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# Strengthening resilience in nursing homes

## The role of emergency preparedness in mitigating COVID-19 outcomes

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**Abstract**

This study investigates the relationship between compliance with Centers for Medicare and Medicaid Services (CMS) emergency preparedness standards and COVID-19 morbidity and mortality rates in U.S. nursing homes. Given the severe impact of COVID-19 on nursing home residents, this research addresses how preparedness influences pandemic outcomes. Using publicly available datasets from CMS and FEMA covering the period 2017 to 2021, a retrospective and longitudinal analysis was conducted. Multiple linear regression analyses were employed to evaluate the association between emergency preparedness deficiencies (E-Tag citations) and COVID-19 morbidity and mortality rates, controlling for facility size, regional location, and ownership type. Statistical significance was set at $\alpha = 0.05$. The results demonstrated a statistically significant association between emergency preparedness deficiencies and increased COVID-19 morbidity ($P < .001$, 0.06% increase per deficiency) and mortality ($P = .035$, 0.01% increase per deficiency), though the effect sizes were modest. Significant regional differences ($P < .001$) and impacts related to ownership type ($P < .05$) were also observed. There was no statistically significant relationship identified between a state's history of federally declared disasters and compliance with emergency preparedness standards. Findings highlight the critical role of adherence to emergency preparedness standards in mitigating COVID-19 impacts in nursing homes. Despite modest effect sizes, even minor improvements in compliance could lead to substantial public health benefits. The study underscores the necessity for targeted training programs, robust emergency planning, and clear policy interventions to strengthen nursing home resilience for future public health crises. The study's reliance on secondary data and potential reporting inconsistencies represent limitations that should be considered when interpreting the findings.

**Abbreviations:** CDC = Centers for Disease Control and Prevention, CMS = Centers for Medicare and Medicaid Services, COVID-19 = coronavirus disease 2019, E-Tag = Emergency Preparedness Tag (deficiency code used by CMS), FEMA = Federal Emergency Management Agency, GAO = Government Accountability Office, NASEM = National Academies of Sciences, Engineering, and Medicine, PPE = personal protective equipment, U.S. = United States, WHO = World Health Organization.

**Keywords:** CMS standards, COVID-19, disaster response, emergency preparedness, health policy, infection control, nursing homes

## 1. Introduction

The COVID-19 pandemic underscored existing challenges within the U.S. public health infrastructure, which has faced constraints due to sustained underinvestment amidst various global health crises, including significant hurricanes and disease outbreaks. Researchers like Clancy et al[1] and Dicken[2] have pointed out that the pandemic's ravages have further eroded the already weakened resilience of this infrastructure.

Particularly impacted were older adults in long-term care facilities. With around 1.3 million individuals in over 15,000 nursing homes across the U.S., the onset of the pandemic

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*The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.*

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brought devastating consequences.[1] The outbreak in a King County, Washington nursing home, leading to 167 cases and 35 deaths, was an early, tragic indicator of this group's vulnerability. Accounting for <1% of the nation's population, nursing homes witnessed a staggering 40% of COVID-19 deaths, emphasizing the acute risks faced by older adults in emergencies.[1,2]

Despite these challenges, engagement with nursing homes in disaster preparedness has been alarmingly inadequate, as noted by Ibrahim and Aitken[3] and National Academies of Sciences, Engineering, and Medicine.[4] This lack of engagement suggests a significant gap in effective emergency planning for these vulnerable facilities. In 2017, the Centers for Medicare and Medicaid Services (CMS) established regulatory standards for emergency preparedness, encompassing a range of programs and procedures.[5] However, the pandemic revealed inconsistencies in the implementation and effectiveness of these standards.[6]

The repercussions of these inadequacies are not confined to the realm of healthcare alone, they resonate across the social and economic fabric of our society, impacting families, communities, and the broader healthcare system. The need for robust emergency preparedness in nursing homes, therefore, transcends the boundaries of individual facilities and speaks to a larger systemic issue within our national healthcare infrastructure.

The COVID-19 pandemic, often described as a "perfect storm,"[7,8] has exacerbated the challenges faced by nursing homes, leading to high morbidity and mortality rates. This variability in outcomes raises pertinent questions: How well were these facilities prepared for such an unprecedented crisis? What role did compliance with CMS emergency preparedness standards play in shaping these outcomes? And, importantly, how can lessons learned from this pandemic inform future preparedness efforts?

Specifically, this study seeks to answer the primary research question: Does the level of nursing home compliance with CMS emergency preparedness standards influence COVID-19 morbidity and mortality rates? Additionally, the research investigates whether specific components of preparedness, such as emergency planning, communication strategies, and training and testing protocols, are differently associated with these health outcomes. Understanding these nuanced relationships can provide critical guidance on which aspects of preparedness should be prioritized to effectively mitigate the impact of future public health emergencies.

This study aims to delve into the compliance of nursing homes with CMS emergency preparedness program standards in the U.S., exploring how previous experiences with federally declared disasters might influence this compliance, and assessing the relationship between compliance and COVID-19 morbidity and mortality, while controlling for facility characteristics like region, facility size, and ownership type. By doing so, we seek to provide insights that could guide policy-making and practical implementations, potentially leading to better preparedness and response strategies in the face of future public health crises. This research is unique in its focus on a previously under-explored area of emergency preparedness, making it a novel and vital contribution to the field.

## 2. Materials and methods

### 2.1. Research design and approach

This quantitative, correlational study aimed to determine whether compliance with Centers for Medicare and Medicaid Services emergency preparedness standards significantly influenced COVID-19 morbidity and mortality rates in U.S. nursing homes, controlling for variables including region, facility size, and ownership type. The research employed a retrospective and longitudinal approach, analyzing data spanning from 2017 to 2021.

