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

Ali Zakaria a, Marc Piper a,1, Lahib Douda c,1, Nancy M. Jackson c, Jeffrey C. Flynn c, Dawn P. Misra b,2, Joseph Gardiner b,2, Abdulghani Sankari a,*

a Department of Internal Medicine, Division of Gastroenterology, Ascension Providence Hospital, Michigan State University College of Human Medicine, Southfield, Michigan, USA
b Department of Epidemiology and Biostatistics, Michigan State University College of Human Medicine, Lansing, Michigan, USA
c Department of Medical Education, Ascension Providence Hospital, Southfield, Michigan, USA

ARTICLE INFO

Keywords:
COVID-19
Race-gender interaction
Racial disparity
Mortality

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.

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.

* Corresponding author.
E-mail address: abdulghani.sankari@ascension.org (A. Sankari).
1 These authors contributed equally to this work.
2 These authors also contributed equally to this work.

https://doi.org/10.1016/j.heliyon.2021.e08566
Received 25 September 2021; Received in revised form 22 November 2021; Accepted 3 December 2021
2405-8440/© 2021 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
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’Halleran 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 et 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 (>18 years-old) who presented to either campus with a confirmed diagnosis of COVID-19 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; ≥35 (Flegal and Graubard 2009). The Charlson comorbidity index (CCI) was

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.
we examined interactions between age, sex, race, BMI, and CCI jointly. we added two-way interactions based on prior hypotheses. Specifically, 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.

### 2.4. Statistical analysis

Statistical analyses were conducted with SAS software version 9.4 (SAS Institute Inc, Cary, NC). Preliminary analyses summarized inhospital 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/m²) 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.

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

| Number (n) | All n (1064) | White (WH) n (280) | African American (AA) n (784) | P-value |
|------------|--------------|---------------------|-------------------------------|---------|
| Age (years), mean ± SD | Age under 60, n (%) | 65.4 ± 17.4 | 68.1 ± 19.1 | 64.4 ± 16.7 | 0.002<sup>a</sup> |
| | Age 60 - <70, n (%) | 243 (22.8) | 61 (21.8) | 182 (23.2) | <0.0001<sup>b</sup> |
| | 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 (%) | Male-age <60, n (%) | 167 (32.3) | 43 (28.3) | 124 (34.0) | <0.0001<sup>b</sup> |
| | 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 (%) | Female-age <60, n (%) | 188 (34.4) | 39 (30.5) | 149 (35.6) | <0.0001<sup>b</sup> |
| | 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/m²), mean ± SD | BMI under 25, n (%) | 31.1 ± 8.5 | 29.6 ± 7.7 | 31.6 ± 8.6 | 0.001<sup>c</sup> |
| | BMI 25 - <30, n (%) | 261 (24.5) | 85 (30.4) | 176 (22.5) | 0.006<sup>c</sup> |
| | BMI 30 - <35, n (%) | 293 (27.5) | 85 (30.4) | 208 (26.5) | |
| | BMI ≥35, n (%) | 219 (20.6) | 49 (17.5) | 170 (21.7) | |
| | CCI score (points) | 4.3 ± 3.1 | 4.4 ± 3.1 | 4.3 ± 3.1 | 0.682<sup>d</sup> |
| | CCI score <4, n (%) | 447 (42.0) | 115 (41.1) | 332 (42.4) | 0.711<sup>d</sup> |
| | 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<sup>b</sup> |
| | Chronic kidney disease, n (%) | 192 (18.1) | 33 (11.8) | 159 (20.3) | 0.002<sup>c</sup> |
| | Single admission, n (%) | 922 (86.7) | 231 (82.5) | 691 (88.1) | 0.020<sup>c</sup> |
| | 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<sup>c</sup> |

P-value for comparison of characteristic by race.

