

# Hospitalization and case fatality rates of adult patients diagnosed with COVID-19 at a tertiary academic medical center, 2020

Ban A. Majeed<sup>1</sup>, Christos Hatzigeorgiou<sup>2</sup>, Mishma Farsi<sup>1</sup>, Matthew Heiken<sup>1</sup>, Deepak N. Ayyala<sup>1</sup> and David W. Walsh<sup>3\*</sup>

<sup>1</sup>Department of Population Health Sciences, Medical College of Georgia at Augusta University, Augusta GA 30912.

<sup>2</sup>Division Chief General Internal Medicine, Department of Medicine, Medical College of Georgia at Augusta University, Augusta GA 30912.

<sup>3</sup>Division Chief Hospital Medicine, Department of Medicine, Medical College of Georgia at Augusta University, Augusta GA 30912.

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## ABSTRACT

The objective of this study is to determine hospitalization and case-fatality rates in adult patients diagnosed with COVID-19 at a large academic medical center in the United States of America which predominately serves rural and underrepresented populations. EMR data abstraction of a cohort of lab-confirmed COVID-19, outpatient and inpatient, adult patients, who tested positive at Augusta University Medical Center (AUMC) in 2020 (N = 18,403) was conducted. Eligible patients were identified using the data mining tool, i2b2. COVID-19 hospitalization and case fatality rates were calculated. Logistic and Poisson regression models were constructed to identify characteristics associated with hospitalization, death, and hospital stay. The hospitalization rate was 3.97%. Patients aged 45-64 and 65+ had significantly higher hospitalization rates. Compared to White, hospitalization rates were higher in Black (AOR 2.35, 95% CI, 1.99-2.77, *p* 0.001) and Hispanic patients (AOR 1.92, 95% CI, 1.92-3.01, *p* 0.01). Overall COVID-19 case fatality rate was 0.62% and, in hospitalized patients, was 14.25%. Patients 65+ had higher odds of death (AOR 7.57, 95% CI, 3.25-22.13, *p* 0.001). Case fatality rates did not vary by race. In conclusion, in a primarily rural and underserved population prior to known effective therapy, overall and hospitalized case fatality rates were similar to studies from large urban areas.

**Keywords:** COVID-19, case fatality, hospitalization rate, rural health.

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\*Corresponding author. E-mail: dawalsh@augusta.edu. Tel: (706) 446 – 0344. Fax: (706) 721 - 4180.

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## INTRODUCTION

In December 2019 severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was first detected in Wuhan, China and emerged as a novel pathogen with person-to-person transmission (Zhou et al., 2020). This led to the, still ongoing, coronavirus disease-2019 (COVID-19) pandemic. In January 2020, the first case of COVID-19 was confirmed in the United States of America (USA) (Haynes et al., 2020), and since then, the disease spread throughout the country, affecting both urban and

rural communities (Pei et al., 2021). As of December 31<sup>st</sup> 2020, the department of Public Health (DPH) of the state of Georgia, USA, reported 651,591 confirmed COVID-19 cases (infections), 461,151 hospitalizations, and 9,789 deaths (Georgia DPH COVID-19 Status Report, 2022). The novelty of SARS-CoV-2 infections, the discovery of new variants, and the severity of the resultant negative health and economic consequences necessitate detailed epidemiological exploration to answer questions pertinent

to the burden, natural history, and prognosis of this disease.

SARS-CoV-2 infections could manifest as: asymptomatic, mild illness, moderate illness, severe illness, critical and fatal (National Institute of Health, 2022). Factors associated with increased risk of severe illness include: age  $\geq$  65 years; comorbidities such as hypertension, obesity, diabetes mellitus, cardiovascular diseases, chronic lung diseases, sickle cell disease (Garg et al., 2020) and pregnancy (Zambrano et al., 2020).