### 2.2. Data sources

The study utilized publicly available secondary data from multiple federal agencies, primarily CMS and FEMA. Datasets included the CMS Nursing Home COVID-19 Public File dataset, FEMA Federally Declared Disasters dataset, and CMS Fire Safety Deficiencies dataset. Although named for fire safety, the CMS Fire Safety Deficiencies dataset also includes citations related to emergency preparedness more broadly, including elements of all-hazard preparedness (e.g., planning, training, and testing) as outlined in CMS E-Tag requirements. Data were extracted using federal provider numbers to ensure accurate linkage and completeness. Verification processes were conducted to maintain the accuracy and integrity of the combined dataset.

### 2.3. Literature review

A structured literature review supported the identification of relevant issues and contextual understanding. The review covered articles from January 2017 to June 2022, retrieved from databases including COVID-19 in America: Response, Issues, and Law, EBSCO, Embase, and PubMed Central, using keywords such as "nursing home," "long-term care facility," and "emergency preparedness." Forty-one publications were ultimately identified as relevant, providing essential context regarding federal emergency preparedness standards, compliance challenges, and the effectiveness of these standards during the COVID-19 pandemic. For a detailed overview of the CMS required elements of emergency preparedness programs in nursing homes and associated E-Tags, see Appendix A (Supplemental Digital Content, https://links.lww.com/MD/P564).

### 2.4. Population and sample

The study population consisted of all CMS-certified U.S. nursing homes, totaling 15,454 facilities as of December 2021. Facilities were included if they provided complete data regarding COVID-19 morbidity, mortality, and emergency preparedness deficiencies. Nursing homes missing comprehensive data on these critical variables were excluded, resulting in a final sample size of 14,754 nursing homes, representing approximately 95.5% of all certified facilities in the United States.

### 2.5. Instrumentation and operationalization of variables

The primary dependent variables were COVID-19 morbidity, defined as the incidence proportion of confirmed COVID-19 cases among residents (i.e., the number of confirmed COVID-19 cases divided by the total number of nursing home residents), and COVID-19 mortality, defined as the incidence proportion of COVID-19-related deaths among residents (i.e., the number of COVID-19 deaths divided by the total number of nursing home residents). Independent variables encompassed the total number of CMS emergency preparedness deficiencies, categorized by specific preparedness elements (emergency plan, policies and procedures, communication plan, training and testing), facility size (number of certified beds), ownership type, and region. Detailed definitions and measurement approaches for each variable are provided in Appendix B (Supplemental Digital Content, https://links.lww.com/MD/P564).

### 2.6. Data analysis

Data analysis was performed using IBM SPSS Statistics for Windows, Version 28.0 (IBM Corp., Armonk). Descriptive statistics were presented as means and standard deviations for continuous variables, and frequencies and percentages for categorical variables. Inferential analyses included Pearson chi-square tests and 1-way ANOVA to assess differences across

**Table 1**

**Nursing home characteristics by region.**

| | Total (n = 14,754) | Northeast (n = 3143) | Midwest (n = 4657) | South (n = 4588) | West (n = 586) | West Coast (n = 1780) | *P* |
|---|---|---|---|---|---|---|---|
| Number of certified beds, mean (SD) | 107.5 (60.7) | 133.7 (87.5) | 94.1 (50.8%) | 109.9 (43.7) | 82.7 (76.0) | 98.6 (52.6) | .000* |
| Number of federally declared disasters, mean (SD) | 16.8 (8.2) | 13.2 (3.8) | 10.7 (4.6) | 23.1 (5.9) | 11.9 (4.3) | 24.4 (9.3) | .000* |
| Ownership type, N (%) | | | | | | | |
| For-profit | 10,365 (70.2) | 2118 (67.4) | 2884 (61.9) | 3598 (78.4) | 321 (54.8) | 1444 (81.1) | .000† |
| Nonprofit | 3447 (23.4) | 927 (29.5) | 1355 (29.1) | 720 (15.7) | 194 (33.1) | 251 (14.1) | |
| Government | 942 (6.4) | 98 (3.1) | 418 (9.0) | 270 (5.9) | 71 (12.1) | 85 (4.8) | |

*Analysis of variance (ANOVA).

†Pearson chi square analysis.

groups. Multiple linear regression analyses examined the associations between CMS emergency preparedness deficiencies (independent variables) and COVID-19 morbidity and mortality (dependent variables), while controlling for region, facility size, and ownership type. Interaction terms between variables were tested but were excluded due to lack of statistical significance. Statistical significance was defined at an alpha level of 0.05.

### 2.7. Power analysis

Power analysis was conducted using G*Power software, assuming a small effect size as typical for epidemiological studies, with an alpha level set at 0.05. Given the large sample size (n = 14,754), the analysis indicated very high statistical power (>95%), sufficient to reliably detect even minor effects. While theoretically approaching 100%, practical power was considered slightly lower due to inherent measurement errors and variability typical of observational studies.

### 2.8. Threats to validity and reliability

Potential threats to validity and reliability, including reporting biases, data entry errors, and unmeasured confounding variables such as resident health status, staffing issues, and variations in facility practices, were acknowledged. Rigorous data screening, careful evaluation and management of outliers, and sensitivity analyses were implemented to mitigate these threats.

### 2.9. Ethical considerations

This study relied on publicly accessible secondary data, eliminating ethical concerns associated with direct human subject interaction. The researchers adhered strictly to ethical guidelines governing secondary data use, ensuring responsible and secure handling of all datasets throughout the research process.

