injury-related ED visits or inpatient hospitalizations.

Conclusions and Implications: Increases in RN staffing hours were associated with reduced injury-related ED use among AL residents with ADRD. RNs provide surveillance and care oversight that may help mitigate injury risk, and they are able to physically assess residents at the time of a fall and/or injury, which can preempt unnecessary ED transfers.

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Assisted living (AL) communities are residential long-term care settings home to more than 1 million adults in the United States who need assistance with daily activities.¹ AL communities provide housing, personal care, at least 2 meals a day, and oversight 24 hours a day. In contrast to nursing homes, AL communities are

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primarily regulated by states rather than the federal government.¹ Although federal regulations require nursing homes to have at least 1 registered nurse (RN) on site 8 hours per day 7 days a week, and most states require nursing staff levels above that. Only 42% of AL communities in the United States had an RN on site in 2018.² Although AL residents typically have fewer comorbidities and are less functionally impaired than nursing home residents, they nonetheless have substantial chronic care needs.¹ More than 32% of the individuals who reside in US AL communities have Alzheimer disease and related dementias (ADRD).² Approximately 77% of AL residents need assistance with bathing and 26% need assistance with eating.³

A key tension in the AL sector is how to preserve residents' autonomy and dignity while also maintaining their safety.¹ Individuals with ADRD who reside in AL are at increased risk of injury-related emergency department (ED) visits when compared to AL residents without ADRD.^{4,5} The most common cause of injuries among older adults is falls,⁶ but injuries also occur as a result of accidents, abuse, and medication errors.^{7,8} ED visits among older adults are associated with functional decline, nursing home admission, and mortality.⁹ These fast-paced and crowded care settings can be especially distressing and disorienting for individuals with ADRD, who are prone to sensory overload, delirium, and may have difficulty comprehending discharge instructions.¹⁰ Thus, examining risk factors for injury-related ED use may be an important step in preventing the need for potentially harmful ED visits.

Many studies have demonstrated that individuals have better outcomes in nursing homes where nursing staff—that is, RNs, licensed practical nurses (LPNs), and personal care aides—are present in sufficient numbers.^{11–14} The strongest positive relationships have been found between RN staffing levels and outcomes.^{13,14} Research in the nursing home setting on the relationship between nursing staff levels and injuries has generally found higher nursing staff levels to be associated with lower rates of injuries.^{15–18} Insufficient staffing contributes to missed nursing care, where necessary care tasks such as resident surveillance and assistance with toileting and ambulation are left undone or inconsistently provided.^{19,20} Missed care is associated with injuries due to falls and medication errors.^{21,22}

AL communities differ from nursing homes in their staffing and service availability, typically providing fewer hours of care by licensed nurses.³ There is also substantial variability among AL communities in their models of staffing. For example, some AL communities employ multiple RNs and LPNs to manage higher resident acuity, while other AL communities provide low hours of mostly LPN care.²³ This variability may have emerged in part as a result of states differing in their approaches to regulating in AL.^{23–25} The most common type of state regulation is “as needed” staffing, where staff levels are loosely required to meet residents' needs.¹

Previous work has found a relationship between nursing staff levels and all-cause hospitalizations among AL residents,^{26–28} particularly in communities with a high dementia case mix.²⁸ More stringent state direct care staffing regulations were associated with reduced hospitalizations among AL residents,²⁴ whereas more stringent state requirements for direct care staffing were associated with higher perceived patient safety culture.²⁹ However, we are aware of no published studies to date that have examined the relationship between changes in nursing staff levels in AL and injury-related ED use. One reason for the relatively few studies on AL staffing, compared with the wealth of studies in nursing homes, is the lack of data on staffing levels in AL. To address this gap, we linked a longitudinal data set of AL characteristics to Medicare claims and explored the relationship between changes in nursing staff levels and injury-related ED visits among AL residents with ADRD.

