Predicting COVID-19 Cases in Nursing Homes of California and Ohio

Does the Work Environment Matter?

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Objective: The cross-sectional study evaluates if the prepandemic work environments in nursing homes predict coronavirus disease 2019 (COVID-19) cases among residents and staff, accounting for other factors. **Method:** Leveraging data from a survey of California and Ohio nursing homes (n = 340), we examined if Workplace Integrated Safety and Health domains — Leadership, Participation, and Comprehensive and Collaborative Strategies predicted cumulative COVID-19 cases among nursing home residents and staff. **Results:** In Ohio, a 1-unit increase in Leadership score was associated with 2 fewer staff cases and 4 fewer resident cases. A 1-unit increase in Comprehensive and Collaborative Strategies score in California showed an average marginal effect of approximately 1 less staff case and 2 fewer resident cases. **Conclusions:** These findings suggest that leadership commitment and interdepartment collaboration to prioritize worker safety may have protected against COVID-19 cases in nursing homes.

Keywords: nursing homes, COVID-19, occupational health, work environment, Total Worker Health®

LEARNING OUTCOMES

After reading this article, readers will be able to:

- Identify work environment factors associated with reduction in COVID-19 cases among nursing home staff and residents in Ohio and California between March and November 2020.
- Identify mutable organizational factors to support and improve nursing home workers' safety health and well-being, during a health emergency.

The Coronavirus disease 2019 (COVID-19) pandemic wreaked havoc on the nursing home industry. According to the Centers for Medicare and Medicaid Services (CMS), by June 2022, there had been over 155,000 resident and staff deaths and well over 1 million cases of COVID-19 in nursing homes.[1] Resident and staff morbidity and mortality exacerbated existing problems such as staffing shortages and the delivery of low-quality care.[2]

Early in the pandemic, facility size, location, and county prevalence were predictive of COVID-19 cases in nursing homes.[3,4] Traditional quality metrics like CMS star quality ratings and previous infection prevention citations showed inconsistent associations with cases and deaths across different state analyses.[5,6] The Centers for Disease Control and Prevention (CDC) identified that staff members working in multiple facilities also contributed to the spread of severe acute respiratory syndrome coronavirus-2 infections among nursing home residents.[7] In previous work, a measure of a nursing home's staff-network connection was estimated by tracking likely staff movements between facilities using geo-coded cellphone data.[8] Other work had shown that different predictors, including the proportion of Medicaid recipients, staffing levels, staff working conditions, and population composition, emerged as important predictors of cases in nursing homes at different stages of the pandemic.[9] Difficulty measuring cases in a standardized way and understanding transmission patterns of a novel disease made explaining the difference in case incidence among nursing homes challenging.

Like others, we consider the nursing home as a work environment, rather than just as a patient care site, when examining COVID-19 cases and their variations among nursing homes.[10–12] Nursing home workers face challenging working conditions and tend to have relatively lower wages compared to other healthcare workers.[13] Work in nursing homes is often both physically and emotionally demanding, which was exacerbated during the COVID-19 pandemic with staffing and personal protective equipment shortages.[14–17]

We utilized the Workplace Integrated Safety and Health (WISH) tool, designed to measure practices, policies, and conditions that support worker health and well-being.[18] The measure was developed at the Harvard T.H. Chan School of Public Health Center for Work, Health and Well-being, a NIOSH Centers of Excellence for Total Worker Health®. Informed by the Total Worker Health (TWH) framework, the WISH focuses on working conditions and organizational factors promoting worker health, safety, and well-being. After validation through cognitive interviewing and Item Response Theory (IRT) analysis, the measure was left with five domains — Leadership Commitment;

Participation; Policies, Programs, and Practices (PPP); Comprehensive and Collaborative Strategies; and Adherence.[19]

The study aims to determine whether the prepandemic nursing home work environment predicted COVID-19 cases among residents and staff in Ohio and California, accounting other factors. The two states differ in their regulation of nursing homes, specifically through the use of hours of care, which we account for in our analyses. In 2018, Ohio required 2.5 hours of care per patient day, whereas California mandated 3.5 hours.[20,21] Additionally, the states vary in the inclusion of staff types to meet the hourly requirements.[20,21] Moreover, in California, the 3.5-hour requirement represented a slight increase from the previous 3.2 hours requirement implemented in July 2018, and many nursing homes sought waivers due to staffing shortages.[20,22]

We used work environment data collected from nursing homes in California and Ohio from the year before the pandemic, other publicly available nursing home characteristics, county-level caseload, and cellphone data information, to determine whether prepandemic nursing home work environment predicted COVID-19 cases among residents and staff.

