Original Report:
COVID-19

Poverty, Comorbidity, and Ethnicity: COVID-19 Outcomes in a Safety Net Health System

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Objective: To determine if race-ethnicity is correlated with case-fatality rates among low-income patients hospitalized for COVID-19.

Research Design: Observational cohort study using electronic health record data.

Patients: All patients assessed for COVID-19 from March 2020 to January 2021 at one safety net health system.

Measures: Patient demographic and clinical characteristics, and hospital care processes and outcomes.

Results: Among 25,253 patients assessed for COVID-19, 6,357 (25.2%) were COVID-19 positive: 1,480 (23.3%) hospitalized; 334 (22.6%) required intensive care; and 106 (7.3%) died. More Hispanic patients tested positive (51.8%) than non-Hispanic Black (31.4%) and White patients (16.7%, P<.001]. Hospitalized Hispanic patients were younger, more often uninsured, and less likely to have comorbid conditions. Non-Hispanic Black patients had significantly more diabetes, hypertension, obesity, chronic kidney disease, and asthma (P<.05). Non-Hispanic White patients were older and had more cigarette smoking history, COPD, and cancer. Non-Hispanic White patients were more likely to receive intensive care (29.6% vs 21.1% vs 20.8%, P=.007) and more likely to die (12% vs 7.3% vs 3.5%, P<.001) compared with non-Hispanic Black and Hispanic patients, respectively. Length of stay was similar for all groups. In logistic regression models, Medicaid insurance status independently correlated with hospitalization (OR 3.67, P<.001) while only age (OR 1.076, P<.001) and cerebrovascular disease independently correlated with in-hospital mortality (OR 2.887, P=.002).

Conclusions: Observed COVID-19 in-hospital mortality rate was lower than most published rates. Age, but not race-ethnicity, was independently correlated with in-hospital mortality. Safety net health systems are foundational in the care of vulnerable patients suffering from COVID-19, including patients from under-represented and low-income groups. *Ethn Dis.* 2022;32(2):113-122;doi:10.18865/ed.32.2.113

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Introduction

The novel coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has resulted in significant morbidity and mortality across the world while drawing attention to significant health care disparities. Racial and ethnic minorities have experienced disproportionately more cases, more hospitalizations, and more deaths from COVID-19 than non-Hispanic White patients.[1-6] In this early literature describing COVID disparities, researchers continue to debate the relative contribution of comorbidity, poverty and other social determinants, and the interaction of these conditions with race and ethnicity.[7, 8] Researchers also continue to explore the differences between number of COVID-related deaths, which are clearly higher in racial and ethnic minorities in the United States, and the case-fatality rate. A higher case fatality rate, if present, would suggest a difference in susceptibility to

dying from COVID-19 among different race and ethnic groups.[7,9]

A recently published meta-analysis of 52 COVID-19 studies determined that while both Hispanic and non-Hispanic Black populations have higher rates of COVID-19 infection, higher rates of COVID-19-related hospitalizations, and higher rates of death per 100,000 people than non-Hispanic White populations, there were no differences in case fatality rates.[9] Most studies included in this meta-analysis reported case fatality rate as in-hospital mortality. Several comorbid conditions have been associated with increased risk of hospitalization and mortality from COVID-19, and those conditions are more prevalent among racial minority and lower income patients.[10-15] Furthermore, multimorbidity – the presence of two or more chronic conditions – is more prevalent in middle-aged and older non-Hispanic Black patients than their non-Hispanic White counterparts.[16, 17]

One goal of this report is to better explore whether different ethnic or racial groups experience a higher case fatality rate due to COVID-19.

Increased rates of infection among Black and Hispanic patients may be a function of social factors that result in increased exposure and infection. Munoz and colleagues reported that zip code of residence was associated with both COVID-19 positivity and hospitalization with 79% of the overall variance in COVID-19 positivity explained by zip code.[18] In a recent international review of COVID-19 and social determinants of health, Upshaw et al suggested that: "Adverse social conditions at the individual and community level, reinforced by systemic issues such as racism, may increase the likelihood of both COVID-19 infection and poor COVID-19 disease outcomes."[8]

In the United States, safety net health systems care for a disproportionate share of low-income, minority, and medically and socially complex patients.[19,20] Relatively little of the COVID literature focuses specifically on the outcomes of patients served by this important sector of the US health care infrastructure.

