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Southeastern United States Predictors of COVID-19 in Nursing Homes

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Abstract

This study's aim was to determine nursing home (NH) and county-level predictors of COVID-19 outbreaks in nursing homes (NHs) in the southeastern region of the United States across three time periods. NH-level data compiled from census data and from NH compare and NH COVID-19 infection datasets provided by the Center for Medicare and Medicaid Services cover 2951 NHs located in 836 counties in nine states. A generalized linear mixed-effect model with a random effect was applied to significant factors identified in the final stepwise regression. County-level COVID-19 estimates and NHs with more certified beds were predictors of COVID-19 outbreaks in NHs across all time periods. Predictors of NH cases varied across the time periods with fewer community and NH variables predicting COVID-19 in NH during the late period. Future research should investigate predictors of COVID-19 in NH in other regions of the US from the early periods through March 2021.

Keywords

COVID-19, Nursing home, Southeastern United States

Severe complications from COVID-19 disproportionally affect specific demographic categories including older adults, minorities, and those with compromised immune systems and coexisting morbidities (Centers for Disease Control [CDC], n. d.; Jordan et al., 2020). Among those to experience the highest morbidity and mortality were residents in long-term care facilities. As of March 1, 2021, nursing homes (NHs), who provide care and services for older adults and those with compromised health, accounted for approximately 40% of COVID-19 deaths in the United States (Chidambaram et al., 2020). NH and assisted living residents are more vulnerable to contracting the virus and its subsequent increased harm than their community-based peers (Robinson et al., 2020). NH deaths were as high as 70–80% in Minnesota, Rhode Island, Connecticut and New Hampshire, thus considered "ground zero" for the COVID-19 pandemic (Barnett & Grabowski, 2020; Lau-Ng et al., 2020).

Studies of NH COVID-19 cases during 2020 indicated that increases in community rates of COVID-19 were related to increases in COVID-19 cases in the NH (Abrams et al., 2020; Li et al., 2020; Stall et al., 2020). These findings are similar to those found in other studies that reported NHs in urban locations, with more beds, a higher Medicaid occupancy, and greater percentage Black residents were more likely to have COVID cases (Abrams et al., 2020; Chatterjee et al., 2020; Li et al., 2020; Stall et al., 2020; Travers et al., 2021). Findings differ in whether NH ownership, nurse staffing, or quality ratings influenced positive cases or the number of cases (Abrams et al., 2020; Chatterjee et al., 2020; Li et al., 2020). These findings could be attributable to the data sets used (CMS or state reported counts), regional variations in reporting of cases, or dates used in the study as regions of the US experienced surges during different phases of the pandemic.

The understanding of COVID-19 and its spread has evolved over the past year. However, what hasn't been evaluated are the predictors of COVID-19 in NHs in the southeastern region of the United States throughout the pandemic. Previous findings indicate quality and staffing in NHs varies and depends on geographic location and could vary overtime. One recent study reported that almost 35% of the NHs in the US were located in the south and had overall lower star and nursing ratings than the rest of the country (Yuan et al., 2018). During 2020, regional differences in the spread and impact of COVID-19 were observed across the

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U.S. when NHs in the New England states had surges of cases in May and June, whereas the southeastern states saw surges in NH cases in July and again in November. States in the middle of the country, Kansas, Nebraska, Iowa and Missouri did not see surges until September (Bagchi et al., 2021). Other research showed that mortality and the 30-day mortality rates for NH residents declined during 2020 (Chidambaram et al., 2020; Kosar et al., 2021). In addition, NH home residents who became infected later in the pandemic had lower mortality rates than those in the earlier months (Kosar et al., 2021). A study of COVID transmission in care homes and communities during two different time periods in England showed differences in first wave versus second wave in transmission and case rates as well as regional differences of transmission (Knock et al., 2021). Understanding the mechanisms affecting these outcomes, such as NH quality, resident acuity, ownership, availability of and correct use of PPE, or visitor restrictions, is not clearly understood.