<sup>a</sup> t-test;

<sup>b</sup> Chi Square test;

<sup>c</sup> Fisher's Exact test for comparison between races (white versus African American).
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](image-url) (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.

| 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 |
| Age under 60, n (%) | 330 (39.6) | 25 (10.8) | <0.0001 |
| 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 |
| Sex-female, n (%) | 450 (54.0) | 97 (42.0) | |
| White (WH), n (%) | 200 (24.0) | 80 (34.6) | 0.002 |
| African American (AA), n (%) | 633 (76.0) | 151 (65.4) | |
| BMI (kg/m²), mean ± SD | 31.7 ± 8.5 | 28.8 ± 7.8 | <0.0001 |
| BMI under 25, n (%) | 182 (21.8) | 80 (34.6) | <0.0001 |
| 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 |
| CCI score <4, n (%) | 418 (50.2) | 20 (13.0) | <0.0001 |
| CCI score ≥4, n (%) | 415 (49.8) | 201 (87.0) | |
| Dementia, n (%) | 103 (12.4) | 95 (41.1) | <0.0001 |
| Chronic kidney disease, n (%) | 123 (14.8) | 67 (29.0) | <0.0001 |
| Single admission, n (%) | 764 (91.7) | 158 (68.4) | <0.0001 |
| 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 |

P-value for comparison of characteristics by alive at discharge or deceased/hospice.
* t-test;  † Chi Square test;  ‡ Fisher's Exact test for comparison between deceased versus survivors.
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...
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 3](image_url)

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.

![Figure 4](image_url)

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/mile² 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; Flynn, Dawn Misra, Joseph Gardiner, and Abdulghani Sankari: Analyzed and interpreted the data; Contributed reagents, materials, and analysis tools or data; Wrote the paper.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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.

Acknowledgements

The authors would like to express the most profound appreciation to the contribution of our colleagues: Dr. Christopher Hakim, Dr. Esraa Al Jabbari, Dr. Ahmad Rashid, Dr. Lyanna Alnimer, Dr. Ayat Ghosn, Dr. Backer Abdu, Dr. Avery Mendelson, Shihab Mussad, Andrea Jamil, and the cardiology and gastroenterology fellows at Ascension Providence Hospital for assisting in data collection and chart review.

References

Asch, D.A., Shillit, N.E., Islam, M.N., Chen, Y., Werner, R.M., Buresh, J., et al., 2021 Apr 1. Variation in US hospital mortality rates for patients admitted with COVID-19 during the first 6 months of the pandemic. JAMA Intern Med. 181 (4), 471–478. PMID: 33531068; PMCID: PMC7756246.

Azar, K.M.I., Shen, Z., Romanelli, R.J., Lockhart, J.H., Smiths, K., Robinson, S., et al., 2020 Jul. Disparities in outcomes among COVID-19 patients in A large health care system in California. Health Aff. (Millwood) 39 (7), 1253–1262. Epub 2020 May 21. PMID: 32407254.

Belanger, M.J., Hill, M.A., Angelidi, A.M., Dalangama, M., Sowers, J.R., Mantzoros, C.S., 2020 Sep 10. Covid-19 and disparities in nutrition and obesity. N. Engl. J. Med. 383 (11), e69. Epub 2020 Jul 15. PMID: 32668105.

Charlson, M.E., Pompei, P., Ales, K.L., Mackenzie, C.R., 1987. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J. Chron. Dis. 40 (5), 373–383.

Corl, K., Levy, M., Phillips, G., Terry, K., Friedrich, M., Trivedi, A.N., 2019 Jul. Racial and ethnic disparities in care following the New York state sepsis initiative. Health Aff. (Millwood) 38 (7), 1119–1126. PMID: 31260359; PMCID: PMC6814952.

Curtin, K.M., Pawloski, L.R., Mitchell, P., Dunbar, J., 2020 Aug 9. COVID-19 and morbidity obesity: associations and consequences for policy and practice. World Med. Health Pol. Epub ahead of print. PMID: 32837780; PMCID: PMC7436757.

Flegal, K.M., Graubard, B.I., 2009. Estimates of excess deaths associated with body mass index and other anthropometric variables. Am. J. Clin. Nutr. 89 (4), 1213–1219.

