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Case report

## COVID 19 in-hospital mortality, body mass index and obesity related conditions

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## ABSTRACT

**Objective:** Obese patients with respiratory failure need more intensive care and invasive mechanical ventilation than their non-obese counterparts. We aimed to evaluate the impact of body mass index and obesity related conditions on fatal outcome during a hospitalization for COVID-19.

**Methods:** From March 1 to April 30, 2020, 425 consecutive patients with severe acute respiratory syndrome coronavirus 2 were hospitalized at University Medical Center, in New Orleans. Clinical variables, comorbidities, and hospital course were extracted from electronic medical records. Special attention was given to obesity related conditions like hypertension, type 2 diabetes, and dyslipidemia. Severe obesity was defined as a body mass index  $\geq 35$ – $< 40$  kg/m<sup>2</sup> and morbid obesity as body mass index  $\geq 40$  kg/m<sup>2</sup>. Risk of mortality was determined by applying multivariate binary logistic regression modeling to risk factor variables (age, sex, race, and Charlson comorbid score).

**Results:** Patients were mostly African American (77.9%) and 51.0% were women. Age and Charlson comorbidity index scores averaged 60 (50–71 years) and 3.0 (1.25–5), respectively. In-hospital mortality was greater in morbidly obese than non-morbidly obese patients. Of the 64 severely obese patients, 16 had no obesity related conditions, and 48 had at least one obesity related condition: hypertension (60%), type 2 diabetes mellitus (28%), and dyslipidemia (20%). In-hospital mortality was greater in severely obese patients with than without at least one obesity related condition.

**Conclusion:** During a hospitalization for COVID-19, severely obese patients with at least one obesity related condition and morbidly obese patients have a high mortality.

## 1. Introduction

Obese patients are prone to need intensive care and invasive mechanical ventilation (IMV) when hospitalized for respiratory failure.<sup>1</sup> Not unexpectedly, obesity has been associated with critical illness during the COVID-19 pandemic.<sup>1–5</sup> We chose in-hospital mortality, a more robust critical illness marker than intensive care or IMV, to evaluate the impact of obesity on outcome during a hospitalization for COVID-19.

Obesity is highly prevalent in Louisiana,<sup>5</sup> and patients hospitalized for COVID-19 at University Medical Center (UMC) in New Orleans have a wide range of body mass index (BMI, kg/m<sup>2</sup>) that enables evaluation of

COVID-19 outcome in evenly distributed BMI strata. We aimed to study the impact of obesity (BMI  $> 30$  kg/m<sup>2</sup>), severe obesity (BMI  $\geq 35$ – $< 40$  kg/m<sup>2</sup>), morbid obesity (BMI  $> 40$  kg/m<sup>2</sup>) and obesity related conditions on in-hospital mortality.<sup>6</sup>

## 2. Methods

## 2.1. Study population

Four hundred and twenty-five consecutive patients with severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) confirmed by real-

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time reverse transcriptase-polymerase chain reaction were hospitalized from March 1 to April 30, 2020, at UMC, a 466-bed tertiary care center serving an indigent population in New Orleans. Patient BMI was recorded in the electronic medical record on admission. It is standard practice at UMC to weigh patients and ask their height on admission.

## 2.2. Study

Demographics, clinical variables and hospital course were extracted from electronic medical records. The Charlson comorbidity index score was calculated using the definition provided by Charlson et al.<sup>7</sup> Q waves on EKG defined myocardial infarction, and other comorbidities were scored based on the past medical history profile excerpt. For every decade over 40 years of age, 1 point was added to the score. The Institutional Review Board at UMC approved the study.

## 2.3. Statistical analysis

We aimed to study the impact of morbid obesity, BMI  $\geq 40$  kg/m<sup>2</sup>, severe obesity BMI  $\geq 35$  -  $< 40$  kg/m<sup>2</sup> and obesity related conditions like hypertension (HTN), type 2 diabetes mellitus (T2D) and dyslipidemia (DLD) on fatal outcome during a hospitalization for COVID-19. The odds ratio (OR) probability for in-hospital mortality was calculated by applying binary logistic regression with adjustment for demographics (age, sex, race, and Charlson score). The *p*-value was set at 0.05. IBM Corp SPSS Version 25 Armonk, NY was used for the analysis.