Previous analysis predicted COVID-19 outbreaks in NHs across the US and noted poor predictive variables for the southeastern US compared to other regions (Sugg et al., 2021). This result highlights the need for further investigation at the regional level, particularly in the southeastern US, where geographic predictors of NH COVID-19 may be different from other regions, highlighting a potentially different mechanism for COVID-19 transmission in the NH setting. In addition, an analysis of 30 COVID-19 studies in the US revealed that most of the studies used data from early in the pandemic, but a majority used data from late spring through the summer months (Ochieng et al., 2021). It is possible that these studies do not report on the changes that occurred after summer of 2020. The aim of our study is to determine the NH and community predictors of COVID-19 outbreaks in NHs in the southeastern part of the US across three different time periods. Our results provide further evidence of potential pathways for transmission, outcomes from the changes as the year progressed, and further understanding of the geographic predictors of NH COVID-19 cases in the southeastern US.

Methods

Data and Study Area

The study setting was the southeastern US, which included the states of Kentucky, Virginia, Tennessee, North Carolina, South Carolina, Georgia, Mississippi, Alabama, and Florida. NH data were collected from the CMS using the compare facility files, Long Term Care (LTC) focus files, and NH infection files (CMS, CMS, 2021, LTCFocus Public Use Data, 2017). NH-level data were matched to county-level American Community Survey (5-year estimates from 2012 to 2016) data by geocoding NH locations by their postal addresses and spatially joining them within their respective counties using ArcPro 10.3 20 (Esri Inc, 2020; US Census Bureau, 2020). County COVID-19 cases were obtained from the USA Facts Web site (USA Facts, 2021). COVID-19 cases within NHs were defined as either a suspected or confirmed COVID-19 case in the NH setting and were aggregated for each temporal window. Three separate time periods were considered: (1) Early Pandemic: May 24 to September 26, 125 days (2) Mid-Pandemic: September 27 to December 26, 90 days and (3) Late Pandemic December 27 to February 6, 41 days. The first period captures the initial data collected by NHSN through summer when cases were high in the southeastern region of the US. The second captures the fall where another increase in cases occurred, with the last period covering when vaccinations first began in NH.

At the time of writing and analysis, data were insufficient to evaluate the impacts of the vaccine. Although beyond the scope of this work, similar analyses should be conducted in the future to measure the impact of the vaccine on infection rates.

Variable Selection and Statistical Analysis

A total of 40 variables (Supplemental Table 1) were considered based on previous research on the impacts of COVID-19 on NHs and underlying vulnerabilities in the community (Abrams et al., 2020; Barnett & Grabowski, 2020; Chatterjee et al., 2020; Cutter et al., 2003; Lau-Ng et al., 2020; Li et al., 2020; Stall et al., 2020; Travers et al., 2021). All models examined the number of confirmed and/or suspected cases of COVID-19 (dependent variable) among NH residents in the southeastern US. Variables were selected based on a general linear regression model with a Poisson distribution for the three time periods. Variables were dropped based on backward stepwise regression for both NH and community-level variables, and were constructed separately for each time period (Hastie & Pregibon, 1992). Multicollinearity among variables was addressed using tolerance and variance inflation factor (VIF) analysis as VIF signifies if the variance is inflated due to collinearity among independent variables. Variables with VIF values over five were removed from further analysis (Fox & Weisberg, 2018). The final general linear regression stepwise models were displayed for both community-level variables and NH-levels and across both scales of data including all significant variables (alpha <0.10). These final variables were used in the subsequent analysis to determine the most significant predictors of COVID-19 in the NH setting (Supplemental Table 2).

Multilevel models which account for correct inferences (do not consider each unit of analysis as independent) were constructed to assess for significant predictors of COVID-19 in NHs. A generalized linear mixed-effect model with a random effect was applied to significant factors identified in the final stepwise regression. Models included a random effect term allowing for nesting of NHs within their respective county (random intercepts model). The highest p-values were

Table 1. Descriptive Statistics of Select Variables Used in Study.