## 3. Results

This section presents the findings of the study, which analyzed compliance with CMS emergency preparedness standards in U.S. nursing homes and their association with COVID-19 morbidity and mortality. The results are structured to first address the assessment of data outliers, followed by an overview of nursing home characteristics, an analysis of compliance with emergency preparedness standards, the influence of prior disaster experiences, and the correlation of these factors with COVID-19 outcomes in nursing homes.

### 3.1. Assessment of outliers

In analyzing the incidence proportions of COVID-19 morbidity and mortality, outlier assessment was a crucial step. A notable positive skew was observed in the morbidity data, indicating a concentration of lower values with some extreme higher values. The power analysis, considering a sample size of 14,754 nursing homes, confirmed the study's capacity to detect even small effect sizes with 100% power, ensuring robustness in identifying statistically significant relationships between variables. These cases were presumed to be the result of either reporting errors or unique resident dynamics not representative of the general trend. To maintain the integrity of the study's findings, these outliers were excluded from the final analysis. This decision was guided by the need to ensure accuracy and representativeness in the results. Consequently, the refined dataset for the final analysis comprised 14,754 nursing homes. This careful outlier management was vital in ensuring that the conclusions drawn were based on reliable and consistent data, thereby enhancing the robustness of the study's findings.

The analysis accounted for the temporal aspect by evaluating compliance with CMS emergency preparedness standards (E-Tag deficiencies) continuously from 2017 to 2021. This approach allowed the assessment of emergency preparedness trends prior to and during the COVID-19 pandemic, helping to differentiate pre-pandemic preparedness levels from changes that occurred during the crisis period. However, the study did not explicitly measure incremental changes or specific improvements that might have resulted directly from the onset of the COVID-19 pandemic.

### 3.2. Nursing home facility characteristics

This section explores the diverse characteristics of nursing homes across the United States, with a particular emphasis on regional differences. The analysis examines facility size, measured by the number of certified beds, the frequency of federally declared disasters within the region, and the nature of ownership. Understanding these characteristics is essential for identifying geographical variations in emergency preparedness and response capabilities among nursing homes. The assessment aims to uncover how regional factors, including environmental risks and local governance, might influence the implementation of emergency preparedness measures and the overall resilience of facilities to health crises such as the COVID-19 pandemic. The detailed analysis of these attributes, presented in Table 1, provides a foundational understanding of the contextual factors that can affect nursing home operations and their capacity to safeguard resident well-being during emergencies.

A summary of the findings reveals that nursing homes in the study varied widely in terms of size, exposure to disasters, and ownership models. Notably, a large portion of the nursing homes were for-profit, suggesting a prevalent business model in this sector. The regional distribution highlighted the concentration of these facilities in the West Coast and South. Additionally, the average number of federally declared disasters experienced in different regions pointed to varying levels of exposure to

emergency situations, which could influence their preparedness and response strategies. These descriptive statistics provide contextual information for subsequent analyses of preparedness deficiencies and COVID-19 outcomes.

### 3.3. Compliance with emergency preparedness standards

The assessment of CMS emergency preparedness standards in U.S. nursing homes uncovered a significant number of deficiencies, with a total of 28,483 E-Tag violations documented across the sample. This translates to an average of approximately 1.41 deficiencies per facility over the 5-year study period. This study examines how emergency preparedness standards in nursing homes have influenced outcomes during the pandemic, considering the historical context of challenges faced by such facilities during previous emergencies. The analysis documents the prevalence and trends of emergency preparedness deficiencies across the study period.

A further breakdown of the data revealed noteworthy trends over the years. Certain categories of deficiencies demonstrated a rising trend, indicating evolving challenges in the emergency preparedness domain within nursing homes. This trend data is crucial as it not only identifies persistent gaps in compliance but also helps in charting the progress and areas needing targeted interventions for future preparedness efforts. Figure 1 illustrates temporal trends in E-Tag citations issued to nursing homes between 2017 and 2021, highlighting patterns in emergency preparedness deficiencies over time.

This figure visually represents the distribution of the various E-Tag deficiencies across nursing homes, offering a clearer understanding of the most common areas of noncompliance.

Figure 2 compares the per cent of items in an emergency preparedness category versus the actual occurrence of citations in different emergency preparedness elements, providing insights into which areas were more or less compliant than anticipated.

Figure 3 illustrates the yearly distribution of deficiencies across different emergency preparedness elements, highlighting trends and changes in compliance over time.

### 3.4. Prior experiences with federally declared disasters

In this detailed examination, we investigate how previous encounters with federally declared disasters influence the emergency preparedness of nursing homes. One might logically speculate that firsthand experience with such disasters would naturally lead to improved preparedness, evidenced by a reduction in E-Tag deficiencies, which are indicative of compliance with emergency preparedness standards. Contrary to expectations, our analysis reveals that the relationship between disaster experience and preparedness compliance is not straightforward. For instance, despite encountering a high number of federally declared disasters, some states did not show a corresponding decrease in E-Tag deficiencies among their nursing homes.

Despite a rigorous examination of the data, no significant correlation emerged between the number of federally declared disasters experienced by a state and the average number of E-Tag deficiencies in its nursing homes. This counterintuitive result persisted even when we adjusted for regional differences, suggesting a more complex interplay of factors influencing emergency preparedness in these critical facilities.

Figure 4 illustrates these findings, presenting a scatterplot that maps the relationship between the frequency of federally declared disasters and emergency preparedness program deficiencies among nursing homes, differentiated by state. While Figure 4 presents a scatterplot illustrating the relationship between the frequency of federally declared disasters and emergency preparedness program deficiencies among nursing homes by state, a visual inspection may suggest a potential negative trend. However, Pearson correlation analysis revealed no significant association ($r = -0.07$, $R^2 = 0.005$, $P = .31$), indicating that the apparent trend does not reliably predict emergency preparedness levels across different states.

