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ORIGINAL RESEARCH

Infectious Disease

Factors associated with clinical severity in emergency department patients presenting with symptomatic SARS-CoV-2 infection

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Abstract

Objective: To measure the association of race, ethnicity, comorbidities, and insurance status with need for hospitalization of symptomatic emergency department patients with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection.

Methods: This study is a cohort study of symptomatic patients presenting to a single emergency department (ED) with laboratory-confirmed SARS-CoV-2 infection from March 7-August 9, 2020. We collected patient-level information regarding demographics, insurance status, comorbidities, level of care, and mortality using a structured chart review. We compared characteristics of patients categorized by (1) home discharge, (2) general hospital ward admission, and (3) intensive care unit (ICU) admission or death within 30 days of the index visit. Univariate and multivariable logistic regression analyses were performed to report odds ratios (OR) and 95% confidence intervals (95% CI) between hospital admission versus ED discharge home and between ICU care versus general hospital ward admission.

Results: In total, 994 patients who presented to the ED with symptoms were included in the analysis with 551 (55.4%) patients discharged home, 314 (31.6%) patients admitted to the general hospital ward, and 129 (13.0%) admitted to the ICU or dying. Patients requiring admission were more likely to be Black or to have public insurance (Medicaid and/or Medicare). Patients who were admitted to the ICU or dying were more likely aged ≥ 65 years or male. In multivariable logistic regression, old age, public

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insurance, diabetes, hypertension, obesity, heart failure, and hyperlipidemia were independent predictors of hospital admission. When comparing those who needed ICU care versus general hospital ward admission in univariate logistic regression, patients with Medicaid (OR 2.4, 95% CI 1.2–4.6), Medicare (OR 4.2, 95% CI 2.1–8.4), Medicaid and Medicare (OR 4.3, 95% CI 2.4–7.7), history of chronic obstructive pulmonary disease (OR 2.2, 95% CI 1.2–4.2), hypertension (OR 1.7, 95% CI 1.1–2.7), and heart failure (OR 2.6, 95% CI 1.4–4.7) were more likely to be admitted into the ICU or die; Black (OR 1.1, 95% CI 0.4–2.9) and Hispanic/Latino (OR 1.0, 95% CI 0.6–1.8) patients were less likely to be admitted into the ICU; however, the associations were not statistically significant. In multivariable logistic regression, old age, male sex, public insurance, and heart failure were independent predictors of ICU care/death.

Conclusion: Comorbidities and public insurance are predictors of more severe illness for patients with SARS-CoV-2. This study suggests that the disparities in severity seen in COVID-19 among Black patients may be attributable, in part, to low socioeconomic status and chronic health conditions.

KEYWORDS
COVID-19 disease, emergency medicine, infectious diseases, SARS-CoV-2 infection, socioeconomic factors

1 | INTRODUCTION

1.1 | Background

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first reported in the United States in January 2020. Since then, there have been 25 million cases of SARS-CoV-2 infection with over 415,000 deaths in the United States, with transmission ongoing.[1] The clinical course of coronavirus disease 2019 (COVID-19), the disease caused by SARS-CoV-2, ranges widely in severity from asymptomatic to life threatening. The mechanism behind this wide variation in patient outcomes is not yet well understood. Many studies thus far have documented associations between underlying patient comorbidities and more severe disease prognoses.[2–5] In addition, reports suggest that Black and Hispanic/Latino populations are disproportionately affected by COVID-19 disease with increased rates of infection and severity of illness compared to White populations.[6–8]

1.2 | Importance

Understanding the reason for disparities among different patient populations is critical for targeting interventions aimed at mitigating the impact of disease.

1.3 | Goals of this investigation

The objective of this study was to evaluate race, ethnicity, comorbidities, and insurance status as predictors of illness severity in patients presenting to the emergency department (ED) with symptomatic SARS-CoV-2 infection.

2 | METHODS

2.1 | Study design and setting

This was a single-center cohort study of patients with symptomatic SARS-CoV-2 infection presenting to an urban academic ED with ≈80,000 annual visits. The Institutional Review Board at The George Washington University in Washington, DC approved the study with a waiver of consent on March 30, 2020.

2.2 | Study population

Patients were included if they tested positive for SARS-CoV-2 by nasopharyngeal swab using polymerase chain reaction at the index ED visit. Patients were excluded if there was a high degree of certainty that the visit was not related to COVID-19. Specifically, patients were excluded if the reason for the ED visit was trauma, intoxication, poisoning, suicidality, involuntary commitment, or other isolated complaints highly unlikely to be related to COVID-19 (eg, suture removal). Additionally, patients displaying no symptoms of COVID-19 or other viral illness were excluded from this study.