Methods

Data

Data on AL characteristics, including nursing staff levels, came from the Biennial Survey of Long-Term Care Facilities, an online survey of AL communities and nursing homes in the state of Ohio that is administered by the Scripps Gerontology Center every 2 years. The survey incorporated questions related to staffing hours, average resident census per month, resident primary payer source, and issues such as emergency preparedness. Response rates for this survey are very high ($\geq 80\%$ each year). This high response rate is attributable to the fact that the Ohio legislature requires that administrators answer the survey and because the Scripps Gerontology Center performs extensive follow-up with administrators.³⁰ The survey represents one of the longest-standing data collection efforts of AL communities in the nation. Please see the Brown University digital repository for more information about the data set and how it was cleaned to account for implausible values.³¹

The AL address information and bed size data came from a national registry of AL communities collected from state licensing agencies. AL resident characteristics came from Medicare administrative data. Specifically, data on resident demographic characteristics came from the Medicare Master Beneficiary Summary File; the Chronic Conditions Warehouse (CCW) segment contained beneficiaries' chronic conditions. The Residential History File was used to exclude individuals who were residing in non-AL settings (ie, hospital and nursing home) at the beginning of each month; this file provided information where a beneficiary received services on each day using Medicare claims and assessment data.³² We used the inpatient Medicare Provider Analysis and Review files and the outpatient Medicare claims to obtain ED visits. Please see [Appendix B](#) for more information regarding how ED visits were identified. We included Medicare data and Biennial Survey of Long-Term Care Facility data from years 2007, 2009, 2011, 2013, and 2015. The 2010 Rural-Urban Commuting Areas Codes were linked to AL addresses to define the rurality of AL communities. We used the ZIP-code-level version of this file.³³

Sample Selection

We first identified a repeated cross-sectional sample of AL residents who resided in AL on the first day of each study month following a previously published methodology.³⁴ We created a finder file of ZIP+4 codes representing ≥ 25 -bed AL communities in Ohio. Using the finder file, we searched Medicare beneficiaries' residential ZIP+4 codes within the Medicare enrollment file to identify individuals who lived in a ≥ 25 -bed AL community on the first of each month. We excluded individuals who were enrolled in Medicare Advantage within the year or the prior month, as data on chronic conditions and ED visits were not complete for these individuals. We also excluded individuals who did not have an ADRD diagnosis at the beginning of the month. We identified individuals with ADRD at the beginning of the month using the CCW flag that documents the first time the beneficiary met claims criteria for ADRD, which classified individuals who had at least 1 home health, inpatient, outpatient, carrier, or skilled nursing facility claim with one of 22 *International Classification of Diseases, Tenth Revision (ICD-10)* codes pertaining to dementia.^{35,36} We then matched our sample of AL residents to AL community characteristics in the Biennial Survey of Long-Term Care Facilities for AL communities that had complete data for at least 2 waves. For more information about the sample selection process, please see [Appendix A](#).

Table 1
Staff-Hours per Resident-Day, by Year

	2007, Median (IQR)	2009, Median (IQR)	2011, Median (IQR)	2013, Median (IQR)	2015, Median (IQR)
Personal care aide—hours per resident-day	0.96 (0.46, 1.40)	1.05 (0.63, 1.53)	1.14 (0.66, 1.62)	1.15 (0.88, 1.59)	1.17 (0.77, 1.59)
LPN—hours per resident-day	0.28 (0.13, 0.46)	0.33 (0.20, 0.50)	0.39 (0.25, 0.54)	0.44 (0.29, 0.60)	0.45 (0.29, 0.60)
RN—hours per resident-day	0.002 (0.00, 0.004)	0.05 (0.00, 0.14)	0.03 (0.00, 0.11)	0.04 (0.00, 0.11)	0.03 (0.00, 0.11)
Total nursing staff—hours per resident-day	1.34 (0.69, 1.80)	1.57 (1.00, 2.16)	1.65 (1.03, 2.21)	1.75 (1.32, 2.26)	1.69 (1.26, 2.24)

Data come from 455 assisted living communities in Ohio.

