Original Article

Regional Disparities in COVID-19 Mortality Rates: An Analysis of the 2021 National Inpatient Sample

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Abstract: Amid the 2019 coronavirus (COVID-19) pandemic, regional disparities in outcomes were identified as crucial for an effective public health response. Regional variations in COVID-19 outcomes in the United States of America (USA) were studied in this retrospective cross-sectional analysis, with a focus on in-hospital mortality rates among COVID-19 patients with pneumonia or respiratory failure, using the 2021 National Inpatient Sample dataset. Patients aged ≥18 years with confirmed diagnoses of COVID-19 associated pneumonia or respiratory failure were included in the study. The association between hospital census regions and in-hospital mortality rates was examined using multivariate logistic regression, adjusting for demographic, clinical, and hospital characteristics. Significant disparities in regional COVID-19 outcomes in the USA were revealed by the results. Mortality rates in the COVID-19 study cohort ranged from 14% in the Midwest to 18% in the West. Adjusted significant differences were shown by regression analysis, with the West exhibiting up to 28% higher odds of death (odds ratio: 1.28, 95% confidence interval: 1.218–1.354, $p<0.001$) than the Midwest, the region with the lowest mortality. The importance of accounting for demographic, clinical, and contextual factors in understanding these disparities and addressing regional disparities to promote health equity during the ongoing pandemic was underscored by these substantial regional variations in COVID-19 mortality rates in the USA.

Keywords: COVID-19 pneumonia mortality rates; National Inpatient Sample; Regional disparities; Respiratory failure

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1. Introduction

In the wake of the 2019 coronavirus (COVID-19) pandemic, a thorough analysis of outcomes across large populations is needed to enhance readiness for future health crises, with a particular focus on healthcare outcomes across diverse regional landscapes. In a recent study, Stoto et al. delineated the regional disparities in COVID-19 mortality within the United States of America (USA), illustrating a division into "two Americas," characterized by differing attitudes towards vaccination and public health measures [1] . Their examination of excess mortality rates highlighted geographic variations, with the south notably experiencing mortality rates consistently higher than the national average, while socioeconomic factors, such as poverty rates and income inequality, further exacerbated these disparities. Bollyky et al. emphasized the significance of analyzing regional disparities in COVID-19 outcomes and policy responses [2]. Through an observational analysis addressing critical policy-relevant questions, including socioeconomic and racial inequities, healthcare and public health capacity, and the impact of policy mandates on the balance between COVID-19 infections, deaths, and socioeconomic outcomes, they uncovered significant state-

by-state variations in the standardized cumulative COVID-19 death rates. Factors such as lower poverty levels, higher educational attainment, and improved healthcare access were associated with lower infection and mortality rates. Enhanced health outcomes were linked to the enforcement of safety mandates, the use of masks, and elevated vaccination levels.

Moreover, historical studies during previous pandemics, such as the 1918 influenza pandemic and the H1N1 influenza pandemic, have also demonstrated stark disparities in mortality rates [3,4]. Research has shown that suboptimal geographic accessibility to comprehensive HIV care further exacerbates mortality disparities [5].

In this study, the regional disparities in COVID-19 outcomes were explored, particularly in-hospital mortality among COVID-19 patients with pneumonia or respiratory failure, within the healthcare framework of the USA, utilizing the extensive and publicly available 2021 National Inpatient Sample (NIS) database. Although the NIS has previously offered insights into the COVID-19 pandemic, its extensive 2021 dataset presents an unparalleled opportunity for novel perspectives, particularly given the increased testing availability, vaccine distribution, and emergence of new viral variants during that year [6-8]. This study fills crucial gaps in the existing literature, as unlike previous studies that predominantly explored demographic disparities, particularly those related to race and ethnicity, this study evaluated the impact of census-region-based differences on healthcare outcomes and examined the factors potentially contributing to these differences.