While, nearly one in five Americans, or approximately 60 million people, reside in a rural setting (<https://www.census.gov/library/stories/2017/08/rural-america.html>), much of the available knowledge on the COVID-19 spectrum of disease severity is based on patients in international or large U.S. cities, such as New York City (Cummings et al., 2020; Zachariah et al., 2020; Gonzalez-Reiche et al., 2020; Zhang et al., 2021). Limited information is available on the hospitalization and case fatality baseline data in smaller U.S. cities and rural areas in general (Hamilton et al., 2022) and on the pattern of distribution and severity of COVID-19 in the state of Georgia in the first half of 2020, in particular (<https://covid.cdc.gov/covid-data-tracker/#new-hospital-admissions>). Augusta-Richmond County is the second largest region in the state of Georgia (<https://data.census.gov/cedsci/table?q=Georgia%20city%20population>). Augusta University Medical Center (AUMC) provides care for this region and the surrounding Central Savannah River Area (CSRA) and serves as the safety net hospital for residents in the city of Augusta. CSRA comprises 21 unique counties across Georgia and South Carolina, with 18 of these counties classified as “rural” based on their population size of less than 50,000 permanent inhabitants (Hamilton et al., 2022). Rigorous examination of epidemiological patterns of COVID-19 in 2020—prior to the discovery and implementation of therapeutics and vaccines—is fundamental to better understanding of COVID-19 burden, severity spectrum, and potential effectiveness of therapeutic and preventive measures that ensued. Therefore, the current study aimed to determine trends in hospitalization and case-fatality rates, overall and by personal characteristics, in all adult patients diagnosed with COVID-19 in AUMC in 2020.

## MATERIALS AND METHODS

### Study design

This retrospective cohort study reviewed medical records of all adult patients diagnosed with COVID-19 through AUMC laboratory facilities in 2020. Data collection, analysis, and reporting were based on Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines (Vandenbroucke et al.,

2007).

### Patient population and period

We examined a cohort of lab-confirmed COVID-19 cases, both outpatient and inpatient, who tested positive at AUMC from March to December 2020 (N = 18,403 adult patients). Lab confirmation was based on a positive real-time reverse-transcription polymerase chain reaction (RT-PCR) assay for nasal swabs. This study was approved by the Institutional Review Board (IRB) at Augusta University. A waiver of informed consent was granted for the study owing to the use of retrospective data, already collected for the purposes of providing health care and stored in patients’ electronic medical records (EMR). Eligible patients were identified and their information were automatically abstracted using a data mining tool, *Informatics for Integrating Biology and the Bedside* (i2b2). The following information were automatically abstracted from EMR: personal attributes (age, sex, and racial background), encounter type (inpatient versus outpatient), and date of diagnosis, and for inpatients only, dates of hospital admission and discharge. Data on COVID-19-related fatality (death) in hospitalized COVID-19 patients (inpatients) were abstracted from EMR manually by three members of the study team.

### Measures

COVID-19 hospitalization rate was defined as the number of new admissions to AUMC of adult patients diagnosed with COVID-19 during a specific week (week 1 to week 41) in March to December 2020, in all newly diagnosed adult cases of COVID-19 during the same week in 2020, multiplied by 100 and expressed as a percentage.

The overall COVID-19 case-fatality rate in 2020 was calculated as the number of COVID-19-related deaths during 2020, divided by the number of all adult cases of COVID-19 diagnosed in 2020, multiplied by 100 and expressed as a percentage. Inpatient COVID-19 case-fatality rate was calculated as the number of COVID-19 deaths during 2020, divided by the number of hospitalized adult (inpatient) cases of COVID-19 diagnosed in 2020, multiplied by 100 and expressed as a percentage. Hospital stay duration, in days, was computed using hospital admission and discharge dates. Patient demographic characteristics included: sex, age (18-44, 45-64, and 65+), and race (White, Black, Other, and Hispanic).

### Statistical analysis

Unadjusted logistic regression models were constructed

where being hospitalized (encounter as inpatient/admitted) was the dependent variable and patient demographic characteristics were the independent variable. To examine characteristics associated with increased risk of COVID-19 hospitalization and death, adjusted logistic regression models were constructed in which hospitalization and death were the dependent variables, respectively, and age, sex, and race were the independent variables. Adjusted odds ratio (AOR) and 95% confidence interval (CI) were presented. For the continuous variable (hospital stay duration) we present the mean and standard deviation (SD). Poisson regression models were constructed to compare hospital stay duration by a group because stay duration data did not follow the normal distribution. The significance level was set at 0.05 for all analyses.

