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American Indians and COVID-19: Morbidity and Mortality Disparities among Indigenous Populations in the Rural South

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Abstract

*Background***:** The COVID-19 pandemic has highlighted health inequities among indigenous populations, with those in rural settings facing compounded barriers. *Purpose*: To investigate morbidity and mortality experiences among American Indian adults from rural and urban settings hospitalized by COVID-19. *Methods*: The described cross-sectional study used retrospective discharge data from the University of Mississippi Medical Center and Hennepin County Medical Center. Adults (≥ age 18) admitted from January 1, 2020 to August 8, 2021with a COVID-19 diagnosis and known race were included. *Results*: A total of 3,659 inpatients met inclusion criteria. Among adults hospitalized with COVID-19 at the University of Mississippi Medical Center, American Indians (n=73) had the highest mean comorbidity risk score (11.2, SD 8.1) and unadjusted mortality rate (42%) among all races. Among adults hospitalized with COVID-19 at Hennepin County Medical Center, American Indians (n=62) had the second lowest comorbidity risk score (6.1, SD 10.7) and the lowest unadjusted mortality rate (6%). American Indian mortality disparities persisted after controlling for age, sex, and comorbidity risk. *Conclusion*: Hospitalized American Indians from predominantly rural settings experienced significant morbidity and COVID-19 mortality disparities when compared to native persons in predominantly urban environments, or Black and White individuals in either setting. Compounded disparities faced by rural, indigenous populations must be addressed.

Keywords: American Indian, Indigenous populations, COVID-19, rural, in-hospital mortality, health disparities

Introduction

The SARS-CoV-2 pandemic (COVID-19) has had a devastating global health impact. As of December 15, 2021, more than 800,000 Americans have died with the virus (CDC, 2022a). Racial minorities and socioeconomically disadvantaged populations have disproportionately suffered severe illness, hospitalization, and death as a result of COVID-19 (Hooper, 2020; Raifman & Raifman, 2020; Wilder, 2021; Yancy, 2020).

American Indians and Alaska Natives (AIs) have been one of the most disparately impacted races in the nation from the novel coronavirus. When adjusted for age, indigenous persons are 1.7 times more likely to be infected, 3.5 times more likely to be hospitalized, and 2.4 times more likely to die with COVID-19 than non-Hispanic White individuals (Artiga et al., 2021). By January 5, 2022, a reported 315,611 AIs contracted the virus (IHS, 2022a); 9,313 died by this same time (CDC, 2022b).

Disparate COVID-19 hospitalization and mortality rates among AI populations have been linked with a disproportionate comorbid condition burden among native individuals (Hooper et al., 2020; Koma et al., 2020). According to the Centers for Disease Control and Prevention (CDC), chronic conditions (such as heart disease, cancer, and diabetes) place individuals at increased risk of severe illness or death from COVID-19 (2022c). These conditions rank first, second, and fourth, respectively, as the leading causes of AI deaths, with AIs dying at higher rates from each when compared to all races in the US (IHS, 2022b). AIs also die at rates higher than the national average from kidney disease, liver disease, stroke, and substance use disorders (IHS, 2022b) — all conditions believed to make individuals more susceptible to severe illness or death due to COVID-19 (CDC, 2022c).

Similarly, rurality has been correlated with increased COVID-19 infection and mortality rates, as compared to those living in more urban settings (Ullrich & Mueller, 2022). Rural areas generally have fewer employment opportunities (Green, 2017), higher rates of poverty (Weber & Miller, 2017), higher rates of uninsurance (Day, 2019), older populations (Peters, 2020), and greater healthcare workforce shortages (Federal Office of Rural Health Policy, 2022) than urban regions. These factors combined with consistently lower COVID-19 vaccination rates in rural regions (Murthy et al., 2021) have placed such communities at heightened vulnerability to the effects of the pandemic.

The Mississippi Band of Choctaw Indians (MBCI) — the only federally-recognized AI tribe in the poorest (US Census Bureau, 2020) and fourth most rural state in the nation (World Population Review, 2021) — has been devastatingly impacted by the COVID-19 pandemic. More than 10% of the approximately 10,000 members of the MBCI had contracted the virus by the fall of 2020, garnering national media attention (Walker, 2020). By the same time, 114 MBCI lives were claimed as a result of the virus (Choctaw Health Center, 2021). Each of the eight official MS Band of Choctaw Indian communities meet federal designations as both rural and medically underserved areas (Health Resources & Services Administration, 2022a & 2022c). The Health Resources & Services Administration has also designated all of the MBCI communities' healthcare professional shortage areas in all areas of consideration — primary care, dental care, and mental health (Health Resources & Services Administration, 2022b).