## 3. Results

Demographics, clinical variables, comorbidities and symptoms, and signs on admission are summarized in Table 1. Most patients were African American (77.9%), and 51.0% were women. The prevalence of comorbidities is detailed in Table 1. Age and Charlson comorbidity index score averaged 60 (50–71 years) and 3.0 (1.2–5.0). Mean BMI was 30.5 kg/m<sup>2</sup> (25.9–37.35). Nine patients had a BMI  $< 18$  kg/m<sup>2</sup>. In-hospital mortality averaged 18.1%. Nearly all patients with BMI  $\geq 40$  kg/m<sup>2</sup> had at least one obesity related condition. In-hospital mortality was significantly greater in patients with BMI  $\geq 40$  kg/m<sup>2</sup> than in patients with BMI  $< 40$  kg/m<sup>2</sup>: OR 2.8, 95% confidence interval (CI) 1.3–6.1 (Fig. 1). Of the 64 patients with BMI  $\geq 35$ – $< 40$  kg/m<sup>2</sup>, 16 had no obesity related conditions and 48 had at least one obesity related condition: HTN (60%), T2D (28%) and DLD (25%). In-hospital mortality was significantly greater in patients with BMI  $\geq 35$ – $< 40$  kg/m<sup>2</sup> and at least one obesity related condition than in their counterparts without obesity related conditions: OR 2.9, 95% CI 1.1–7.5 (Fig. 1). In-hospital mortality did not statistically differ in the 64 patients with BMI  $\geq 35$  -  $< 40$  kg/m<sup>2</sup> and the remaining patients: OR: 1.8, 95% CI 0.9–3.6 (Fig. 1).

## 4. Discussion

A BMI  $\geq 40$  kg/m<sup>2</sup> or a BMI  $\geq 35$  kg/m<sup>2</sup> with at least one obesity related condition is associated with an increased risk of fatal outcome during a hospitalization for COVID-19. The present data parallel the COVID-19 experience in New York City.<sup>8,9</sup> After controlling for all covariates, Palaiodimos and Rapp found a BMI  $> 35$  kg/m<sup>2</sup> to be independently associated with increased mortality in hospitalized patients for COVID-19 at Montefiore Medical Center and Mount Sinai Hospital System. In contrast, the relative risk of in-hospital mortality was greater in overweight than in obese hospitalized patients for COVID-19 at Downstate Health Sciences Center University: 1.4 (95% CI:1.1–1.9, *p* = 0.003), and 1.3 (95% CI:1.0–1.7 *p* = 0.04) respectively.<sup>10</sup> Last, after controlling for age, sex, race, smoking, and multiple comorbidities, Goyal reported a J shape pattern of in-hospital mortality and BMI, with patients with BMI  $< 18.5$  kg/m<sup>2</sup> having the greatest in-hospital mortality.<sup>11</sup>

The use of ICU and IMV is closely related to BMI in hospitalized

**Table 1**

Clinical characteristics of 425 hospitalized patients for COVID-19 at University Medical Center in New Orleans.

| Study population(n)                |                                     | 425                  |
|------------------------------------|-------------------------------------|----------------------|
| Age-yr                             |                                     | 60 (50–71)           |
| Sex                                | Female-no. (%)                      | 218 (51.3)           |
| Ethnicity                          | African American-no. (%)            | 331 (77.9)           |
|                                    | Others-no. (%)                      | 94 (22.1)            |
| BMI (kg/m <sup>2</sup> )           |                                     | 30.5<br>(25.9–37.35) |
| Comorbidities                      | Charlson Comorbidity Index Score    | 3 (1.25–5)           |
|                                    | Hypertension-no. (%)                | 243 (57.2)           |
|                                    | Diabetes-no. (%)                    | 179 (42.1)           |
|                                    | Hyperlipidemia-no. (%)              | 98 (23.1)            |
|                                    | COPD-no. (%)                        | 24 (5.6)             |
|                                    | OSA-no. (%)                         | 22 (5.2)             |
|                                    | Chronic Heart Failure-no. (%)       | 50 (11.8)            |
|                                    | Coronary Artery Disease-no. (%)     | 77(18.2)             |
|                                    | Chronic Kidney Disease/ESRD-no. (%) | 74 (17.4)            |
|                                    | Chronic Liver Disease-no. (%)       | 11 (2.6)             |
|                                    | Cancer-no.(%)                       | 50 (11.8)            |
|                                    | CVA-no. (%)                         | 24 (5.6)             |
|                                    | HIV-no. (%)                         | 6 (1.4)              |
|                                    | Temperature (>100.4 Degree F)       | 171 (40.2)           |
| Signs and symptoms on presentation | Hypoxia (<94% O2 Sat)               | 105 (24.7)           |
|                                    | Hypotension (<90/60 mmHg)           | 67 (15.8)            |
|                                    | Tachycardia (HR > 100 bpm)          | 153 (36)             |
|                                    | Cough-no. (%)                       | 58 (13.6)            |
|                                    | Abdominal Pain/ Diarrhea-no. (%)    | 45 (10.6)            |
|                                    | Myalgia-no. (%)                     | 32 (7.5)             |
|                                    | Weakness/ Dizziness-no. (%)         | 43 (10.1)            |
|                                    | Dyspnea-no. (%)                     | 176 (41.4)           |