2. Methodology

A retrospective, cross-sectional analysis was conducted using data from the 2021 NIS database managed by the Agency for Healthcare Research and Quality. The NIS collects a 20% stratified sample of patient stays from 4,500 non-federal, short-term general and specialty community hospitals. This collection method employs specific weighting to ensure nationwide hospital representation and facilitates the extrapolation of consistent national estimates. In 2021, the NIS compiled data from 47 states and Washington, DC, in the USA.

Each record in the NIS corresponds to a hospitalization occurrence rather than a distinct patient [9]. To streamline the statistical interpretation and analysis in this study, each instance of hospitalization was considered as an individual patient encounter. This methodology can be implemented even in situations where patients may be admitted multiple times for similar clinical conditions.

The study cohort comprised individuals aged 18 years or older admitted to the hospital, all of whom had a discharge diagnosis of COVID pneumonia [International Classification of Diseases, Tenth Revision (ICD-10) code J12.82], indicating pneumonia caused by the novel coronavirus SARS-CoV-2, confirmed at the time of discharge. Additionally, patients with a confirmed diagnosis of COVID-19 (ICD-10 code U07.1) plus concurrent diagnoses of acute respiratory distress syndrome (ARDS) (ICD-10 code J80), acute respiratory failure (ICD-10 code J96.00), or pneumonia of unspecified organism (ICD-10 code J18.9) were included. In the remainder of this manuscript, this diagnostic group is identified as having COVID-19 respiratory complications. Individuals under 18 years of age and those without a diagnosis of COVID-19 pneumonia or COVID-19 plus pneumonia of an unspecified organism or respiratory failure were excluded.

The primary exposure was the hospital census region, as defined by the US Census Bureau. There are four census regions: Northeast, Midwest, South, and West (Figure 1) [10].

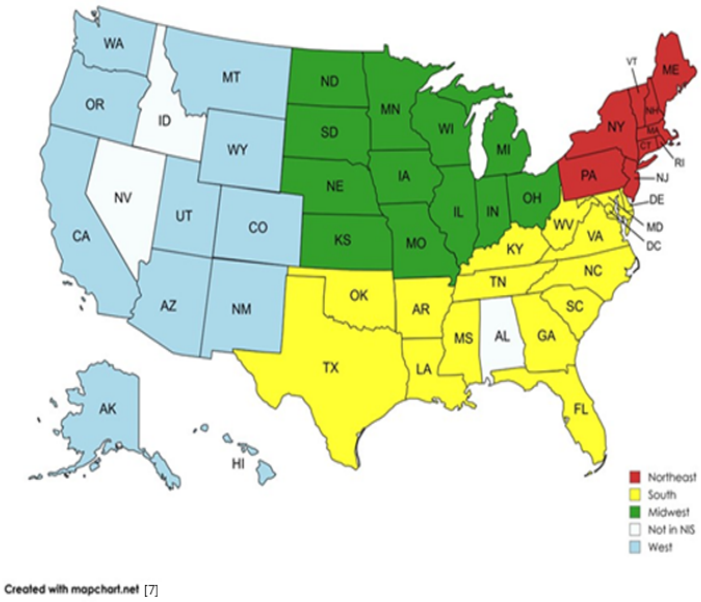


Figure 1. National Inpatient Sample by Census Region

The outcome of interest was in-hospital mortality. Other predictors included in the regression model were race, sex, expected primary payer of healthcare services, median household income for patient's ZIP code, Charlson Comorbidity Index (CCI), All Patient Refined Diagnostic Related Group (APRDRG) severity-of-illness subclass, age category, hospital ownership/control, and hospital location/teaching status [11,12].

Race data were extracted from patient records and administrative databases documenting patients' self-reported races. The sex of the patients, as provided by the data source, was captured in the NIS, with male and female categories. Any values outside of these categories were recorded as missing values. Additionally, instances in which the indicated sex did not align with other medical records or coding systems were considered inconsistent. Processing practices can vary by state, reflecting differences in confidentiality concerns and data handling guidelines [13]. Expected primary payer information is collected from patient records to identify the primary payer responsible for the healthcare services. The median household income for a patient's ZIP code was derived from the Claritas database, which provides income data relevant to patients' geographic areas [14]. The CCI was calculated based on comorbid conditions documented in medical records, whereas the APRDRG severity-of-illness subclass was assigned using the severity of illness and risk of mortality indicators from the APRDRG coding [11,15]. Hospital location and teaching status were assessed based on geographic location and teaching status, respectively.