No significant association was observed between disaster frequency and preparedness deficiencies, as detailed in Figure 4.

### 3.5. COVID-19 morbidity and mortality in nursing homes

The analysis of COVID-19 morbidity and mortality in nursing homes found that, on average, 12% of residents were infected, and 2% died from the disease. On average, 12% of residents were infected and 2% died from COVID-19. These values provide a national-level estimate of morbidity and mortality outcomes among nursing home residents during the pandemic period.

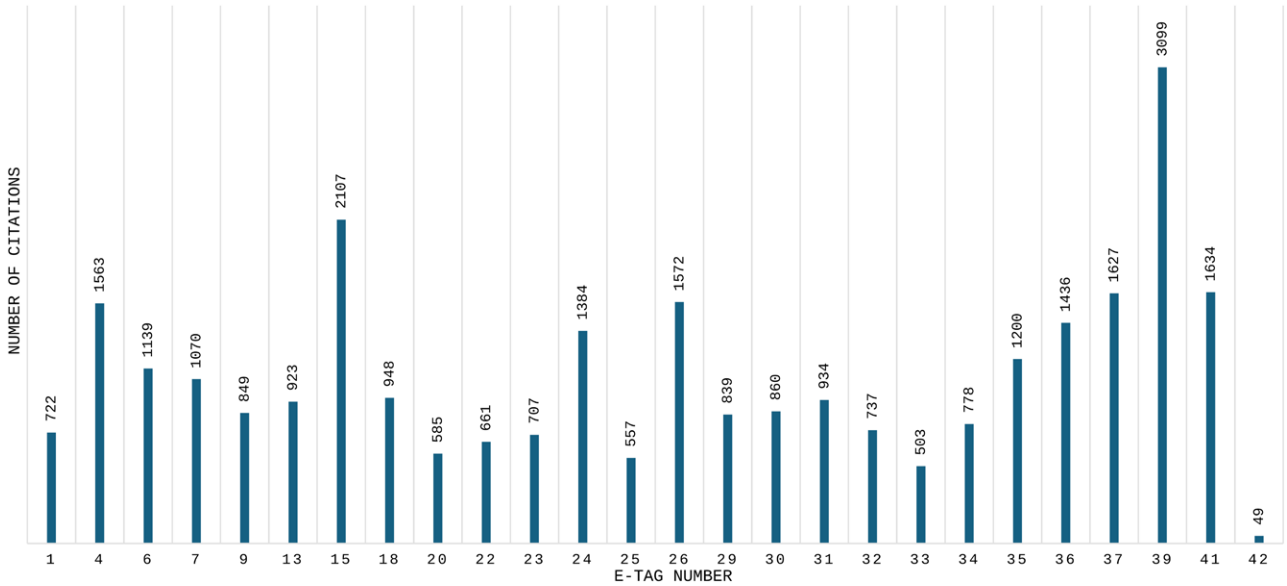


**Figure 1.** E-Tag citation trends in nursing homes (2017–2021).

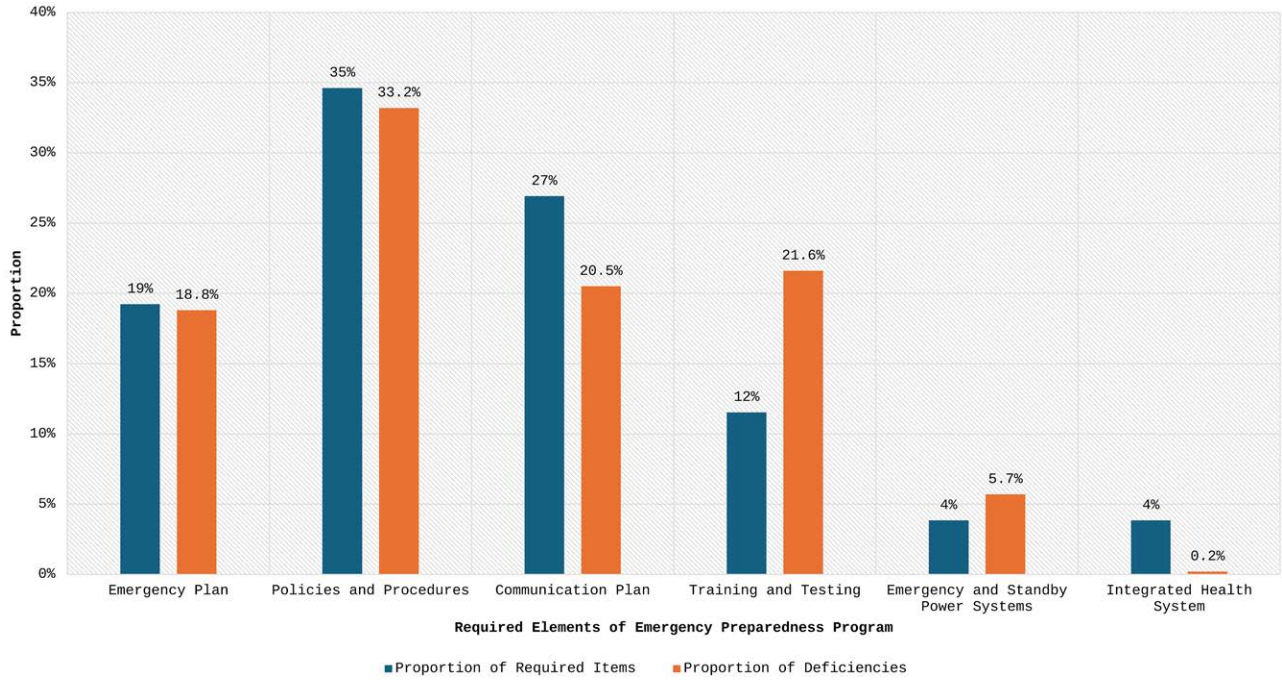


**Figure 2.** Emergency preparedness citation discrepancies in nursing homes (2017–2021).

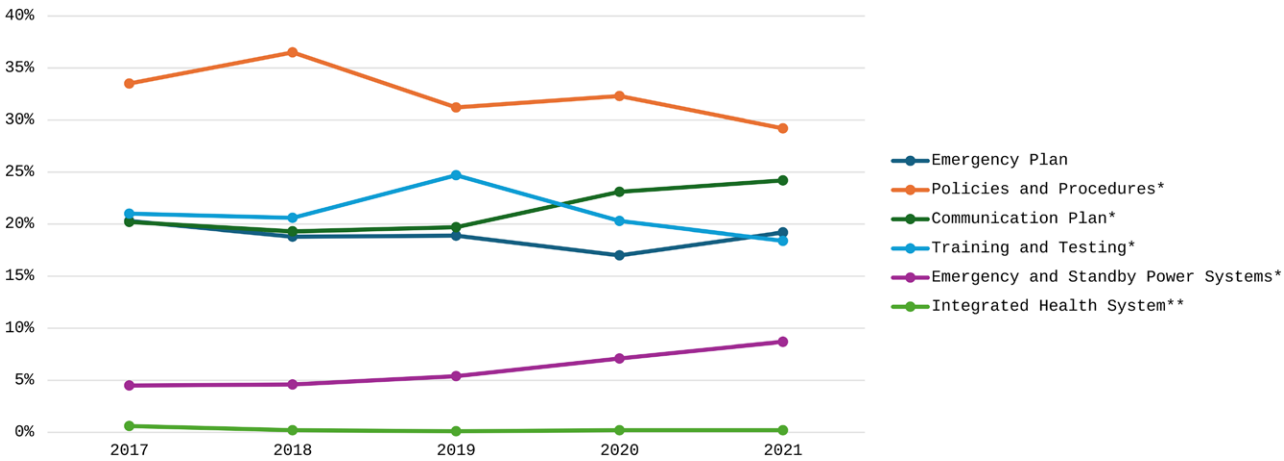


**Figure 3.** Annual emergency preparedness citations by program element (2017–2021).

Sophisticated multivariate linear regression models were constructed to dissect the relationship between emergency preparedness and COVID-19 outcomes. The models reveal a significant and positive correlation between the number of recorded emergency preparedness deficiencies and higher rates of COVID-19 morbidity and mortality. These associations persisted even after adjusting for regional disparities, the scale of the facilities, and their ownership structures, highlighting the pervasive influence of emergency preparedness on health outcomes.

In our analysis, Table 2 serves as a cornerstone, quantitatively unraveling the intricate relationship between emergency preparedness deficiencies and COVID-19 outcomes in nursing homes. A closer examination of the data reveals nuanced insights: notably, the overall number of E-Tag deficiencies is positively associated with increased COVID-19 