

BMI is Associated with Coronavirus Disease 2019 Intensive Care Unit Admission in African Americans

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Objective: Coronavirus disease 2019 (COVID-19) has disproportionately impacted the African American community. This study aims to identify the risk factors for severe COVID-19 disease in African American patients.

Methods: This was a retrospective cross-sectional analysis of African American patients with COVID-19 treated between March 12 and April 9, 2020, at a single tertiary center. The primary outcome of interest was severe disease defined as those requiring intensive care unit (ICU) admission.

Results: The study included 158 consecutive patients. The mean age was 57 years, and 61% were women. The mean (SD) of BMI was 33.2 (8.6) kg/m². Overall, patients admitted to the ICU were older (62 vs. 55 years, $P=0.003$) and had higher BMI (36.5 kg/m² vs. 31.9 kg/m², $P=0.002$). In unadjusted and adjusted analysis, the factors most associated with ICU admission in this sample were age (adjusted odds ratio [aOR]: 1.073; 95% CI: 1.033-1.114), BMI (aOR: 1.115; 95% CI: 1.052-1.182), and lung disease (aOR: 3.097; 95% CI: 1.137-8.437).

Conclusions: This study identified risk factors for severe disease in COVID-19, specifically in an African American population. Further inclusive research aimed at optimizing clinical care relevant to the African American population is critical to ensure an equitable response to COVID-19.

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Introduction

By January 7, 2020, the novel severe acute respiratory syndrome coronavirus 2 was identified as the cause for an outbreak in China due to what is now called coronavirus disease 2019 (COVID-19). On March 11, 2020, the World Health Organization declared the COVID-19 outbreak a global pandemic (1). The severity and clinical presentation of COVID-19 are widely variable, ranging from asymptomatic or mild disease in the majority of cases to severe respiratory failure and dysregulated inflammatory responses in a minority of patients. Age and certain comorbidities, such as hypertension and diabetes, have been well identified as risk factors for the development of severe disease (1-3). Obesity is also emerging as a likely risk factor for severe disease development (4-6).

The COVID-19 epidemic in the United States tracks along well-documented and historical health disparities, with early data suggesting disproportionate morbidity and

Study Importance

What is already known?

- ▶ There is a wide clinical spectrum of disease in coronavirus disease 2019 (COVID-19), ranging from asymptomatic and mild cases to profound critical illness and respiratory failure.
- ▶ Age and specific comorbidities such as hypertension and diabetes mellitus have been identified as independent risk factors for severe COVID-19.

What does this study add?

- ▶ Major health disparities have been identified in the COVID-19 epidemic within the United States, and this is one of the first studies to focus specifically on the risk factors within an African American population, a community that has been disproportionately impacted by this disease.
- ▶ In addition to age, obstructive lung disease, and hypertension, this study adds further evidence supporting the association between BMI and disease severity in COVID-19.

How might these results change the direction of research or focus of clinical practice?

- ▶ Current Centers for Disease Control and Prevention recommendations describe individuals with BMI > 40 as being at “high risk” for severe illness in COVID-19, whereas our results suggest that a lower threshold should be considered for this high-risk category in COVID-19.
- ▶ This study calls for further mechanistic studies aimed at understanding the association observed between obesity and the severity of respiratory disease and the inflammatory response.

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mortality within the African American community (7,8). Despite this, there is a relative dearth of analysis relevant to the African American experience. In Louisiana, 55 % of COVID-19–related deaths have occurred among black persons, who represent 32.7% of the state’s population (9,10). New Orleans, a predominantly African American city, has experienced among the most severe outbreaks of COVID-19 in the United States.

In this study, we aim to describe the baseline characteristics of laboratory-confirmed COVID-19–positive African American patients and determine the possible risk factors, including BMI, for the development of severe disease and admission to the intensive care unit (ICU).

Methods

This is a single-center retrospective cross-sectional study of all consecutive, self-reported African American patients confirmed to have COVID-19 who presented to a tertiary academic hospital between March 12 and April 9, 2020. Patients were identified through reported positive laboratory test results during this specified time period, and individual patient data were obtained through retrospective electronic medical record review by members of the investigatory team. This study was reviewed and approved by the Tulane University Biomedical Institutional Review Board and was granted a waiver of consent.

The primary outcome of this study was severe disease, defined here as those patients requiring ICU admission for COVID-19–related complications. In our study, this aligned closely with respiratory failure requiring mechanical ventilation. Individuals with nonsevere disease were defined as patients who presented to the emergency department or who were admitted to the hospital and successfully discharged home without need for further escalation of care. Patients with missing data or pending COVID-19–confirmatory testing were excluded from the study.