One goal of this report is to better explore whether different ethnic or racial groups experience a higher case fatality rate; this would suggest a difference in susceptibility to dying from COVID-19 even when controlling for potential confounding variables such as comorbidity, poverty, and clinical care processes, such as differences in rates of intensive care interventions or advanced directives. We report on the outcomes of a novel cohort because this diverse group of patients all accessed the same safety net health care system with multiple clinical locations in under-served neighborhoods; all locations utilized a single enterprise electronic medical record. We thereby accessed clinical care processes and outcomes from the time of initial COVID screening to ultimate hospital discharge among a diverse low-income patient population. We address the following research question: Is race or ethnicity significantly correlated with case-fatality rate (reported as in-hospital mortality) among a diverse cohort of patients hospitalized for COVID-19 and accessing a single safety net health system when controlling for comorbidity?

Methods

This is a longitudinal cohort study utilizing data from a systemwide integrated electronic health record to capture patient demographics, diagnostic testing, selected care processes, and outcomes of care from March 2020 to January 2021. The study relies on a limited dataset (including blinding of dates of service) and was approved as exempt research by the Indiana University Institutional Review Board.

Study Site

Eskenazi Health is located in Indianapolis, Indiana in the US Midwest. Indianapolis is the 17th largest city in the United States and the largest in Indiana; the city's largest race and ethnic groups are non-Hispanic White (50%), non-Hispanic Black (27%), and Hispanic (13%). Eskenazi Health includes a 327-bed Sidney and Lois Eskenazi hospital, a 10-site federally qualified health center (FQHC), and a 20-site Sandra Eskenazi Community Mental Health Center. The FQHC and Community Mental Health Center sites are located in distinct Indianapolis neighborhoods by design and provide a broad range of wraparound services. Eskenazi Health also includes the city's busiest emergency depart-

ment, a Level I Trauma Center, and the regional Burn Center. Each of these Eskenazi Health clinical sites is served by a single, integrated, electronic health record (EHR). Among other key features of this modern health system, the hospital was built in 2013 and designed with a large number of acuity adaptable beds and high rates of air exchange throughout the building. The Pulmonary and Critical Care team utilized standardized protocols for the care of patients hospitalized with COVID-19; these protocols were developed early in the course of the pandemic in Indianapolis based on the experience of national colleagues at the earliest epicenters of the pandemic. Eskenazi Health is one of the major teaching hospitals affiliated with the Indiana University School of Medicine and staffed by faculty from the School of Medicine.

Study Population and Data Collection

The study population includes 26,890 patients assessed for COVID-19 at any Eskenazi Health site. Eskenazi Health uses the Epic EHR platform (Epic Systems Corporation, Verona, Wisconsin) for all inpatient and outpatient care, including the registry and population health functionality used for monitoring suspected and confirmed COVID-19 cases. COVID-19 positive status was defined as a positive SARS-CoV-2 polymerase chain reaction (PCR) test handled by the Eskenazi Health Laboratory or a clinical designation of COVID-19 positive status by the local infection control leadership. (Due to high volume during surges in the pandemic, some PCR testing was completed by outside laboratories).

Data analysts employed by Eskenazi Health extracted data from the Epic EHR. Unique patient identifiers, including specific dates of events were removed but relative dates were provided to allow calculation of, eg, length of stay. Data included demographic information (age, sex, race, insurance status), history of ambulatory care visit to Eskenazi Health in two years prior to COVID-19 testing, resuscitation status on admission, latest resuscitation status during admission, history of ICD-10 diagnosis of common chronic medical conditions, smoking status, and body mass index.

Comorbidity was defined as more than one of the 10 common chronic conditions (see Table 1). We extracted data specific to the first COVID-19-related hospitalization, defined as the first hospital admission (inpatient or observation) with a positive COVID-19 test or infection control team identification of COVID-19 (eg, external test) within 4 weeks prior to or during the admission. Unless stated otherwise, we report data from the first COVID-19-related hospitalization. Hospitalization-related data included care in the intensive care unit (ICU), mechanical ventilation, and inpatient mortality.