	Level	Overall
N		2951
Proportion of the residents whose support is primarily medicaid (mean (SD))		61.98 (23.47)
Proportion of the residents whose support is primarily medicare (mean (SD))		15.83 (14.14)
Acuity index is a measure of the care residents need (mean (SD))		12.75 (1.25)
Proportion of the residents who are female (mean (SD))		58.96 (9.67)
Proportion of the residents who are Black (mean (SD))		24.00 (20.05)
Proportion of the residents who are Hispanic (mean (SD))		3.03 (10.90)
Proportion of the residents who are White (mean (SD))		75.98 (20.98)
Average resource utilization group nursing case index for all resident admitted during calendar year (mean (SD))		1.32 (0.13)
Survey Rating (%)	1	586 (19.9)
	2	683 (23.1)
	3	680 (23.0)
	4	682 (23.1)
	5	320 (10.8)
Quality rating (%)	1	211 (7.2)
	2	466 (15.8)
	3	705 (23.9)
	4	768 (26.1)
	5	796 (27.0)
Staffing rating (%)	1	199 (7.1)
	2	808 (28.7)
	3	919 (32.7)
	4	647 (23.0)
	5	241 (8.6)
RN staffing level adjusted to be comparable across the nation (mean (SD))		0.64 (0.37)
Aide staffing level adjusted to be comparable across the nation (mean (SD))		2.31 (0.50)
LPN staffing level adjusted to be comparable across the nation (mean (SD))		0.97 (0.30)
Total staffing level adjusted to be comparable across the nation (mean (SD))		3.92 (0.81)
Number of fines for the year (mean (SD))		0.43 (0.74)
The total dollar amount of fines for the year (mean (SD))		19910.31 (68290.60)
The number of penalties for the year (mean (SD))		0.50 (0.89)
Total weighted health survey score for three cycles (mean (SD))		46.04 (62.93)
Number of health deficiencies (mean (SD))		15.12 (10.45)
% Total Population: 85 Years and Over (mean (SD))		1.87 (0.79)
% Total Population: Hispanic or Latino (mean (SD))		7.95 (9.75)
Average household size (mean (SD))		2.54 (0.18)
Percentage of civilian population in labor force 16 Years and over: Unemployed (mean (SD))		10.61 (2.70)
Average gross rent for renter-occupied Housing units (mean (SD))		745.30 (242.68)
Percentage of families with income in 2012 below poverty level (mean (SD))		13.40 (4.86)
Percentage of occupied Housing units with No vehicle available mean (SD))		7.03 (2.61)
Percentage of population in nursing facilities (mean (SD))		0.55 (0.31)
Percentage of African American-alone population from 2010 census		0.21 (0.17)
Percentage of native American-alone population from 2010 census		0.01 (0.02)
Percentage of Asian population from 2010 census		0.02 (0.02)
Percentage of Hispanic population from 2010 census		0.08 (0.10)
Population from 2010 census per square mile (mean (SD))		570.73 (838.21)
County-level per capita income (in 2012 inflation adjusted dollars) (mean (SD))		24262.20 (5842.42)
Type of ownership: For profit, not for-profit, government (%)	FOR PROFIT	2210 (74.9)
	GOVERNMENT	117 (4.0)
	NON-PROFIT	624 (21.1)
Number of beds the facility is certified to have (mean (SD))		109.77 (47.88)