Efforts to address the potential sources of bias in this study were systematically implemented. Rigorous diagnostic inclusion criteria were applied to select the patients. Standardized data collection was performed by the Healthcare Cost and Utilization Project, which employs reliable and validated methodologies designed to minimize bias [16]. Data analysis techniques, such as regression modeling, were employed to adjust for potential confounding variables, including demographic factors, comorbidities, and hospital characteristics.

In the analyses, quantitative variables were handled using appropriate statistical methods, considering their diverse nature. Age was categorized into three groups: 18–44 years, 45–64 years, and 65 years or older, reflecting distinct age brackets commonly used in healthcare research. Median household income was also treated as a categorical variable and was divided into quartiles to capture variations in socioeconomic status of participants across different patient populations. The CCI was treated as a continuous variable, enabling a detailed assessment of patient comorbidities. Additionally, the APRDRG severity-of-illness subclass was categorized into four groups: no or minor loss of function, moderate, major, and extreme, reflecting the severity of the patients' conditions. These groupings were chosen to facilitate meaningful comparisons and interpretation of the study results, while capturing the complexity of patient and hospital characteristics.

The statistical methods employed in this study primarily involved multivariate logistic regression to examine the relationships among the dependent variable (in-hospital mortality) and various independent variables. To control for confounding factors, demographic factors, including age, race, and sex, as well as comorbidities and hospital characteristics, were included as covariates in the regression model.

Missing data were handled by assuming that the missingness type was random. With missing data among variables at less than 3%, available case analysis was utilized for modeling purposes. As part of the sensitivity analysis, we employed multiple imputations via chained equations and utilized multinomial logistic regression to manage the categorical aspect of the race variable. In addition, a sensitivity analysis using multinomial logistic regression was employed to explore subgroup variations and assess the relationship between predictor variables and census regions. This statistical model facilitated a comprehensive analysis of demographic factors, such as race, sex, socioeconomic status, and comorbidities in relation to healthcare outcomes across diverse geographical areas. Statistical analyses were performed using STATA software version 18 MP software (College Station, TX, USA). A two-sided p-value of < 0.05 was taken to signify statistical significance.

In this study, analytical methods were tailored to accommodate the complex survey design of the NIS, ensuring accurate estimation at the national level by addressing its stratification, clustering, and weighting. To achieve this, the study utilized "survey data analysis modules" within statistical software packages, ensuring that the intricate survey design features were taken into consideration during statistical analyses.

The Institutional Review Board of Ponce Health Sciences University determined that the study (protocol ID # 2403189550) qualified for exemption of ethical review because it involved minimal risk, and classified it under the exempt category of research, thereby eliminating the need for obtaining informed patient consent.

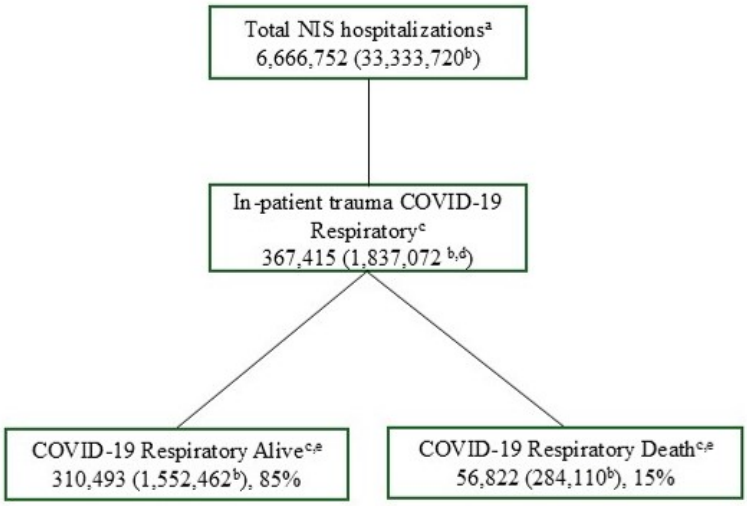
WordTune Editor and ChatGPT (version GPT-4) were used to enhance the manuscript's grammar and clarity of expression [17,18]. The manuscript was prepared following the methodology outlined by EQUATOR Network's Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [19]. The STROBE checklist is provided in Supplementary Material.

