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Research article

Determinants of all-cause in-hospital mortality among patients who presented with COVID-19 to a community teaching hospital in Michigan

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ABSTRACT

Background & objectives: Race plays an important role in healthcare disparities, often resulting in worse health outcomes. It is unclear if other patient factors and race interactions may influence mortality in patients with COVID-19. We aimed to evaluate how multiple determinants of all-cause in-hospital mortality from COVID-19 were linked to race.

Methods: A retrospective observational study was conducted at two hospitals in metropolitan Detroit. We identified patients aged ≥18 years-old who had tested positive for COVID-19 and were admitted between March 9 through May 16, 2020. Multivariable logistic regression was performed assessing predictors of all-cause in-hospital mortality in COVID-19.

Results: We identified 1064 unique patients; 74% were African Americans (AA). The all-cause in-hospital mortality was 21.7%, with the majority of deaths seen in AA (65.4%, $P = 0.002$) and patients 80 years or older (52%, $P < 0.0001$). AA women had lower all-cause mortality than AA men, white women, and white men based on race-gender interactions. In multivariable logistic regression analysis, older age (>80-year-old), dementia, and chronic kidney disease were associated with worse all-cause in-hospital mortality. Adjusted for race and body mass index (BMI), the main odds ratios (OR) and 95% confidence intervals (CI) are: Age 80 and older vs < 60 in females: OR = 7.4, 95% CI: 2.9, 18.7; in males OR = 7.3, 95% CI: 3.3, 16.2; Chronic Kidney Disease (CKD): OR = 1.7, 95% CI: 1.2, 2.6; Dementia: OR = 2.2, 95% CI: 1.5, 3.3.

Conclusion: Gender significantly modified the association of race and COVID-19 mortality. African American females had the lowest all-cause in-hospital mortality risk compared to other gender-race groups.

Strength

1) A large sample size among two hospitals that were the first to admit COVID-19 cases in Michigan. The sample included an urban population in Southfield, MI (bordering Detroit, MI) and a suburban population in Novi, MI.
2) The diligent and robust data collection/retrieval method ensures accuracy of information with strict follow-up on readmission rates and discharge location.

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Limitation

1) The hospital system is part of one of the largest not-for-profit healthcare systems in the United States, Ascension. The hospitals have two distinct locations which serve two different demographics, where AA are the more common population in the Southfield, MI location and WH are the more common population in Novi, MI. However, the two systems share the same administration, costs and physician pool.
2) The study could not include data on mortality from those who were not hospitalized in the community; nevertheless, the included sample was consecutive and representative of the population in Southeast Michigan.
3) Like nearly all work published on COVID-19 mortality, we have relied on existing data and medical records in this case, so we cannot examine potentially important factors requiring questionnaire or interview data, such as smoking.

1. Introduction

Racial inequities in nearly all health outcomes have persisted for more than a century in the United States (Frist, 2005). COVID-19 incidence has followed this same pattern. On June 5, 2020, Morbidity and Mortality Weekly Report, the Centers for Disease Control and Prevention provided their first report describing the disproportionate incidence of COVID-19 due to racial disparity among 205 counties in 33 states tracking race among cases (Moore et al., 2020). The interim report of the Michigan Coronavirus Racial Disparities Task Force reports similar disparities in our state of Michigan: "Across the pandemic, the cumulative COVID-19 case rate in Black and African American populations has been over 40% higher than the rate in White populations." Several reports have called out racism, particularly structural racism, as a root cause of racial disparities in incidence and mortality for COVID-19 (Khazanchi et al., 2020; Laster Pirtle, 2020).

COVID-19 mortality is a function of both incidence and the case fatality rate for the condition. The higher incidence rates of COVID-19 for African Americans would contribute to racial disparities in COVID-19 mortality rates. In studies of other well-described inequality, such as breast cancer and HIV, the disparities in incidence have been compounded by decreased survival of African Americans with the condition, leading to even larger mortality disparities relative to incidence (Levine et al., 2007; O'Hanlan and Isler 2007). Early reports in the pandemic of larger disparities in mortality relative to incidence suggested that the virus was deadlier for African Americans, exacerbating the inequalities produced by higher incidence rates (Vasquez-Reyes, 2020). The higher rates of obesity and chronic diseases that have been linked to higher COVID-19 mortality suggest some reasons why case fatality may be elevated for African Americans and compound the risks from higher incidence rates (Curtin et al., 2020; Jayawardena et al., 2020; Belanger et al., 2020; Tartof e al., 2020). While most studies have described higher COVID 19 mortality rates for African Americans, at least one recent report showed no difference in mortality related to COVID-19 between Blacks and other races/ethnicities among hospitalizations in a single health system (Killerby et al., 2020; Gold et al., 2020; Ogedegbe et al., 2020).