Measures

We created a count of the number of times an individual residing in AL at the start of each month had an injury-related ED while in assisted living (ie, not in a nursing home) in each of the 60 study months. We classified whether an ED visit represented an injury using the New York University algorithm, which categorized ED visits in administrative data by type using *International Classification of Diseases, Ninth Revision (ICD-9)* or *ICD-10* codes.^{37,38} We classified injuries into 2 separate outcomes: (1) a count of any injury-related ED use regardless of whether it ended in a hospitalization within the month and (2) a count of any injury-related ED visit that resulted in a hospitalization within the month. As AL communities have varying thresholds for ED transfer following a resident injury,³⁹ we examined both outcomes to explore whether the relationships were robust when only considering the most severe injuries (ie, those that resulted in a hospitalization). For the codes used to identify ED visits and the most common diagnoses in the sample, please see [Appendix B](#).

Our primary exposures were changes in the levels of total nurse staffing and levels of RNs, LPNs, and personal care aides. We operationalized staffing levels as staff-hours per resident-day, which for brevity we refer to as “staff-hours.” The numerator was the number of nursing staff-hours provided per day by each type of staff. Administrators were asked what pay schedule was used for the majority of their employees; they were then asked to provide the total number of hours (contract and noncontract) that each type of employee worked

during a payroll period. After adding contract and noncontract hours together, we converted the hours to a per-day format. The denominator was the number of residents on the average day. Administrators were asked to provide the average number of residents in their AL community during each month in the calendar year. We averaged this number across months to create our denominator.

At the resident level, we included age (categorized <65, 65–74, 75–84, 85–94, ≥95), race/ethnicity [Black, Hispanic, white, other race (Asian, American Indian, Alaska Native, Native Hawaiian, or Pacific Islander)], sex, and dual enrollment in Medicare and Medicaid. We adjusted for the presence of chronic conditions associated with injurious falls including arthritis, atrial fibrillation, cancer, congestive heart failure, diabetes, depression, ischemic heart disease, osteoporosis, and stroke at the beginning of each study month using the CCW flag that identifies the first time a beneficiary met claims criteria for the diagnosis.^{40,41} We also adjusted for a count of these conditions. At the AL level, to account for resident acuity, we incorporated the percentage of residents with moderate or severe cognitive impairment and the percentage of residents who needed assistance with eating in the past week. We also adjusted for the percentage of residents who had Medicaid as a primary payer source. At the AL level, for descriptive purposes, we included the number of beds, whether the AL community was part of a continuing care retirement community, whether the AL community was for profit, and rurality. Rurality may relate to AL staff workforce resources as well as distance to the nearest ED, which is a correlate of ED use in AL.⁴² Similar to previous work, rurality was

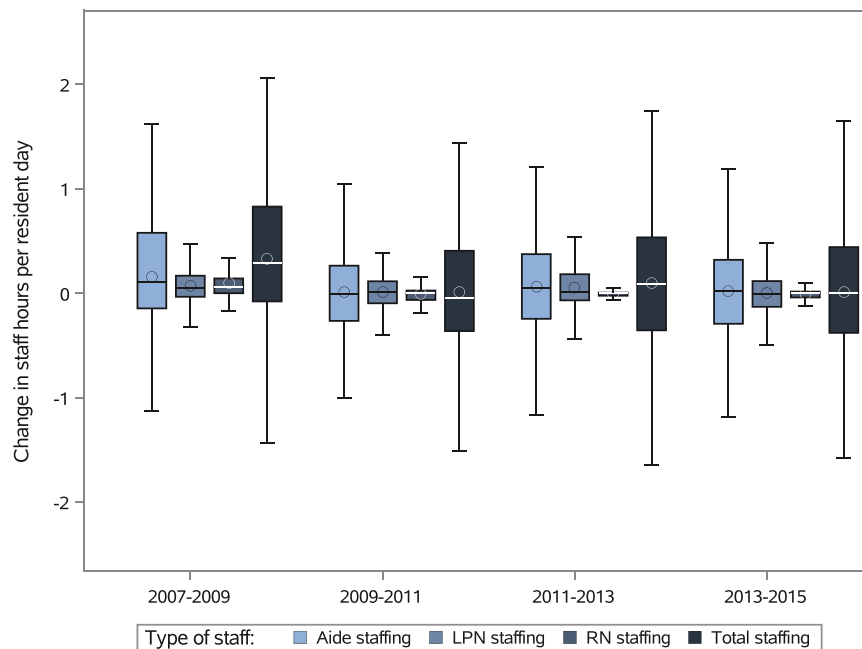


Fig. 1. Distribution of changes in staff-hours per resident-day between 2-year periods, by type of staff. Notes: Outliers (1.5 times the IQR values) are included in the data set but are not displayed in the box and whisker plot. Data come from 455 AL communities in Ohio.

