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Nursing Home Sustainability: Controlling Covid-19 Infections

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Abstract

Background: Until May 2020, the coronavirus pandemic has caused 25,000 nursing home resident deaths in the United States. Nursing home facilities are facing severe challenges in maintaining quality care and minimizing Covid-19 infections and fatalities. As Texas re-opened its economy at the end of April, nursing homes should prepare sufficiently to respond to the strike's second wave. We aimed to investigate factors related to Covid-19 nursing home infections on Texas's residents and staff aspects, respectively, and propose appropriate steps to control Covid-19 infections. ***Method:*** A secondary dataset from CMS was employed, and a total of 958 nursing home facilities were qualified for the study. Each dependent variable (total resident infectious numbers and total staff infectious numbers) was determined by two simultaneous regressions from characteristics of nursing homes and shortage of staff as well as PPE variables. After that, the statistically significant predictors from simultaneous regressions were selected into each dependent variable's final regression model, respectively. ***Results****:* For residents perspective, regression analysis indicated that the size of a nursing home ($\beta = 0.200$, $p < 0.001$), passed a quality assurance check ($\beta = -0.097$, $p = 0.003$), a shortage of other staff ($\beta = 0.084$, $p = 0.008$), and the total number of occupied beds ($\beta = -0.123$, $p = 0.014$) were statistically significant with resident infections. For staff perspective, the regression revealed that passed a quality assurance check ($\beta = -0.263$, $p < 0.001$) and private nursing homes ($\beta = -0.074$, $p = 0.018$) were related to the staff infections. ***Conclusion****:* Nursing homes are suggested to focus on those factors to prevent and manage Covid-19 infections as well as to minimize outbreaks and fatalities.
Keywords*:* Covid-19, nursing homes, infections, factors, sustainability, Texas

According to the Kaiser Family Foundation (KFF; 2020), almost 2.5 million cases and appropriate 120,000 deaths have been reported due to the coronavirus pandemic in the United States since December 31st, 2019. A well-known fact is that the United States experiences the most significant diagnosed cases and deaths worldwide (Solis et al., 2020). Of those enormous death numbers, at least 25,000 deaths happened on nursing home residents were recorded until May 2020 (Behrens and Naylor, 2020; Stall et al., 2020). Because of the smooth transmission and the high fatality rate among the aging population, the coronavirus perils care quality in nursing home facilities. Those affected facilities become hard-hit areas. In some countries, such as Canada and the U.S., nursing home facilities are related to the first documented coronavirus outbreaks and deaths with up to a 33.7% fatality rate (Stall et al., 2020).

Many kinds of research have been focusing on Covid-19 related fatalities in nursing homes. For example, residents' age is considered as a risk factor contributing to nursing homes' high fatalities, and the fatality rate among the aging population may be ten folded than young people (Dosa et al., 2020). Gardner, States, and Begley (2020) proved a similar statement. Residents' health condition is acknowledged as another risk factor (Dosa et al., 2020). Residents with more comorbidities or medical conditions have the highest fatality rate (Solis et al., 2020; Ouslander, 2020; Yancy, 2020). Besides those, the percentage of African American residents is one of those risk factors. A nursing home with a high percentage of African American residents has more fatalities during the pandemic. The CMS dataset we applied for the research doesn't furnish whether all residents with severe infections have been staying in nursing homes over time or were just transferred from hospitals. Therefore, the nursing home infectious numbers are more accurate than fatalities in this scenario. From the nursing home level, factors contributing to infections include location and facility size. Abrams et al. (2020) demonstrated Covid-19 outbreaks and fatalities in nursing homes are linked with urban location and bigger facility size. In addition to following the CDC guidelines, nursing homes are also suggested to delve into resident and staff infections at the nursing home level to minimize infections and fatalities.

As the State of Texas re-opened its economy at the end of April this year, there's a severe consideration that the second wave of coronavirus will strike the state again. To control nursing home infections and maintain their sustainability, risk factors leading to infections should be evaluated appropriately. Even many published articles provide guidelines or protocols for nursing home facilities to prevent and manage infections, factors associated with the Covid-19 infections in Texas are understudied when considering the state as a risk factor. This article sought to deliver the information on factors related to Covid-19 infections on both residents and staff aspects, then investigated applicable methods to control infections and maintain nursing homes sustainability in the Texas region.