METHODS

Data Sources

This study combined data from five different sources. Figure 1 presents a schematic representation of the conceptual model and various datasets used in our study.

The primary work environment measures came from a cross-sectional Enterprise Outcomes (EO) Survey, of all operating nursing homes in California (CA), Ohio (OH), and Massachusetts (MA). For this study, we have used data from CA and OH.

The EO survey was conducted in two waves between October 2018 and June 2019 and included CMS-certified nursing homes that were operating at the time of the survey, serving adults, and had at least 30 beds. The self-administered survey took approximately 20 minutes to complete with Directors of Nursing (DONs) or other appropriate health and safety representatives, such as nursing home administrators or assistant/interim DONs, responding. Respondents received $25 Amazon gift cards after completing the survey. The first wave of the survey began in Fall 2018, involving a simple random sample of nursing homes within each state for a total of 582 facilities (304 in CA and 278 in OH). Initially, the survey was distributed electronically via email to the DON of each facility. We sent three reminders to nonrespondents electronically with the final reminder sent in paper version to nonrespondents in late January 2019. For nursing homes in each state not included in the first wave, we included them in the second wave in March 2019. In total, 1108 facilities were included from CA and 907 from OH.

The overall response rate for the survey was 23.3% (19.5% in CA and 25.8% in OH). Whereas the response rate was low, overall response rates have been trending downwards for quite a while.[23]

To address whether respondents differed from nonrespondents, we used observable characteristics from CMS to predict response.[23] We did not find that for-profit status, number of beds, rurality, survey wave, ownership change in the previous 12 months, CMS quality rating, CMS staffing rating, or CMS health inspection rating was statistically significantly associated with whether a nursing home responded. The study was approved by the Institutional Review Board of the Harvard T.H. Chan School of Public Health (IRB 18-1245). This study was conducted as per the STROBE Statement Checklist (see Supplement Digital Content 1, STROBE checklist, http://links. lww.com/JOM/B652).

Dependent Variable

The key outcomes were the cumulative number of COVID-19 cases among nursing home residents and staff from March through November 2020. We used state-level sources of cases rather than those reported to the CMS based on known problems with the data[24] and our own comparison of the federally available data to our state-level sources. Data on the number of COVID-19 cases among nursing home residents and staff were obtained for Ohio and California from the Ohio Department of Health and the California Department of Social Services, respectively.[25,26] Ohio reported the cumulative number of COVID-19 cases among nursing home residents and staff separately. The number of cases of nursing home staff and residents in California was reported in categories as zero cases, less than 11 cases, and the cumulative number of cases for nursing homes with at least 11 cases.

Primary Predictors — WISH Domains

Our primary predictors measuring the work environment were from the Workplace Integrated Safety and Health Assessment and included the domains of Leadership Commitment, Participation, and Comprehensive and Collaborative Strategies.[18] Because of the comparatively small sample size in our survey, this analysis prioritized three, of the five, WISH domains mentioned earlier.

After careful consideration of what components of the work environment each WISH domain measured in the survey, we expected these domains to be most closely associated with the characteristics of the work environment that would predict the number of COVID-19 cases among nursing home residents and staff. The Leadership Commitment domain assessed the extent to which organization leadership prioritized worker safety, health, and well-being and leadership's accountability in providing the necessary resources to fulfill their expressed commitment. The Participation domain assessed the involvement of stakeholders at every level of the organization in the planning and execution of worker safety measures. Finally, the extent to which employees across the organization worked together to develop worker safety and well-being initiatives was measured by the Comprehensive and Collaborative Strategies domain.[19]

Nursing home leadership commitment to worker safety, health, and well-being has been previously found to be associated with lower
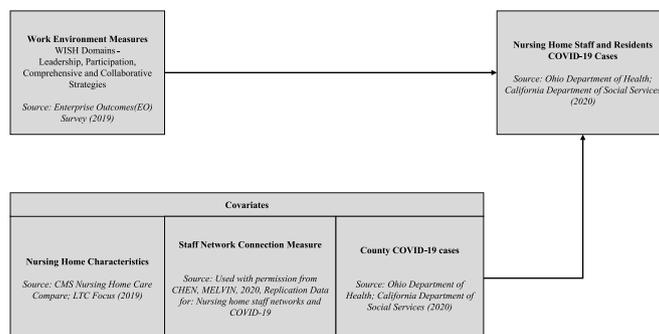
FIGURE 1. Conceptual model and data source diagram. WISH, Workplace Integrated Safety and Health; CMS, Centers for Medicare and Medicaid Services; LTCFocus, Long-Term Care Focus.