Table 2
Sample Characteristics and Outcomes of Medicare Fee-for-Service Ohio AL Residents With ADRD Between 2007 and 2015 (n = 122,700 Monthly Observations on 12,145 Medicare Beneficiaries)

	Mean (SD) or n (%)
Outcome measures	
Average monthly count of injury-related emergency department visits, mean (SD)	0.027 (0.17)
Average monthly count of injury-related visits that ended in a hospitalization, mean (SD)	0.0069 (0.083)
Resident characteristics	
Age, y, n (%)	
<65	4381 (3.6)
65–74	6724 (5.5)
75–84	29,596 (24.5)
85–94	68,770 (56.0)
95+	13,229 (10.8)
Sex, n (%)	
Male	32,653 (26.6)
Female	90,047 (73.4)
Race or ethnicity, n (%)	
Black	4197 (3.4)
Hispanic	312 (0.3)
White	117,146 (95.5)
Other race*	1045 (0.9)
Dual enrollment, n (%)	19,592 (16.0)
Chronic conditions, n (%)†	
Atrial fibrillation	34,005 (27.7)
Arthritis	97,496 (79.5)
Cancer	25,558 (20.8)
Congestive heart failure	62,779 (51.2)
Depression	77,223 (62.9)
Diabetes	46,882 (38.2)
Ischemic heart disease	84,383 (68.8)
Osteoporosis	58,569 (47.7)
Stroke	45,408 (37.0)
Number of chronic conditions, mean (SD)‡	4.34 (1.8)
Assisted living characteristics	
Rurality	
Rural or small rural town	5571 (4.5)
Micropolitan	23,432 (19.1)
Urban	93,697 (76.4)
For-profit, n (%)	71,126 (58.0)
Continuing care retirement community, n (%)	57,896 (47.2)
Beds, mean (SD)	108.64 (61.9)
Percentage of residents with Medicaid as a primary payment source, mean (SD)	10.46 (17.6)
Percentage of residents who need assistance with eating, mean (SD)	7.71 (15.2)
Percentage of residents with moderate to severe cognitive impairment, mean (SD)	26.99 (26.2)

*Asian, American Indian, Alaska Native, Native Hawaiian, or Pacific Islander.

†Calculated at the AL level.

‡First diagnosed before the present month.

defined using the following categories: urban, large rural city/town (micropolitan), and small rural town/isolated small rural town (rural).⁴³

Table 3
Relationship Between Changes in Staff-Hours per Resident-Day and the Risk of Injury-Related ED Visits Within the Month

Model Adjustment	Model 1 (Model Using Individual Staff Types)			Model 2 (Model Using Total Staff-Hours)		
	IRR (95% CI)	AME (95% CI)	P Value	IRR (95% CI)	AME (95% CI)	P Value
Personal care aide—hours per resident-day	1.02 (0.93, 1.11)	0.019 (−0.069, 0.11)	.68			
LPN-hours per resident-day	0.89 (0.72, 1.10)	−0.12 (−0.33, 0.093)	.28			
RN-hours per resident-day	0.59 (0.36, 0.96)	−0.53 (−1.01, −0.04)	.033			
Total staff-hours per resident-day				0.97 (0.92, 1.03)	−0.03 (−0.09, 0.03)	.300

AME, average marginal effect.

Table shows estimated incidence rate ratio of staff-hours and CIs in parentheses. All models were adjusted for resident characteristics and time-varying AL characteristics (the percentage of residents on Medicaid and average resident acuity).