Method

Design and Participants Selection

This study was quantitative descriptive research. We utilized the secondary dataset named the Covid-19 nursing home dataset. It is a national-wide public file reported by nursing home facilities in each state and entered by the Centers for Medicare & Medicaid Services (CMS). We chose all nursing home facilities in Texas reported until May 24th, 2020. There were 1219 nursing home facilities selected for the study. Despite 274 nursing homes missing reports, a total of 965 cases were eligible for the study.

Table 1.
Characteristics of Nursing Homes, Staff Shortage and PPE (*N* = 958)

	n (%)	M (SD)
Characteristics		
Passed Quality Assurance Check		
Yes	944 (98.5)	
No	14 (1.5)	
Number of All Beds		112.05 (38.97)
Total Number of Occupied Beds		71.08 (28.88)
Laboratory Type is State Health Department		
Laboratory Type is Private		
Yes	848 (88.5)	
No	110 (11.5)	
Laboratory Type is Others		
Yes	123 (12.8)	
No	835 (87.2)	
Staff Shortage and PPE		
Nursing Staff		
Yes	137 (14.3)	
No	811 (85.7)	
Clinical Staff		
Yes	31 (3.2)	
No	927 (96.8)	
Aides		
Yes	189 (19.7)	
No	769 (80.3)	
Other Staff		
Yes	82 (8.6)	
No	876 (91.4)	
Any Current Supply of PPE		5.46 (1.46)
0	55 (5.7)	
1	0 (0.0)	
2	1 (0.1)	
3	1 (0.1)	
4	73 (7.6)	
5	42 (4.4)	
6	786 (82.0)	
Residents Confirmed Covid-19 Cases		1.66 (7.43)
Staff Confirmed Covid-19 Cases		1.53 (15.00)

Assessments and Measures

Characteristics of nursing homes. Those characteristic variables included passed quality assurance check (*yes or no*), numbers of all beds, total number of occupied beds, state laboratory (*yes or no*), private laboratory (*yes or no*), other type laboratory (*yes or no*).

Shortage of staff variables. Nursing homes self-reported if with a shortage of staff (*yes or no*), including nursing staff, clinical staff, aides, and other staff.

Current supply of PPE variable. The PPE variable was computed from six items measured yes or no, which were N95 masks, surgical masks, eye protection, gowns, gloves, and hand sanitizer. It was scaled from 0 to 6.

Confirmed Covid-19 variables. The variables include residents total confirmed Covid-19 cases and staff total confirmed Covid-19 cases.

Data Screening and Analysis

By running frequencies in the Statistical Package for the Social Sciences (SPSS, ver. 25), there were some missing data on staff shortage variables and each current supply of PPE variable, with none of the aforementioned variables having above 10% missing cases. According to Cohen et al. (2013), those missing data were handled by the mean. Besides that, outliers were diagnosed by comparing resident confirmed Covid-19 cases and a total number of occupied beds, as well as the number of all beds and the total number of occupied beds. In this scenario, the resident confirmed Covid-19 cases should be less than the total number of occupied beds, and the number of all beds was considered equal or over the total number of occupied beds. Seven cases were not qualified for the study due to the inaccurate numbers on all beds variable without other significant outliers. As a result, a total of 958 cases were qualified for this study. Before running regressions, we tested collinearity diagnostics to ensure that the variance inflation factors (VIF) were under ten or the tolerance values were near 1 (Cohen et al., 2013).