morbidity and mortality rates. Specifically, each additional E-Tag deficiency correlates with a 0.06% increase in morbidity and a 0.01% increase in mortality, even when adjusting for regional variations, facility size, and ownership structure. This underscores the tangible impact of emergency preparedness on health outcomes.

Unexpectedly, certain variables like the negative coefficients observed for the South region in mortality outcomes challenge intuitive expectations, hinting at complex underpinnings behind these associations. Among the variables, the largest effect sizes were observed in regional differences, particularly the South's elevated morbidity rates and the West Coast's lower mortality rates, highlighting the significance of geographical context in pandemic responses.

The model's fit, as indicated by an Adjusted R-squared of 0.0372 for morbidity and 0.0081 for mortality, suggests that while our model captures a statistically significant relationship, it accounts for a modest proportion of the variance in outcomes. This points towards the multifaceted nature of factors influencing COVID-19 impacts in nursing homes beyond what is captured by emergency preparedness deficiencies alone. These findings quantify the association between emergency preparedness deficiencies and COVID-19 outcomes. Further analysis of additional influencing factors may be warranted.

Table 3 delves into the specific elements of emergency preparedness. Here, we see which particular areas of deficiency

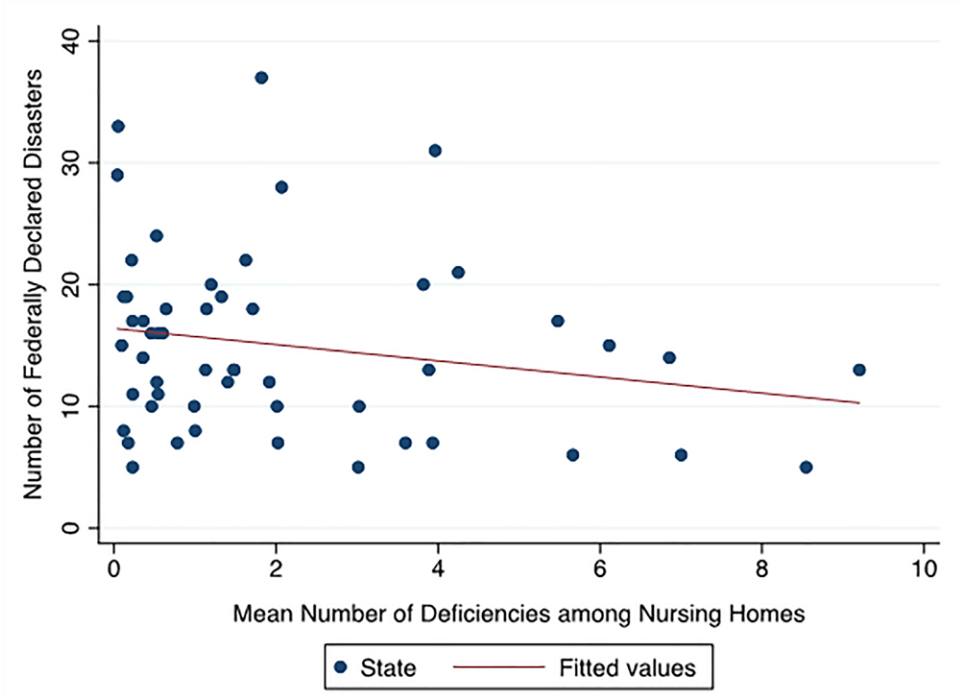


**Figure 4.** Nursing home deficiencies versus state disasters. Pearson correlation between the frequency of federally declared disasters and emergency preparedness deficiencies was not statistically significant ($r = -0.07$, $R^2 = 0.005$, $P = .31$).

