The Relationship of Vaccine Uptake and COVID-19 Infections among Nursing Home Staff and Residents in Missouri

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Abstract

Introduction

Older adults living in communal spaces, such as nursing or retirement communities are at greater risk of infection due to close proximity to others, advanced aging-related or medical conditions, and engagement with staff that support multiple clients and facilities. Mobility between residents and facilities may result in staff acting as vectors of COVID-19 infection in these spaces. Vaccine uptake has been shown to markedly reduce the spread of COVID-19, yet there is little data on vaccine uptake and the continued COVID-19 risk among residents.

Methods

Data for this study were extracted from two publicly available. First, Centers for Medicaid and Medicare Services (CMS) public data included characteristics of nursing homes, weekly reported observations of residential COVID-19 cases, and COVID-19 vaccine coverage of staff and residents. Second, average weekly COVID-19 infection rate from Missouri Department of Health and Senior Services (MDHSS) were extracted and aggregated.

A zero-inflated Poisson (ZIP) regression model was constructed to predict (1) if COVID-19 infections were reported, and if so, (2) the number of cases reported using a priori variables as predictors. ZIP regression was used due to the count nature of the outcome and due to the pre-determined overdispersion of observations when zero COVID-19 cases were reported during the study period.

Results

A total of 504 nursing homes were included in the study and 1124 COVID-19 infections were reported during the study period. As the percent of vaccinated staff increased, the risk of COVID-19 infections among residents significantly decreased. Percent of residents vaccinated was not significantly associated with whether COVID-19 cases were reported, nor the number of cases reported. Other factors, such as county COVID-19 rate and CMS staff rating, were significantly associated with COVID-19 cases in nursing homes.

Discussion

This study identified that nursing home staff, likely due to greater mobility, are important to prioritize in vaccination efforts to protect themselves and residents of their facilities from COVID-19 infections. Further, the CMS staff ratings were significant predictors of infection as well, which highlight the structural challenges that exist within and outside the context of a highly infectious and deadly pandemic. These results also provide insights to optimizing vaccination roll-out to best protect our communities' most vulnerable residents.

Introduction

In the United States, COVID-19 infections continue to spread, with outcomes disproportionately affecting specific populations, particularly racial/ethnic minorities.[1] In addition, older individuals, those over the age of 60, are at particularly increased risk of morbidity and mortality associated with COVID-19 due to widely prevalent pre-existing conditions in this age group such as cardiovascular disease and hypertension.[2-3] Within this population of older adults, those living in communal spaces such as nursing or retirement communities are at even greater risk of infection due to close proximity to others, more advanced aging-related or medical conditions, and engagement with staff that may support multiple clients and facilities.[4] This mobility between residents and facilities provides opportunity for staff to act as potential vectors of COVID-19 transmission. Throughout the pandemic, nursing homes experienced significant morbidity and mortality and reports continue of outbreaks occurring at nursing home facilities throughout the country.[5]

As a result, the Centers for Disease Control and Prevention (CDC) has established recommendations for COVID-19 infection control strategies that include routine staff and resident testing, use of personal protective equipment, and implementation of respiratory protection programs.[6] Additionally, the CDC has prioritized healthcare personnel and nursing home residents as first line recipients of the COVID-19 vaccine. However, nursing home healthcare staff may not have been initially perceived in the same manner as those working in hospital settings or those who are credentialed, professional staff (i.e., nurses, physician assistants).

In addition to control strategies, vaccine uptake has been shown to reduce the spread of COVID-19 in the general population.[7] However, despite being a high-risk population, there is little data on vaccine uptake and outcomes among nursing home residents, and what role staff vaccine uptake may play on continued COVID-19 risk among residents. Importantly, how vaccine uptake may differ between staff and residents, and whether vaccine uptake is more effective in mitigating fatal outcomes when focused on staff, residents, or both. These data are crucial for informing organizational and public policy applicable to COVID-19 within nursing homes amidst an ongoing pandemic.

Methods

Study Design and Sample

This study was conducted among nursing home staff and residents in the state of Missouri. Missouri boasts a moderate population size that spans urbanicity and rurality, with a substantial population of African American/ Black residents and has experienced geographically-patterned vaccination and infection rates throughout the state.