Description of covariates

Several covariates of interest were collected, including age, sex, BMI reported in kilograms per meter squared as calculated on admission through measurements of both weight and height, and the comorbidities diabetes mellitus (DM), hypertension, chronic kidney disease (CKD), congestive heart failure, and obstructive lung disease (including both chronic obstructive pulmonary disease and asthma). Comorbidities were identified if the patient had a medical record with an established diagnosis, was on medications known to treat these comorbidities, or had previously reported laboratory values, such as an estimated glomerular filtration rate < 60 to define CKD.

Statistical analysis

Means and SD were calculated for age and BMI separately for non-ICU and ICU cases, and two-sample *t* tests were used to test for significant differences in these means. Categorical patient characteristics were summarized with counts and percentages. Pearson χ^2 tests were used to test for significant percentages among the non-ICU and ICU cases.

Multivariable logistic regression analysis was performed to examine the association between BMI and critical illness in patients with

COVID-19, adjusting for the potential effects of the covariates of age, sex, DM, hypertension, congestive heart failure, CKD, and obstructive lung disease (both chronic obstructive pulmonary disease and asthma). Results were presented as odds ratios (OR) with 95% CIs and *P* values. Data were statistically analyzed using SAS software version 9.4 (SAS Institute Inc., Cary, North Carolina).

Results

Population characteristics

Of the screened consecutive 183 patients with positive COVID-19 test results, 158 were African American and were enrolled in our study. The mean age was 57, and 61% were women. The mean (SD) BMI was 33.2 (8.6). Characteristics of the study population based on the disease severity are presented in Table 1. Eighty-five percent of the severe cases admitted to the ICU had respiratory failure requiring intubation and mechanical ventilation. ICU mortality for severe cases was 37%; however, 21.7% of the patients were still intubated and requiring mechanical ventilation at the time of analysis, which may impact and potentially increase this percentage.

Patients with severe disease requiring ICU admission were older (62 vs. 55 years, *P*=0.003) and had higher BMI (36.5 vs. 31.9, *P*=0.002). The prevalence of DM and CKD was also significantly higher in patients with severe disease (*P* values of 0.016 and 0.012, respectively). Thirty-nine of the forty-six patients admitted to the ICU during this study period were in respiratory failure requiring mechanical ventilation. An additional two patients required high-flow nasal canula, and an additional three patients required the use of a nonbreather mask. On the basis of the available data, the average ratio of the partial pressure of oxygen to the fraction of inspired oxygen of patients admitted to the ICU was 171.1 (*n*=42), which is consistent with moderate acute respiratory distress syndrome; the average admission lactate dehydrogenase level was 500.5 (*n*=43); the average admission ferritin level was 2,266.2 (*n*=41); and the average high-sensitivity C-reactive protein level was 11.52 (*n*=41).

In adjusted analysis, hypertension, age, BMI, and obstructive lung disease are independent risk factors for severe disease

In adjusted analysis (Table 2), the factors most associated with ICU admission in African Americans were hypertension (adjusted OR [aOR]: 0.34; 95% CI 0.122- 0.984), age (aOR: 1.073; 95% CI: 1.033-1.114), BMI (aOR: 1.115; 95% CI: 1.052-1.182), and lung disease (aOR: 3.097; 95% CI: 1.137-8.437). Full model analysis is shown in Table 2.

Table 3 shows that the predicted aOR from Table 2 results in an increase in BMI by 5 kg/m² and 10 kg/m² (OR: 1.72; 95% CI 1.29-2.31 and OR: 2.97; 95% CI 1.66-5.32, respectively).

Discussion

In this retrospective observational cross-sectional study, we found that age, higher BMI, and obstructive lung disease were associated with severe COVID-19 in an African American population. These results were unchanged after adjusting our analysis for age, sex, and underlying comorbidities.