In stark contrast, median household incomes in Minnesota continually rank in the top third of wealthiest states (US Census Bureau, 2021a), and nearly three-quarters of residents live in an urban region of the state (Minnesota State Demographic Center, 2017). Two AI tribes call the state home — the Ojibwe, or Chippewa, and the Dakota, or Sioux, Indians (Minnesota Department of Health, 2022a). Minnesota is considered the birthplace of the Dakota Indians who have four official communities in the state (Minnesota Department of Health, 2022a). The Ojibwe, one of the largest AI tribes in the country, have seven reservations across the state (Minnesota Department of Health, 2022a). Drawing greater contrast with the MBCI, the majority of AIs in the state live in urban areas (Minnesota State Demographic Center, 2017).

A prior study including Mississippians admitted at a single facility with COVID-19 revealed significantly greater odds of in-hospital COVID-19 mortality among AIs when compared to all other races. Although only one of ten comorbid conditions assessed was found positively associated with such mortality (Musshafen et al., 2021). At the same time, colleagues in Minnesota reported vastly different anecdotal experiences among the AI population they serve from primarily urban regions. Recognizing the heterogeneity of each AI tribe and tribal environment, the authors aimed to expand investigations to evaluate in-hospital COVID-19 outcomes across tribes and states and those comorbidities assessed. The authors hypothesized that 1) mean comorbidity risk scores would be higher among AIs in predominantly rural settings than AIs in predominantly urban settings, and 2) in-hospital mortality rates would be significantly greater among AIs in predominantly rural settings than AIs in predominantly urban settings, regardless of comorbidity risk.

Methods

Study Design and Setting

The described study was conducted at the University of Mississippi Medical Center (UMMC) and Hennepin County Medical Center (HCMC) utilizing retrospective, de-identified patient data from each facility's electronic health record (EHR) system. A data use agreement was executed by each site to define utilization terms and conditions prior to data transmission. Given the datasets did not contain identifiers, efforts were not being made to extrapolate identifiable patient information. The study did not include an intervention, and the Human Research Office at the University of Mississippi Medical Center granted an exemption from institutional board review.

UMMC — Mississippi's only academic teaching hospital, level I trauma center, and safety net hospital — cares for a disproportionate share of medically underserved and socioeconomically disadvantaged patients from across the state. A total of 1,003 beds are spread across UMMC's six hospitals, 256 of which are located within its flagship University Hospital on the main Jackson campus (University of Mississippi Medical Center, 2022). HCMC is a 484-bed hospital in downtown Minneapolis, Minnesota. One of four major health systems in the Twin Cities, annually HCMC cares for more AI patients from predominantly urban settings than almost any other hospital in the country (T. Wyatt, personal communication, December 14, 2021).

The Elixhauser Comorbidity Index (ECI) is a health risk assessment tool developed to predict statistical probabilities of several health outcomes, including in-hospital death (Elixhauser, 1998). The ECI accounts for thirty or thirty-one chronic conditions in each risk evaluation,

providing a comprehensive comorbidity assessment (Elixhauser, 1998). An algorithm developed by van Walraven et al. (2009) further advanced the Index by applying validated risk weights to each condition such that the sum produces a single risk score for each patient. Most recently the ECI has been validated and empirically reported in COVID-19 mortality investigations (Goodman et al., 2021; Zhou et al., 2020), including inquiries utilizing van Walraven risk weights (Ebinger et al., 2020).

Population and Data Sources

All adults aged eighteen or older hospitalized at UMMC or HCMC from January 1, 2020-August 8, 2021 with a COVID-19 diagnosis and a known race were included. COVID-19 diagnoses were defined in accordance with official CDC coding guidelines, which utilize International Classification of Diseases, 10th Revision (ICD-10), code B97.29 (other coronavirus as the cause of diseases classified elsewhere) from March 1 to April 30, 2020, or code U07.1 (COVID-19, virus identified) from April 1, 2020 onward (CDC, 2020). Outpatients, those without a known race or a confirmed COVID-19 diagnosis were excluded.

Age, sex, race(s), discharge status, ICD-10 code associated with COVID-19 diagnosis, as well as ICD-10 codes associated with any of the one chronic conditions or risk factors included in the ECI were abstracted for all patients meeting inclusion criteria. Age, sex, and race(s) were self-reported by patients at both facilities. For patients with more than one race indicated within their health record, the primary/first race served as the race for evaluative purposes. Patients with a primary/first race of AI/Alaska Native (AN), Native American, or Mississippi Band of Choctaw Indian were evaluated as AIs. Racial categories with ≤100 individuals across sites (Asian, Hispanic, Multiracial, Native Hawaiian/Pacific Islander, Other) were collapsed into one "Other" racial category to ensure patient privacy and prevent identification. HCMC data was abstracted via an automated data query from a de-identified data mart on August 9, 2021. EHR data was extracted at UMMC on October 25, 2021 utilizing the institution's COVID-19 Research Registry, a database of de-identified and date-shifted records of all COVID-19 patients seen at a UMMC facility (UMMC Center for Informatics and Analytics, 2020).