Data for this study were extracted from two publicly available sources. Data specific to nursing homes were extracted from the Centers for Medicaid and Medicare Services (CMS) public data

repository. This longitudinal dataset contains characteristics of nursing homes, weekly reported observations of residential COVID-19 cases, and COVID-19 vaccine coverage of healthcare staff and residents from nursing homes and long-term care facilities that utilize reimbursement for public insurance sources.[8] Second, as COVID-19 infection rates in nursing homes may be associated with rates in the surrounding county, data from Missouri Department of Health and Senior Services (MDHSS) were extracted and aggregated to calculate the average weekly COVID-19 rate for each Missouri county.[9]

Weekly observations for this study were limited to nursing homes located within the state of Missouri and occurring between May 24, 2021 and August 29, 2021, a period when vaccine distribution across the state and country was more widely prevalent than earlier in the year.

Measures

The weekly confirmed COVID-19 case count among residents per nursing home was the primary study outcome. New weekly cases of COVID-19 infections were identified among residents of nursing homes and confirmed with one of several diagnostic tests, according to CMS. Observations with missing values were excluded from analysis.

The primary predictors of interest for this study were: 1) the proportion of healthcare staff (e.g., exclusive of maintenance or other support staff) per nursing home who had received a partial or complete COVID-19 vaccination at the time each observation was made; and 2) the proportion of residents per nursing home who had received a partial or completed COVID-19 vaccination at time of each observation. These measures, calculated by CMS, utilize the total number of staff and residents per nursing home, reported each week, as the denominator. For observations with missing values, the respective nursing home average was used.

Additional a priori predictor variables included were: 1) total number of residents ; 2) weekly average COVID-19 rate of the county where the nursing home resides; and 3) most recent CMS staff rating were used as control variables. To the latter point, CMS assigns nursing homes a staff rating of a 1 to 5 composite score, 1 being weakest and 5 being strongest, of staff adequacy based on needs of residents being met and number of hours of care provided on average to each resident each day by staff.

Statistical Analysis

Descriptive statistics of weekly COVID-19 cases among nursing home residents along with a priori variables were assessed.

A zero-inflated Poisson (ZIP) regression model was constructed to predict (1) if COVID-19 was reported, and if so, (2) the number of cases reported. ZIP regression was used due to the count nature of the outcome and due to the pre-determined overdispersion of observations when zero COVID-19 cases were reported during the study period.

Results

A total of 1124 cases of COVID-19 were reported among residents among 504 Missouri nursing homes during the study period. Table 1 details nursing home characteristics.

Table 1. Missouri Nursing Home Descriptive Statistics and Correlation to Weekly COVID-19 Case among Residents (N=504)		
Characteristic	Weekly Average (SD)	25 and 75 Interquartiles
Proportion of nursing home staff partially or completely COVID-19 vaccinated	48.2 (19.7)	34.2, 62.2
Proportion of residents partially or completely COVID-19 vaccinated	84.3 (15.1)	79.4, 94.0
Average number of weekly residents in nursing home	66.2 (34.9)	44, 81
County COVID-19 rate per 1,000 residents	25.4 (21.8)	6.3, 40.6
Staff rating	2.8 (1.2)	2, 4

Each week, there was an average of 48.2% (SD=19.7) of nursing home staff and 84.3% of residents (SD=15.1) were partially or completely vaccinated across Missouri. Nursing homes had a weekly average of 66 residents staying at the facility (SD= 34.9), with a range of 2 to 100. Among the 115 counties in Missouri, the average COVID-19 rate was 25.4 per 1,000 (SD=21.8) and ranged from 0 to 127.6 per 1,000 throughout the study period. On a scale of 1 to 5, the average staff rating of nursing homes was 2.8 (SD= 1.2).

Table 2. Zero Inflated Poisson Regression Model Predicting Weekly COVID-19 Cases Among Missouri Nursing Homes Residents (n=504)			
Part 1: Zero-logistic (Bernoulli Logit Process)			
	Adjusted Odds Ratio	95% CI	P-Value
Number of residents	0.99	0.99, 0.99	0.007
County COVID-19 rate	0.97	0.97, 0.98	<0.001
Staff rating	0.94	0.85, 1.03	0.180
Percentage of nursing home staff any COVID-19	1.00	0.99, 1.01	0.066

vaccination			
Percentage of residents any COVID-19 vaccination	0.99	0.98, 1.00	0.137
Part 2: Count (Poisson Log Process)			
	Incidence Risk Ratio	95% CI	P-Value
Number of residents	1.00	0.99, 1.00	0.353
County COVID-19 rate	1.00	1.00, 1.01	0.008
Staff rating	0.87	0.81, 0.93	<0.001
Percentage of nursing home staff any COVID-19 vaccination	0.99	0.98, 0.99	0.008
Percentage of residents any COVID-19 vaccination	0.99	0.99, 1.01	0.153

Table 2 details the model exponentiated coefficients of the zero inflated Poisson regression. First, the Bernoulli process indicates that as the number of nursing home residents increases, the odds of COVID-19 infections being reported significantly increased by 1% (AOR 0.99, 95% CI 0.99, 0.99) and as the county rate of COVID-19 infections increased the odds of COVID-19 being reported among nursing home residents significantly increased by 3% (AOR 0.97, 95% CI 0.97, 0.98). Staff vaccination coverage and staff rating were not detected to significantly predict this part of the model.