Estimating case fatality rates in the U.S. has been challenging as the denominator (cases of COVID-19) is underestimated due to insufficient testing throughout the pandemic (Meyerowitz-Katz and Merone 2020). Death rates for patients admitted to hospitals with COVID-19 are a more readily available measure that could shed light on racial disparities, albeit at an advanced stage of disease progression. The fact that racial disparities in COVID-19 mortality may be related to upstream factors such as poverty, lack of insurance, crowding with little social distancing, socioeconomic status, lack of education, higher prevalence of comorbidities, lack of proper care, and follow up due to limited access to health care services makes examining race post-admission essential to evaluate (Ogedegbe et al., 2020; Hasnain-Wynia et al., 2007; Yancy, 2020; Corlet al., 2019). Gender has been noted in numerous studies, both within and outside the U.S., to relate to COVID-19 mortality, with women appearing to survive at higher rates (Jin et al., 2020). As expected, age is a potent risk factor with an increased risk of COVID-19 mortality across age groups (Williamson et al., 2020). However, prior studies of the impact of gender have not examined how it may intersect with the effect of race or age on COVID-19 mortality.

We conducted a retrospective chart review of all COVID-19 cases presented to our two community teaching hospital campuses during the initial surge of COVID-19 in Michigan. We evaluated determinants of all-cause in-hospital mortality among our population as a primary outcome. We also examined the relationship and interactions between race, age, gender, BMI (calculated using recorded weight in kilograms and height in meters with the formula for BMI: weight (kg)/[height (m)]^2) and comorbidities in patients admitted with COVID-19 disease (Flegal and Graubard 2009).

2. Methods

2.1. Study design and participants

We conducted a retrospective observational study of COVID-19 admissions at Ascension Providence Hospital (APH) from March 9 through May 16, 2020. APH is a 654-bed teaching complex located in the Metro Detroit area serving the three Michigan counties with the highest reported cases of COVID-19: Wayne, Oakland, and Macomb County. In Southfield and Novi, two APH campuses share the same administration, costs, and physician pool. They are, however, separated by 18 miles; one is adjacent to the densely populated city of Detroit (Southfield) and the other in a more rural/suburban area (Novi). All adult patients ($\geq$18 years-old) who presented to either campus with a confirmed diagnosis of COVID-19 using a nasopharyngeal swab for real-time polymerase chain reaction (RT-PCR) test were considered eligible. The list of eligible patients was identified using data obtained from the APH COVID-19 command center, data warehouse queries, and infectious control service lists. The APH Institutional Review Board approved the study before patient identification and data collection; waiver of informed consent was granted due to the minimal risk nature of the study (chart review).

2.2. Patients and public involvement

This was a retrospective study, and no patients were involved in the study design or setting the research questions or reported outcomes. No patients were asked for advice on interpretation or writing up of results.

2.3. Data collection

The patients' demographic, symptomatology, clinical data, laboratory results, and radiographic images were manually abstracted through a review of electronic medical records by project team members and data warehouse queries. BMI was calculated from recorded weight and height and categorized into four groups under 25; 25 - <30; 30 - <35; $\geq$35 (Flegal and Graubard 2009). The Charlson comorbidity index (CCI) was

computed from the abstracted medical record data (Charlson et al., 1987). The data was de-identified and shared with a biostatistician for analysis. Data quality was ensured by random sample review by the co-investigator (LD), continuous communication with the project primary investigator and the data collection team, and manual inspection of entered data by the biostatistician. Where missing, duplicate and discordant inputs were identified and communicated with the data collection team; they were adjusted and confirmed as appropriate. All discharges to hospice during the review period were confirmed to result in the death of the patient. To be conservative, we included all deaths, whether at discharge or following hospice.