Variables of Interest

In-hospital mortality served as the primary outcome and dependent variable of all analyses. All patient discharge statuses from both facilities were collapsed into a binary alive/deceased variable. A binary indicator was also created for each of the thirty-one ECI conditions and risk factors such that each was either present or absent based on the associated ICD-10 codes in a patient's medical record. The van Walraven et al. (2009) algorithm was then applied to create a single, weighted mortality risk score for each patient such that higher scores were associated with increased odds of death. To aid in comparisons across patients and sites, all weighted ECI scores were stratified into one of five groups: ≤0, 1-5, 6-10, 11-15, or ≥16. ECI score group, race, age, and male sex served as risk factors of interest.

Data Analysis

Statistical analyses were conducted using Stata/SE, version 17.0. Age was analyzed as a continuous variable, with race, sex, ECI score group, and in-hospital mortality assessed as categorical variables. Descriptive statistics were used to define demographic and clinical characteristics of both patient cohorts. Each variable of interest was first assessed using Wald-chi

square tests. Univariate assessment of the primary in-hospital mortality outcome was performed next using chi-square tests. Multivariate logistic regression models were then constructed and tested for fit and multicollinearity among independent variables using variance inflation factors.

Results

A total of 3,659 COVID-19 adults with a known race were admitted at UMMC (n=2,712) and HCMC (n=947) from January 1, 2020-August 8, 2021 (see Table 1). Included patients had a mean age of 56.7 (± 17.8); just over half (n=1,881) were female. AIs accounted for 3.7% (n=135) of the study population, Black individuals 60.1% (n=2,199), White individuals 31.9% (n=1,168), and all Other patients 4.3% (n=157). ECI risk scores ranged from -14 to 49, with a mean score of 8.75 (±9.54) across both sites. Nearly 17% (n=618) of all included COVID-19 patients died while in-hospital.

Including all races, the total mean ECI comorbidity risk score at UMMC was lower (8.65, ±9.38) than at HCMC (9.04, ±9.99). Black patients had the same mean weighted ECI score at both sites (8.9, ±9.6), while White and Other UMMC patients had lower mean comorbidity scores (8.6, ±9.1 and 3.9, ±6.7, respectively) compared to their peers at HCMC (9.5, ±10.3 and 10.3, ±10.0, respectively). AIs were the only racial group found to have a greater comorbidity risk score at UMMC (11.2, ±8.1) than at HCMC (6.1, ±10.7).

Of the thirty ECI risk factors and chronic conditions, more than a quarter of AIs at HCMC suffered from drug abuse (48.4%), fluid and electrolyte disorders (46.8%), cardiac arrhythmias (45.2%), uncomplicated hypertension (41.9%), and depression (27.4%) (see Table 2). The most commonly observed conditions among AIs at UMMC were fluid and electrolyte disorders (74.0%), uncomplicated hypertension (67.1%), uncomplicated diabetes (52.1%), coagulopathy (45.2%), obesity (38.4%), complicated hypertension (35.6%), and renal failure (31.5%).

Table 1

Demographic and clinical characteristics of COVID-19 inpatient adults with a known race at Hennepin County Medical Center and the University of Mississippi Medical Center, January 1, 2020-August 8, 2021