As the dependent variables, the residents total confirmed Covid-19 cases and staff total confirmed Covid-19 cases shared the same independent variables and measurements in the study. Therefore, we conducted two simultaneous regressions to determine risk factors associated with each dependent variable from characteristics of nursing homes and shortage of staff and PPE variables. Both simultaneous regressions of two dependent variables applied predictor variables from characteristics of nursing homes: (a) passed quality assurance check; (b) numbers of all beds; (c) a total number of occupied beds; (d) state laboratory; (e) private laboratory; and (f) other types of laboratory. The shortage of staff and PPE simultaneous regressions were operated with predictor variables: (a) shortage of nursing staff; (b) shortage of clinical staff; (c) shortage of aids; (d) shortage of other staff, and (e) any current supply of PPE. The statistically significant predictors from simultaneous regressions were selected into each dependent variable's final regression model, respectively.

Results

Descriptive Statistics

As shown in Table 1, almost all nursing home facilities passed quality assurance checks (*n*=944, 98.5%). The estimated numbers of state health department laboratory, private laboratory, and other type were 402 (42.0%), 848 (88.5%), and 123 (12.8%). The means of the number of all beds and the total number of occupied beds were 112.05 (*SD*=38.97) and 71.08 (*SD*=28.88), respectively. One hundred and thirty-seven cases (14.3%) reported shortage of nursing staff, 31 (3.1%) described as a shortage of clinical staff, 189 (19.7%) presented shortage of aides, and 82 (8.6%) declared a shortage of other staff. The mean of the PPE variable was 5.46 with a 1.46 standardized deviation. As the dependent variables, the means of residents confirmed Covid-19 cases and staff confirmed Covid-19 cases were 1.66 and 1.53 with 7.43 and 15.00 standardized deviations, respectively.

Characteristics of Nursing Home

The model was statistically significant (R = 0.169, R^2 = 0.028, F = 9.305, p < 0.001) when predicting residents confirmed Covid-19 cases from characteristics of nursing homes. Among the predicted variables, number of all beds (β = 0.206, t = 4.136, p < 0.01), passed quality assurance check (β = -0.101, t = -3.164, p = 0.002), and total number of occupied beds (β = -0.124, t = -2.481, p = 0.013) were statistically significant to the residents confirmed Covid-19 cases.

Table 2. ***Outcomes of Two Simultaneous Regressions for Residents Confirmed Covid-19 Cases (N=958)***

	R^2	B	SE B	β
Characteristics of nursing homes	0.028			
Number of all beds		0.039	0.009	0.206
Passed quality assurance check		-6.269	1.981	-0.101
Total number of occupied beds		-0.032	0.013	-0.124**
Staff shortage and PPE	0.009			
Other staff shortage		2.543	0.860	0.096

Note. Model for staff shortage and PPE: R = 0.096, R^2 = 0.009, F = 8.751, p = 0.003; Model for characteristics of nursing homes: R = 0.169, R^2 = 0.028, F = 7.337, p < 0.001. * p < 0.05, ** p < 0.01.

Table 3. ***Outcomes of Two Simultaneous Regressions for Staff Confirmed Covid-19 Cases (N=958)***

	R^2	B	SE B	β
Characteristics of nursing homes	0.077			
Passed quality assurance check		-32.858	3.892	-0.263
Private type of laboratory		-3.462	1.465	-0.074**

Note. Model for characteristics of nursing homes: R = 0.278, R^2 = 0.077, F = 39.902, p < 0.001. * p < 0.05, ** p < 0.01.

Table 4. ***The Predictor Outcome for the Final Model of Residents Confirmed Covid-19 Cases (N=958)***

	R^2	B (95% CI)	SE B	β
	0.036			
Characteristics of nursing homes				
Number of all beds		0.038 (0.020, 0.057)	0.009	0.200
Passed quality assurance check		-5.984 (-9.866, -2.102)	1.978	-0.097
Total number of occupied beds		-0.032 (-0.057, -0.006)	0.013	-0.123**
Staff shortage and PPE				
Other staff shortage		2.242 (0.578, 3.905)	0.848	0.084

Note. The final model: R = 0.188, R^2 = 0.036, F = 8.772, p < 0.001. * p<0.05, ** p<0.01.