2.4. Statistical analysis

Statistical analyses were conducted with SAS software version 9.4 (SAS Institute Inc, Cary, NC). Preliminary analyses summarized in-hospital mortality by frequencies and percentages in categories of age, sex, race, and clinical characteristics (BMI, comorbidity). Comorbidity was assessed by the CCI and categorized as either <4 or ≥4 (range 0–17). BMI (kg/m^2) was categorized as <25, 25-<30, 30-<35, and ≥35 (range 14.3–66.4). We developed a series of multiple logistic regression models to assess the effects of age, sex, race, CCI, and BMI, recognizing from our preliminary analysis that interactions could be present. The first model contained only the main effects of the potential explanatory factors. Next, we added two-way interactions based on prior hypotheses. Specifically, we examined interactions between age, sex, race, BMI, and CCI jointly. For model parsimony, we retained significant interactions at P < .15, which led to the inclusion of the interactions age with sex and race with BMI. In the third step, we explored specific comorbidities that could have an impact on mortality. For the full model, we calculated odds ratios and associated 95% confidence intervals.

Using the C-statistic, we gauged a model's discriminative power and applied it to compare the main effects and complete model. The C-statistic is for the area under the receiver operating characteristic (ROC) curve. We plotted ROC curves for the main effects model and the full model. A C-statistic above 0.75 was considered excellent. Deviance, Hosmer-Lemeshow and Spiegelhalter tests assessed goodness-of-fit (Hosmer et al., 1997; Spiegelhalter, 1986). Regression diagnostics flagged two potential, influential observations but deleting them did not substantively impact the overall fit of the full model.

We also conducted a time-to-event analysis for the length of illness defined as the number of days from the first admission to the date of death or the last date the patient was discharged alive from the hospital during the study period. Kaplan-Meier curves were obtained by sex and race and compared by the log-rank test. We estimated the median length of illness for the four sex-by-race groups.

3. Results

Our study identified 1064 unique patients who had tested positive for COVID-19 and were admitted to APH between March 9 through May 16, 2020, with follow-up through May 16, 2020. 740 COVID cases were

Table 1. Distribution of characteristics of individuals hospitalized with COVID-19 by race.

Number (n)	All	White (WH)	African American (AA)	P-value
	n (1064)	n (280)	n (784)	
Age (years), mean ± SD	65.4 ± 17.4	68.1 ± 19.1	64.4 ± 16.7	0.002$^{\alpha}$
Age under 60, n (%)	355 (33.4)	82 (29.3)	273 (34.8)	<0.0001$^{\beta}$
Age 60 - <70, n (%)	243 (22.8)	61 (21.8)	182 (23.2)	
Age 70 - <80, n (%)	228 (21.4)	43 (15.4)	185 (23.6)	
Age 80+, n (%)	238 (22.4)	94 (33.6)	144 (18.4)	
Sex-male, n (%)	517 (48.6)	152 (54.3)	365 (46.6)	0.021$^{\gamma}$
Male-age <60, n (%)	167 (32.3)	43 (28.3)	124 (34.0)	<0.0001$^{\beta}$
Male-age 60-<70, n (%)	129 (25.0)	47 (30.9)	82 (22.5)	
Male-age 70-<80, n (%)	122 (23.6)	26 (17.1)	96 (26.3)	
Male-age 80+, n (%)	99 (19.2)	36 (23.7)	63 (17.3)	
Sex-female, n (%)	547 (51.4)	127 (45.4)	420 (53.6)	0.021$^{\gamma}$
Female-age <60, n (%)	188 (34.4)	39 (30.5)	149 (35.6)	<0.0001$^{\beta}$
Female-age 60-<70, n (%)	114 (20.8)	14 (10.9)	100 (23.9)	
Female-age 70-<80, n (%)	106 (19.4)	17 (13.3)	89 (21.2)	
Female-age 80+, n (%)	139 (25.4)	58 (45.3)	81 (19.3)	
BMI (kg/m^2), mean ± SD	31.1 ± 8.5	29.6 ± 7.7	31.6 ± 8.6	0.001$^{\alpha}$
BMI under 25, n (%)	261 (24.5)	85 (30.4)	176 (22.5)	0.006$^{\beta}$
BMI 25 - <30, n (%)	293 (27.5)	85 (30.4)	208 (26.5)	
BMI 30 - <35, n (%)	219 (20.6)	49 (17.5)	170 (21.7)	
BMI ≥35, n (%)	291 (27.4)	61 (21.8)	230 (29.3)	
CCI score (points)	4.3 ± 3.1	4.4 ± 3.1	4.3 ± 3.1	0.682$^{\alpha}$
CCI score <4, n (%)	447 (42.0)	115 (41.1)	332 (42.4)	0.711$^{\gamma}$
CCI score ≥4, n (%)	617 (58.0)	165 (58.9)	452 (57.7)	
Dementia, n (%)	199 (18.7)	78 (27.9)	121 (15.4)	<0.0001$^{\gamma}$
Chronic kidney disease, n (%)	192 (18.1)	33 (11.8)	159 (20.3)	0.002$^{\gamma}$
Single admission, n (%)	922 (86.7)	231 (82.5)	691 (88.1)	0.020$^{\gamma}$
Multiple admissions, n (%)	142 (13.3)	49 (17.5)	93 (11.9)	
Length of illness (days), mean ± SD	7.6 ± 7.2	7.5 ± 6.7	7.6 ± 7.4	0.409$^{\alpha}$