	Race								
Characteristic	**HCMC American Indian** n=62 (1.7%)	**UMMC American Indian** n=73 (2.0%)	**HCMC Black** n=469 (12.8%)	**UMMC Black** n=1,730 (47.3%)	**HCMC White** n=361 (9.9%)	**UMMC White** n=807 (22.1%)	**HCMC Other** n=55 (1.5%)	**UMMC Other** n=102 (2.8%)	**ALL** N=3,659
Gender, n (%)									
Female	20 (0.6%)	41 (1.1%)	215 (5.9%)	989 (27.0%)	135 (3.7%)	388 (10.6%)	26 (0.7%)	67 (1.8%)	1,881 (51%)
Male	42 (1.1%)	32 (0.9%)	254 (6.9%)	741 (20.3%)	226 (6.2%)	419 (11.5%)	29 (0.8%)	35 (1.0%)	1,778 (49%)
Age in years									
Mean (SD)	49.0 (16.1)	53.2 (15.7)	55.7 (17.3)	55.3 (17.4)	61.5 (17.6)	61.5 (17.2)	55.4 (20.1)	39.2 (16.9)	56.7 (17.8)
Median (IQR)	50 (36-65)	56 (40-64)	58 (43-69)	57 (43-68)	63 (51-76)	64 (51-74)	53 (42-89)	34 (26-50)	59 (44-70)
Weighted Elixhauser Comorbidity Index score, n (%)									
Mean (SD)	6.1 (10.7)	11.2 (8.1)	8.9 (9.7)	8.9 (9.6)	9.5 (10.3)	8.6 (9.1)	10.3 (10.0)	3.9 (6.7)	8.8 (9.5)
≤0	19 (31%)	7 (10%)	114 (24%)	372 (22%)	87 (24%)	175 (22%)	10 (18%)	51 (50%)	835 (23%)
1-5	14 (23%)	15 (21%)	90 (19%)	394 (23%)	56 (16%)	198 (25%)	10 (18%)	19 (19%)	796 (22%)
6-10	8 (13%)	15 (21%)	85 (18%)	312 (18%)	67 (19%)	152 (19%)	11 (20%)	18 (18%)	668 (18%)
11-15	8 (13%)	16 (22%)	60 (13%)	250 (14%)	59 (16%)	100 (12%)	13 (24%)	7 (7%)	513 (14%)
≥16	13 (21%)	20 (27%)	120 (26%)	402 (23%)	92 (25%)	182 (23%)	11 (20%)	7 (7%)	847 (23%)
Patient Status, n (%)									
Alive	58 (94%)	42 (58%)	430 (92%)	1,425 (82%)	316 (88%)	627 (78%)	50 (91%)	93 (91%)	3,041 (83%)
Deceased	4 (6%)	31 (42%)	39 (8%)	305 (18%)	45 (12%)	180 (22%)	5 (9%)	9 (9%)	618 (17%)

Abbreviations: HCMC, Hennepin County Medical Center; IQR, interquartile range; SD, standard deviation; UMMC, University of Mississippi Medical Center.

Table 2

Elixhauser Comorbidity Index chronic disease experiences among adult COVID-19 American Indian, Black, and White inpatients at Hennepin County Medical Center (HCMC) and the University of Mississippi Medical Center (UMMC), January 1, 2020-August 8, 2021