Table 5. ***The Predictor Outcome for the Final Model of Staff Confirmed Covid-19 Cases (N=958)***

	R^2	B (95% CI)	SE B	β
	0.077			
Characteristics of nursing homes				
Passed quality assurance check		-32.858 (-40.496, -25.221)	3.892	-0.263
Private type of laboratory		-3.462 (-6.337, -0.587)	1.465	-0.074**

Note. The final model: R = 0.278, R^2 = 0.077, F = 8.772, p < 0.001. * p<0.05, ** p<0.01.

The model to predict staff confirmed Covid-19 cases from characteristics of nursing homes was statistically significant (R = 0.278, R^2 = 0.077, F = 39.902, p < 0.001). Among those variables, passed quality assurance check (β = -0.263, t = -8.443, p < 0.001) and private type of laboratory (β = -0.074, t = -2.363, p = 0.018) were statistically significant to the staff confirmed Covid-19 numbers.

Shortage of Staff and PPE

The model was statistically significant (R = 0.096, R^2 = 0.009, F = 8.751, p = 0.003) when predicting residents confirmed Covid-19 cases from shortage of staff and any current supply of PPE. Among the predicted variables, shortage of other staff (β = 0.096, t = 2.958, p = 0.003) was statistically significantly to the residents confirmed Covid-19 numbers. However, the model to predict staff confirmed Covid-19 cases from a shortage of staff and PPE was not statistically significant. Tables 2 and 3 present the outcomes of both simultaneous regressions for each dependent variable.

Final Models

The final model to predict residents confirmed Covid-19 cases from four statistically significant variables based on those simultaneous regressions was statistically significant (R = 0.188, R^2 = 0.036, F = 8.772, p < 0.001). Among all predictors, number of all beds (β = 0.200, t = 4.042, p <0.001), passed quality assurance check (β = -0.097, t = -3.025, p = 0.003), shortage of other staff (β = 0.084, t = 2.645, p = 0.008), and total number of occupied beds (β = -0.123, t = -2.469, p = 0.014) were still statistically significant.

The final model to predict staff confirmed Covid-19 cases based on simultaneous regression was also statistically significant (R = 0.278, R^2 = 0.077, F = 39.902, p < 0.001). Both passed quality assurance check (β = -0.263, t = -8.443, p < 0.001) and private type of laboratory (β = -0.074, t = -2.363, p = 0.018) were statistically significant.

Discussion

Our findings suggest that Covid-19 Texas nursing home infections among residents are more related to the number of all beds, passed quality assurance check, shortage of other staff, and the total number of occupied beds rather than nursing staff, clinical, staff, and aides shortage, as well as any current supply of PPE. From the staff perspective, nursing home infections were associated with passed quality assurance checks and private laboratory type instead of others.

The analysis mentioned above shows that the number of all beds explained the most variance of infectious cases among residents. This is an imperative finding in Covid-19 infections at the nursing home level. The bigger size of a nursing home leads to higher infections. The result is similar to an article that described the relationship between the spread of the disease and family size (Liotta et al., 2020). Both analyses demonstrated that people in a larger setting would have higher risks of infection and fatality rates. The results are associated with the long incubation period of coronavirus and the high frequencies between residents and personnel flow. However, minimizing resident infections can be adjusted via reducing occupied beds since its negative beta weight. Reducing occupied beds in such sizable facilities has a positive effect on dwindling infection cases. A similar example is that any restaurant's maximum capacity in Texas was set up to 25% in early May.

While a nursing home is short of other staff, the resident infectious numbers presumably increase. The infections have no relationship with the shortage of clinical staff, aides, and nursing staff. The result implies that maintaining adequate other staff under the pandemic is challenging for nursing homes (Dosa et al., 2020). Many conditions may cause this shortage, such as fear of Covid-19 infection, lack of PPE, and sick leave. To keep staff adequately, it's essential for nursing homes to hold training sections related to Covid-19 prevention and to obtain enough supply of PPE to protect residents and employees.

Both resident and staff infections have connections with whether a nursing home passed a quality assurance check. Compared to those that failed to pass the examination, the one passed has fewer infectious resident and staff cases. Quality assurance in nursing homes implies a high quality of health care. A nursing home with passed the check is more likely to be capable of providing and maintaining a high quality of health care to residents. Many reasons contribute to those failed to pass the check, such as inefficient management and unmet needs for residents. The result suggests that those who were unable to pass should pay more attention to prevention and protection for their residents and staff to minimize infectious cases.