## RESULTS

Table 1 shows the personal characteristics of the study sample (N = 18,403). Half of this sample was aged 18-44 years and 32.9% were between the ages of 45-64 years. Of the population, 48.22% were White and 44.25% were Black.

The overall hospitalization rate was 3.97% in adults diagnosed with COVID-19. Table 2 depicts differences in hospitalization rates by personal characteristics. Compared to younger patients (18-44 years), older

adults, 45-64 (AOR 3.04, 95% CI, 2.74-3.76,  $p$  0.001) and 65 and older (AOR 10.64, 95% CI, 8.66-13.14,  $p$  0.001) had significantly higher odds of hospitalization in adults diagnosed with COVID-19, controlling for race and sex. Male patients had a higher rate of hospitalization than females (4.53% vs 3.57;  $p$  0.001). Hospitalization rates were higher among Black (AOR 2.35, 95% CI, 1.99-2.77,  $p$  0.001) and Hispanic patients (AOR 1.92, 95% CI, 1.92-3.01,  $p$  0.01) compared to their White counterparts.

**Table 1.** Characteristics of study sample of adult patients with COVID-19, GA, March-December 2020.

Characteristics	N	%
Age		
18-44	9,859	53.62
45-64	6,050	32.90
65+	2,476	13.46
Sex		
Male	8,154	55.59
Female	10,131	55.40
Race		
White	7,646	48.22
Black	7,017	44.25
Hispanic	522	3.29
Other	670	4.22

**Table 2.** Hospitalization rate by personal characteristics in adult patients with COVID-19, GA, March-December 2020.

Characteristics	%	AOR	95% CI	P value
Overall	3.97			
Age				
18-44	1.49	1		
45-64	4.43	3.04	2.47, 3.76	0.001
65+	12.72	10.64	8.66, 13.14	0.001
Sex				
Male	4.53	1.35	1.16, 1.58	0.001
Female	3.57	1		
Race				
White	3.15	1		
Black	6.14	2.35	1.99, 2.77	0.001
Hispanic	3.83	1.92	1.16, 3.01	0.01
Other	3.13	1.63	0.99, 2.53	0.04