	Race						
	HCMC American Indians n=62 (1.7%)	**UMMC American Indians** n=73 (2.0%)	**HCMC Blacks** n=469 (12.8%)	**UMMC Blacks** 1,730 (47.3%)	**HCMC Whites** n=361 (9.9%)	**UMMC Whites** n=807 (22.1%)	**ALL** N=3,659
Chronic disease/condition, n (%)							
Congestive heart failure	5 (8.1%)	13 (17.8%)	75 (16.0%)	323 (18.7%)	55 (15.2%)	118 (14.6%)	602 (16.5%)
Cardiac arrhythmias	28 (45.2%)	17 (23.3%)	202 (43.1%)	552 (31.9%)	164 (45.4%)	250 (31.0%)	1,258 (34.4%)
Valvular disease	2 (3.2%)	4 (5.5%)	24 (5.1%)	82 (4.7%)	27 (7.5%)	55 (6.8%)	198 (5.4%)
Pulmonary circulation disorders	2 (3.2%)	4 (5.5%)	30 (6.4%)	167 (9.7%)	22 (6.1%)	56 (6.9%)	285 (7.8%)
Peripheral vascular disorders	4 (6.5%)	3 (4.1%)	21 (4.5%)	93 (5.4%)	21 (5.8%)	46 (5.7%)	192 (5.3%)
Hypertension, uncomplicated	26 (41.9%)	49 (67.1%)	221 (47.1%)	1,211 (70%)	150 (41.6%)	510 (63.2%)	2,209 (60.4%)
Hypertension, complicated	8 (12.9%)	26 (35.6%)	113 (24.1%)	585 (33.8%)	91 (25.2%)	206 (25.5%)	1,053 (28.8%)
Paralysis	1 (1.6%)	3 (4.1%)	15 (3.2%)	71 (4.1%)	15 (4.2%)	21 (2.6%)	129 (3.5%)
Other neurological disorders	5 (8.1%)	8 (11.0%)	32 (6.8%)	196 (11.3%)	41 (11.4%)	73 (9.1%)	361 (9.9%)
Chronic pulmonary disease	15 (24.2%)	7 (9.6%)	95 (20.3%)	320 (18.5%)	100 (27.7%)	187 (23.2%)	738 (20.2%)
Diabetes, uncomplicated	14 (22.6%)	38 (52.1%)	161 (34.3%)	584 (33.8%)	73 (20.2%)	233 (28.9%)	1,133 (31.0%)
Diabetes, complicated	2 (3.2%)	4 (5.5%)	17 (3.6%)	100 (5.8%)	3 (0.8%)	23 (2.9%)	152 (4.2%)
Hypothyroidism	4 (6.5%)	6 (8.2%)	30 (6.4%)	156 (9.0%)	46 (12.7%)	157 (19.5%)	410 (11.2%)
Renal failure	5 (8.1%)	23 (31.5%)	107 (22.8%)	512 (29.6%)	78 (21.6%)	162 (20.1%)	912 (24.9%)
Liver disease	13 (21.0%)	13 (17.8%)	41 (8.7%)	93 (5.4%)	29 (8.0%)	71 (8.8%)	270 (7.4%)
Peptic ulcer disease, excluding bleeding	3 (4.8%)	0 (0.0%)	6 (1.3%)	12 (0.7%)	2 (0.6%)	5 (0.6%)	30 (0.8%)
AIDS/HIV	1 (1.6%)	0 (0.0%)	14 (3.0%)	39 (2.3%)	9 (2.5%)	4 (0.5%)	68 (1.9%)
Lymphoma	1 (1.6%)	0 (0.0%)	0 (0.0%)	16 (0.9%)	2 (0.6%)	12 (1.5%)	32 (0.9%)
Metastatic cancer	0 (0.0%)	1 (1.4%)	9 (1.9%)	47 (2.7%)	11 (3.1%)	29 (3.6%)	100 (2.7%)
Solid tumor without metastasis	1 (1.6%)	3 (4.1%)	20 (4.26%)	79 (4.6%)	23 (6.4%)	53 (6.6%)	185 (5.1%)
Rheumatoid arthritis/collagen vascular diseases	0 (0.0%)	5 (6.9%)	14 (3.0%)	58 (3.4%)	9 (2.5%)	40 (5.0%)	130 (3.6%)
Coagulopathy	6 (9.7%)	33 (45.2%)	57 (12.2%)	326 (18.8%)	52 (14.4%)	174 (21.6%)	673 (18.4%)

Obesity	6 (9.7%)	28 (38.4%)	62 (13.2%)	644 (37.2%)	29 (8.0%)	230 (28.5%)	1,025 (28.0%)
Weight loss	10 (16.1%)	3 (4.1%)	72 (15.4%)	101 (5.8%)	57 (15.8%)	39 (4.8%)	292 (8.0%)
Fluid and electrolyte disorders	29 (46.8%)	54 (74.0%)	236 (50.3%)	961 (55.6%)	177 (49.0%)	455 (56.4%)	1,971 (53.9%)
Blood loss anemia	2 (3.2%)	1 (1.4%)	2 (0.4%)	50 (2.9%)	2 (0.6%)	17 (2.1%)	74 (2.0%)
Deficiency anemia	4 (6.5%)	1 (1.4%)	36 (7.7%)	165 (9.5%)	17 (4.7%)	40 (5.0%)	276 (7.5%)
Alcohol abuse	4 (6.5%)	5 (6.9%)	7 (1.5%)	62 (3.6%)	7 (1.9%)	28 (3.5%)	115 (3.1%)
Drug abuse	30 (48.4%)	1 (1.4%)	57 (12.2%)	73 (4.2%)	56 (15.5%)	39 (4.8%)	261 (7.1%)
Psychoses	10 (16.1%)	0 (0.0%)	62 (13.2%)	71 (4.1%)	60 (16.6%)	28 (3.5%)	234 (6.4%)
Depression	17 (27.4%)	4 (5.5%)	99 (21.1%)	194 (11.2%)	108 (29.9%)	186 (23.1%)	620 (16.9%)

Abbreviations: AIDS, Acquired Immunodeficiency Syndrome; HCMC, Hennepin County Medical Center; HIV, Human Immunodeficiency Virus; UMMC, University of Mississippi Medical Center.

Despite lower overall ECI morbidity scores, rates of in-hospital death among included patients at UMMC (19.4%) were nearly double those observed among included patients at HCMC (9.8%) across all racial categories. Proportionally the same or more UMMC patients died while in-hospital within each racial category when compared to those at HCMC. Unadjusted mortality rates at UMMC and HCMC were 18% and 8% among Black patients, and 22% and 12% among White patients, respectively. Roughly 9% of patients in the Other racial category died while in-hospital at both sites.