Staff infections are related to private nursing homes. Our analysis demonstrates that when a nursing home in Texas is private, the infectious staff numbers will be reduced, which differentiates from one study in New Jersey. That study reported that private nursing homes are confronted with more problems than non-private nursing homes under the coronavirus pandemic. Consequently, their Covid-19 infection rate for residents is much higher than public facilities in New Jersey. Abrams et al. (2020) mentioned that the state is considered a risk factor, and diverse states have specific results regarding nursing home Covid-19 infections. In Texas, the means of the resident and staff confirmed cases in private nursing homes are much lower than those in public nursing homes. Texas's private nursing homes are presumably preventing and managing the Covid-19 effectively since resident infections have no statistically significant relationship with private nursing homes. Such private facilities decrease infectious staff cases exclusively.

Surprisingly, both resident and staff infections are not related to the current supply of PPE. A well-known fact is that adequate PPE, including masks, gowns, and gloves, etc., can protect employees or healthcare professionals in nursing homes against Covid-19 infection and fatality (American Geriatrics Society, 2020). For instance, those PPEs are capable of preventing the spread of the disease among staff to residents and residents to residents. A possible reason that PPE failed to be statistically significant with the infectious resident and staff numbers in the study is that when they live or work in the same enclosed building with long-term exposure, the possibilities of spreading the virus and infecting people nearby go high. In this case, the effectiveness of PPE gets reduced. However, with appropriate training and strict implementations, staff and residents can prevent and manage Covid-19 infections. In addition, other necessary guidelines and protocols, such as banned visitors, canceled all group activities, and heightened infection control should be rigorously implemented.

In summary, the study's findings have two major implications: (1) risk factors associated with Covid-19 infectious cases on both residents and staff perspectives in Texas nursing homes, and (2) the prevention and management of infections and fatalities according to each risk factor. As the second wave of Covid-19 starts to strike Texas, nursing homes face severe challenges in minimizing Covid-19 outbreaks and deaths again. The study could benefit nursing home residents and staff.

The study has some limitations. Firstly, the CMS dataset was with some errors. For instance, the Saugus Rehab and Nursing Center administrator in Saugus found 794 infectious cases falsely reported in her facility in the dataset (Clark, 2020). Given the matter, two prudent methods in our study were applied to detect those errors in the data screening and selecting section. Additionally, we backtracked unqualified cases based on those mentioned above methods to minimize possible inaccurate outcomes caused by those errors. Secondly, the results in the study may vary based on time. The cases and variable information were chosen until May 24th, 2020. Since the CMS dataset was updated every week, the status of staff shortage and the number of occupied beds in each nursing home may vary with time. However, the inevitable risk factor, such as nursing homes' characteristics, will not be affected along with time. Thirdly, when the state variable becomes a risk factor, a different state will have distinctive results regarding its risk factors associated with nursing home Covid-19 infections and fatalities (Abrams et al., 2020). For instance, different types of nursing homes between Texas and New Jersey hold diverse outcomes.

Conclusion

Resident infections in nursing homes are significantly related to the size of a nursing home (total number of all beds), the total number of occupied beds, whether a nursing home passed a quality assurance check, and a shortage of other staff. Infectious staff numbers decrease based on private nursing homes or passed quality assurance check nursing homes. Our study recognizes no factors contributing to the increase of staff infections based on CMS's current variables provided. By acknowledging those factors and following guidelines or protocols, nursing homes can prevent and manage Covid-19 infections and minimizing their outbreaks and fatalities to maintain sustainability ultimately. Additionally, strong infection control causing social isolation of elders in nursing homes during the Covid-19 pandemic should be vigilant. Therefore, nursing homes should consider two perspectives, which are controlling infections and reducing social isolation. The leadership in nursing home facilities needs to adopt new technology (e.g. digital smart TVs) and other social activities (e.g. fresh production of vegetables) for their residents.

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