Abbreviations: BMI: body mass index, COPD: Chronic obstructive pulmonary disease, ESRD: end stage renal disease, CVA: cerebrovascular accident, HIV: Human immunodeficiency virus. OSA: obstructive sleep apnea HR: heart rate. All values are in total no. of patients with percentage, and interquartile range.

patients for COVID-19.<sup>12–16</sup> Obesity (BMI  $> 30$  kg/m<sup>2</sup>) was independently associated with IMV use in 103 consecutive hospitalized COVID-19 patients at Brown University-Rhode Island Hospital.<sup>12</sup> After adjustment for age, race, and troponin levels, obesity was also associated to IMV in 770 hospitalized patients for COVID-19 at New York-Presbyterian Hospital and Weill Cornell Medical Center.<sup>12</sup> The use of ICU was 2-fold greater in  $< 60$  years old patients with BMI 30–34 kg/m<sup>2</sup> than in their counterparts with BMI  $< 30$  kg/m<sup>2</sup> at the New York University Langone Health System.<sup>15</sup> Among 124 hospitalized patients for COVID-19 in Lille (France), the prevalence of obesity was 56.4% in patients who required IMV and 28.2% (*p*  $< 0.01$ ) in those who did not.<sup>16</sup>

Severe obesity may worsen COVID-19 through several mechanisms.<sup>17</sup> Adipose tissue may serve as a SARS-CoV-2 reservoir and promote fibrosis through angiotensin and reduced angiotensin-converting enzyme activity.<sup>18,19</sup> Immune dysregulation leading to an acute inflammatory state may worsen COVID-19 outcomes.<sup>20,21</sup> Last, obesity-induced activation of the mammalian target of rapamycin (mTOR) pathway and release of pro-inflammatory adipokines may accelerate viral replication and exacerbate systemic inflammation.<sup>17</sup>

In summary, morbidly obese and severely obese patients with at least one obesity related condition have an increased risk of fatal outcome when hospitalized for COVID-19. We acknowledge that our study population predominantly consisted of African Americans who have larger BMI than most other patients. The stress that severe obesity imposes on the health care system may contribute to in-hospital mortality during hospitalization. Transport, imaging, and procedural challenges hinder the care of severely obese patients.

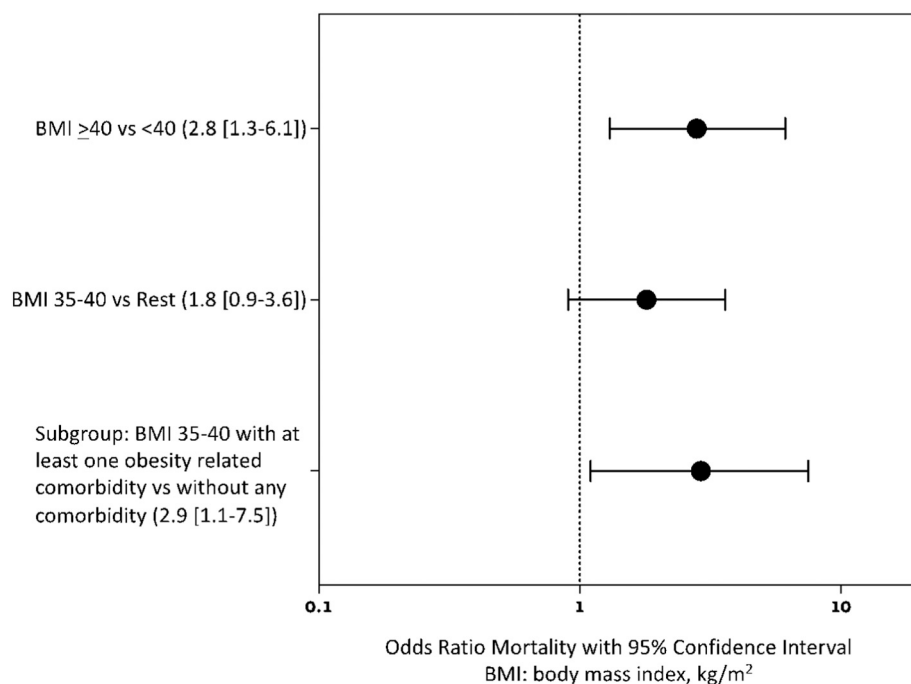


Fig. 1. COVID 19 In-hospital Mortality and Body Mass Index

\*Binary logistic regression modeling with adjustment for demographics (age, sex, race, Charlson score), to calculate the odds ratio (OR) probability for each patient.

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## CRediT authorship contribution statement

RS and GS conceived and carried out the study. GS and SHN collected and analyzed the data. All authors were involved in writing the paper and had final approval of the submitted and published versions.

## Declaration of competing interest

The authors declared no conflict of interest.

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