3. Results

From January 1, 2021 to December 31, 2021, 6,666,752 hospitalizations were included in the NIS data, leading to a national estimate of 33,333,720 patient admissions after applying the relevant weights (Figure 2). However, this assumption may not be entirely accurate, as some individuals may have been hospitalized multiple times within a given period. Therefore, the actual number of unique individuals may have been lower than the estimated number. The data included 367,415 individuals aged 18 years or older with COVID-19 respiratory complications, which corresponds to a national estimate of 1,837,072 (Figure 2). Some individuals were not included into the study cohort due to the age restriction, whereas others were not tested for COVID-19 because of logistical constraints or limited access to testing resources. Additionally, instances of

mortality before test result availability and logistical barriers to testing contributed to non-inclusion.

Figure 2. National Inpatient Sample patient flow-diagram for this study



a. Hospitalizations are treated as a distinct patient encounter (see methods section for details)
b. ( ) = National estimates
c. Covid-19 respiratory includes: Covid pneumonia, respiratory failure or pneumonia of unspecified organism with confirmed Covid 19
d. 18 years or older
e. Available case analysis

The study encompassed four distinct regions: Northeast, Midwest, South, and West. These regions exhibited variations in patients' admissions, COVID-19 respiratory complications, and mortality rates (Table 1). The South region had the highest percentage of admissions, accounting for 40% of the total, and the highest number of cases with COVID-19 respiratory complications among all regions, comprising 6.1% of these cases. In contrast, the Northeast region had the lowest percentage of admissions, representing 18% of the total, and the lowest number of cases, accounting for 4.5% of cases. Mortality rates among COVID-positive cases ranged from 14% in the Midwest to 18% in the West. However, the age distribution showed a consistent trend across regions, with the majority of cases occurring in individuals aged 65 years and older. Sex distribution, payer demographics, racial demographics, median household income, CCI, hospital location/teaching status, APRDRG severity-of-illness subclass, and hospital control (ownership) also showed notable variations across the four regions.

Table 1. National Inpatient Sample (NIS) Demographics Using Sample Weights to Achieve National Estimates