Race and ethnicity were self-reported at the time of patient visits in response to separate questions as recommended by the US Department of Health and Human Services. Race categories included: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, and White. Ethnic categories included: Hispanic or Latino and Not Hispanic or Latino. Approximately 20% of patients report race as "other" or "unknown" and are thereby often excluded from reports on race and ethnicity. Prior reports demonstrate that the large majority of patients reporting race as "unknown" or "other" are Hispanic patients for whom the meanings of these race categories are uncertain and variable across different Hispanic populations.[21] According to the Pew Research Center 2011 National Survey of Latinos and the US Census Bureau, more than 30% of Hispanic respondents describe their race as "other" or "unknown" as compared with 1% of non-Hispanics.[22] In the present study, three racial-ethnic groups were identified using a hierarchical approach. First, patients self-reporting Hispanic ethnicity were identified as Hispanic; remaining patients (non-Hispanic) who self-reported Black or African American race were identified as non-Hispanic Black. Remaining patients who self-reported White race were identified as non-Hispanic White. Among the 26,890 patients assessed for COVID-19 at Eskenazi Health, 1,637 (6.1%) were excluded due to reporting a racial-ethnic category other than the three groups noted above. Of these, 73 patients had a COVID-19-related hospitalization and there were 7 deaths.

Data Analysis

We compared the demographic and clinical characteristics, as well as the care outcomes of first COVID-related hospitalization of Hispanic, non-Hispanic Black, and non-Hispanic White patients. Comparisons of categorical and continuous characteristics were made using Chi-square tests and one-way Analysis of Variance (ANOVA)

tests, respectively. We compared the lengths of hospital stay using the nonparametric Kruskal–Wallis test among the four race/ethnicity groups. We further examined factors related to hospitalization, mechanical ventilation, and in-hospital mortality using logistic regression analysis. We included all demographic and clinical variables listed in Table 4. Age, sex, race/ethnicity, and Medicaid status were included in the model first as a group, followed by comorbid conditions as a group. Myocardial infarction and CHF were removed from the model for death because there were no deaths where the patient had a history of either. In-hospital mortality calculations excluded patients who remained admitted as of the data extraction date. As a secondary exploration, we also examined the effects of two-way interactions involving age. All analyses were performed using R software (www.R-project.org). P values <.05 were considered statistically significant.

In contrast to our focus on a single safety net health system, Rosenthal et al reported the clinical characteristics of patients hospitalized for COVID-19 across 592 acute care hospitals in the United States.[23] Because age was significantly correlated with mortality in that national representative sample, and because our local sample included a younger cohort, we resampled the Eskenazi Health population of patients to replicate the 20% prevalence of patients aged ≥80 years as reported in by Rosenthal et al[23] Through this simulation, we sought to explore whether our lower observed mortality rate was explained solely by enrolling a younger patient sample. We report this simulated mortality rate and the empirical confidence interval.

Results

Between March 2020 and January 2021, 25,253 patients of one of the predefined race-ethnicity groups were tested for COVID-19. Patients tested for COVID-19 were more likely to be non-Hispanic Black (40%) compared with Hispanic (30.9%) or non-Hispanic White (29.2%) The average age of this study population was 41.1 years, 57.2% were women, and 41.7% received Medicaid. Among all patients tested, 32.2% had two or more comorbid conditions, 74% had received ambulatory care in at least one Eskenazi Health clinical site in the two years prior to COVID testing, and 19% had a hospitalization at Eskenazi Health in the prior two years. (Table 1)

As shown in Table 2, among the 25,253 patients tested, 6,357 (25.2%) patients were confirmed COVID-19 positive. Hispanic patients were significantly more likely to test positive (51.8%) than non-Hispanic Black patients (31.4%) and non-Hispanic White patients (16.7%), P<.001. COVID-19 positive Hispanic patients were younger (38.8 years) compared with non-Hispanic Black or White patients (45.5 years, 46.7 years, respectively) and were less likely to have health insurance and less likely to have been hospitalized in the two years prior to the COVID-19 diagnosis. Hispanic patients were less likely to have two or more chronic conditions (23.2%) compared with non-Hispanic Black or White patients, (46.7%, and 35.3%, respectively).

Among all COVID positive patients, 1,480 (23.3%) were hospitalized. These 1,480 patients hospitalized in the safety net health system represented 20% of all COVID-19 related hospital discharges in Indianapolis during this time period whereas the safety net hospital represents only 9% of the city's hospital beds. This demonstrates foundational role of the safety net health systems in caring for a large proportion of seriously ill COVID-19 patients in Indianapolis, IN. As shown in Table 3, the mean age of hospitalized patients was 53.4 years and 27% of the patients were aged ≥65 years. All the measured demographic and clinical characteristics vary significantly among the race and ethnic groups. Compared with the Indianapolis census data, the patients hospitalized were more likely to be Hispanic or non-Hispanic Black, more likely to receive Medicaid, and more likely to have been hospitalized in the prior 2 years. The mean age of Hispanic patients was 10 years younger than non-Hispanic Blacks and 13 years younger than non-Hispanic White patients. Hospitalized non-Hispanic Black patients had the highest rates of diabetes, hypertension, elevated body mass index, chronic kidney disease, and asthma. Hospitalized non-Hispanic White patients were more likely to have a history of cigarette smoking, COPD, and cancer. Although all three groups had a significant burden of chronic conditions, nearly 70% of non-Hispanic Black patients suffered from two or more chronic conditions.