P-value for comparison of characteristic by race.
$^{\alpha}$ t-test;
$^{\beta}$ Chi Square test;
$^{\gamma}$ Fisher's Exact test for comparison between races (white versus African American).

Table 2. Characteristics of individuals hospitalized with COVID-19 based on survival status.

Number (n)	Alive at discharge	Deceased or Hospice	P-value
	n (833)	n (231)	
Age (years), mean ± SD	61.9 ± 16.9	77.9 ± 12.9	<0.0001[α]
Age under 60, n (%)	330 (39.6)	25 (10.8)	<0.0001[β]
Age 60 - <70, n (%)	211 (25.3)	32 (13.9)	
Age 70 - <80, n (%)	174 (20.9)	54 (23.4)	
Age 80+, n (%)	118 (14.2)	120 (51.9)	
Sex-male, n (%)	383 (46.0)	134 (58.0)	0.001[γ]
Sex-female, n (%)	450 (54.0)	97 (42.0)	
White (WH), n (%)	200 (24.0)	80 (34.6)	0.002[γ]
African American (AA), n (%)	633 (76.0)	151 (65.4)	
BMI (kg/m^2), mean ± SD	31.7 ± 8.5	28.8 ± 7.8	<0.0001[α]
BMI under 25, n (%)	182 (21.8)	80 (34.6)	<0.0001[β]
BMI 25 - <30, n (%)	221 (26.5)	69 (29.9)	
BMI 30 - <35, n (%)	175 (21.0)	42 (18.2)	
BMI ≥35, n (%)	255 (30.6)	43 (17.3)	
CCI score (units)	3.8 ± 2.9	6.3 ± 2.8	<0.0001[α]
CCI score <4, n (%)	418 (50.2)	20 (13.0)	<0.0001[γ]
CCI score ≥4, n (%)	415 (49.8)	201 (87.0)	
Dementia, n (%)	103 (12.4)	95 (41.1)	<0.0001[γ]
Chronic kidney disease, n (%)	123 (14.8)	67 (29.0)	<0.0001[γ]
Single admission, n (%)	764 (91.7)	158 (68.4)	<0.0001[γ]
Multiple admissions, n (%)	69 (8.3)	73 (31.6)	
Length of illness (days), mean ± SD	6.7 ± 6.8	10.3 ± 7.3	<0.0001[α]

P-value for comparison of characteristics by alive at discharge or deceased/hospice.
[α] t-test;
[β] Chi Square test;
[γ] Fisher's Exact test for comparison between deceased versus survivors.

admitted to the Southfield campus, and 324 patients were admitted to the Novi campus. The sample comprised 922 patients with a single admission and 142 patients with multiple admissions, the earliest of which was included in the sample. There were 231 deaths at discharge or following the discharge to hospice.

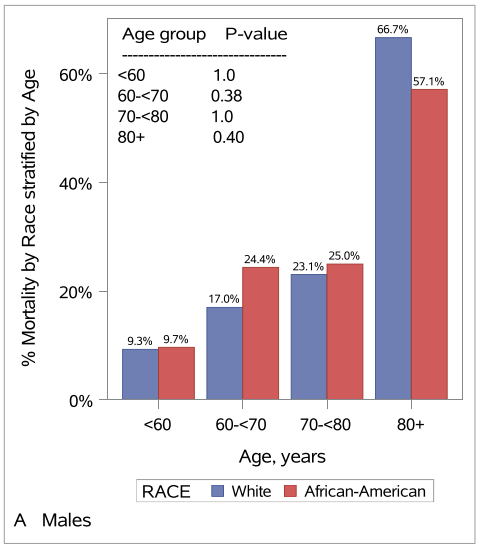
3.1. Demographics (race, age, gender)