	Northeast		Midwest		South		West	
US Population (NIS)	57,259,257		68,836,505		122,296,183		73,539,047	
National admissions estimate	6,012,228 (18%)		7,267,247 (22%)		13,435,463 (40%)		6,618,782 (20%)	
COVID Respiratory Positive	271,254		354,475		818,603		342,974	
Died n, %	39,455	15%	48,090	14%	127,920	16%	60,115	18%
Age category n, %								
18–44 years	36,205	13%	58,195	15%	151,530	18%	65,090	18%
45–64 years	97,345	35%	141,620	38%	320,124	38%	133,205	38%
≥ 65 years	141,300	51%	176,070	47%	361,169	43%	155,219	44%
Sex								
Male	148,915	54%	199,320	53%	436,469	52%	199,324	56%
Female	125,920	46%	176,300	47%	396,294	48%	154,174	44%
Payer								
Medicare	138,935	51%	182,000	49%	359,814	43%	150,759	43%
Medicaid	42,360	15%	45,710	12%	74,740	9%	79,000	22%
Private insurance	80,450	29%	123,695	33%	293,659	35%	101,660	29%
Self-pay	4,835	2%	11,615	3%	46,880	6%	7,560	2%
No charge	600	0.2%	215	0.1%	3,380	0.4%	120	0.03%
Other	6,800	2%	11,655	3%	52,910	6%	13,865	4%
Race								
White	174,069	64%	274,185	77%	484,349	59%	173,404	51%
Black	38,280	14%	49,335	14%	170,295	21%	19,905	6%
Hispanic	32,620	12%	19,165	5%	124,375	15%	107,740	31%
Asian or Pacific Islander	9,985	4%	5,360	2%	11,410	1%	23,490	7%
Native American	475	0.2%	1,885	1%	4,085	1%	6,900	2%
Other	15,895	6%	4,560	1%	24,260	3%	11,750	3%
Median household income for patient's ZIP code								
0–25th percentile	58,085	21%	113,385	30%	336,114	41%	75,035	22%
26th–50th percentile	64,130	24%	118,015	32%	227,410	28%	86,365	25%
51st–75th percentile	73,565	27%	95,390	26%	158,565	19%	102,750	30%
76th–100th percentile	75,425	28%	46,675	12%	97,415	12%	79,880	23%
Charlson Comorbidity Index (95%	1.92	(1.878–1.956)	1.96	(1.930–1.987)	1.75	(1.722–1.770)	1.79	(1.761–1.819)

confidence interval)								
Location/teaching status of hospital								
Rural	20,000	7%	65,410	17%	107,359	13%	25,144	7%
Urban nonteaching	27,795	10%	63,844	17%	210,525	25%	89,315	25%
Urban teaching	227,055	83%	246,631	66%	514,939	62%	239,055	68%
APRDRG severity-of-illness subclass								
None to Minor	30	<0.001%	25	<0.001%	135	<0.001	25	<0.001%
Moderate	1,625	1%	1,065	<0.001%	4,270	1%	1,210	<0.001%
Major	73,475	27%	87,920	23%	182,204	22%	57,905	16%
Extreme	199,719	73%	286,875	76%	646,214	78%	294,374	83%
Hospital Control								
Government, nonfederal	13,625	5%	28,409	8%	122,739	15%	39,839	11%
Private, non-profit	252,594	92%	329,066	88%	524,049	63%	256,505	73%
Private, investor-owned	8,630	3%	18,410	5%	186,035	22%	57,170	16%

APRDRG, All Patient Refined Diagnostic Related Group

Regarding payer demographics, Medicaid emerged as a significant payer across all regions, although with varying proportions. In the Northeast, Medicaid covered 15% of cases, whereas private insurance covered 29%. The Midwest had similar proportions, with Medicaid covering 12% of cases and private insurance covering 33%. In the South, Medicaid covered 9% of cases, while private insurance covered 35%. The West saw a slight shift, with Medicaid covering 22% and private insurance covering 29% of cases.

Analysis of racial demographics revealed distinct patterns among the regions. While the Northeast and Midwest regions had predominantly White populations, the South exhibited greater diversity, with a notable proportion of Black and Hispanic patients. In contrast, the West displayed a more balanced distribution of White and Hispanic patients. The South had the highest concentration of patients in the lowest income bracket (41%) and tied with the Midwest in having the lowest proportion of cases in the highest income bracket (76th–100th percentile) at 12%.

The dataset exhibited varying levels of missingness across different variables. Among the variables examined, the highest proportion of missing data was observed for the race variable, with 2.68% of entries missing. This was followed by median household income (1.57% missing) and payer information (0.21% missing). Other variables, such as death and sex, exhibited minimal missing observations, with only 0.03% and 0.02% missing values, respectively.