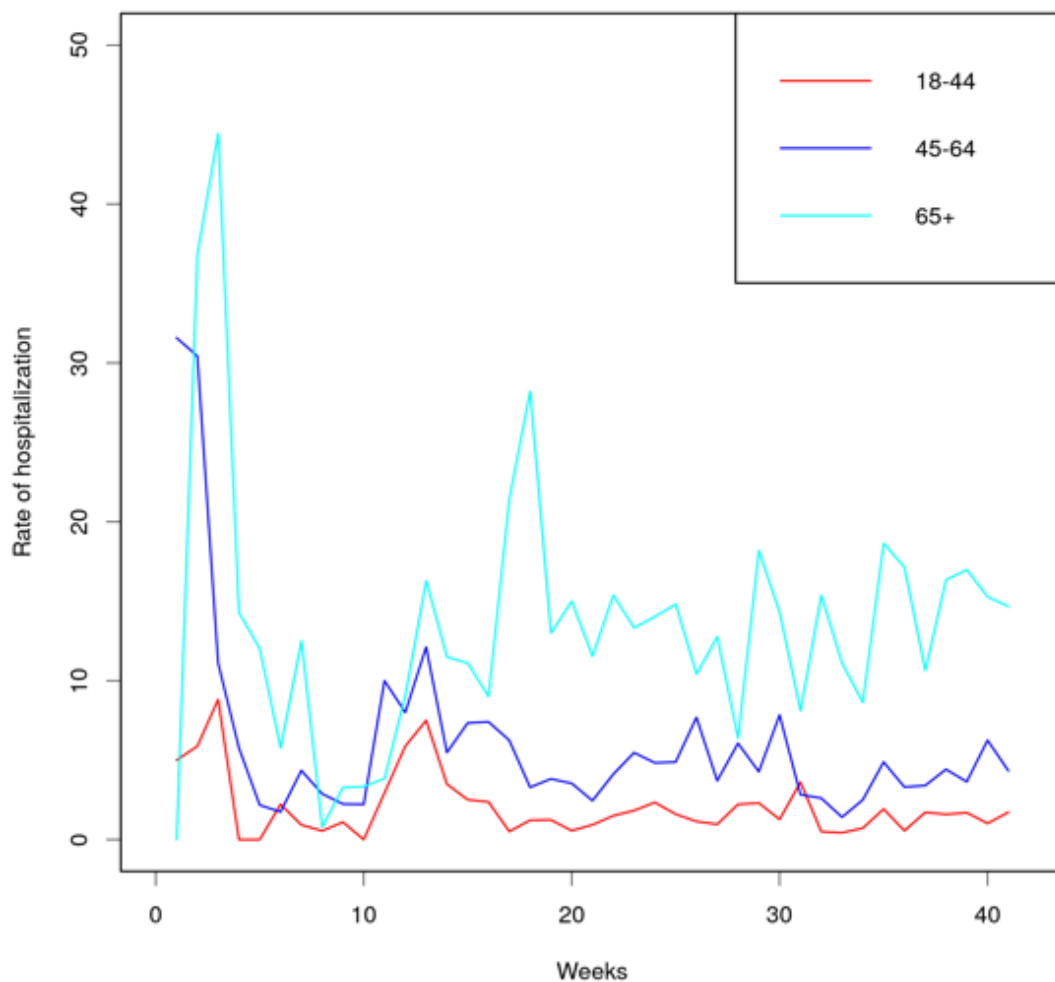
AOR, adjusted odds ratio estimated using multivariable logistic regression model.

Hospitalization rate estimated by number of patients admitted by total number of cases (included patients diagnosed with COVID-19 more than once).

Figure 1 shows COVID-19 hospitalization rates, over time, by patient age. Rates of hospitalization in patients aged 65 and older were consistently higher than rates in younger patients. In patients aged 65+, hospitalization rates had two prominent peaks in weeks 1-3 and weeks 18-19 and remained relatively constant (with minor fluctuations) over the remainder of the year 2020. Similar time trend patterns, though with lower magnitude, were observed in rates of hospitalization of patients aged 18-44 and 45-64. Figure 2 depicts higher COVID-19 hospitalization rates, overtime, in Black compared to

White patients, beginning in week 11 and lasting till the end of the year 2020.