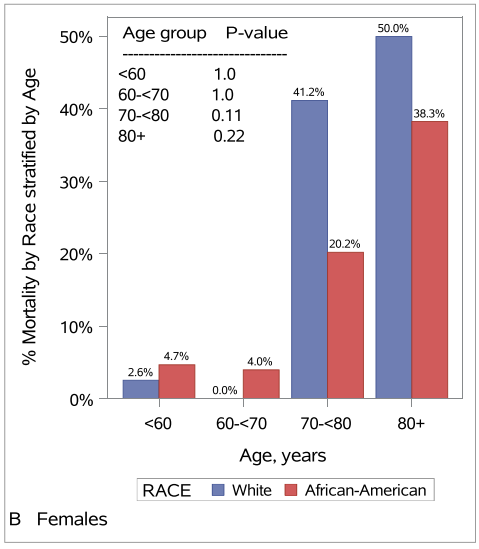
In our population, the majority (74%, 784/1064) of our patients identified as African American (AA) compared to non-Hispanic White (WH). Less than 30 patients identified as Hispanic or Asian and were not included in our study total of 1064. This study compared only the AA and WH patients. African Americans were significantly younger compared to WH (mean age 64.4 ± 16.7 vs. 68.1 ± 19.1, $P = 0.002$), with a significant difference in those younger than 60 years old (34.8% vs. 29.3%, $P < 0.0001$) (Table 1). This difference in age between AA and WH was seen in both sexes.

The AA group had significantly more female patients than the WH group (53.6% vs. 45.4%, $P = 0.021$), and this, coupled with the large age distribution differences between AA females and WH females, likely contributed to the differences in outcomes between the two groups (e.g., 19.3% of AA females were age 80 and older compared to 45.3% of WH females) (Table 1).

3.2. Race and comorbidities

There was a statistically significant difference in comorbidities between AA and WH. For example, BMI was higher in AA compared to WH (31.6 ± 8.6 vs. 29.6 ± 7.7, $P = 0.001$), with a significantly lower





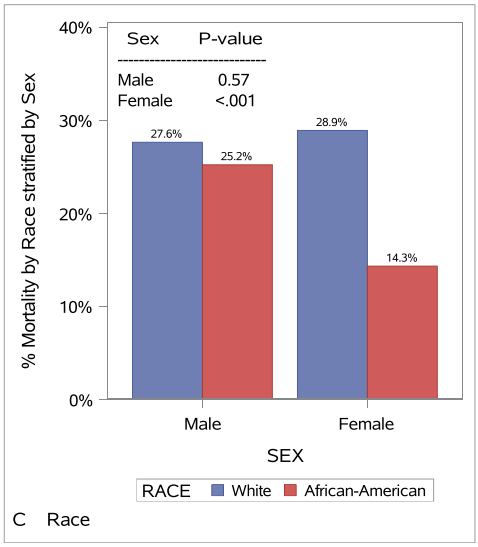


Figure 1. (A) Incidence of mortality of individuals hospitalized with COVID-19 among men and women based on race and gender. (B) Incidence of mortality of individuals hospitalized with COVID-19 among men based on race and age. (C) Incidence of mortality of individuals hospitalized with COVID-19 among men and women based on race.