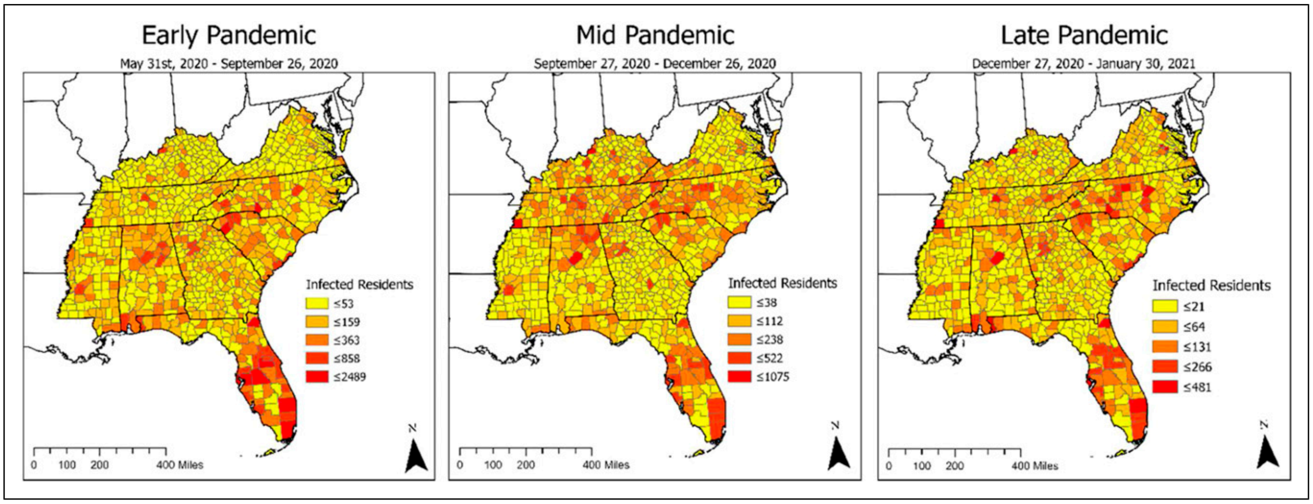

Figure 1. Number of COVID-19 nursing home cases aggregated to the county level for the early (left), mid (middle), and late (right) pandemic. Data are from the COVID-19 data set from the Centers for Medicare and Medicaid Services.

removed from the models one at a time until all variables remaining were significant at alpha <0.10. Models were constructed for the three time periods (1) Early Pandemic (2) Mid-Pandemic and Late-Pandemic. All analyses were conducted in R using the *lme4* package (Bates et al., 2015).

Results

The analyses included 2951 NHs located in 836 counties. More NH cases occurred in the early pandemic period (n = 57,655) than the mid-pandemic period (n = 46,964) and late-pandemic period (n = 31,742), respectively. The average number of cases per day for each period was higher in the later periods than the early periods of the pandemic with 461.24 (SD = 26.19), 521.80 (SD = 23.05), and 774.20 (SD = 16.81) cases reported in NHs in the early, mid, and late periods, respectively. When compared to the daily rate of NH cases, as the pandemic progressed, increases in county cases did not increase NH cases. In the early pandemic there were 34.22 county cases for every one NH case, the mid-pandemic saw 47.26 county cases for every one NH case, and during December through February 59.34 county cases for every one NH case occurred (Table 1). Figure 1 shows the spatial distribution of NH cases.