turnover among nurses.[27] The need for better leadership became even more crucial during the COVID-19 pandemic as nursing homes grappled with significant staffing shortages.[28] Previous studies that have explored components of the work environment in nursing homes that needed to be reformed during COVID-19 pandemic have highlighted the importance of teamwork, open communication, and adaptive leadership to be most beneficial in managing the unprecedented care load during the pandemic.[29,30] Our measures of Leadership Commitment, Participation, and Comprehensive and Collaborative Strategies were theoretically most closely related to COVID response in the nursing homes.

We opted to exclude the WISH domains of Policies, Programs, and Practices, and Adherence from our analysis. This decision was based on their focus on more long-term measures of the work environment, which may not be applicable during an infectious disease pandemic. PPP assessed an organization's policies and practices related to safeguarding workers from psychosocial stressors, such as evaluating health and safety hazards, supporting employees with family issues or post–health condition return to work, and preventing harm from abuse and harassment. Adherence measured whether an organization followed federal and state regulations. Given the dynamic changes in federal, state, and local guidelines and health hazards during the pandemic, nursing homes adapted accordingly. As a result, prepandemic measures of PPP and Adherence were unlikely to predict the COVID-19 response in nursing homes.

All the selected domains were measured on a scale of 0 to 12 with higher scores reflecting adherence to best practices that support worker health and well-being.

Covariates

Covariates included nursing home characteristics such as nursing home location, percentage of residents who are Medicaid recipients, and ownership status according to the CMS.[3] Ownership status was categorized as follows: (1) corporate, for profit; (2) corporate, not for profit; (3) noncorporate, for profit; and (4) noncorporate, not for profit. Nursing home locations were classified as rural v/s urban using the 2010 Rural-Urban Commuting Area (RUCA) codes.[31] Locations with RUCA codes 1 to 3 were categorized as urban, whereas all other codes (RUCA 4–8) were considered rural. Nursing home staffing levels and facility size have been found to be strongly associated with their COVID-19 outcomes.[3,11,32] Thus, the regression model for staff cases was also adjusted for the number of nursing staff (full time equivalent [FTE]), and the model for resident cases was adjusted for nursing staff ratio and facility bed count. We did not have access to the number of individual nursing staff members in our data; hence, a measure of nursing staff FTE derived from the staffing hours per patient day and resident count was used as a proxy.[33] We multiplied the staffing hours per patient day with resident count and then by 14 for the 2-week staffing hours reporting period. We divided this by 70 work hours for the period to derive a measure of the nursing staff FTE. The nursing staff ratio was a measure of the adjusted total nurse staffing hours per resident per day. Both these measures of the nursing staff included registered nurses (RNs), licensed nurse practitioners (LPNs), and nurse aides (CNAs). Nursing home characteristics were obtained from CMS's Nursing Home Compare and from Long-Term Care Focus (LTCFocus). LTCFocus is sponsored by the National Institute on Aging (1P01AG027296) through a cooperative agreement with the Brown University School of Public Health. LTCFocus draws data from the Certification and Survey Provider Enhanced Reports (CASPER), Nursing Home Compare, and the Minimum Data Set. We also used data downloaded directly from CMS Nursing Home Compare, for location and ownership status.

We characterized county-level COVID-19 burden by a variable indicating whether the cumulative number of COVID-19 cases in the county, weighted by the county population (cases per 100,000), was above or below the state median from March to November 2020. Previous studies had indicated that staff sharing between nursing homes contributed to the spread of severe acute respiratory syndrome coronavirus-2 infection among nursing home residents.[7,8] Therefore, we included a measure of the staff-network connection between nursing homes, meant to track employee movements between facilities, based on the network metrics developed by Chen et al.[8] The authors used geotagged cellphone data to gather information regarding nursing home staff that worked in more than one facility and the extent to which these nursing homes were connected to each other was derived based on that. We use the eigenvector centrality metric for our measure of staff-network connection, which in this context reflects the number of employees that work in multiple facilities.[8] The eigenvector centrality metric denotes the extent to which a facility is connected to other highly connected facilities in the network and ranges from 0 to 1 for each state, where 1 is the most connected facility and 0 is least connected. More connected facilities were those that have a higher number of employees that work in multiple facilities, which could potentially increase the risk of COVID-19 cross-infections between the nursing homes.