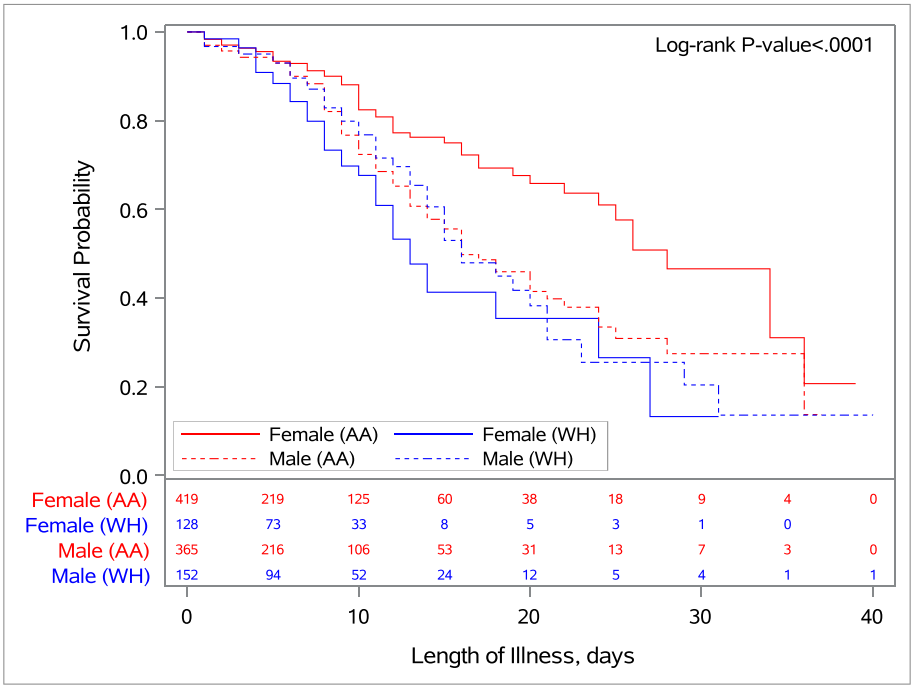


Figure 2. Kaplan-Meier curves for sex by race and compared by the log-rank test. Length of illness is defined as the number of days from the first admission to the date of death or the last date the patient was discharged alive from the hospital to home or hospice. AA = African-American, WH = White.

proportion of AA compared to WH with BMI <25 (22.5% vs. 30.4%, $p = 0.006$). The CCI score was the same in AA and WH populations (4.3 ± 3.1 vs. 4.4 ± 3.1, $P = 0.682$). However, AA was more likely to have chronic kidney disease (CKD) compared to WH (20.3% vs. 11.8%, $P = 0.002$), while WH patients were more likely to have dementia (27.9% vs. 15.4%, $P < 0.0001$) (Table 1).

3.3. All-cause in-hospital mortality (primary outcome)

In our study, 21.7% (231/1064) of patients admitted died at discharge or following hospice care. The mean age of the deceased group was 77.9 ± 12.9. Most deaths were seen in patients older than 80 years old (51.9%, $P < 0.0001$), African Americans (65.4%, $P = 0.002$), and men (58.0%, $P = 0.001$). Regarding comorbidities, patients with a higher CCI score, dementia, CKD, and lower BMI were all associated with higher mortality (Table 2).

When assessing interactions between race-gender and mortality, AA females were less likely to die compared to other gender-race groups ($P < 0.0001$) (Figure 1-B and Figure 2). Mortality was significantly lower in AA females than WH females (14.3% vs. 28.9%, $P < 0.0001$). In contrast, no significant difference in mortality rates was noticed between AA males and WH males (25.2% vs. 27.6%, $P = 0.57$) (Figure 1-A & C).

In our population, 13.3% (142/1064) of patients were readmitted. White patients were more likely to be readmitted than African American patients (17.5% vs. 11.9%, $P = 0.02$) (Table 1). Both multiple admissions (31.6% vs. 8.3%, $P < 0.0001$) and greater length of stay (days) (10.3 ± 7.3 vs. 6.7 ± 6.8, $P < 0.0001$) were associated with worse mortality (Table 2). There was no statistically significant difference in COVID-19 related deaths between the two APH campuses (25% at Novi, 20% at Southfield, *P =0.107)*.

Our multivariable logistic regression analysis adjusted for age, gender, race, BMI, CCI, dementia, and CKD. Older age (>80 years), compared to age<60 years in both men and women [OR: 7.26; 95% CI, 3.26–16.19] and [OR: 7.36; 95% CI, 2.90–18.69] respectively, prevalence dementia [OR: 2.17; 95% CI, 1.46–3.25], and prevalence of CKD [OR: 1.73; 95% CI, 1.16–2.59] were all associated with all-cause in-hospital mortality. Additionally, a very close association was also seen in CCI ≥4 and mortality [OR: 1.78; 95% CI, 0.99–3.20] (Figure 3).

The receiver operating curves (ROC) for the main effects model and the final model are shown in Figure 4. A C-statistic above 0.75 was considered excellent. The primary model area under the ROC was 0.798, and the whole model AUC was 0.809. Regression diagnostics flagged two potential, influential observations in chronic kidney disease and dementia, but deleting them did not substantively impact the overall fit of the models.

4. Discussion

The major findings of this study were that (1) majority of patients admitted with COVID-19 were AA compared to WH with the interaction between gender and race; (2) older age, chronic kidney disease, and dementia were predictors of all-cause in-hospital mortality for patients with confirmed COVID-19; (3) mortality rate from COVID-19 was significantly less for the AA compared to the WH population (less mortality was noted in AA women) which indicates the importance racial disparities in health care and its effect on our cohort COVID-19-related mortality.