**Table 2**

**Impact of total emergency preparedness deficiencies on COVID-19 in nursing homes.**

| | COVID-19 morbidity | | | | COVID-19 mortality | | | |
|---|---|---|---|---|---|---|---|---|
| | **Coeff** | **Std Err** | ***P*** | **Effect size** | **Coeff** | **Std Err** | ***P*** | **Effect size** |
| Overall number of E-Tag deficiencies | 0.0006 | 0.0002 | .000 | 0.0009 | 0.0001 | 0.0000 | .035 | 0.0003 |
| Region (ref = Northeast) | | | | 0.0095 | | | | 0.0080 |
| Midwest | 0.0129 | 0.0018 | .000 | | 0.0003 | 0.0006 | .638 | |
| South | 0.0165 | 0.0017 | .000 | | −0.0020 | 0.0005 | .000 | |
| West | 0.0004 | 0.0034 | .891 | | −0.0001 | 0.0011 | .885 | |
| West Coast | −0.0004 | 0.0023 | .858 | | −0.0065 | 0.0007 | .000 | |
| Number of certified beds | −0.0001 | 0.0000 | .000 | 0.0022 | −0.0000 | 0.0000 | .074 | 0.0002 |
| Ownership type (ref = For-profit) | | | | 0.0240 | | | | 0.0009 |
| Nonprofit | −0.0266 | 0.0015 | .000 | | −0.0012 | 0.0005 | .012 | |
| Government | −0.0226 | 0.0025 | .000 | | −0.0025 | 0.0008 | .002 | |
| Constant | 0.1276 | 0.0020 | .000 | | 0.0253 | 0.0006 | .000 | |
| *Model fit* | | | | | | | | |
| Model statistic | | $F(8, 14{,}745) = 72.22$ | | | | $F(8, 14{,}745) = 16.01$ | | |
| Adjusted $R^2$ | | 0.0372 | | | | 0.0081 | | |
| *P*-value | | .000 | | | | .000 | | |

Coeff (coefficient) represents the estimated change in the outcome variable (COVID-19 morbidity or mortality) associated with a 1-unit change in the predictor variable (number of E-Tag deficiencies), assuming all other variables in the model are held constant. Std Err (standard error): The standard deviation of the coefficient's estimated value, indicating the level of uncertainty around the coefficient estimate. *P* (*P*-value): The probability of obtaining an effect at least as extreme as the 1 observed, assuming that the true coefficient is zero (no effect). A value below .05 typically indicates statistical significance. Effect size quantifies the degree of association between the predictor and outcome variables; it helps assess the practical significance of the predictor's effect.

– such as emergency planning or training and testing – hold the most weight in predicting COVID-19 outcomes. This table is particularly instructive for policymakers and healthcare administrators aiming to pinpoint critical areas for intervention.

Interaction effects between regional location, facility size, and ownership type with emergency preparedness deficiencies were also tested to determine if these variables moderated the relationship with COVID-19 morbidity and mortality outcomes. These interaction terms were not statistically significant and thus were excluded from the final regression models, indicating that the influence of emergency preparedness deficiencies on COVID-19 outcomes was consistent across different regions, facility sizes, and ownership types.

## 4. Discussion

In examining compliance with CMS emergency preparedness program standards among U.S. nursing homes and the impact of federally declared disasters on this compliance, this study contributes significantly to the understanding of emergency preparedness in the context of public health emergencies like the COVID-19 pandemic. It particularly focuses on the relationship

**Table 3**

**Emergency preparedness and COVID-19 outcomes in nursing homes.**

| | COVID-19 morbidity | | | | COVID-19 mortality | | | |
|---|---|---|---|---|---|---|---|---|
| | Coeff | Std Err | *P* | Effect size | Coeff | Std Err | *P* | Effect size |
| *Emergency Plan* deficiencies | 0.0021 | 0.0010 | .040 | 0.0003 | 0.0000 | 0.0003 | .997 | 0.0000 |
| *Policies and Procedures* deficiencies | −0.0006 | 0.0007 | .324 | 0.0001 | 0.0000 | 0.0002 | .984 | 0.0000 |
| *Communication Plan* deficiencies | 0.0002 | 0.0009 | .795 | 0.0000 | 0.0000 | 0.0003 | .875 | 0.0000 |
| *Training and Testing* deficiencies | 0.0023 | 0.0009 | .012 | 0.0004 | 0.0007 | 0.0003 | .013 | 0.0004 |
| *Emergency Preparedness Systems* deficiencies | 0.0016 | 0.0019 | .414 | 0.0000 | −0.0002 | 0.0006 | .781 | 0.0000 |
| *Integrated Health System* deficiencies | −0.0093 | 0.0111 | .399 | 0.0000 | −0.0048 | 0.0035 | .168 | 0.0001 |
| Region (ref = Northeast) | | | | 0.0091 | | | | 0.0077 |
| Midwest | 0.0125 | 0.0018 | .000 | | 0.0002 | 0.0006 | .735 | |
| South | 0.0163 | 0.0017 | .000 | | −0.0020 | 0.0005 | .000 | |
| West | 0.0003 | 0.0034 | .938 | | −0.0002 | 0.0011 | .868 | |
| West Coast | −0.0006 | 0.0023 | .779 | | −0.0065 | 0.0007 | .000 | |
| Number of certified beds | −0.0001 | 0.0000 | .000 | 0.0022 | 0.0000 | 0.0000 | .072 | 0.0002 |
| Ownership type (ref = For-profit) | | | | 0.0232 | | | | 0.0009 |
| Nonprofit | −0.0262 | 0.0015 | .000 | | −0.0011 | 0.0005 | .019 | |
| Government | −0.0223 | 0.0025 | .000 | | −0.0024 | 0.0008 | .002 | |
| Constant | 0.1275 | 0.0020 | .000 | | 0.0253 | 0.0006 | .000 | |
| *Model fit* | | | | | | | | |
| Model statistic | $F(8, 14{,}745) = 45.18$ | | | | $F(8, 14{,}745) = 10.37$ | | | |
| Adjusted $R^2$ | 0.0375 | | | | 0.0082 | | | |
| *P*-value | .0000 | | | | .0000 | | | |