Analysis

We present the descriptive statistics of the selected WISH domains for both the states. Correlation between the domains was assessed using Spearman correlation. Because the process and categories of reporting COVID-19 cases were different for the two states, we decided to build separate regression models to assess the association between COVID-19 cases and the predictors for Ohio and California. The regression models were shaped by the functional forms of the reported COVID-19 data and employed the best-fit model without losing information by creating broader categories. The distribution of COVID-19 cases for both Ohio and California was rightly skewed and can be found in Supplementary Figures 1 and 2 (in Supplemental Digital Content 2, http://links.lww.com/JOM/B653), respectively. The two states also have different regulatory regimes for nursing homes and were at comparably different points in the pandemic in November 2020—the processes generating cases might have differed between the states based on these factors.

The COVID-19 cases reported in the nursing homes included in our sample in Ohio were right skewed and reported as raw numbers of cases. We used a modified version of the Park test to look for potential functional forms for a generalized linear model.[34] When the modified Park test rejected the most common families, and the fit of other possibilities, such as Poisson and negative binomial, was also poor, we switched to using the inverse hyperbolic sine function as suggested in the literature.[35] Thus, the association between WISH domains and COVID-19 cases among nursing home residents and staff in Ohio was estimated through linear regression models with an inverse hyperbolic sine (IHS) of cases as the dependent variable to transform the nonnegative skewed distribution. Duan's nonparametric smearing estimate was used to derive the marginal effects on the original scale from the linear regression estimates with IHS-transformed dependent variable.[35]

The association between WISH domains and COVID-19 cases among nursing home residents and staff in California was estimated through a two-part model with logit specification for the first part and a GLM with gamma family and log-link for the right-skewed positive values in the second part of the model. We used a two-part model because California reported cases as being below 11 (category) and the raw numbers when cases were at least 11. The first part of the model had a dependent variable that was equal to zero when cases were below 11 and 1 when cases were at least 11. The second part of the model used the number of cases as the dependent variable, conditional on having at least 11 cases.

All the models were adjusted for percent of Medicaid recipients, the staff-network connection measure, nursing home ownership, location, and county COVID-19 cases above or below the respective state median. Additionally, the regression models for staff cases in both states were also adjusted for number of nursing staff, and the models for resident cases were adjusted for the nursing staff ratio and facility bed count.

RESULTS

The initial EO Survey data included 234 nursing homes in Ohio and 216 in California.[23] Among this sample, COVID-19 data were not

reported for 63 facilities, and 47 nursing homes were missing at least one covariate. We excluded these from the sample, resulting in a final analytic sample of 340 nursing homes.

Table 1 presents the summary statistics of the study variables. The final sample comprised 161 nursing homes in Ohio and 179 in California. In November 2020, Ohio nursing homes had an average of 14 staff COVID-19 cases and 22 resident cases, without adjusting for nursing home size. During the same time period, California nursing homes reported an average of 21 staff cases and 25 resident cases, without adjusting for nursing home size. Furthermore, nursing homes in California exhibited higher average scores in all WISH domains compared to Ohio. Among the WISH domains, the Leadership domain had the highest average score for both the states (9.67 for CA and 9.25 for OH out of 12), whereas the Participation domain had the lowest average scores (8.91 for CA and 8.31 for OH out of 12). The domains showed a moderately high correlation (0.72 to 0.75).

Among the nursing homes included in our sample, California had a slightly higher proportion of for-profit nursing homes (80% for CA and 72% for OH). The average number of beds was slightly higher in California compared to Ohio (98.23 in CA and 93.24 in OH). Adjusted total nursing staff ratio was higher for California as compared to Ohio (4.28 in CA and 3.54 in OH). On average, California also had much higher staff numbers than Ohio (69.97 per nursing home for CA and 56.8 for OH).[36] Nursing homes in Ohio were more connected—shared more staff among more facilities— than those in California, based on the eigenvector measure of centrality.[8] About 28% of nursing homes in Ohio were in rural areas; however, only 6% of the nursing homes were in rural areas in California. The percentage of counties with COVID-19 cases above the state median was much higher for Ohio compared to California (36% for OH and 14% for CA).