We found that most admitted patients were AA compared to WH (2.8:1); this finding was comparable to previously reported data from Louisiana and California (Price-Haywood et al., 2020; Azar et al., 2020). The all-cause in-hospital mortality rate among our cohort (21.7%) was comparable to previously reported rates by Rosenthal et al. (2020) in their large cohort (20.3%), however, it was higher than the adjusted hospital's risk-standardized event rate (RSER) of 30-day in-hospital mortality or referral to hospice reported by Asch et al. (2021) (9.06%–15.65%). This higher mortality rate can be because the state of Michigan had the third-highest rate of COVID-19 cases early in the pandemic (NCHS, 2020), and our sample involved patients admitted around that time.

In multiple regression analyses conducted without including the race-gender interactions, we found older age (especially age over 80 years), male gender, and comorbidities reflected by a CCI >4 were independently the strongest predictors of mortality in admitted patients with

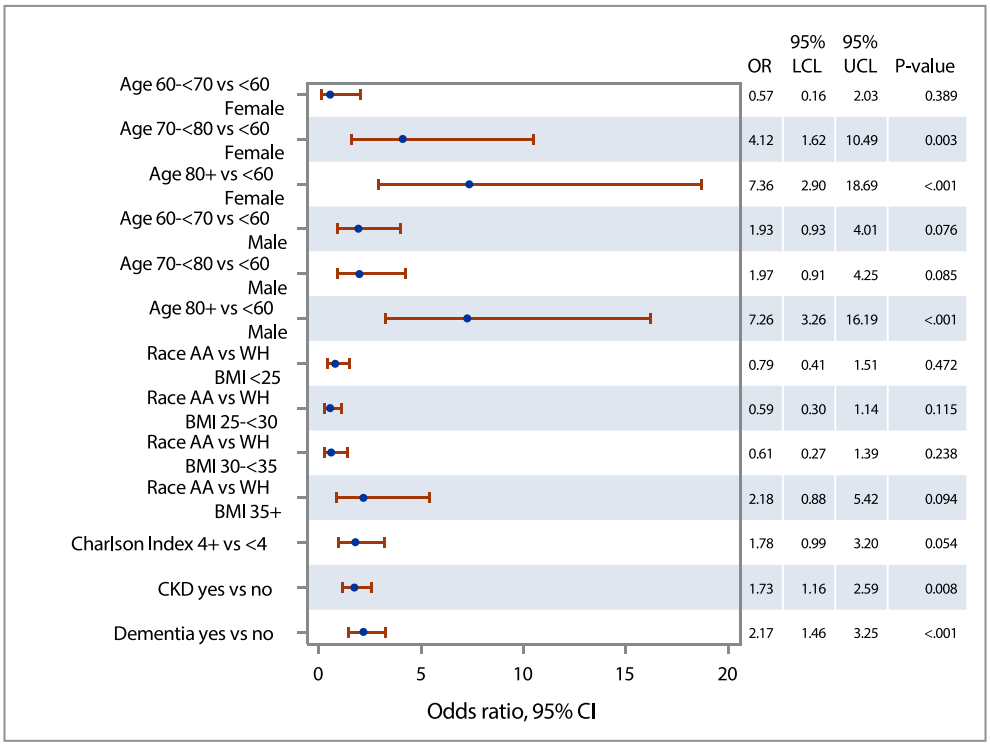


Figure 3. Multivariable logistic regression models for Odds Ratio of all-cause in-hospital mortality for patients with confirmed COVID-19 based on age, race, sex, BMI and comorbidities. Abbreviations: AA: African American; BMI = body mass index; CKD: chronic kidney disease; LCL = lower confidence limit; UCL = upper confidence limit; OR: odds ratios, associated 95% confidence intervals and P-value; WH: White.

confirmed COVID-19 illness. These findings are similar to published data from multiple other studies (Ogedegbe et al., 2020; Price-Haywood, 2020; Azar et al., 2020; Rosenthal et al., 2020; Asch et al., 2021; Imam et al., 2020).