Frist, W.H., 2005. Overcoming disparities in U.S. health care. Health Aff. (Millwood) 24 (2), 445–451. PMID: 15757929.

Gold, J.A.W., Wong, K.K., Szablewski, C.M., Patel, P.R., Rossow, J., da Silva, J., et al., 2020 May 8. Characteristics and clinical outcomes of adult patients hospitalized with COVID-19 - Georgia, March 2020. MMWR Morb. Mortal. Wkly. Rep. 69 (18), 545–550. PMID: 32357928; PMCID: PMC7757948.

Hasnain-Wynia, R., Baker, D.W., Nerenz, D., Feinglass, J., Beal, A.C., Landrum, M.B., et al., 2007 Jun 25. Disparities in health care are driven by where minority patients seek care: examination of the hospital quality alliance measures. Arch. Intern. Med. 167 (12), 1233–1239. Erratum in: Arch Intern Med. 2007 Oct 22;167(19):2147. PMID: 17592095.

Hosmer, D.W., Hosmer, T., LeCesne, S., Lemeshow, S., 1997. A comparison of goodness-of-fit tests for the logistic regression model. Statist. Med. 16 (9), 965–980.

Imam, Z., Odish, F., Gill, I., O'Connor, D., Armstrong, J., Vanood, A., et al., 2020 Oct. Gender differences in patients with COVID-19: focus on severity and mortality. Front. Publ. Health 8, 152.

Jayawardena, R., Yokoyama, D.T., Misra, A., Hills, A.P., Ransanbeh, P., 2020. Obesity: a potential risk factor for infection and mortality in the current COVID-19 epidemic. Diab. Metab. Syndr. 14 (6), 2199–2203. Epub 2020 Nov 11. PMID: 33395781; PMCID: PMC7655158.

Kaza, K.H., Evans, C.T., Marcellin, J.R., 2020 Sep 1. Racism, not race, drive inequities across the COVID-19 continuum. JAMA Netw. Open 3 (9), e2019933. PMID: 32975562.

Killerby, M.E., Link-Gelles, R., Haight, S.C., Schrodt, C.A., England, L., Gomes, D.J., et al., 2020 Jul. Disparities in outcomes among COVID-19 patients in A large health care system - metropolitan Atlanta, Georgia. J. Intern. Med. 288 (4), 469–476. Epub 2020 Jun 22. PMID: 32498135; PMCID: PMC7300081.

Jin, J.M., Bai, P., He, W., Wu, F., Liu, X.F., Han, D.M., Liu, S., Yang, J.K., 2020. Gender differences in patients with COVID-19: focus on severity and mortality. Front. Public Health 8, 152.

Jayawardena, R., Yokoyama, D.T., Misra, A., Hills, A.P., Ransanbeh, P., 2020. Obesity: a potential risk factor for infection and mortality in the current COVID-19 epidemic. Diab. Metab. Syndr. 14 (6), 2199–2203. Epub 2020 Nov 11. PMID: 33395781; PMCID: PMC7655158.

Kaza, K.H., Evans, C.T., Marcellin, J.R., 2020 Sep 1. Racism, not race, drive inequities across the COVID-19 continuum. JAMA Netw. Open 3 (9), e2019933. PMID: 32975562.

Killerby, M.E., Link-Gelles, R., Haight, S.C., Schrodt, C.A., England, L., Gomes, D.J., et al., 2020 Jul. Disparities in outcomes among COVID-19 patients in A large health care system - metropolitan Atlanta, Georgia. J. Intern. Med. 288 (4), 469–476. Epub 2020 Jun 22. PMID: 32498135; PMCID: PMC7300081.

Kaza, K.H., Evans, C.T., Marcellin, J.R., 2020 Sep 1. Racism, not race, drive inequities across the COVID-19 continuum. JAMA Netw. Open 3 (9), e2019933. PMID: 32975562.