The most significant racial mortality disparities across sites were observed among AIs. AIs had the lowest unadjusted mortality rate (6%) among all races at HCMC. Conversely, at UMMC AIs suffered the greatest unadjusted rates of death at just over 42% — nearly twice the next highest rate of 22% observed among UMMC White patients. While AIs accounted for 5.9% (n=31) of all COVID-19 patient deaths at UMMC, they represented only 2.7% (n=73) of the included patient population at the facility. Comparatively, AIs accounted for 4.3% (n=4) of all in-hospital COVID-19 deaths at HCMC, but 6.6% of the hospital's included patient population.

Univariate regression models revealed age [OR 1.04 (1.04, 1.05)], the male sex [OR 1.33 (1.12, 1.58)], AI race [OR 1.77 (1.19, 2.62)] and ECI score group [OR 1.82 (1.70, 1.95)] all significantly associated ($p \leq 0.005$) with the in-hospital mortality outcome of interest across included patients. The selected multivariate regression model included these four independent variables given these results and empirically reported associations with COVID-19 in-hospital mortality.

The adjusted probability of in-hospital death with COVID-19 was greater at UMMC than HCMC for all races at every comorbidity risk level, excluding only AIs with the lowest ECI comorbidity risk scores (≤0) as no AI patient died at either facility in this risk category (see Table 3 and Figure 1). For all other risk categories at UMMC (1-16+), AIs were significantly more likely to die in-hospital with COVID-19 than Black or White patients of the same comorbidity risk in adjusted models; the same was true at HCMC for patients with ECI risk scores from 1-15 though not with statistical significance ($P>.05$). The adjusted probability of in-hospital mortality among

COVID-19 AIs at UMMC was 2 to 9+ times that of AIs at HCMC depending on comorbidity risk level. The greatest adjusted mortality disparity between AIs at the medical centers was among those with comorbidity risk scores ≥16. AIs at this highest risk level had an adjusted probability of in-hospital mortality of 0.07 (P>.05) at HCMC, compared to 0.68 (P<.05) at UMMC.

Table 3

Adjusted associations of COVID-19 in-hospital mortality among adults with a known race at Hennepin County Medical Center and the University of Mississippi Medical Center by weighted Elixhauser Comorbidity Index (ECI) score, January 1, 2020 – August 8, 2021

ECI Score	Race	HCMC aPr[a]	UMMC aPr[a]	HCMC aOR[b] (95% CI)	UMMC aOR[b] (95% CI)
≤0	American Indian	0*	0*	1 [Reference]	1 [Reference]
	Black	0.03	**0.05**	NE	NE
	White	0*	**0.08**	NE	NE
1-5	American Indian	0.10	**0.25**	1 [Reference]	1 [Reference]
	Black	0.03	**0.10**	0.28 (0.07, 1.04)	**0.33 (0.15, 0.74)**
	White	**0.07**	**0.12**	0.68 (0.25, 1.86)	**0.41 (0.19, 0.87)**
6-10	American Indian	0.14	**0.36**	1 [Reference]	1 [Reference]
	Black	**0.07**	**0.19**	0.46 (0.18, 1.20)	**0.42 (0.22, 0.80)**
	White	**0.11**	**0.20**	0.76 (0.33, 1.76)	**0.44 (0.23, 0.84)**
11-15	American Indian	0.15	**0.61**	1 [Reference]	1 [Reference]
	Black	**0.13**	**0.21**	0.85 (0.38, 1.89)	**0.17 (0.09, 0.32)**
	White	**0.09**	**0.27**	0.56 (0.23, 1.35)	**0.24 (0.13, 0.43)**
≥16	American Indian	0.07	**0.68**	1 [Reference]	1 [Reference]
	Black	**0.14**	**0.34**	2.16 (0.83, 5.61)	**0.24 (0.13, 0.44)**
	White	**0.20**	**0.35**	**3.32 (1.34, 8.26)**	**0.25 (0.14, 0.46)**

Abbreviations: aOR, adjusted odds ratio; aPR, adjusted probability; ECI, Elixhauser Comorbidity Index score; HCMC, Hennepin County Medical Center; NE, not estimable; UMMC, University of Mississippi Medical Center