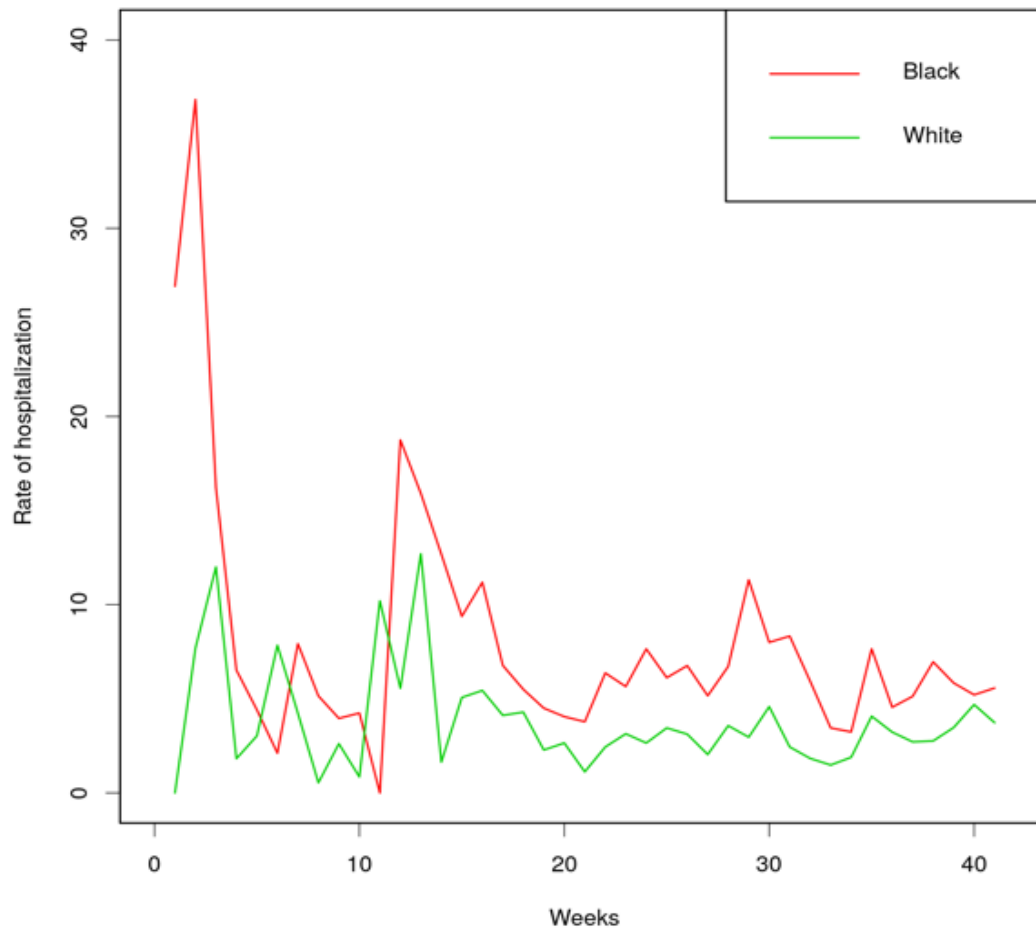
The mean hospital stay was 11.22 days (SD, 13.19). Mean hospital stay varied significantly by age (Table 3). Compared to younger patients, adults aged 45-64 (12.5 days) and 65 and older (10.78 days) had higher stay duration. No significant difference between male and female patients was observed in the mean duration of hospital admission. Compared to White patients, Black patients had a longer duration of stay (mean 11.76,  $p$  0.0001).



**Figure 1.** Time trends in hospitalization rate by age groups of adult patients with COVID-19, GA, March-December 2020.

COVID-19 case-fatality rate was 0.62% (N=100) in all COVID-19 adult patients included in this study, and 14.25% in adult inpatients (admitted to AUMC; N=702). Table 4 shows differences in inpatient COVID-19 case fatality rates by age, sex, and race. Patients aged 65 and

older had higher odds of death (AOR 7.57, 95% CI, 3.25-22.13,  $p$  0.001) than younger patients, controlling for sex and race. No statistically significant difference was observed in case fatality rates between patients of different racial backgrounds (Black AOR 0.78, 95% CI, 0.50-1.24,  $p$  0.29).



**Figure 2.** Time trends in hospitalization rate by race of adult patients with COVID-19, GA, March-December 2020.

**Table 3.** Duration of hospital stay (admission) in adult inpatients with COVID-19, GA, March-December 2020.

Characteristics	Mean hospital stay in days (SD)	Coefficient Estimate	P value
Overall	11.2 (13.19)		
Age			
18-44	9.8 (14.13)	0	
45-64	12.5 (15.85)	0.203	0.0001
65+	10.78 (9.81)	0.117	0.0003
Sex			
Male	11.58 (13.31)	0.027	0.22
Female	10.85 (13.08)	0	
Race			
White	9.99 (11.27)	0	
Black	11.76 (13.17)	0.161	0.0001
Hispanic	8.65 (6.24)	-0.121	0.125
Other	7.5 (7.7)	-0.286	0.0007

SD, standard deviation; P value was based on Generalized Linear Models (GLM).