Analysis

We first described changes over time (2007–2015) in the median and interquartile range of AL nursing staff-hours using box-and-whisker plots for 4 categories: personal care aide, LPN, RN, and total nursing staff-hours. Outliers were excluded from the plots. To evaluate the association between nursing staff-hours and residents' injury-related ED use, we estimated Poisson regression models of the association of the 3 staffing types with the residents' monthly count of injury-related ED visits. Model 1 regressed injury-related ED use on staff-hours of each type in 1 model (RN, LPN, and aide), adjusting for AL fixed effects, year fixed effects, resident characteristics, and time-varying AL characteristics shown in Table 1. Model 2 repeated the sequence of covariates, with total staff-hours per resident-day as the primary exposure. For both models, we estimated incidence rate ratios and average marginal effects for our key measures. The interpretation of these 2 models is the “within AL” effect of changes over time in staff-hours. These models hold constant all other AL characteristics that are consistent over time such as geographic location. The second set of models, shown in Table 3, repeated the analysis using injury-related ED visits that resulted in an inpatient hospitalization as an outcome. In all models, standard errors were clustered at the AL community level. Statistical analyses were conducted using Stata, version 17.0 (StataCorp LLC), and SAS, version 9.4 (SAS Institute).

Results

Our final sample included 122,706 person-months, representing 12,145 fee-for-service Medicare beneficiaries with ADRD within 455 different AL communities in Ohio between 2007 and 2015. The median and interquartile range of nursing staff-hours at the AL community level, by year, are shown in Table 1. On average, median staff-hours increased slightly from 2007 to 2015, from 0.96 to 1.17 for personal care aides and from 1.34 to 1.69 for total nursing staff. In Figure 1, we display the distribution of changes in nursing staff-hours among AL communities between 2-year periods. As shown in the box and whisker plot (Figure 1), there was variation in nursing staff-hours across time. This variability was apparent in all staff categories but most pronounced in the total nursing staff category. For example, as shown in the figure there was little change in the median total nurse staff-hour per resident-day between 2007 and 2009, as well as between 2013 and 2015. However, 50% of communities experienced substantial changes between years 2007 and 2009 (interquartile range −0.078, 0.83) and between 2013 and 2015 (interquartile range −0.38, 0.44).

In Table 2, we display characteristics of the overall sample, as well as average monthly injury rates. The sample was primarily female (73.4%), of white race (95.5%), and aged 85–94 years (56.1%). The AL communities in the sample on average had 109 beds and had for-profit ownership (58.0%).

Table 4

Relationship Between Changes in Staff-Hours per Resident-Day and the Risk of Injury-Related ED Visits That Ended in a Hospitalization Within the Month

Model Adjustment	Model 1 (Model Using Individual Staff Types)			Model 2 (Model Using Total Staff-Hours)		
	IRR (95% CI)	AME (95% CI)	P Value	IRR (95% CI)	AME (95% CI)	P Value
Personal care aide hours per resident-day	1.08 (0.90, 1.29)	0.074 (−0.11, 0.25)	.42			
LPN-hours per resident-day	1.03 (0.67, 1.59)	0.031 (−0.40, 0.47)	.89			
RN-hours per resident-day	0.40 (0.16, 1.04)	−0.91 (−1.85, 0.04)	.061			
Total staff-hours per resident-day				1.034 (0.92, 1.16)	0.033 (−0.081, 0.15)	.57

AME, average misclassification error.

Table shows estimated coefficient on staff-hours and SEs in parentheses. All models were adjusted for resident characteristics and time-varying AL characteristics (the percentage of residents on Medicaid and average resident acuity).

Table 3 reports the association of personal care aide, LPN, RN, and total nursing hours with injury-related ED utilization among residents with ADRD in multivariable models within AL communities. In Model 1, we examined the relationship between an increase in staff-hours of each type (RN, LPN, and aide) and a count of injury-related ED visits. In this fully adjusted model, an increase in 1 RN-hour per resident-day was associated with a decrease in risk of injury-related ED use (IRR 0.59, 95% CI 0.36–0.96). Expressed as marginal effects, this represented a 53% decrease in risk of injury-related ED visits for each RN-hour per resident-day. There was no statistically significant relationship between changes in total nursing staff-hours per resident-day and injury-related ED use. In Model 2, we report the relationship between changes in total nursing hours and injury-related ED use. Similarly, there was no significant relationship between changes in total nurse staffing hours and injury-related ED use.