TABLE 1. Descriptive Statistics of Nursing Home Characteristics

	Ohio (n = 161)	California (n = 179)
	Mean (SD) or Percent	Mean (SD) or Percent
Predictors		
WISH Leadership	9.25 (2.68)	9.67 (2.5)
WISH Participation	8.31 (2.8)	8.91 (2.63)
WISH Comprehensive and Collaborative Strategy	9.17 (2.88)	9.61 (2.82)
Control variable(s) — nursing home level		
% of residents on Medicaid	61.96 (16.62)	58.81 (26)
Staff-network connection	0.05 (0.11)	0.03 (0.11)
Staff FTE	56.8 (26.82)	69.97 (39.97)
Staff ratio	3.54 (0.7)	4.28 (0.7)
Bed count	93.24 (37.16)	98.23 (50.49)
Ownership		
Corporate, for profit	57.76%	62.01%
Corporate, not for profit	19.25%	14.53%
Noncorporate, for profit	14.29%	17.88%
Noncorporate, not for profit	8.70%	5.59%
Location		
Urban	72.05%	94.41%
Rural	27.95%	5.59%
Control variable(s) — county level		
Counties with COVID-19 cases below state median	64%	86%
Counties with COVID-19 cases above state median	36%	14%

Data obtained from different years — predictors (2019); % residents on Medicaid, staff FTE, staff ratio, bed count, ownership, and location (2019); staff-network connection, and county-level control variables (2020).

WISH, Workplace Integrated Safety and Health.

Table 2 presents the association between various domains of the work environment as measured by the WISH tool and COVID-19 cases among nursing home staff and residents in Ohio as of November 2020, after controlling for the number of FTE staff and beds respectively. In Ohio, the Leadership domain showed a significant association with both staff cases (−2.04; 95% CI, −3.35 to −0.73; $P = 0.002$) and resident cases (−4.85; 95% CI, −9.53 to −0.17; $P = 0.042$). This implies that a 1-unit increase in the Leadership domain score in nursing homes in Ohio corresponded to approximately two fewer cumulative staff cases and four fewer cumulative resident cases while holding other factors constant. We also found that moving from the 25th to the 75th percentile of the Leadership score among Ohio nursing homes in our sample would be associated with 10 fewer cumulative staff cases and 25 fewer cumulative resident cases during the same time period. We found no significant associations between COVID-19 cases and the Participation or Comprehensive Strategies domain.

Table 3 presents the association between various domains of the work environment as measured by the WISH tool and COVID-19 cases among nursing home staff and residents in California as of November 2020, after controlling for the number of FTE staff and beds, respectively. The Comprehensive and Collaborative Strategies domain emerged as a significant predictor of staff and resident cases in California. The estimated coefficients for this domain were negative for the first part of the two-part model (logit) and statistically significant at the 5% level for both staff cases (−0.23; 95% CI, −0.43 to −0.03; $P = 0.025$) and resident cases (−0.23; 95% CI, −0.42 to −0.04; $P = 0.016$). Thus, holding other factors constant, higher scores on the Comprehensive and Collaborative Strategies domain in California nursing homes resulted in 23% decreased odds of having at least 11 COVID-19 cases among staff and residents, as of November 2020. Additionally, by estimating the marginal effects for the combined logit and generalized linear model (GLM) parts of the model, we found that the average marginal effect of a 1-unit increase in the WISH Comprehensive and Collaborative Strategies score led to approximately 1 less cumulative staff case and 2 fewer cumulative resident cases in the California nursing homes included in our sample. We found no significant associations between COVID-19 cases and the Leadership or Participation domain for California.

DISCUSSION

This study aimed to determine whether the prepandemic nursing home work environment predicted COVID-19 cases among residents and staff. We observed that certain aspects of the nursing home work environment, as measured by the WISH tool, were associated with COVID-19 cases after accounting for other variables. However, these findings varied between the two states analyzed. In Ohio, nursing homes with leadership teams that prioritized worker safety, health, and well-being, prior to the pandemic, had fewer cumulative COVID-19 cases by November 2020, whereas, in the California nursing homes, better interdepartmental collaboration for worker safety and health, before the pandemic, showed potential for protection against COVID-19 infections among nursing home staff and residents during the initial months of the pandemic.