Coeff (coefficient) indicates the expected change in the dependent variable (COVID-19 morbidity or mortality) for a 1-unit increase in the independent variable, holding all other variables constant. Std Err (standard error) measures the accuracy of the coefficient by indicating the standard deviation of the sampling distribution for that coefficient. *P* (*P*-value) represents the probability that the observed association – or 1 more extreme – would occur if there was no actual association; a low *P*-value (typically ≤ .05) indicates statistical significance. Effect size reflects the size of the relationship between the independent variable and the dependent variable; can be used to determine the practical significance of the findings.

between these standards and COVID-19 morbidity and mortality among nursing home residents.

The analysis reveals challenges in both the CMS emergency preparedness standards and their implementation within nursing homes. Despite the standards' intent to ensure readiness, our findings indicate that a substantial number of facilities received no citations during the study period. However, this does not necessarily confirm full compliance or preparedness and may instead reflect limitations in the inspection or reporting processes. This observation suggests a potential misalignment between the regulatory framework and the practical needs of nursing homes facing emergencies. Specifically, the prevalence of deficiencies in "testing and exercise requirements" (E-Tag 39) and "subsistence needs" (E-Tag 15) highlights ongoing issues with resource allocation and emergency planning. These findings suggest that enhancing both the standards and their application in nursing homes is crucial for improving emergency preparedness.[9,10]

The hypothesis that a greater experience with federally declared disasters would correlate with better emergency preparedness was not supported by the findings. This lack of correlation might be attributed to high staff turnover in nursing homes, which often disconnects the accumulated experience of a facility from its current preparedness[11,12] Moreover, the specific nature of the COVID-19 pandemic, which differs markedly from natural or man-made disasters, suggests that previous disaster experiences may not directly translate to better pandemic preparedness.

The absence of correlation between prior disaster experiences and emergency preparedness compliance may also reflect several unmeasured confounding factors. For example, variability in local governmental policies, financial constraints, staffing shortages, and turnover rates could dilute or nullify the beneficial effects typically expected from prior disaster exposure.[13,14] Additionally, institutional memory loss due to frequent staff turnover, combined with inconsistent training and emergency drills, may impede the effective translation of past experiences into tangible improvements in preparedness.[15,16] Furthermore, preparedness for a pandemic such as COVID-19 differs substantially from preparedness for typical natural disasters (e.g., hurricanes or floods), possibly explaining why prior disaster experience did not translate effectively into better pandemic preparedness.[17–19]

Regarding COVID-19 morbidity and mortality, the study found a positive association with the number of E-Tag deficiencies, but the effect sizes were minimal. This suggests that while compliance with CMS standards is statistically significant, its practical impact on patient outcomes might be limited. This finding is consistent with other studies that did not find significant associations between compliance with infection prevention and control standards and COVID-19 outcomes in nursing homes.[20,21]

The study also highlights the influence of regional factors, facility size, and ownership type on COVID-19 outcomes in nursing homes. The higher mortality in the Northeast and the negative association of facility size with morbidity challenge some preconceived notions about resources and outcomes. For-profit nursing homes' poorer outcomes compared to nonprofit or government-operated facilities further underscore the complex dynamics of ownership and management in emergency preparedness.[22,23]

Interestingly, while Training and Testing deficiencies were significant predictors of COVID-19 outcomes, other elements like Policies and Procedures and Communication Plans were not. This could be due to the rapidly changing guidelines and policies during the pandemic, which might have made consistent compliance challenging across facilities.[16–18] These findings suggest a need for more dynamic and responsive preparedness frameworks in nursing homes.

Moreover, this study underscores the critical role of continuous and dynamic training in emergency preparedness for nursing home staff. The disconnect between the theoretical knowledge of emergency procedures and their practical application in real-world scenarios is evident.[24] This gap highlights the need for more hands-on, scenario-based training exercises that go beyond mere compliance to genuinely prepare staff for a range of emergency situations, including pandemics.[25–28] Enhancing staff competence and confidence through regular,

comprehensive training could significantly contribute to more effective emergency response and better resident outcomes.