Table 3 displays the care and outcomes of COVID-19 positive patients in their first COVID-19-related hospitalization. Nearly 1 in 4 patients required care in the intensive care unit and 106 (7.3%) died; among those who died, less than 1% had a "do not resuscitate" order at the time

Table 1. Demographic and clinical characteristics of all patients assessed for COVID-19[a]

Variable	All Patients COVID assessed N=25,253	Hispanic N=7,785 (30.9%)	Non-Hispanic Black N=10,093 (40.0%)	Non-Hispanic White N=7,375 (29.2%)
Age in years, mean (SD)	41.08 (19.03)	34.60 (17.49)	42.48 (19.45)	46.00 (18.12)
0-17, n (%)	2561 (10.1)	1368 (17.6)	858 (8.5)	335 (4.6)
18-34, n (%)	7238 (28.7)	2416 (31.0)	2919 (28.9)	1903 (25.8)
35-49, n (%)	6708 (26.6)	2516 (32.3)	2420 (24.0)	1772 (24.0)
50-64, n (%)	5881 (23.3)	1127 (14.5)	2537 (25.1)	2217 (30.1)
65-79, n (%)	2352 (2.0)	307 (3.9)	1104 (10.9)	941 (12.8)
80+, n (%)	510 (2.0)	51 (.7)	254 (2.5)	205 (2.8)
Female, n (%)	14439 (57.2)	4713 (60.5)	5868 (58.1)	3858 (52.3)
Insurance, n (%)				
Medicaid	10518 (41.7)	3093 (39.7)	4679 (46.4)	2746 (37.2)
Medicare	1292 (5.1)	74 (1.0)	579 (5.7)	639 (8.7)
Dual-eligible[b]	2348 (9.3)	97 (1.2)	1318 (13.1)	933 (12.7)
Commercial	4618 (18.3)	893 (11.5)	1803 (17.9)	1922 (26.1)
Self-pay	4421 (17.5)	2362 (30.3)	1276 (12.6)	783 (10.6)
Other	2056 (8.1)	1266 (16.3)	438 (4.3)	352 (4.8)
Seen in ambulatory care in the 2 years prior to testing, n (%)[b]	18676 (74.0)	6308 (81.0)	7449 (73.8)	4919 (66.7)
Hospitalized in 2 years prior to testing, n (%)[c]	4810 (19.0)	1029 (13.2)	2183 (21.6)	1598 (21.7)
Current smoker, n (%)	5996 (23.7)	465 (6.0)	2842 (28.2)	2689 (36.5)
Comorbidities, n (%)				
Diabetes	4041 (16.0)	1100 (14.1)	1907 (18.9)	1034 (14.0)
Hypertension	7642 (30.3)	1323 (17.0)	4090 (40.5)	2229 (30.2)
Body mass index ≥30	10110 (40.0)	2935 (37.7)	4398 (43.6)	2777 (37.7)
Myocardial infarction	853 (3.4)	90 (1.2)	455 (4.5)	308 (4.2)
Chronic kidney disease	1458 (5.8)	166 (2.1)	909 (9.0)	383 (5.2)
COPD	1806 (7.2)	40 (.5)	744 (7.4)	1022 (13.9)
Cancer	1078 (4.3)	162 (2.1)	485 (4.8)	431 (5.8)
Cerebrovascular disease	586 (2.3)	65 (.8)	305 (3.0)	216 (2.9)
Congestive heart failure	1065 (4.2)	72 (.9)	613 (6.1)	380 (5.2)
Asthma	2475 (9.8)	546 (7.0)	1278 (12.7)	651 (8.8)
≥ 2 comorbidities, n (%)	8136 (32.2)	1589 (20.4)	4108 (40.7)	2439 (33.1)
≥ 3 comorbidities, n (%)	4386 (17.4)	614 (7.9)	2350 (23.3)	1422 (19.3)

a. All listed variable values significantly different among groups at P<.001
b. Eligible beneficiary for both Medicare and Medicaid
c. At an Eskenazi Health facility

of hospital admission. There were no significant differences in length of hospital stay or frequency of mechanical ventilation by race and ethnicity. Non-Hispanic White patients were more likely to require care in the ICU, but Hispanic patients had the longest lengths of stay in the ICU and also the longest duration of mechanical ventilation. Non-Hispanic White patients were more likely to have "do not resuscitate" (DNR) orders both on admission (and as the last resuscitation status recorded) and were more likely to die (12%) compared with non-Hispanic Black patients (7.3%) and Hispanic patients (6.6%), P<.001. Among 234 COVID-19 patients who required hospitalization and mechanical ventilation, 65 (29.1% of the 223 completed hospitalizations) died.