In Table 4, we display the association between changes in staffing levels and injury-related ED visits resulting in an inpatient hospital admission among residents with ADRD. In Model 1, an increase in RN staff-hours was associated with a reduced probability of injury-related ED visit resulting in an inpatient hospital admission, but did not achieve statistical significance at the .05 level. There were no statistically significant relationships between total nursing hours and injury-related ED visits that resulted in an inpatient hospital admission.

Discussion

This article examines the relationship between changes in staffing and ED use among residents with ADRD in assisted living communities. Specifically, we examined the relationship between changes in nursing staff-hours per resident-day and injury-related ED visits among AL residents with ADRD, a population that is at high risk of injury.

We found that within AL communities, an increase in 1 RN-hour per resident-day was associated with a 53% decrease in the monthly risk of injury-related ED visits. Although all types of nursing staff provide surveillance and safety oversight to prevent falls and injuries within an AL community, RNs are qualified to conduct physical assessments to determine whether an injury is significant enough to warrant an ED transfer.⁴⁴ Previous literature has shown that many AL communities transfer residents to the ED regardless of fall severity, which may be because of a lack of RN presence.⁴⁵ However, additional research is needed to better understand decisions to transfer AL residents to the ED after a fall. RNs may also influence the likelihood of injury and decisions to transfer by providing oversight on care planning, fall and injury risk assessments, medication management, and early identification of changes in resident condition. These findings align with recommendations from a panel of experts who endorsed the importance of presence of an RN in assisted living communities in order to provide high quality care.⁴⁶

After adjusting for resident and AL community characteristics, there was no statistically significant relationship between total nursing staff levels and injury-related ED utilization among AL

residents with ADRD. One potential reason for the lack of statistically significant relationship between total nursing staff levels and injury-related ED use after statistical adjustment is that overall nursing staff levels in AL may be insufficient to provide enough supervision to prevent injuries. The Centers for Medicare and Medicaid Services recommends that a minimum of 4.1 total nursing staff-hours is needed to consistently meet the care needs of residents in nursing homes.⁴⁷ The median total nursing staff-hours was 1.69 in this sample of Ohio AL communities in 2015. In Ohio, AL communities are required to have at least 1 staff member on duty at all times. In addition, “sufficient additional staff members” are required “for the services they perform,” which include care, supervisory, and emotional needs. RNs are only required on site if communities provide skilled nursing care.⁴⁸ This model of staffing is not unique to Ohio, although more and less stringent staffing requirements exist in other states.²⁴ Although overall resident acuity is not as high in AL communities as it is in nursing homes, AL residents with dementia may need more assistance than many AL communities can provide.

Of note, many injuries in AL among residents with dementia may be related to intrinsic factors rather than extrinsic factors such as AL nursing staff levels. Many falls are related to impaired judgment, gait deficits, difficulty with balance and muscle weakness that are considered part of the disease process of ADRD.⁴⁹ To obtain a fuller picture of the staffing and quality relationship in AL, research is needed to examine whether staff-hours are related to other resident outcomes and AL quality metrics.

There were some limitations to this analysis. The staffing hours and resident census measures relied on administrator-reported data, which could lead to measurement error. States may consider increasing data collection efforts using auditable systems such as electronic payroll-based data as is now the practice in nursing homes.⁵⁰ Additionally, we used the CCW flag to identify individuals with ADRD, which likely resulted in underidentification and overidentification of ADRD. Relatedly, we measured resident acuity using the presence of chronic conditions. We were unable to measure functional status, frailty, dementia severity, or other clinical metrics important to adjusting for resident acuity. Therefore, there may be residual confounding in our analysis. Additionally, because we limited our facility sample to AL communities with ≥25 beds in Ohio, our results may not be generalizable to smaller AL communities or AL communities in other states. Finally, our data came from 2007–2015, before the COVID-19 pandemic, which has contributed to significant staffing shortages across many long-term care settings.