Multivariate logistic regression analysis revealed significant differences in COVID-19 respiratory complication mortality rates across regions, even after adjusting for potential confounding variables (Table 2). In the Northeast, individuals with COVID-19 had approximately 10% higher odds of experiencing COVID-19 respiratory complication-related deaths than those in the Midwest (reference group; odds ratio [OR] 1.10, 95% confidence interval [CI]: 1.038–1.165, $p = 0.001$). In the South, individuals had approximately 21.0% higher odds of COVID-19 respiratory complication-related deaths than the reference group (OR 1.21; 95%CI: 1.159–1.272; $p < 0.001$). Additionally, individuals in the West had approximately 28% higher odds of COVID-19 respiratory complication-related deaths than those in the reference group (OR 1.28; 95%CI: 1.218–1.354; $p < 0.001$).

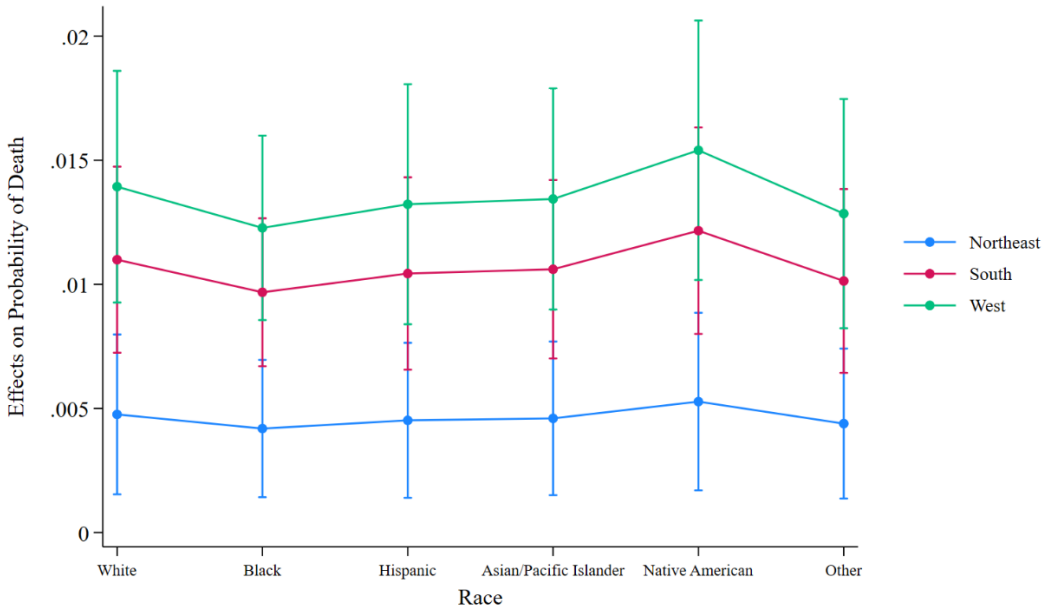
Table 2. Multivariate Logistic Regression with Death as Outcome Variable

	Odds ratio	Std. Error	p=value	95% Conf. Interval	
Hospital region					
Midwest (reference)					
Northeast	1.10	0.032	0.001	1.038	1.165
South	1.21	0.029	<0.001	1.159	1.272
West	1.28	0.035	<0.001	1.218	1.354
Race					
White (reference)					
Black	0.91	0.017	<0.001	0.877	0.941
Hispanic	1.18	0.023	<0.001	1.138	1.227
Asian or Pacific Islander	1.10	0.038	0.004	1.033	1.181
Native American	1.34	0.080	<0.001	1.188	1.503
Other	1.08	0.036	0.018	1.014	1.154
Sex					
Male (reference)					
Female	0.81	0.008	<0.001	0.791	0.823
Payer					
Medicare (reference)					
Medicaid	1.12	0.025	<0.001	1.074	1.170
Private Insurance	0.92	0.017	<0.001	0.887	0.955
Self-Pay	1.07	0.040	0.085	0.991	1.148
No Charge	1.02	0.124	0.845	0.807	1.299
Other	1.36	0.049	<0.001	1.266	1.459
Median household income for patient's ZIP code					
0–25th percentile (reference)					
26th–50th percentile	0.88	0.014	<0.001	0.856	0.910
51st–75th percentile	0.82	0.014	<0.001	0.794	0.851
76th–100th percentile	0.73	0.016	<0.001	0.696	0.758
Charlson Comorbidity Index	1.14	0.003	<0.001	1.133	1.144
Age category					
18–44 years (reference)					
45–64 years	2.11	0.044	<0.001	2.026	2.199
≥ 65 years	3.81	0.095	<0.001	3.628	4.002
Hospital Control					
Government, nonfederal (reference)					
Private, non-profit	0.90	0.025	<0.001	0.852	0.950
Private, investor-own	0.91	0.032	0.006	0.848	0.972
Location/teaching status of hospital					
Rural (reference)					
Urban nonteaching	1.09	0.034	0.006	1.024	1.156