Given the significant differences in age and comorbidities among the three groups, we completed three separate logistic regressions using hospitalization, mechanical ventilation, or in-hospital death as the dependent variable (Table 4). Older age, being male, Medicaid insurance status, diabetes, myocardial infarction, chronic kidney disease, cerebrovascular disease and asthma were independently associated with hospitalization, but not race or ethnicity. Older age, being male, and diabetes were each independently associated

Table 2. Demographic and clinical characteristics of all COVID-19 positive patients[a]

Variable	COVID Patients N=6,357	Hispanic N=3,295 (51.8%)	Non-Hispanic Black N=1,999 (31.4%)	Non-Hispanic White N=1,063 (16.7%)
Age in years, mean (SD)	42.26 (17.81)	38.81 (16.38)	45.54 (18.70)	46.75 (18.16)
0-17, n (%)	515 (8.1)	361 (11.0)	114 (5.7)	40 (3.8)
18-34, n (%)	1633 (25.7)	855 (25.9)	504 (25.2)	274 (25.8)
35-49, n (%)	2019 (31.8)	1264 (38.4)	506 (25.3)	249 (23.4)
50-64, n (%)	1516 (23.8)	627 (19.0)	559 (28.0)	330 (31.0)
65-79, n (%)	546 (8.6)	164 (5.0)	251 (12.6)	131 (12.3)
80+, n (%)	128 (2.0)	24 (.7)	65 (3.3)	39 (3.7)
Female, n (%)[b]	3640 (57.3)	1890 (57.4)	1192 (59.6)	558 (52.5)
Insurance, n (%)				
Medicaid	2375 (37.4)	1282 (38.9)	792 (39.6)	301 (28.3)
Medicare	223 (3.5)	34 (1.0)	107 (5.4)	82 (7.7)
Dual-Eligible[c]	488 (7.7)	39 (1.2)	306 (15.3)	143 (13.5)
Commercial	1160 (18.2)	397 (12.0)	444 (22.2)	319 (30.0)
Self-pay	1465 (23.0)	1014 (30.8)	271 (13.6)	180 (16.9)
Other	646 (10.2)	529 (16.1)	79 (4.0)	38 (3.6)
Seen in ambulatory care in the 2 years prior to testing, n (%)[d]	4888 (76.9)	2623 (79.6)	1506 (75.3)	759 (71.4)
Hospitalized in 2 years prior to testing, n (%)[d]	932 (14.7)	381 (11.6)	378 (18.9)	173 (16.3)
Current smoker, n (%)	608 (9.6)	145 (4.4)	269 (13.5)	194 (18.3)
Comorbidities, n (%)				
Diabetes	1265 (19.9)	593 (18.0)	490 (24.5)	182 (17.1)
Hypertension	1895 (29.8)	629 (19.1)	919 (46.0)	347 (32.6)
Body mass index ≥30	2873 (45.2)	1360 (41.3)	1054 (52.7)	459 (43.2)
Myocardial infarction	168 (2.6)	40 (1.2)	84 (4.2)	44 (4.1)
Chronic kidney disease	357 (5.6)	59 (1.8)	237 (11.9)	61 (5.7)
COPD	239 (3.8)	11 (.3)	115 (5.8)	113 (10.6)
Cancer	167 (2.6)	42 (1.3)	74 (3.7)	51 (4.8)
Cerebrovascular disease	105 (1.7)	28 (.8)	55 (2.8)	22 (2.1)
Congestive heart failure	183 (2.9)	21 (.6)	113 (5.7)	49 (4.6)
Asthma	556 (8.7)	198 (6.0)	267 (13.4)	91 (8.6)
≥ 2 comorbidities, n (%)	2072 (32.6)	764 (23.2)	933 (46.7)	375 (35.3)
≥ 3 comorbidities, n (%)	1060 (16.7)	285 (8.6)	555 (27.8)	220 (20.7)