This study emphasizes the critical need for updated CMS emergency preparedness standards that more accurately reflect the operational realities and emergency challenges of nursing homes. It advocates for an integrated approach to emergency preparedness, highlighting the importance of regular training, policy updates, and stronger support from the broader healthcare and emergency management sectors. As underscored by the National Academies of Sciences, Engineering, and Medicine (NASEM) report on Nursing Home Quality Care, it is essential for nursing homes to be integral components of public health and natural disaster planning at local, regional, state, and federal levels. This study's findings serve as a valuable guide for nursing home administrators, emergency preparedness partners, and policymakers aiming to bolster the resilience of nursing homes against future public health emergencies.[4,29]

Based on the findings of this study, several actionable policy recommendations and practical interventions can be proposed. Policymakers should prioritize targeted investments in scenario-based emergency preparedness training tailored specifically to pandemic response, emphasizing ongoing staff education to mitigate the negative impacts of frequent staff turnover. Additionally, incorporating mandatory periodic audits and simulations of emergency plans, with explicit benchmarks for preparedness, could enhance the operational readiness of nursing homes. Strengthening collaboration between nursing facilities and local emergency response agencies through formal partnerships and joint exercises would also ensure better integration and support during actual emergencies. Lastly, policy revisions could include incentives or funding mechanisms aimed at improving nursing home staffing levels, infection control practices, and access to essential resources like personal protective equipment, all of which are vital for effective emergency response.

While this study provides crucial insights into the relationship between CMS emergency preparedness standards and nursing home outcomes during the COVID-19 pandemic, it also opens avenues for further research. Future studies should focus on the qualitative aspects of emergency preparedness, exploring how nursing home culture, staff morale, and leadership styles impact the effectiveness of emergency response. Additionally, there is a need for longitudinal studies to understand the long-term impacts of emergency preparedness interventions on nursing home resilience and resident well-being.[30–33] The ultimate goal should be to not only meet standards but to foster environments where both residents and staff feel secure and well-equipped to handle any emergency.

Furthermore, this study suggests the need for a more holistic and integrated approach to emergency preparedness in nursing homes. It is not just about meeting regulatory standards, but also about fostering a culture of preparedness that permeates all levels of nursing home operations. This includes developing robust communication networks within and across facilities, strengthening ties with local healthcare and emergency management communities, and ensuring that preparedness is not merely a checkbox exercise but an ingrained part of the nursing home's ethos.[34–38] Such a comprehensive approach is likely to yield more sustainable and effective outcomes in the face of emergencies.

## 5. Limitations

This study provides a detailed examination of the association between compliance with CMS emergency preparedness standards and COVID-19 morbidity and mortality in U.S. nursing homes. Nevertheless, several limitations should be acknowledged.

The reliance on secondary data from CMS introduces potential reporting biases and inconsistencies, as morbidity and mortality data are self-reported by nursing homes. Such reporting might contain inaccuracies due to misinterpretation of guidelines, data entry errors, or intentional underreporting. Additionally, the delayed initiation of mandatory CMS reporting of COVID-19 cases and deaths (commencing in May 2020) may have resulted in underreported cases and mortality rates, particularly from the early stages of the pandemic. Reduced nursing home occupancy during the pandemic further complicates the interpretation of morbidity and mortality proportions, potentially leading to underestimation of true incidence rates.

Moreover, the study did not incorporate several critical factors known to influence COVID-19 outcomes, such as community infection prevalence, which significantly impacts nursing home morbidity and mortality. Resident-specific data including age, comorbidities, physical health, and cognitive conditions were not available for analysis, limiting the ability to adjust for key individual-level risk factors and potentially resulting in residual confounding.

The research also focused solely on CMS emergency preparedness program standards, excluding other influential preparedness and response components, such as staffing levels, training quality, infection control measures, availability of personal protective equipment, and local governmental regulations and policies. Additionally, the role of support from local emergency response agencies was not considered, despite its known impact on facility preparedness.

These limitations highlight the necessity for future research employing primary data collection methods and encompassing a broader spectrum of influencing variables. Addressing these gaps would enhance the precision of future assessments regarding the effectiveness of emergency preparedness in nursing home settings.

## 6. Conclusions

This study has yielded valuable insights into the intricate relationship between compliance with CMS emergency preparedness program standards in U.S. nursing homes and the subsequent impact on COVID-19 morbidity and mortality among residents. It underscores the crucial need for ongoing assessment and refinement of these standards, along with more stringent oversight and enforcement.

A key finding of this research is the significant positive correlation between the number of E-Tag deficiencies cited in nursing homes and the incidence of COVID-19 morbidity and mortality. This relationship, while statistically significant, demonstrated a relatively small effect size, suggesting that while compliance with CMS standards is important, it is not the sole determinant of outcomes in the context of a pandemic.

Additionally, the study highlights the importance of regional variation, facility size, and ownership type as significant contributors to differences in morbidity and mortality outcomes. These findings align with existing research and emphasize the multifaceted nature of factors influencing resident outcomes in nursing homes.

Particularly noteworthy is the emphasis on the importance of specific elements within the CMS standards, namely Training and Testing and Emergency Plan components, as key predictors of morbidity and mortality. This highlights the critical need for nursing homes to focus on these areas to enhance preparedness and response capabilities.

Contrary to initial hypotheses, the study revealed that prior experience with federally declared disasters did not correlate significantly with compliance with emergency preparedness standards. This finding challenges the notion that past disaster experience automatically translates into better preparedness and suggests that other factors play more pivotal roles in shaping compliance and effectiveness in emergency management within nursing homes.

In conclusion, this study adds to the growing body of evidence on the need for robust emergency preparedness in nursing homes, particularly in the face of public health emergencies like the COVID-19 pandemic. It calls for a multifaceted approach that not only focuses on compliance with regulatory standards but also considers regional dynamics, facility characteristics, and the importance of specific preparedness elements. The findings serve as a valuable resource for policymakers, healthcare administrators, and emergency preparedness professionals, guiding efforts to enhance the resilience and preparedness of nursing homes for future public health emergencies.

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