Urban teaching	1.21	0.033	<0.001	1.151	1.280
Severity-of-illness subclass					
None to minor (reference)					
Moderate	0.11	0.091	0.007	0.023	0.549
Major	0.57	0.433	0.462	0.131	2.523
Extreme	2.61	1.970	0.204	0.595	11.460

When examining the average marginal effects (AVEs) of COVID-19 respiratory complication mortality rates across different racial groups and regions, consistent patterns emerged (Figure 3). For all racial groups, an increase in the probability of COVID-19 respiratory complication-related deaths was observed across all regions as compared with the reference region (Midwest). Although the magnitude of this increase varied slightly across racial groups, the overall trend remained consistent across regions. Notably, the South and West consistently exhibited higher AVEs for all racial groups than did the Northeast, indicating heightened risks of COVID-19 respiratory complication-related mortality in these regions. Despite variations in the absolute values, the disparities in COVID-19 respiratory complication-related mortality rates appeared to be consistent across regions for all racial groups analyzed.

Figure 3. Average Marginal Effects of Regions, with 95% Confidence Intervals, Against the Midwest Region as Reference



A sensitivity analysis was conducted for multiple imputations of the race variable but revealed no discernible disparities in outcomes when compared to the regression analysis utilizing all available data. Additionally, as part of the sensitivity analysis, multinomial logistic regression was used to compare the regions, with the Midwest serving as the reference group. Significant differences emerged across the regions in terms of race, payer status, median income, hospital control, and hospital teaching status. Detailed findings from this sensitivity analysis are provided in the supplemental documents accompanying this study (Tables S2 and S3).

4. Discussion

In this study, regional disparities in COVID-19 outcomes, particularly in-hospital mortality among COVID-19 patients with pneumonia or respiratory failure, were examined using the 2021 NIS database in the USA. Significant

regional disparities in COVID-19 outcomes across the USA were revealed by the findings, with variations in hospitalization rates, COVID-19 respiratory complication rates, and related mortality rates observed in the Northeast, Midwest, South, and West regions. Notably, the highest proportion of COVID-19 respiratory complications was observed in the South, while the lowest proportion was observed in the Northeast. Mortality rates ranged from 14% in the Midwest to 18% in the West. Particularly noteworthy results emerged from the West, where up to 28% higher odds of COVID-19 respiratory complication-related death were revealed by regression analysis compared to the Midwest, indicating a pronounced disparity in mortality rates. The necessity of employing advanced analytical techniques to adjust for confounding factors is underscored by these findings.

Previous studies examining regional differences in outcomes across various diseases, including COVID-19, have consistently reported similar disparities [20-24]. For instance, research has shown that regions with lower socioeconomic status and limited access to healthcare facilities often experience higher mortality rates and worse health outcomes [1]. These findings align with the observed regional variations in COVID-19 outcomes, suggesting that the underlying systemic factors play a crucial role in shaping health disparities. Furthermore, studies focusing specifically on COVID-19 have highlighted the influence of factors such as population density, healthcare infrastructure, and public health policies in driving regional differences in the outcomes of this disease [25-28].

The analysis aligns with a robust body of literature that highlights disparities across various health conditions and regional constructs within the United States. These disparities manifest in diverse ways, influenced by factors such as healthcare utilization patterns, racial disparities in healthcare access, differential healthcare expenditures, and specific health conditions [29-32].