a. All listed variable values significantly different among groups at P<.001 except where noted
b. P=.001
c. Eligible beneficiary for both Medicare and Medicaid
d. At an Eskenazi Health facility

with an increased risk of mechanical ventilation while congestive heart failure was independently associated with decreased risk. Race or ethnicity were not independently associated with mechanical ventilation. Older age and cerebrovascular disease were each independently associated with an increased risk of in-hospital mortality. In the mortality model, diabetes was associated with an increased risk of death at marginal statistical significance and non-Hispanic Black race was associated with a decreased risk of death at marginal statistical significance. In data not shown, if we exclude from this inpatient mortality analysis those patients who presented to the hospital with existing DNR orders on hospital admission, these same associations remain significant with the addition of non-Hispanic Black race associated with a decreased risk of inpatient mortality.

We next completed four sensitivity analyses to explore the impact of differing analytic approaches to our study findings. First, a sensitivity analysis was completed to explore the effect of including patients who reported a racial-ethnic category other than Hispanic, non-Hispanic Black, and non-Hispanic White. Second, we ex-

Table 3. Demographic and clinical characteristics of all hospitalized COVID-19 positive patients

Variable	All Patients Hospitalized N=1,480	Hispanic N=630 (42.6%)	Non-Hispanic Black N=570 (38.5%)	Non-Hispanic White N=280 (18.9%)
Age in years, mean (SD)[a]	53.41 (17.43)	47.08 (15.86)	57.14 (17.24)	60.05 (16.54)
0-17, n (%)[a]	7 (.5)	7 (1.1)	0 (.0)	0 (.0)
18-34, n (%)[a]	229 (15.5)	125 (19.8)	77 (13.5)	27 (9.6)
35-49, n (%)[a]	369 (24.9)	239 (37.9)	91 (16.0)	39 (13.9)
50-64, n (%)[a]	477 (32.2)	167 (26.5)	208 (36.5)	102 (36.4)
65-79, n (%)[a]	296 (20.0)	73 (11.6)	144 (25.3)	79 (28.2)
80+, n (%)[a]	102 (6.9)	19 (3.0)	50 (8.8)	33 (11.8)
Female (%)[b]	734 (49.6)	311 (49.4)	309 (54.2)	114 (40.7)
Insurance, n (%)				
Medicaid[a]	710 (48.0)	400 (63.5)	213 (37.4)	97 (34.6)
Medicare[a]	119 (8.0)	13 (2.1)	58 (10.2)	48 (17.1)
Dual-Eligible[a,c]	294 (19.9)	19 (3.0)	193 (33.9)	82 (29.3)
Commercial[a]	153 (10.3)	50 (7.9)	68 (11.9)	35 (12.5)
Self-pay[a]	60 (4.1)	37 (5.9)	14 (2.5)	9 (3.2)
Other[a]	144 (9.7)	111 (17.6)	24 (4.2)	9 (3.2)
Seen in ambulatory care in the 2 years prior to testing, n (%)[a,d]	942 (63.6)	398 (63.2)	401 (70.4)	143 (51.1)
Hospitalized in 2 years prior to testing, n (%)[a,d]	517 (34.9)	161 (25.6)	245 (43.0)	111 (39.6)
Current smoker, n (%)[a]	166 (11.2)	25 (4.0)	79 (13.9)	62 (22.1)
Comorbidities, n (%)				
Diabetes[b]	561 (37.9)	222 (35.2)	247 (43.3)	92 (32.9)
Hypertension[a]	760 (51.4)	212 (33.7)	396 (69.5)	152 (54.3)
Body mass index ≥30[e]	775 (52.4)	310 (49.2)	322 (56.5)	143 (51.1)
Myocardial infarction[a]	110 (7.4)	22 (3.5)	57 (10.0)	31 (11.1)
Chronic kidney disease[a]	240 (16.2)	37 (5.9)	160 (28.1)	43 (15.5)
COPD[a]	147 (9.9)	6 (1.0)	80 (14.0)	61 (21.8)
Cancer[a]	86 (5.8)	16 (2.5)	40 (7.0)	30 (10.7)
Cerebrovascular disease[e]	65 (4.4)	17 (2.7)	34 (6.0)	13 (5.0)
Congestive heart failure[a]	114 (7.7)	11 (1.7)	68 (11.9)	35 (12.5)
Asthma[a]	122 (8.2)	24 (3.8)	75 (13.2)	23 (8.2)
≥ 2 comorbidities, n (%)[a]	810 (54.7)	249 (39.5)	395 (69.3)	166 (59.3)
≥ 3 comorbidities, n (%)[a]	510 (34.5)	108 (17.1)	285 (50.0)	117 (41.8)