Bolded figures: P<.05

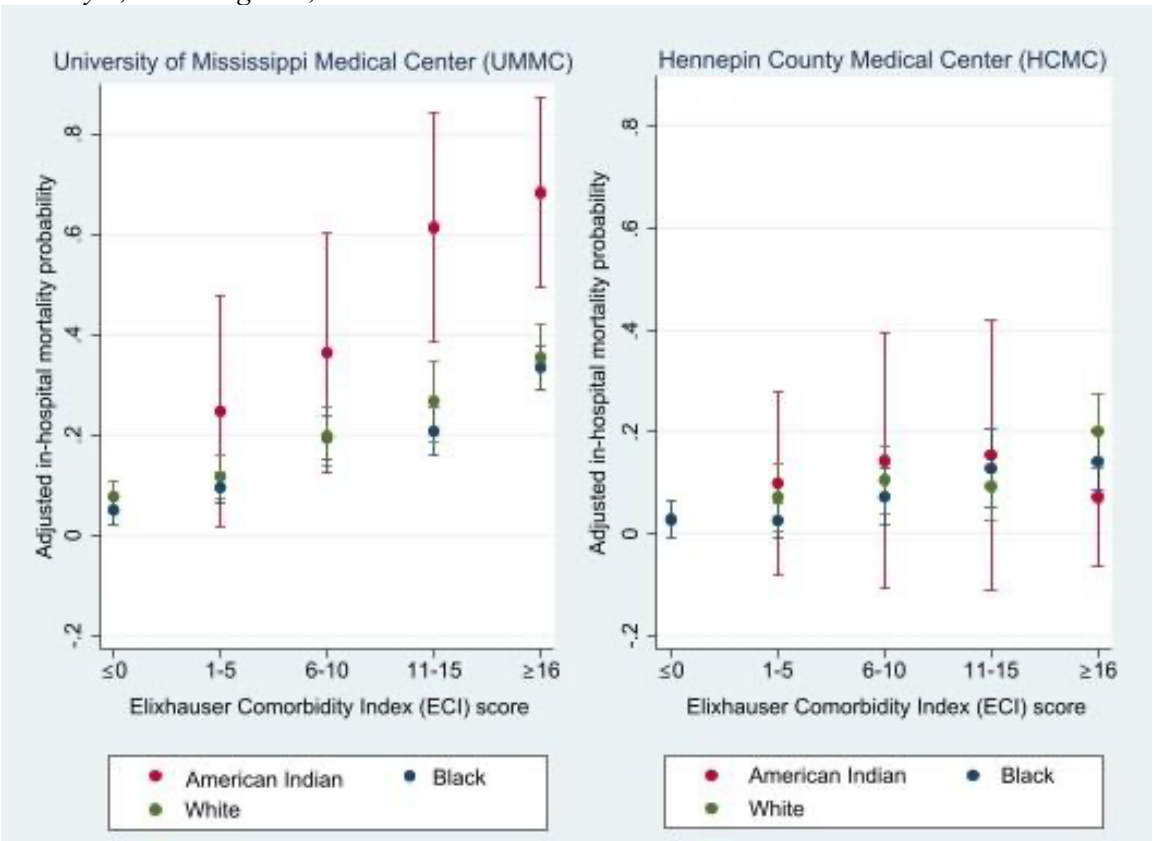
*No deaths occurred in this group

[a]Adjusted probability of inpatient mortality from multivariate logistic regression model including risk factors: age, race, male sex, and Elixhauser Comorbidity Index score group

[b]Adjusted odds ratio of inpatient mortality from multivariate logistic regression model including risk factors: age, race, male sex, and Elixhauser Comorbidity Index score group

American Indians and COVID-19

Figure 1
Adjusted in-hospital mortality probabilities among COVID-19 adults at the University of Mississippi Medical Center and Hennepin County Medical Center
January 1, 2020-August 8, 2021



Discussion

Despite considerable media attention, there is a dearth of public health and empirical reports of COVID-19 experiences among indigenous populations. Even fewer investigations have included AIs in rural regions. Our finding that AIs from predominantly rural areas in the Deep South had significantly greater ECI comorbidity risk scores than AIs from predominantly urban regions in the north maintains our hypothesis, given the double disparities these vulnerable populations often experience.

Though comorbidity risk scores were significantly associated with in-hospital mortality, we find this outcome unevenly experienced across races and regions. Black adults admitted with COVID-19 had the same mean comorbidity risk score at both facilities, yet unadjusted and adjusted rates of in-hospital mortality were greater at UMMC than HCMC. White adults at UMMC had greater unadjusted and adjusted mortality rates than those at HCMC, despite lower mean comorbidity risk scores. AI adults admitted with COVID-19 at UMMC had the highest mean comorbidity risk scores and the highest mortality rates (unadjusted or adjusted) of all races

across either medical center. They were also younger when admitted than Black or White adults at either facility.

Comorbidities have undoubtedly influenced COVID-19 experiences across the globe, yet they do not fully explain our findings. Social and environmental barriers further upstream must also be considered to comprehensively assess and improve indigenous health outcomes. Several such barriers to health exist for AIs.