Final multilevel model results are shown with significant and the most influential predictors for NH COVID-19 cases at both the county and NH level (Table 2). Variables were selected from the stepwise regression results and variables were further removed by eliminating the least significant variable in each model iteration of the multilevel models. Number of certified beds in the NHs and county-level estimates of COVID-19 were the highest predictors of NH cases across all time periods. NHs with more certified beds had higher rates of COVID-19 cases during the early, mid-, and late periods (RR: 1.75, CI: 1.64–1.88; RR: 1.58, CI: 1.48–1.70, RR: 1.61, CI: 1.48–1.74) respectively. The county-level COVID-19 incidence rate ratios were RR:1.55 (CI: 1.43–1.68) in the early and mid-periods and lower in the late period (RR:1.26, CI: 1.15–1.38). In the early period, percent of the general population that was Black (RR: 1.19, CI: 1.10–1.29), percent of the general population that was Asian (RR: 1.25, CI: 1.12–1.38), proportion of NHs residents whose payment source is Medicaid (RR: 1.14, CI: 1.06–1.23), and adjusted nurse aide staffing (RR: 1.31, CI: 1.13–1.52) were the highest predictors of COVID-19 cases in a NH. In the mid-pandemic period, the percentage of families below poverty level (RR: 1.15, CI: 1.05–1.26) and proportion of NH residents whose payment source is Medicare (RR: 1.09, CI: 1.01–1.17) were high predictors of COVID-19 cases. Surprisingly, counties with a high proportion of Black (RR: 0.77, CI: 0.70–0.85) and Hispanic populations (RR: 0.74, CI: 0.68–0.81) had lower rates of COVID-19 cases within the NH. Lower rates of COVID-19 cases in NH were also found during the early and mid-pandemic periods in NHs with higher overall staffing. In the late-pandemic period, December-February, a higher number of NH residents who are female (RR: 1.16, CI: 1.07–1.25) was the only predictor other than higher number of certified beds and county-level estimates of COVID-19 previously mentioned. The variability in predicting COVID-19 in nursing homes decreased throughout the pandemic with higher marginal R2 and conditional R2 in the early, mid, followed by late-pandemic period (Table 2).

Discussion

The present study evaluated the facility and community predictors of COVID-19 outbreaks in NHs in the southeastern part of the U.S. across three stages of the pandemic May-September - 2020, September-December - 2020, and December-February - 2021. The daily rate of infections in both NHs and the community successively increased, yet the

Table 2. Final Multilevel Model Predictors for Nursing Home COVID-19 Cases.

	Early			Mid			Late		
Predictors	Incidence Rate Ratios	CI	*p*	Incidence Rate Ratios	CI	*p*	Incidence Rate Ratios	CI	*p*
(Intercept)	11.17	10.30–12.12	**<0.001**	5.50	5.10–5.94	**<0.001**	2.73	2.47–3.01	**<0.001**
Number of beds the facility is certified to have	1.75	1.64–1.88	**<0.001**	1.58	1.48–1.70	**<0.001**	1.61	1.48–1.74	**<0.001**
The total dollar amount of fines for the year	0.94	0.88–1.00	**0.041**						
Proportion of the residents whose support is primarily medicaid	1.14	1.06–1.23	**0.001**						
Aide staffing level adjusted to be comparable across the nation	1.31	1.13–1.52	**<0.001**						
Total staffing level adjusted to be comparable across the nation	0.72	0.61–0.84	**<0.001**	0.87	0.80–0.93	**<0.001**			
Percentage of Asian population from 2010 census	1.25	1.12–1.38	**<0.001**						
Population from 2010 census per square mile	0.90	0.81–1.00	0.057						
Percentage of Black population from 2010 census	1.19	1.10–1.29	**<0.001**	0.77	0.70–0.85	**<0.001**			
County COVID-19 rates (early)	1.55	1.43–1.68	**<0.001**						
Proportion of the residents whose support is primarily medicare				1.09	1.01–1.17	**0.024**			
Percentage of families with income in 2012 below poverty level				1.15	1.05–1.26	**0.002**			
Percentage of Hispanic population from 2010 census				0.74	0.68–0.81	**<0.001**			
County COVID-19 rates (mid)				1.55	1.44–1.68	**<0.001**			
County COVID-19 rates (late)							1.26	1.15–1.38	**<0.001**
Proportion of the residents who are female							1.16	1.07–1.25	**0.001**
Random effects									
σ^2	2.22			2.60			3.20		
τ_{00}	$2.22_{PROVNUM2:FIPS2}$ 0.24_{FIPS2}			$2.60_{PROVNUM2:FIPS2}$ 0.07_{FIPS2}			$3.20_{PROVNUM2:FIPS2}$ 0.25_{FIPS2}		
ICC	0.10			0.03			0.07		
N	$2555_{PROVNUM2}$ 790_{FIPS2}			$2672_{PROVNUM2}$ 798_{FIPS2}			$2684_{PROVNUM2}$ 801_{FIPS2}		
Observations	2555			2672			2684		
Marginal R^2/Conditional R^2	0.245/0.319			0.180/0.201			0.072/0.140		