a. Values significantly different among groups at P<.001
b. Values significantly different among groups at P<.01
c. Eligible beneficiary for both Medicare and Medicaid
[d] At an Eskenazi Health facility
[e] values significantly different among groups at P<.05

plored the effect of using the number of comorbid conditions (0-10) in the model rather than individual chronic conditions. Third, we explored the effect of including interaction terms (age*Medicaid, age*[chronic conditions]). None of these variations in the analysis meaningfully changed our findings and neither the number of chronic conditions nor the interaction terms reached statistical significance (data not shown). Finally, because our study population had a lower mean age in years compared with a nationally representative sample,[23] we resampled the Eskenazi Health population of patients to replicate 20% prevalence of patients aged ≥80. This resulted in a mortality rate of 11.7% (95%CI, 10.1% to 13.2%), which remains lower than nationally reported rates.

Discussion

This study explores whether race-ethnicity is significantly correlated with case-fatality rates, reported as in-hospital mortality, among a diverse cohort of patients hospitalized for COVID-19 when controlling for comorbidity. We describe the COVID-19 experience and outcomes of vulnerable patients cared for within

Table 4. Multivariable regression analysis for hospitalization among COVID-19 positive patients and for mechanical ventilation and death among hospitalized patients

Variable	Hospitalization		Mechanical Ventilation		Death	
	Odds Ratio (OR)	OR 95%CI	Odds Ratio (OR)	OR 95% CI	Odds Ratio (OR)	OR 95%CI
Demographics						
Age	1.044	(1.039,1.050)[c]	1.019	(1.008, 1.030)[c]	1.076	(1.058, 1.095)[d]
Female[a]	.669	(.584,0.767)[c]	.600	(.444, .811)[c]	.660	(.421, 1.034)
Non-Hispanic Black[b]	1.000	(.817, 1.225)	.714	(.473, 1.077)	.586	(.342, 1.006)
Hispanic[c]	1.140	(.937, 1.388)	1.050	(.694, 1.589)	.706	(.391, 1.276)
Medicaid	3.670	(3.189, 4.223)[c]	1.283	(.928, 1.776)	1.459	(.891, 2.389)
Comorbid Conditions						
Diabetes	1.583	(1.340, 1.868)[c]	1.673	(1.224, 2.288)[c]	1.566	(.985, 2.489)
Hypertension	.942	(.792, 1.122)	1.089	(.762, 1.556)	.643	(.376, 1.101)
Obesity	1.193	(1.038, 1.372)[c]	1.201	(.888, 1.625)	1.140	(.720, 1.804)
Chronic kidney disease	2.232	(1.699, 2.931)[c]	1.085	(.722, 1.631)	1.559	(.939, 2.588)
COPD	1.247	(.907,1.714)	.857	(.509, 1.444)	.944	(.519, 1.719)
Cancer	1.229	(.857, 1.762)	.748	(.395, 1.418)	.831	(.366, 1.885)
Cerebrovascular disease	1.701	(1.084, 2.670)[c]	1.750	(.972, 3.153)	2.887	(1.470, 5.672)[d]
Asthma	.776	(.605, 0.995)[c]	.929	(.523, 1.648)	.904	(.391, 2.092)
Myocardial infarction	1.952	(1.345, 2.832)[c]	1.475	(.893, 2.436)	Removed from model[d]	
Congestive heart failure	1.226	(.842, 1.786)	.434	(.226, .834)[c]	Removed from model[d]	

a. The reference group of sex is male
b. The reference group of race is non-Hispanic White
c. P<.05.
d. Myocardial infarction and CHF were removed from the model because there were no deaths in first COVID hospitalizations where the patient had a history of either

an urban safety net health system. Our patient population included a larger population of Hispanic and non-Hispanic Black patients and a larger sample of patients receiving Medicaid than reported in national samples. [23]

Although our study question focuses on difference in in-hospital mortality by race and ethnicity, our first observation was that in-hospital mortality in this vulnerable population was only 7.3% compared with a reported US national rate of 20.3%.[23] This rate also compared favorably to 21% in-hospital mortality rate in Indianapolis during this period.