Conclusions and Implications

We observed that higher RN staffing was associated with a reduced risk of injury-related ED use among assisted living community residents with ADRD. Better data systems are needed to capture both staffing levels and resident outcomes for assisted living communities in order to strengthen this evidence base and inform safe staffing policies for this sector.

Disclosure

The authors declare no conflicts of interest.

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Supplementary Material

Appendix A: Selection of Assisted Living Communities for Inclusion in the Sample

Our cleaned data set of assisted living characteristics consisted of 656 communities with staffing data in at least 1 wave. We further excluded observations that did not match to our national directory of assisted living communities (4), or did not have complete data for at least 2 waves which included observations with implausible changes over time (>2 SD change between years) that were set to missing (134), those who had a capacity of <25 beds (45) and those who did not match to our national sample of assisted living residents (11), for a total of 462 AL communities. After following the exclusion criteria of the residents (below), the total number of AL communities was 455.

Selection of Assisted Living Residents for the Sample

We created a yearly finder file of validated 9-digit zip codes for licensed assisted living communities across the study period using our national directory of AL communities. Using this finder file, we searched beneficiaries' residential zip codes to identify Medicare beneficiaries residing in 25+bed assisted living settings in Ohio with a validated 9-digit zip code pertaining to assisted living on the first of each month. We then matched the Medicare claims data to the Biennial Survey data. If a beneficiary's zip code matched to more than one AL community, we did not include their data. [Figure B1](#) depicts how assisted living residents were further excluded. We excluded person-months from beneficiaries who began the month in settings other than assisted living (ie, hospital, nursing home). We further excluded person-months from individuals with Medicare Advantage coverage within the past two months and from beneficiaries without dementia.

Appendix B: Identification of ED Visits

To identify emergency department (ED) visits, we used two files: the Medicare Provider Analysis and Review (MedPAR) file and the Medicare outpatient claims data set. The MedPAR file contains

information from Medicare beneficiaries' hospitalizations. Within the MedPAR file, claims from a beneficiary's entire stay in the hospital are rolled up into a single record. To identify hospitalizations that began as ED visits, we flagged those that had an ED charge of greater than \$0.00.

The Medicare outpatient claims file contains information about beneficiaries' outpatient stays that did not result in an inpatient hospitalization. Within the Medicare outpatient file, we identified ED visits based on hospital outpatient claims with revenue center codes 0450–0459, 0981. We also included observation stays, which we define as revenue center codes (0762) or Healthcare Common Procedure Coding System codes: G0378; G0379). ED visits that ended in observation stays were categorized as any injury-related ED use. In the outpatient file, multiple claims can be submitted for one ED visit; for example, separate claims can be generated for radiographs and physician services. To account for this, we removed claims with the same hospital provider number and the same patient ID that were generated within a single 72-hour period. ED visits that occurred while the resident was in a nursing home were not incorporated in the analysis.

Classification of ED Visits

The NYU algorithm is a validated measure that was created by researchers at NYU in consultation with a team of expert emergency physicians. The researchers used medical records from a sample of 6 hospitals in Bronx, New York, to compile a set of probabilistic weights according to each patient's primary ED diagnostic code at discharge. The original algorithm used ICD-9 codes; we used a patch that incorporated ICD-10 codes for visits that occurred after October 1, 2015. Visits were assigned a weight for 8 categories based on type and potential severity of the diagnosis. These categories included (1) nonemergent; (2) emergent, primary care treatable; (3) emergent, ED care needed, but preventable/avoidable; and (4) emergent, ED care needed, not preventable/avoidable; (5) injuries; (6) mental health (7) alcohol use and (8) substance abuse, injuries, mental health, alcohol use, and substance abuse were carved out as a separate, mutually exclusive category and were, therefore, given a weight of 1 on a scale of 0 to 1. For this analysis, we focused specifically on injuries. Table B1 displays the most common diagnoses included in the sample.