ratio of NH cases to community cases decreased. This suggests that NHs were able to better control the spread of the coronavirus in the later stages potentially due to knowledge and implementation of infection control and prevention practices, availability of testing and PPE, and visitor restrictions (Shrader et al., 2020).

The final multilevel model identified variation in the drivers of COVID-19 outbreaks in NHs in the southeast during the early, mid and late stage of the pandemic with the exception of NH size and county-level COVID-19 cases which were strong predictors across all periods studied. Larger NHs often have more residents and staff therefore increasing the opportunity for viruses to enter the building and potentially spread. With visitor restrictions in place from March 2020 to March 2021(CMS, 2020) staff working in multiple NHs were believed to be an unknowing but likely source of spread (Chen et al., 2020). Although county-level COVID-19 cases was a predictor of NH COVID-19 cases across our study, the rate of county cases to NH cases declined, potentially indicating improvements in care. During the May-September months, NH predictors were the proportion of NH residents whose payment source is Medicaid and the adjusted aide staffing level, with community predictors being a higher percentage of Asian and African-American members. Early studies of COVID-19 in NHs across the US reported similar findings (Abrams et al., 2020; Sun et al., 2020). Research has indicated that NHs with a higher Medicaid payer mix, which reimburses at or below costs, have less revenue, often have lower staffing rates, and provide poorer quality care (Harrington, et al., 2015). NHs in the SE with a higher Medicaid payer mix may not have had access to PPE, and infection control and prevention training during this time period. NHs with more nurse aides had more opportunities for the virus to enter the building as studies have shown that asymptomatic spread occurred frequently (Chen et al., 2020). Understanding community demographics where staff live provided critical information on the outbreak and subsequent resident deaths. NHs whose staff live in high density and less white neighborhoods and use public transportation were more likely to experience a NH COVID-19 outbreak (Shen, 2020).

Predictors of COVID-19 outbreaks changed between the early stage of the pandemic and the mid-stage of the pandemic, with fewer community and NH variables predicting COVID-19 cases in NHs in the southeastern US in the mid-stage. During the September-December timeframe, community COVID-19 rate and number of beds were still predictors of COVID-19 outbreaks in NHs. The primary community predictor during the mid-stage was the percentage of the population with family incomes below the poverty line. Poverty itself increased vulnerability and risk of contracting the coronavirus as was seen in the early stages of the pandemic (Buchanan et al., 2020; Wang et al., 2020). Nationally 12% of the population lives below the poverty level, whereas the southeastern states have a higher percentage of counties having over 20% of the population living below the poverty line, when compared to other regions (Chin et al., 2020).

As the current findings reveal, along with previous studies, the early stages were rampant with both racial and socioeconomic disparities in terms of COVID-19 cases and deaths. When it pertains to NH staff, much attention must be directed at the wages and work conditions of nursing assistants and other staff working in NHs. Nursing assistants provide 80% of the care for the residents in NHs, and earn less than a livable wage (Institute of Medicine Committee, 2001). The average national wage for nursing assistants in 2019 was $13.90, with 36% relying on public assistance, 25% on public health insurance and almost 13% live in a household below the poverty level (Scales, 2021). Due to the low wage, many nursing assistants work in two or more NHs which increases the risk of transmission of COVID-19 between NHs (Scales, 2021).

Counties with a higher percent of the population African-American and Hispanic were also less predictive in the later stages of the pandemic, this could be from these populations working in the health care and services industries which during the later time periods required and supplied PPE for their workers.