Age is one of the greatest risk factors for COVID-19 mortality.[24] While the volume of older age patients in our sample population was lower than the national average, simulation analyses oversampling older age patients to the national average increases the estimated in-hospital mortality rate to only 11.7%. Our observed case fatality rate for COVID-19 patients who required both hospitalization and mechanical ventilation (29.1%) was also substantially lower than the case fatality rate (56%) reported in an international meta-analysis, including 54 studies across 5 continents.[25] When these international data were stratified by age, the youngest group (age less than 40 years) had a case fatality rate of 47.9%.[25] In the same report, the case fatality rate across 21 studies of mechanically ventilated patients in the United States was 61%.[25]

Our second observation is that race-ethnicity was not independently correlated with in-hospital mortality among this cohort of vulnerable patients. Like prior studies, age was the strongest independent correlate of in-hospital mortality and largely explains the observed increase in mortality among non-Hispanic White patients in our patient cohort. When patients who had a DNR order on admission were excluded (which includes a larger proportion of non-Hispanic White patients), logistic regression revealed that non-Hispanic Black race-ethnicity was independently associated with a decreased risk of in-hospital mortality. This finding is supported by a previously published analysis that showed improved survival among non-Hispanic Black and Hispanic patients after adjustment for age, sex, and socioeconomic status.[30] Another analysis found no difference

in survival between Black and White patients after similar adjustments.[31]

Both Medicaid insurance, a proxy for low-income individuals in the United States, and comorbid conditions were independently associated with risk of hospitalization while race and ethnicity were not. As comorbid conditions are more prevalent in low-income populations, these variables may reflect the pervasive impact of poverty, racism, and other social factors on COVID-19 outcomes.[18] The interrelation between Medicaid insurance and COVID-19 incidence and hospitalization may be partially due to increased exposure to COVID-19. Medicaid-insured patients are more likely to be employed in essential occupations, and these occupations have been exempted from stay-at-home orders in several states including Indiana.[26-29] Importantly, Medicaid insurance was not independently associated with an increased risk of in-hospital mortality suggesting that the access to care afforded by this program promotes favorable clinical outcomes. We chose to use individual comorbidities rather than comorbidity indices in the regression model because prior reports had already noted the increased risk among persons with specific comorbid conditions (eg, diabetes).

Study Limitations

The major limitation of this study is the observational design using data routinely collected and stored during the conduct of clinical care. Thus, we cannot make causal inferences. Second, constructs such as race and ethnicity are culturally defined, and we rely on current federal guidelines that recommend the self-reported categories of race-ethnicity used in this study. We did not measure patient's experiences of racism or other social determinants of health. Third, we relied on Medicaid status as a proxy for low-income status. Fourth, this study was not designed to test the efficacy of approaches to care, and therefore conclusions regarding the possible factors that resulted in the favorable observed mortality outcomes are hypotheses. Indianapolis, located in the middle of the United States, experienced the pandemic 6-8 weeks later than health systems on either coast. Thus, we were able to learn from best practices developed in that interval. However, this safety net health system also experienced favorable mortality rates compared with those reported in Indianapolis in general. We suggest that the favorable survival rate was the result of high-quality supportive team-based medical care, including integration of pharmacists in the care team, combined with consistent provision of up-to-date treatment, scaling of the workforce to maintain pre-pandemic staffing ratios, and a highly adaptable physical environment that provided adequate capacity to expand the intensive care unit settings (including mechanical ventilation) and to expand the diverse workforce. Additionally, the newly built environment of Eskenazi Hospital (opened in 2013) was designed with state-of-the-art air exchange throughout the hospital which is not widely available in other hospitals.

Conclusion

While disparities in COVID-19 test-positivity and hospitalization were confirmed among socially disadvantaged patients in our cohort, outcomes during hospitalization did not differ by social factors or self-reported race. Indeed, this safety net health system achieved some of the lowest in-hospital and mechanically ventilated COVID-19 case fatality rates reported in the literature to date. The health system's response to COVID-19 combined provision of pre-pandemic multidisciplinary, evidence-based care with consistent implementation of up-to-date treatments and scaling of the workforce in a state-of-the-art physical environment to achieve uniform high-quality care.

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Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Smith, Grout, Tu, Crabb, Carlos; Acquisition of data: Smith, Grout; Data analysis and interpretation: Smith, Kressel, Grout, Weaver, Cheatham, Tu, Li, Crabb, Carlos; Manuscript draft: Smith, Kressel, Grout, Weaver, Cheatham, Li, Harris, Carlos; Statistical expertise: Grout, Tu, Li; Acquisition of funding: Harris; Administrative: Kressel, Grout, Weaver, Cheatham, Crabb, Harris

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