TABLE 1 Clinical patient characteristics

| | Non-ICU cases (n = 112) | ICU cases (n =46) | P value | All subjects (n = 158) |
|-------------------------------------|-------------------------|-------------------|---------|------------------------|
| Age (y), mean (SD) | 55 (14.7) | 62 (14.6) | 0.003 | 57 (15.1) |
| Sex, n (%) | | | 0.787 | |
| Males | 44 (39.3) | 17 (37.0) | | 61 (38.6) |
| Females | 68 (60.7) | 29 (63.0) | | 97 (61.4) |
| BMI (kg/m ²), mean (SD) | 31.9 (8.5) | 36.5 (7.8) | 0.002 | 33.2 (8.6) |
| BMI group, n (%) | | | 0.006 | |
| <30 kg/m ² | 51 (82.3) | 11 (17.7) | | 62 (39.3) |
| 30 to <35 kg/m ² | 28 (75.7) | 9 (24.3) | | 37 (23.4) |
| 35 to <40 kg/m ² | 23 (62.2) | 14 (37.8) | | 37 (23.4) |
| ≥40 kg/m ² | 10 (45.5) | 12 (54.5) | | 22 (13.9) |
| Intubated patients, n (%) | 0 (0.0) | 39 (84.8) | — | — |
| Diabetes mellitus, n (%) | 47 (42.0) | 29 (63.0) | 0.016 | 76 (48.1) |
| Hypertension, n (%) | 75 (67.0) | 32 (69.6) | 0.751 | 107 (67.7) |
| Chronic kidney disease, n (%) | 10 (8.9) | 11 (23.9) | 0.012 | 21 (13.3) |
| Congestive heart failure, n (%) | 11 (9.8) | 10 (21.7) | 0.045 | 21 (13.3) |
| Obstructive lung disease, n (%) | 18 (14.0) | 14 (25.9) | 0.058 | 32 (17.5) |
| Mortality, n (%) | 0 (0) | 17 (37.0) | — | — |

TABLE 2 Unadjusted and adjusted analyses

| Effect | Unadjusted analysis | | | Adjusted analysis | | |
|--------------|---------------------|-----------------------|---------|-------------------|-----------------------|---------|
| | OR | 95% confidence limits | P value | OR | 95% confidence limits | P value |
| Age | 1.036 | 1.011-1.062 | 0.0044 | 1.073 | 1.033-1.114 | 0.0003 |
| Sex | 1.104 | 0.543-2.242 | 0.7847 | 0.585 | 0.230-1.488 | 0.2603 |
| DM | 2.359 | 1.164-4.782 | 0.0173 | 1.738 | 0.736-4.101 | 0.2073 |
| HTN | 1.128 | 0.537-2.366 | 0.7508 | 0.347 | 0.122-0.984 | 0.0466 |
| HF | 2.551 | 0.999-6.511 | 0.0502 | 2.400 | 0.734-7.845 | 0.1475 |
| Lung disease | 2.058 | 0.910-4.654 | 0.0831 | 3.097 | 1.137-8.437 | 0.0270 |
| CKD | 3.206 | 1.254-8.194 | 0.0150 | 2.096 | 0.643-6.831 | 0.2194 |
| BMI | 1.063 | 1.020-1.108 | 0.0044 | 1.115 | 1.052-1.182 | 0.0002 |

CKD, chronic kidney disease; DM, diabetes mellitus; HF, heart failure; HTN, hypertension; OR, odds ratio.

TABLE 3 Predicted OR, adjusted for cofactors

| | OR | 95% confidence limits |
|--------------------------|------|-----------------------|
| BMI (kg/m ²) | | |
| Increase by 5 | 1.72 | 1.29-2.31 |
| Increase by 10 | 2.97 | 1.66-5.32 |

OR, odds ratio.

In early studies of the international experience, obesity was not evaluated as an independent risk factor for critical illness; however, recent analyses regarding the COVID-19 pandemic in Europe and the United States suggest that obesity is highly prevalent among patients suffering from severe COVID-19 (1-6, 11). As a recognized independent risk factor for severe respiratory illness in viral pneumonias such as H1N1 (12), special attention to the needs of patients with obesity is urgently

needed as the COVID-19 pandemic spreads to communities with a high prevalence of obesity. Current Centers for Disease Control and Prevention recommendations describe individuals with BMI>40 as being at “high risk” for severe COVID-19 illness, whereas our results suggest that a lower threshold should be considered for this high-risk category.

A significant knowledge gap remains regarding the mechanisms underlying the association between viral respiratory disease severity and the cluster of illnesses that define metabolic syndrome. A severe inflammatory cytokine response appears to be the hallmark of severe COVID-19. To this point, obesity is associated with low-grade inflammation associated with insulin resistance and diabetes and therefore may lead to the amplification of the inflammatory response to infection (13). Further studies looking into the mechanisms behind these observations are ongoing.

A recently published report from the Centers for Disease Control and Prevention showed that a third of hospitalized patients with COVID-19

in the United States were African American (14), evidencing a disproportionate impact on the African American community. Further inclusive research toward optimizing clinical care relevant to the African American population is critical to ensuring an equitable response to COVID-19.

Previous studies have identified obesity as a risk factor for severe disease in several populations (4-6). Our analysis confirmed that obesity is a significant determinant of disease severity in an African American population. These data further support the utility of BMI in the identification of patients at high risk of severe COVID-19. Appropriate management of obesity and the associated comorbidities of metabolic syndrome, as well as of the social determinants of health that underlie these conditions, is therefore critical to addressing the evolving COVID-19 crisis. **O**

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