When COVID-19 infections were reported among nursing home residents, the count process of the regression model indicates significant associations in part 2 of the model. As county COVID-19 rate increased, the risk of COVID-19 incidence among nursing home residents significantly increased (IRR 1.0, 95% CI 1.00, 1.01). As the rating of the staff increased, the risk of COVID-19 infection among residents decreased by 13% (IRR 0.87, 95% 0.81, 0.93). Finally, as the percent of vaccinated staff increased, the risk of COVID-19 infections among residents significantly decreased (IRR 0.99, 95% CI 0.98, 0.99). Percent of residents vaccinated against COVID-19 was not significantly associated with whether COVID-19 cases were reported, nor the number of COVID-19 infections reported.

Discussion

The purpose of this study was to examine the role of vaccine uptake among staff and residents of nursing homes, and their association with COVID-19 infection among high-risk, nursing home populations throughout Missouri. These results highlight the importance of prioritizing vaccine uptake among nursing home staff as a method of protecting resident populations, as well as themselves. Developing and implementing comprehensive infection control protocols during a pandemic for nursing homes has been challenging, and these findings should be incorporated into future policy planning, particularly prioritizations for booster vaccination shots.
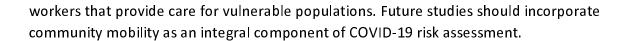
The finding that nursing home staff had significant associations with COVID-19 nursing home infection rates, as compared to nursing home residents, can be understood in the context of community mobility. Nursing home staff members have greater mobility, not only within single or multi-site organizational spaces as a matter of employment, but also throughout one's non-employment-related life. Thus, there are increased opportunities for COVID-19 infection and subsequent transmission compared to less mobile and more isolated residential populations of nursing homes. Higher community mobility has been shown to occur among individuals who are likely to be employed in health care support positions, and resulting in greater rates of COVID-19 in their home communities.[10] As an important component of risk to nursing home residents, family or close friends were not allowed to visit their family and loved ones in these environments due to risk of COVID-19 transmission. Yet, staff may be more predictable in their risk as they move from their home communities to their work spaces, as well as other environments. Staff working in congregate housing likely would have benefitted from being prioritized in the roll-out of COVID-19 vaccinations, much like other health care workers.

Despite the identification of healthcare personnel within nursing home communities as "essential" in terms of continued employment, this role was not prioritized as a possible vector of infection transmission among vulnerable populations, older adults in organized, community settings. While such employees were encouraged to become vaccinated, there were not particular, systematic efforts to enhance support for these workers that place themselves at risk. Furthermore, the Biden administration has recently implemented a requirement where that all staff at nursing homes will receive a COVID-19 vaccine to receive continued Medicare funding, this signals the support of these type of data and results.

Interestingly, this study also identified that nursing home staff ratings were important predictors of COVID-19 infections; higher ratings suggested lower number of reported COVID-19 infections among nursing home residents. While more research is needed to understand this finding, it is possible that appropriate staffing may result in fewer resident contacts per staff member; a single staff member in a nursing home with a high rating may see fewer patients and have less opportunity to transmit COVID-19 than a staff member in a home with a lower rating that is forced to see a larger number of patients. This further highlight structural challenges that may exist outside of the context of a pandemic and provide validation that this measure can and should be used as a tool for intervention to improve health outcomes of the residents in other domains.

While Missouri is only one state, this study provides a model of how urban, suburban, and rural communities interact within their communities and with nursing homes as a vulnerable population. This study period was only a selected timeframe of the pandemic, yet we selected this timeframe to allow for the greater availability and accessibility of COVID-19 vaccinations.

In conclusion, these findings highlight the need to prioritize vaccinations in community members who are more mobile throughout their daily lives, in this case nursing home healthcare staff. These findings inform policy and can justify the need to prioritize front line

workers that provide care for vulnerable populations. Future studies should incorporate community mobility as an integral component of COVID-19 risk assessment.

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