The Indian Health Service (IHS), the federal agency charged with providing health services to indigenous populations, is chronically understaffed, underfunded, and under-resourced. IHS per capita spending is roughly half the per capita spent for Medicaid or Veterans Affairs beneficiaries, and roughly one-third that of Medicare recipients (US Government Accountability Office, 2018). The pandemic has only amplified these disparities with IHS facilities across the nation reporting an inability to acquire the needed personal protective equipment, cleaning supplies, beds, and ventilators to care for COVID-19 patients (Walker, 2021).

Currently, federal funds appropriated by Congress only cover an estimated 40% of AI health care needs (IHS, 2022c). When patients are unable to receive care at an IHS facility or must be transferred to a non-IHS facility, federal funds are further limited through what is known as Purchased/Referred Care (PRC) programs. PRC programs often require complex and multi-step application processes, and approved funds are not guaranteed to cover any portion of incurred costs at a non-IHS facility or by a non-IHS provider (Akee & Reber, 2021). Health insurance therefore remains important for many AI individuals to be able to access quality and timely care.

A 2021 Kaiser Family Foundation survey found more than half of adults in the country delayed or skipped medical care over the past year due to cost; 63% of adults from lower income households reported the same (Kearney et al., 2021). Mississippi has the highest poverty rate in the US, combined with some of the highest unemployment and uninsurance rates in the country (US Census Bureau, 2021b). Approximately 15% of nonelderly Mississippians lack insurance coverage (Kaiser Family Foundation, 2019); 34% living on the Choctaw reservation live below the federal poverty line (US Census Bureau, 2018).

Though statewide poverty and uninsurance rates in Minnesota beat national averages, rates among AIs in the state are considerably lower and closely aligned with those of indigenous persons in Mississippi. An estimated 14% of nonelderly, AI Minnesotans are uninsured (Kaiser Family Foundation, 2019); slightly more than 34% live in poverty (Minnesota Department of Health, 2022b). Despite these similarities, it is notable that AIs in Minnesota have the lowest mean comorbidity risk score across nearly all races at both facilities and significantly lower mortality rates than AIs at UMMC. We believe other structural factors therefore warrant investigation.

The communities of the MBCI are not only rural and medically underserved, but they are also served by a single IHS-affiliated hospital. The Choctaw Health Center self-designated as a facility of the lowest acuity level, Level IV, as part of Mississippi's COVID-19 Systems of Care Plan (Mississippi State Department of Health, 2021). As such, providers were instructed to transfer patients in need of care beyond stabilization to higher acuity facilities (Mississippi State

Department of Health, 2021). UMMC, seventy-five miles from the Choctaw Health Center, is the sole facility meeting Level I designation criteria to provide care to the sickest Mississippians. Only one Level II facility is closer, yet still roughly a one-hour drive from the Choctaw Health Center. This compares strikingly to Minnesota, where three of the six Level I facilities providing care to the state are in the metropolitan Minneapolis-St. Paul area. The Mayo Clinic, another Level I facility in the state, is roughly eighty-five miles south.

Limitations

We acknowledge the limitations of the described study. Both study sites are Level I trauma centers and, therefore, likely to care for those patients most critically ill, particularly during portions of the observed period when both states had a shortage of beds. Included patients may have been higher acuity at the time of admission and mortality with COVID-19 more probable than in a lower acuity setting. The likelihood of this was greater at UMMC given the distance to the Choctaw reservation and very small AI population in the metro area where the medical center is located. Further, both facilities are not affiliated with the IHS. This increases the likelihood that AI patients admitted were high acuity as IHS facilities in both states were available to care for less critically ill patients at no cost for registered tribal members. AIs were racial minorities at each site, representing a small portion of the included COVID-19 patient population. The proportion of AI patients at each site, however, was greater than the portion of the population they represented in their respective states. Causal relationships may not be drawn given the cross-sectional study design. Future studies including AI populations living in predominantly rural settings are needed to more broadly understand the impact of the COVID-19 pandemic on native nations and to devise the most effective population health strategies alongside indigenous communities moving forward.

Conclusion

Our findings underscore the critical intersection of race and geography in the COVID-19 pandemic. Conceivably, the barriers many AI Mississippians faced during the observed period could have resulted in delayed care of those infected with COVID-19, exacerbating in-hospital mortality outcomes. Addressing those factors driving disparate COVID-19 infection rates among AIs are a critical first step in reducing, if not eliminating, the racial mortality disparities that exist among those with the virus. Future efforts must be made to account for structural barriers populations face in preventing and treating illnesses. Further, insisting on policies and systems that promote true health equity may help to protect our most vulnerable populations.

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