During the mid-period of the pandemic the only NH predictor of COVID-19 cases in a NH other than size was the proportion of NH residents whose payment source is Medicare. Medicare pays for short term stays in NH unlike Medicaid that pays for care and services for lower income residents who meet state established criteria and often consider the NH their home. During the September to December period, state bans on elective surgeries were lifted and residents were being admitted to NH for rehabilitation or other post-acute care needs. Thus, increasing the number of people entering and leaving the NH and opportunities for the virus to be transmitted.

The variables and the models that were predictive of COVID cases in NHs during the early months of 2020 were found to not be predictive of cases during the December 27, 2020–February 6, 2021 time period. Other than the community COVID-19 rate and number of beds, the percentage of residents who were female was the only predictor of COVID-19 in NHs. Nationally more females (64%) than males (35%) reside in NHs (Harris-Kojetin, et al., 2019). In this study females made up on average 59% of the resident population in NH in the SE. A study of patients with the coronavirus reported an equal prevalence of the disease for males and females, but males were 2.4 times more likely to die than females (Jin et al., 2020). The demographics and gender differences in NH residents following the pandemic deserves further study; initial COVID-19 studies indicate that biological factors and behaviors could contribute to the mortality differences between males and females (Lawton, 2020).

The first COVID-19 vaccines were administered in NHs across the nation beginning December 18, 2020, during the late period of this study. Early research showed a 48% decline in NH cases and a 33% decrease in staff cases 3 weeks after the first vaccination clinic (Domi et al., 2021). Research indicates that unvaccinated residents and staff are three and four times more likely to become infected than vaccinated residents and staff, respectively (Cavanaugh et al., 2021; Domi et al., 2021). Research continues to show the effectiveness of the authorized mRNA COVID-19 vaccines in residents, health care workers, and other essential and front-line workers in preventing SARS-CoV-2 infection (Domi et al., 2021).

The strength of this study is its longitudinal design across three different time periods of the coronavirus pandemic. This study had several notable limitations. First, our analysis was limited to the states in the southeastern region of the US, other regions may differ in the predictors of COVID-19 in NHs during these three different time periods. The data periods contained different time periods (125, 90 and 41 days) which may have affected the findings for the late period as there were only 41 days studied. The study's ecological design limited our analysis to the county-level for the community-level variables and census variables from previous years before the pandemic (2010, 2012–2017). This study is unlike other spatial analysis research on COVID-19, we included two scales of analysis by also incorporating NH data, thus reducing ecological fallacy and scale limitations. This study does not include data on vaccinations for residents or NH staff; it is unknown as to whether the findings would be different. Reports indicate that during the week of December 18, 2020, a total of 713,909 residents and 582,104 staff received the first vaccination dose in 11,460 NHs across the US (Gharpure et al., 2021).

Conclusions and Implications

Our findings highlight the change in predictors of COVID-19 outbreaks in NHs as the pandemic progressed, only two of the drivers identified during the early periods of the pandemic predicted an outbreak in the later stage, community COVID-19 rate and number of NH beds. The decrease in the ratio of NH cases to community cases from the early period to the late period, indicates that NH staff infection control competencies appear to improve over time. This suggests that NHs were able to better control the spread of the coronavirus in the later stages potentially due to knowledge, availability of testing kits and PPE, and visitor restrictions. Research prior to the pandemic indicated implementation of the recent infection control policy changes (CMS, 2016) improved antibiotic stewardship and outbreak control practices in NHs (Agarwal et al., 2020). It is possible that the timing of the regulation provided some preparedness of NH as 39% of NHs in 2018 had a specially trained infection preventionist (Stone et al., 2018). Virtual training provided by the Center for Disease Prevention and Control throughout 2020, potentially contributed to staff knowledge, skill and ability to control spread of COVID during the late stage. Administrators should encourage and support continued participation in education opportunities to increase staff infection control competencies. Policy-makers should consider the education, training, and resource needs of all health care providers and ensure they meet the needs of their stakeholders including distribution of supplies.