**Table 4.** Case fatality rate by personal characteristics in adult inpatients with COVID-19, GA, March-December 2020.

Characteristics	%	AOR	95% CI	P value
Overall	14.25			
Age				
18-44	3.50	1		
45-64	9.13	2.64	1.06, 8.01	0.05
65+	23.43	7.57	3.25, 22.13	0.001
Sex				
Male	16.67	1.58	1.02, 2.48	0.04
Female	11.52	1		
Race				
White	18.53	1		
Black	12.65	0.78	0.50, 1.24	0.29
Hispanic	5.00	0.41	0.02, 2.23	0.40
Other	9.52	0.81	0.12, 3.14	0.79

AOR, adjusted odds ratio estimated using multivariable logistic regression model.  
Case fatality rate estimated by number of deaths divided by number of admitted patients.

## DISCUSSION

The results of this large cohort describe an average hospitalization rate was 3.97%. Older age, being male and being black or Hispanic was associated with higher rates of hospitalization. In addition, aged >44 and the black race were associated with longer hospitalization stays. The overall case fatality rate was 0.62% with age and sex being the only identified variables associated with an increase in the case fatality rate. During the study period, the peak hospitalization rates occurred at weeks 1-3 (March-April) and weeks 18-19 (June-July) and an overall declining hospitalization rate was observed.

Our research provides epidemiologic insight into a cohort of patients that are often underrepresented in primary literature – those that live in rural settings and those that comprise a minority based on race. Interesting our data is in line with previous rates of hospitalization during the study period provided by larger, primarily northeast epidemiologic studies (Reid and Fang, 2022). Additionally, our study found that age and sex are associated with increased fatality rates which is in line with previous studies (Mackey et al., 2021). Our study did not find race to be associated with increased fatality which is in contrast to previous studies (Mackey et al., 2021) and requires further exploration.

Our data provide a robust picture of the epidemiologic impact of COVID-19 on a largely rural population. The findings suggest that rates of hospitalization and case fatality rates are similar to other regions. Additionally, older age remains a primary risk factor for severe

disease. This was expected based on previous studies showing similar findings (Finelli et al., 2021). Interestingly, our findings do not suggest an increased fatality rate based on race which differs from previous large national epidemiologic data (CDC, 2022). This difference would be of interest in further investigation.

The overall strength of our study includes the robust database of patients that are often underrepresented in research. It provides insight into epidemiologic trends prior to the implementation of therapeutics. Every patient that was tested had an encounter created in our electronic medical record which streamlined the data abstraction process. This also allowed data to be abstracted from a single source. This study provides the foundation for future longitudinal studies on the effects and effectiveness of therapeutics on this cohort.

Our study also has certain limitations. While the database was robust, it did not incorporate all of the positive patients in the CSRA. There are two private hospitals, a VA, and multiple private offices that eventually had testing capabilities. Those tests could not be captured in this study. Cases that tested positive as outpatients who then required hospitalization, but went to another facility could not be captured. While previous studies and census information show a large proportion of rural patients in the CSRA, we did not explicitly measure that percentage in this study. An additional limitation is that data were abstracted retrospectively from the EMR and, therefore, relied on the assumption of data insertion accuracy at the time of the encounter. Finally, rates were only calculated based on positive test results

and could not measure those patients that may have had COVID-19, but failed to present for testing.

Our data suggest that overall hospitalization and case fatality rates were similar to those of larger national data sets. Age and race were associated with an increased risk of hospitalization, however, age alone was associated with an increased case fatality rate. Further studies should look to continue to monitor the rate of hospitalization and case fatality through subsequent waves of COVID-19, evaluate the impact of the discovery and release of various treatments and their impact on overall hospitalization and case fatality rate, and further explore the finding of age being the sole driver of fatality in this unique patient population.

## Conclusion

In a primarily rural and underserved population prior to known effective therapy, overall and hospitalized case fatality rates were similar to studies from large urban areas. Interestingly, age alone was associated with an increased case fatality rate and deserves further investigation given the difference with larger, less rural areas. Additionally, understanding the impact of novel therapeutics on hospitalization and case fatality rate in rural and underserved areas would be of interest.

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