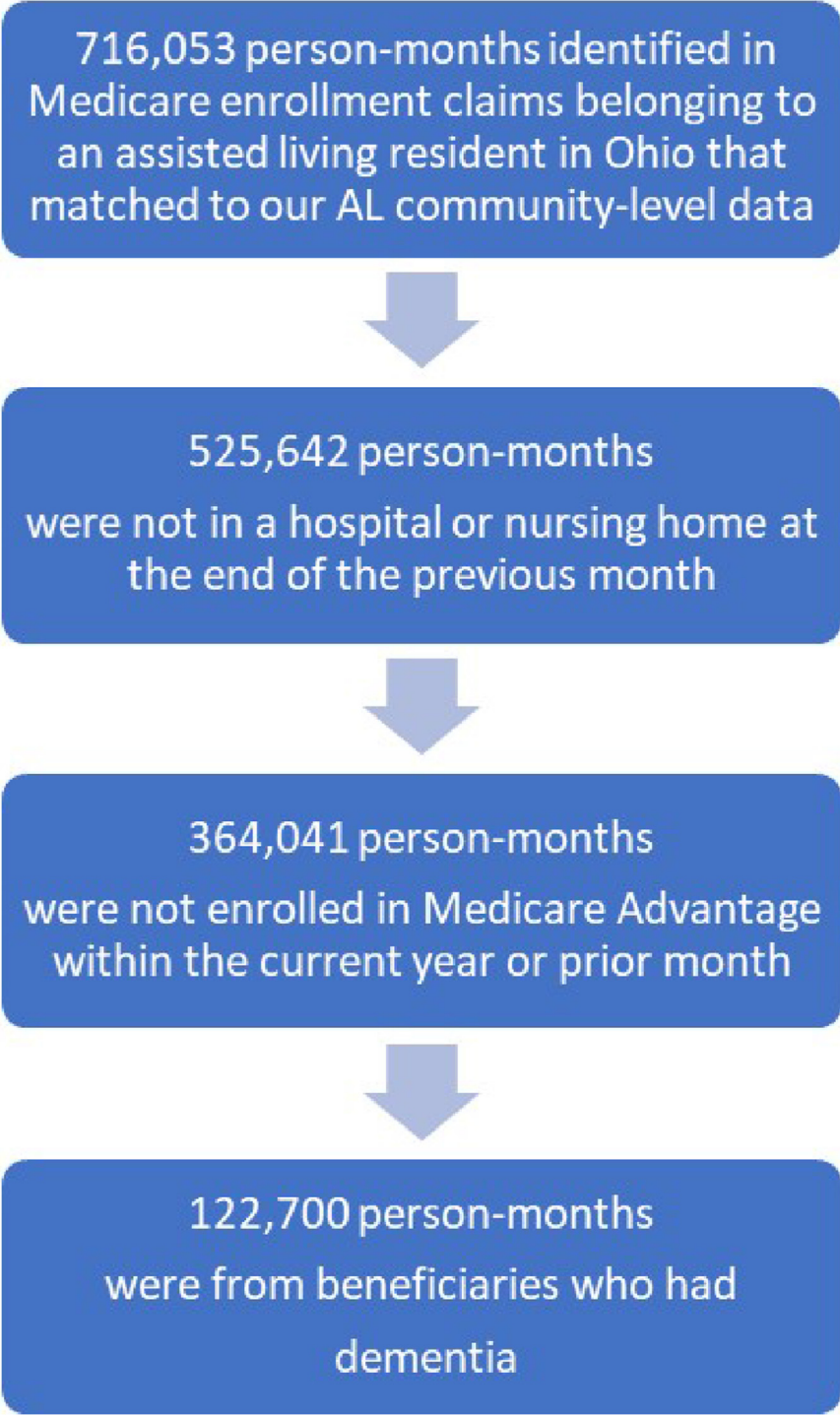


Figure A1. Description of how assisted living residents were selected for the sample.

Table B1
Most Common Diagnoses Included in the Sample

ICD-9 or ICD-10 Code	Diagnosis	Frequency
959.01	Other and unspecified injury to head	574
920	Contusion of face scalp and neck except eye(s)	462
820.21	Displaced intertrochanteric fracture of unspecified femur	257
873.0	Other open wound of head	254
924.01	Contusion of hip	232

ICD-9/10, International Classification of Diseases, Ninth/Tenth Revision.