In addition, community COVID-19 cases and spread contributed to cases in NHs, therefore future national policies should include community resources that address social determinants of health and inequities that were exacerbated during the COVID-19 pandemic. Leaders should proactively address and support communities at the most basic level (food access, work conditions/policies, access to PPE and health services).

Larger NHs will have more residents and require more staff to provide care and services. Research has shown that the more staff entering the NH the more opportunities there are for transmission (Chen et al., 2020). Using fewer different staff members (i.e. part-time or agency staff) and more consistent staff (i.e. full-time) may contribute to fewer opportunities for spread of infectious diseases in NH (McGarry et al., 2021).

Rate of pay has been a major dissatisfier for NH staff for decades, a study using 2017 and 2018 payroll data reported the average staff turnover to be 128% (Gandhi et al., 2021), staff turnover and shortages increased during 2020 and 2021 (McCall et al., 2021). Recent research indicates that when wages are increased resident safety improves, mortality decreases and staff turnover decreases (Ruffini, 2020). Other factors of dissatisfaction for NH staff are not having adequate staff and resources, poor communication and lack of recognition. For administrators to improve recruitment and retention in NHs, dissatisfaction with the work place environment needs to be addressed including improving communication, recognizing staff for their work, and providing a livable wage (Scales, 2021). Policy-makers need to assess the costs of NH care and service in relation to the Medicare and Medicaid payment structure.

Policy-makers should focus on continued support for NHs to prevent the spread of infectious disease in NH. The U.S. Department of Health and Human Services (HHS) COVID-19 relief funds for health care providers were critical to nursing home solvency due to lost revenues and increases in infection control and staffing expenses from the pandemic. As of January 2021, Medicaid paid for approximately 65% of the care provided by the nation's nursing homes. Of importance is the ongoing concern that Medicaid reimbursement rates do not cover the cost of care and services (National Investment Center for Seniors Housing and Care [NIC], 2021). Monetary policy should focus on funds to hire and retain staff in NH, increasing nurse aide wages to a living wage can contribute to reduced staff shortages and turnover and allow for a more stable full-time workforce (Weller et al., 2020).

It is plausible that the vaccination of residents and staff moderated the early stage predictors of a COVID-19 outbreak in NHs. McGarry et al. reported that higher staff vaccination rates decreased resident and staff cases and deaths (2021), yet as of the end of December 2021 only 80.3% of nursing home staff were vaccinated (CMS, 2021). CMS mandated that all nursing home staff be vaccinated by March 15, 2022 (CMS, 2022), administrators will need to work closely with their staff improving communication and building trust to encourage getting vaccinated versus staff leaving for a job in an industry that does not require a vaccination. Policy-makers should consider the impact of mandatory vaccination in an industry with a crisis staffing shortage.

Future research should investigate predictors of COVID-19 in NH in other regions of the US from the early periods through later March 2021 when many residents and staff were fully vaccinated. The other regions of the US may have different predictors of COVID-19 during the different time periods. Including resident and staff vaccination rates could also contribute to health beliefs and behaviors that could contribute to infection control and prevention efforts and prevent the introduction of new COVID-19 cases and other highly infectious viruses.

With fewer community predictors contributing to outbreaks in the late stage, administrators and policy-makers should also investigate the use of technologies such as use of ultraviolet-C (UV-C) devices (Malhotra et al., 2020), upper-room ultraviolet air disinfection systems (Beggs & Avital, 2020), and robots to sterilize high-touch surfaces to enhance their infection prevention and control programs. Future nursing home construction or renovation projects should evaluate designs such as Green House Models that limit the congestion of residents and features such as antimicrobial copper surfaces (Zerbib et al., 2020) to prevent nosocomial infections.

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Supplemental Material

Supplemental material for this article is available online.

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