The incidence of death rate from COVID-19 in our hospital system was significantly less for the AA compared to the WH population (19.3% vs. 28.8%, $P = 0.002$). We identified just one prior publication in which lower in-hospital mortality among AA has been described: Ogedegbe

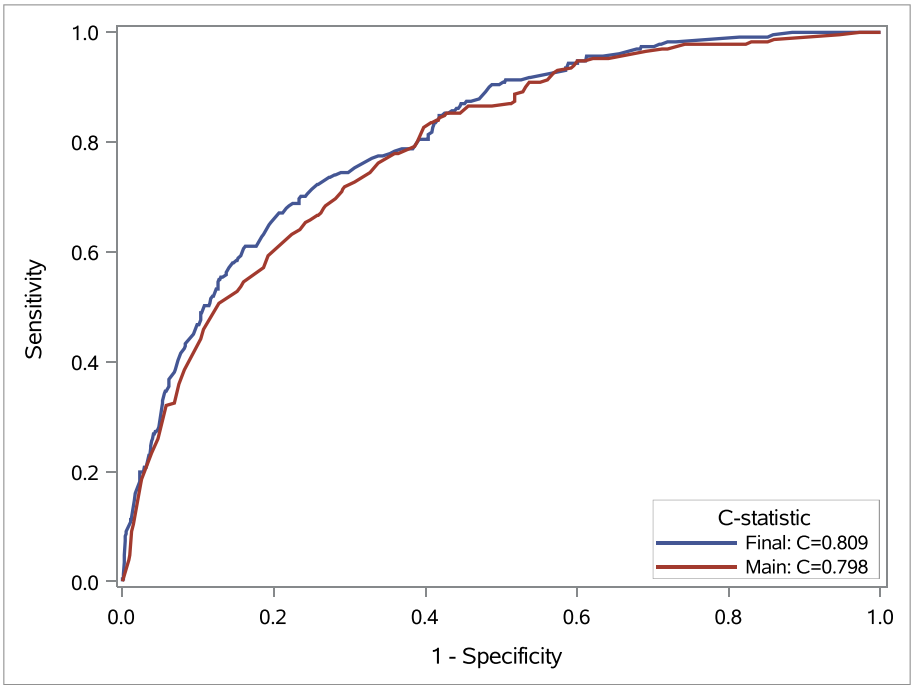


Figure 4. Receiver operating curves (ROC) for the main effects model and the final model. The main effect includes race, sex, age, BMI, CCI. The full model additionally had CKD and dementia.

et al. (2020) reported a lower risk of death in Black patients compared to White patients, even after adjusting for age, sex, insurance status, and comorbidities. This study was similar to ours in that it was conducted in a metro area hard hit early in the pandemic (New York). Overall, we replicated the increased mortality risk for the male gender seen in several other, albeit not all, studies without considering interactions.

We found no prior published reports on interactions between race and gender, despite numerous studies examining both factors. We had large numbers of patients within each of the four subgroups, enabling us to determine whether gender moderated the effect of race on mortality or vice versa. Our analyses identified strong interactions with AA women at the lowest mortality, followed by WH women, WH men, and finally AA men at highest risk. This interaction is not explained by differences in BMI, age, or comorbidities as it persisted after adjustment for these covariates. With only medical record data, we were unable to assess smoking and other health behaviors rigorously.

The racial disparities in health care and its effect on our cohort COVID-19-related mortality could be related to multiple factors. The United States Census Bureau reported data regarding Southfield where 69% of its population are AA reflected an 11.3% poverty rate, 6.5% of the population younger than 65 without insurance, crowding with 2730 population/mile^2 which led to limited social distancing, and lack of education with only 37.7% of the population holding a bachelor's degree or higher (US Census Bureau 2010). Although home isolation orders helped control the spread of the infection, a recent meta-analysis reported a secondary household transmission rate of 16.6% (Madewell et al., 2020). This can be a significant factor in our AA population with higher numbers of people living in the same house. However, despite these risk factors, we found that hospitalized AA had lower mortality rates from COVID-19 compared to WH, which emphasizes that access to care plays a significant factor in healthcare disparity. These factors, along with the higher prevalence of comorbidities and lack of proper care and follow-up due to limited access to health care services, can explain the differences noticed between AA and WH patients in our study.

5. Conclusion

Our cohort had lower all-cause mortality in AAs compared to WHs patients admitted with COVID-19 disease. That difference can be related to a lower mortality rate in AA females than in other gender-race groups. Older age (>80 years old), dementia, CKD, and greater length of stay were associated with worse outcomes.

Declarations

Author contribution statement

Ali Zakaria, Marc Piper, Lahib Douda, Nancy M. Jackson, Jeffrey C. Flynn, Dawn Misra, Joseph Gardiner, and Abdulghani Sankari: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

The data that has been used is confidential.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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