The WISH leadership domain measures the extent to which leadership communicates their commitment to a supportive work environment for employee safety, health, and well-being; sufficient resources are allocated to implement policies to protect and promote worker safety and health; worker health and safety are part of the organization's mission, vision, or business objectives; and the importance of health and safety is consistently reflected in actions across the organization. Similarly, the WISH Comprehensive and Collaborative Strategies domain measures the extent to which policies, programs, and practices for worker health, safety, and well-being are coordinated across departments; managers are held accountable and given resources to implement best practices for worker safety, health, and well-being; and the company prioritizes worker safety and health

TABLE 2. Effects of the Work Environment on COVID-19 Cases Among Nursing Home Staff and Residents in Ohio

| | Linear Regression With IHS-Transformed Dependent Variable | | | |
| | Staff Cases† (n = 161) | | Resident Cases‡ (n = 161) | |
	Coefficient* [95% CI]	*P* Value	Coefficient* [95% CI]	*P* Value
WISH Leadership	−2.04 [−3.35 to −0.73]	0.002	−4.85 [−9.53 to −0.17]	0.042
WISH Comprehensive and Collaborative Strategy	1.06 [−0.20 to 2.32]	0.098	1.79 [−2.63 to 6.22]	0.428
WISH Participation	0.58 [−0.62 to 1.77]	0.346	2.1 [−2.10 to 6.29]	0.328

Outcome: Cumulative COVID-19 cases between March and November 2020.
Covariates include % Medicaid, staff-network connection, nursing home ownership, location, and county COVID cases above or below the median.
WISH, Workplace Integrated Safety and Health.
*Coefficient indicates an incremental number of cases per unit increase in WISH domain score.
†Model for staff cases also adjusted for staff FTE.
‡Model for resident cases also adjusted for staff ratio and bed count.

when selecting vendors and subcontractors. Although both domains stress resources and accountability, they tackle different levels of management and include distinct items that set them apart as identified in an earlier IRT analysis.[19]

Ohio and California also differ in many ways. As discussed earlier, one significant distinction lies in the nursing home staffing regulations between the two states, which could potentially have influenced resident cases. We accounted for this by adjusting for staffing hours per patient day in our analyses; however, systemic differences in the overall nursing home operating environment within each state could not be accounted for in the models. Moreover, Ohio reported the cumulative number of COVID-19 cases among nursing home residents and staff separately. The number of cases of nursing home staff and residents in California was reported in categories as zero cases, less than 11 cases, and the cumulative number of cases for nursing homes with at least 11 cases.

In terms of the pandemic timeline, California reported verified COVID cases as early as January 2020, making it one of the first states affected by the pandemic. In comparison, Ohio encountered cases slightly later, starting in March.[37] Although the impact of these timing differences on the results remains unclear, the significance of various factors likely varied depending on the pandemic stage and setting.[9] To address these variations, we controlled for county-level infection rates, number of beds (for resident case models), and number of staff (for staff case models). This area of research is expected to expand in the coming years as we strive to enhance our preparedness and response to pandemics.

Limitations

These conclusions should however be inferred with caution considering some of the study limitations. First, the sample size was relatively small, with <200 nursing homes in each state. To examine potential differences between responding and nonresponding nursing homes in our sample, we compared COVID-19 cases reported by California nursing homes in our sample to nonresponding facilities from the state.[38] Results from a two-sample *t* test indicated no significant difference in average COVID-19 cases (when the WISH was

TABLE 3. Effects of the Work Environment on COVID-19 Cases Among Nursing Home Staff and Residents in California

	Two-Part Model With Logit and GLM (Gamma Family and Log Link)						
	Staff Cases† (n = 179)				Resident Cases‡ (n = 179)			
	Logit		GLM	Average Marginal Effect	Logit		GLM	Average Marginal Effect
	Coefficient [95% CI]	*P* Value	Coefficient [95% CI]	Coefficient [95% CI]	Coefficient [95% CI]	*P* Value	Coefficient [95% CI]	Coefficient [95% CI]
WISH Leadership	0.09 [−0.11 to 0.29]	0.394	−0.0008 [−0.07 to 0.07]	0.39 [−1.11 to 1.89]	0.13 [−0.08 to 0.34]	0.225	0.0278 [−0.04 to 0.10]	1.68 [−0.65 to 4.01]
WISH Comprehensive and Collaborative Strategy	−0.23 [−0.43 to −0.03]	0.025	−0.0028 [−0.06 to 0.05]	−1.09 [−2.41 to 0.21]	−0.23 [−0.42 to −0.04]	0.016	−0.0022 [−0.08 to 0.07]	−2.00 [−4.14 to 0.14]
WISH Participation	0.17 [−0.04 to 0.38]	0.111	−0.018 [−0.08 to 0.04]	0.49 [−0.85 to 1.82]	0.15 [−0.05 to 0.34]	0.135	0.01 [−0.07 to 0.09]	1.46 [−0.88 to 3.79]