For instance, studies consistently show significant regional disparities in healthcare outcomes for conditions such as cardiovascular disease, cancer, and diabetes, where access to specialized care and treatment options varies across different geographic regions[33-35]. Additionally, disparities in healthcare utilization and outcomes have been documented among racial and ethnic minority populations, often due to systemic barriers to accessing quality healthcare services [36,37] .

By contextualizing these findings within the broader literature, this study contributes to a deeper understanding of how regional disparities manifest across various health conditions and emphasizes the ongoing need for targeted interventions to promote equitable healthcare access and improve health outcomes across diverse regional landscapes.

To mitigate these disparities, interventions such as enhancing healthcare infrastructure in underserved areas, implementing targeted public health campaigns for minority populations, expanding Medicaid coverage, and fostering community partnerships are crucial. These interventions aim to improve access to quality care and promote equity in healthcare outcomes.

Despite its comprehensive nature, this study had several limitations that must be acknowledged. First, the reliance on administrative databases entails inherent biases and limitations in retrospective analyses, potentially causing inaccuracies in data interpretation [38]. Furthermore, the scope of the study was limited to individuals who had undergone COVID-19 testing, potentially excluding those who did not seek testing or were unable to access healthcare services, thereby limiting the generalizability of the findings. Additionally, the retrospective design of the study precluded the establishment of causal relationships between the variables, necessitating cautious interpretation of the results. Moreover, although efforts have been made to adjust for confounding factors using advanced statistical techniques, the possibility of residual confounding remains, which may influence the observed associations. Finally, the study's reliance on data from a single year [3] limits its ability to assess temporal trends and longitudinal changes in COVID-19 outcomes over time. Despite these limitations, this study provided valuable insights into the regional disparities in COVID-19 outcomes, highlighting the need for further research to address these

disparities and inform targeted interventions aimed at promoting health equity across diverse populations.

The NIS provides a robust foundation for examining regional disparities in COVID-19 outcomes, offering insights into diverse patient populations across the USA. However, since the study utilized national estimates from the NIS, its findings can be applied across all non-federal, short-term, general, and specialty community hospitals in the 47 US states and Washington, DC [39]. Although efforts were made to ensure the representativeness of the sample through meticulous weighting procedures, caution should be exercised when extrapolating the results to populations that are not captured within the NIS framework, such as individuals treated in long-term care facilities or outpatient settings. Despite these considerations, the NIS remains a valuable resource for understanding healthcare trends and disparities at the national level, providing a foundation for further investigations of regional variations in COVID-19 outcomes.

5. Conclusions

In conclusion, by employing a rigorous regression analysis, this study shed light on the significant regional disparities in COVID-19 outcomes across the USA, emphasizing the pronounced differences in mortality rates observed in the Western region. The findings of this study underscored the importance of understanding and addressing regional nuances in healthcare outcomes and highlight the significance of targeted interventions to mitigate disparities and promote health equity in diverse populations. Continued research on regional differences is essential to inform evidence-based policies and interventions to improve healthcare outcomes and resilience in the face of future health crises.

Supplementary Materials: The following are available online at www.mdpi.com/xxx/s1, Table S1: Supplemental 1. STROBE Statement: Checklist of items that should be included in reports of observational studies; Table S2. Multiple Imputation for Race; Table S3. Multinomial Logistic Regression Analysis by Region.

Author Contributions: The author framed the study objectives, established the research methodology, processed and analyzed the data, and wrote the manuscript.

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Institutional Review Board Statement: Ethical review and approval were waived for this study by the Institutional Review Board of Ponce Health Sciences University because it involved minimal risk and was classified under the exempt category of research.

Informed Consent Statement: The need for informed consent was waived by the Institutional Review Board of Ponce Health Sciences University.

Data Availability Statement: The data supporting the findings of this study can be accessed from Healthcare Cost and Utilization Project at https://hcup-us.ahrq.gov/.

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Conflicts of Interest: The author declares no competing interests.

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