Killerby, M.E., Link-Gelles, R., Haight, S.C., Schrodt, C.A., England, L., Gomes, D.J., et al., 2020 Jul. Disparities in outcomes among COVID-19 patients in A large health care system - metropolitan Atlanta, Georgia. J. Intern. Med. 288 (4), 469–476. Epub 2020 Jun 22. PMID: 32498135; PMCID: PMC7300081.
Moore, J.T., Ricaldi, J.N., Rose, C.E., Pulido, J., Partise, M., Kang, G.J., et al., 2020 Aug 21. COVID-19 state, tribal, local, and territorial response team. Disparities in incidence of COVID-19 among underrepresented racial/ethnic groups in counties identified as hotspots during June 5-18, 2020 - 22 states, February-June 2020. MMWR Morb. Mortal. Wkly. Rep. 69 (33), 1122–1126. PMID: 32817602; PMCID: PMC7439982.

National Center for Health Statistics, 2020. United States COVID-19 Cases and Deaths by State over Time. Public-use data file and documentation. https://data.cdc.gov/Case-Surveillance/United-States-COVID-19-Cases-and-Deaths-by-State-a-9m6q-ch36.

Ogedegbe, G., Ravenell, J., Adhikari, S., Butler, M., Cook, T., Francois, F., et al., 2020 Dec 1. Assessment of racial/ethnic disparities in hospitalization and mortality in patients with COVID-19 in New York city. JAMA Netw. Open 3 (12), e2026881. PMID: 33275153; PMCID: PMC7718605.

O’Hanlan, K.A., Iler, C.M., 2007. Health care of lesbian and bisexual women. In: Meyer, I.H., Northridge, M.E. (Eds.), The Health of Sexual Minorities: Public Health Perspectives on Lesbian, Gay, Bieexual and Transgender Populations. Springer, New York, pp. 506–522.

Price-Haywood, E.G., Burton, J., Fort, D., Seoane, L., 2020 Jun 25. Hospitalization and mortality among Black patients and white patients with covid-19. N. Engl. J. Med. 382 (26), 2534–2543. Epub 2020 May 27. PMID: 32459916; PMCID: PMC7269015.

Rosenthal, N., Cao, Z., Gundrum, J., Stanis, J., Safa, S., 2020 Dec 1. Risk factors associated with in-hospital mortality in a US national sample of patients with COVID-19. JAMA Netw. Open 3 (12), e2029058. Erratum in: JAMA Netw Open. 2021 Jan 4;4(1): e2036103. PMID: 33301018; PMCID: PMC7729428.

Spiegelhalter, D., 1986. Probabilistic prediction in patient management and clinical trials. Stat. Med. 5 (5), 421–433.

Tartof, S.Y., Qian, L., Hong, V., Wei, R., Nadjafi, R.F., Fischer, H., et al., 2020 Nov 17. Obesity and mortality among patients diagnosed with COVID-19: results from an integrated health care organization. Ann. Intern. Med. 173 (10), 773–781. Epub 2020 Aug 12. PMID: 32783686; PMCID: PMC7429998.

United States Census Bureau, 2010. In QuickFacts Novi City, Michigan; Southfield City, Michigan. Retrieved from. https://www.census.gov/quickfacts/fact/table/novicymichigan,southfieldcitymichigan/951045219.

Vasquez-Reyes, M., 2020. The disproportional impact of COVID-19 on African Americans. Health Hum. Right 22 (2), 299–307.

Williamson, E.J., Walker, A.J., Bhaskaran, K., Bacon, S., Bates, C., Morton, C.E., Curtis, H.J., Mehrkar, A., Evans, D., Inglesby, P., Cockburn, J., McDonald, H.L., Mackenna, B., Tomlinson, L., Douglas, I.J., Rentch, C.T., Mathur, R., Wong, A., Grieve, R., Harrison, D., Goldacre, B., 2020. Factors associated with COVID-19-related death using OpenSAFELY. Nature 584 (7821), 430–436.

Yancy, C.W., 2020 May 19. COVID-19 and African Americans. J. Am. Med. Assoc. 323 (19), 1891–1892. PMID: 32293639.