Outcome: Cumulative COVID-19 cases between March and November 2020.
P values are from the logit part of the two-part model.
Covariates include % Medicaid, staff-network connection, nursing home ownership, location, and county COVID cases above or below the median.
WISH, Workplace Integrated Safety and Health.
*Coefficient indicates an incremental number of cases per unit increase in WISH domain score.
†Model for staff cases also adjusted for staff FTE.
‡Model for resident cases also adjusted for staff ratio and bed count.

collected), indicating generalizability for the results (Supplemental Digital Content 2, Supplementary Table 1, http://links.lww.com/JOM/B653). Second, there was a considerable lag between the work environment measurements (October 2018 to June 2019) and COVID-19 case measurements (March to November 2020). Amidst variations in staffing levels, reallocation of resources, and shifts in organizational policies to address the dynamic conditions of the COVID-19 pandemic, research indicated that maintaining steady and supportive leadership practices, along with effective communication with staff, was linked to improved COVID-19 outcomes.[29,30] Apart from this, nursing home leadership's efforts in implementing new and creative interventions, incorporating often conflicting regulations with sound medical judgment and better staff bonding, were all found to be beneficial in addressing resident loneliness and isolation, as reported in a qualitative inquiry into the experiences of nursing home leadership during the pandemic.[39] Consequently, insights from the prepandemic work environment can be valuable in assessing a facility's readiness to navigate the challenges posed by the pandemic.

Of the 450 nursing homes that responded to the initial EO survey, 63 facilities had missing COVID-19 data as of November 2020. This could be due to closure of some facilities between the EO survey in 2018 and when the COVID-19 cases were measured in 2020, or nonreporting of cases in the early months of the pandemic. This could introduce potential bias, although its direction is challenging to ascertain. We were unable to calculate incidence or prevalence rates for the dependent variables because the data from CA did not include the number of COVID-19 cases when they were below 11. To maintain consistency, we instead controlled for potential rate denominators in the regressions. Although this leads to some differences in the interpretation of the results, the estimated increase in cases based on features of the work environment held the number of beds (for resident cases) and number of staff constant resulting in similar information as using the rates at the dependent variable. Finally, although the EO survey also covered nursing homes in MA that data could not be included since, the state only reported COVID-19 cases in categories of 0 cases, 1 to 10 cases, 11 to 30 cases, and >30 cases. This fact, coupled with the lower number of nursing homes in the state, made models estimating the probability of reaching each threshold problematic to estimate.

CONCLUSIONS

The COVID-19 pandemic exacerbated existing challenges in US nursing homes, including poor care quality and staffing shortages. This study examined whether prepandemic work environments in nursing homes predicted COVID-19 cases among staff and residents. Certain aspects of the nursing home work environment, as measured by the WISH tool, were associated with the COVID-19 cases, after accounting for other variables. Fewer staff and resident cases were associated with higher leadership scores in Ohio and higher comprehensive and collaborative strategies scores in California. These findings underscore the importance of leadership commitment and interdepartment collaboration in prioritizing worker safety, health, and well-being, potentially reducing COVID-19 cases in nursing homes.

Implications

Further research should explore the specific elements of organizational-level workplace measures, like the WISH instrument, to identify their varying significance in different contexts, such as during a health emergency, providing empirical evidence for targeted interventions. Qualitative studies, incorporating the perspectives of workers in assessment of work environment measures, may offer nuanced insights into the underlying mechanisms, albeit with potential limitations in sample size. Subsequent work on nursing home work environment should expand their focus beyond structural measures such

as staffing FTEs or hours of care per patient day. A comprehensive approach is essential to consider all mutable factors, particularly in the context of chronic staff shortages.

In work environment research, it is crucial to account for the psychosocial aspects of working in a nursing home during a pandemic. This entails examining the impact of COVID-19 on mental health and evaluating workplace policies designed to accommodate family needs amid health emergencies. Gaining a deeper insight into workers' perspectives of a supportive work environment can offer valuable information for developing effective strategies in nursing home workforce development and enhancing healthcare staff retention.

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