2.3 | Data collection

Patients were identified via monthly electronic health record (EHR) queries for positive tests for COVID-19 in the ED from March 12, 2020

until August 9, 2020. Data abstraction were performed after the index visit to capture 30-day outcomes. Chart review was performed according to guidelines by Gilbert et al.[9] Case report forms were created by Indiana University for use in a multicenter registry. All data were entered into a REDCap database. All data abstractors were trained specifically for this study and 10% of charts were verified by a second abstractor for accuracy.

2.4 | Statistical analysis

Data were analyzed to identify significant associations by 3 categories of disposition: convalesce at home, admit to general hospital ward, and admit to ICU care or death. Patient disposition was chosen as a proxy for severity of disease. Patients who were initially discharged but then returned to the ED and needed admission were classified in the hospital admission category. Patients who were first admitted to the general hospital wards but ultimately were transferred to ICU were included in the ICU category. Patients who died during hospitalization or within 30 days after being seen were included in the ICU group representing the highest severity. We did not differentiate between COVID-related deaths or potential other causes.

Descriptive statistics were used to describe the demographics and comorbidities of patients per disposition. Frequencies and proportions were generated for categorical variables. Continuous variables were described using means and SDs. Methods for bivariate analyses assessing the association between disposition and patient characteristics were chi-square or Fisher's exact test for categorical data and analysis of variance (ANOVA) for continuous data. We ran logistic regression models for 2 separate sets of outcomes: hospital admission versus ED discharge and ICU care or death versus general hospital ward admission. Univariate logistic regression analyses were first performed on demographics, health insurance status, and comorbidities. We then developed multivariable logistic regression models for hospital admission versus ED discharge and for ICU or death versus general hospital ward admission. Independent variables include age, sex, race, ethnicity, health insurance, and comorbidities. To develop a parsimonious model, stepwise selection and likelihood ratio tests were performed. Model calibration and discrimination were also assessed for the selected models. We used the Hosmer-Lemeshow test to assess calibration and c-statistic (area under the curve [AUC]) to evaluate discrimination.[10] Crude odds ratio (OR) and adjusted OR (aOR) and the corresponding 95% confidence intervals (95% CI) were reported. All analyses were completed using SAS 9.4 (SAS Institute, Cary, NC).

3 | RESULTS

We collected patient-level data on a total of 994 patients seen in the ED from March 7-August 9. Of these, 551 were discharged from the ED, 314 were admitted to the floor, and 129 had initial admission to the ICU/death. Of patients discharged home, 32 were readmitted within 30 days. Descriptive statistics of patient characteristics were performed for all 3 categories (Table 1). Characteristics with statistically significant differences in disposition were age, race, ethnicity, and health insurance. In addition, there was statistically significant variation in disposition for multiple comorbid conditions: diabetes mellitus, systemic hypertension, ischemic heart disease, obesity, hyperlipidemia, heart failure, atrial fibrillation, cancer, chronic obstructive pulmonary disease (COPD), and non-specified lung disease. When analyzed by logistic regression, age and health insurance were associated with need for hospital admission (Table 2). Patients aged ≥65 were more likely to be admitted (OR 9.0, 95% CI 6.3–12.7) compared to those under 65. For patients with public health insurance, the odds ratio of being admitted were also significantly higher (Medicaid: OR 4.8, 95% CI 3.3–7.0; Medicare: OR 11.0, 95% CI 6.3–19.1; Medicaid and Medicare: OR 14.5, 95% CI 9.4–22.4) than that of patients with private/commercial health insurance. Notably, after adjusting for other covariates in multivariable logistic regression model after stepwise selection, neither race nor ethnicity was considered for admission (Table 2).

Of the comorbid conditions analyzed, diabetes mellitus, hypertension, obesity, hyperlipidemia, and heart failure were independent predictors of hospital admission (Table 2). Odds of admission or death were 1.9 (95% CI 1.2–2.9) times higher for patients with diabetes mellitus, 2.4 (95% CI 1.6–3.4) times higher for patients with hypertension, 1.6 (95% CI 1.1–2.4) times higher for obese patients, 1.9 (95% CI 1.2–3.0) times higher for patients with hyperlipidemias, and 4.2 (95% CI 1.5–11.7) times higher for patients with heart failure when compared to previously healthy patients.

When only admitted patients were analyzed to determine predictors of need for ICU care/death, patients with Medicaid were 2.4 times (95% CI 1.2–4.6) more likely to need ICU care compared to patients with private or commercial insurance (Table 3). A comorbid diagnosis of diabetes (OR 1.4, 95% CI 0.9–2.1]) and hyperlipidemia (OR 1.1, 95% 0.7–1.6), also predicted need for ICU care versus general hospital ward admission; however, the results were not statistically significant, except for COPD, heart failure, hypertension, and atrial fibrillation. In multivariable logistic regression, patients aged ≥65 years (aOR 2.0, 95% CI 1.1–3.4), male sex (aOR 2.1, 95% CI 1.3–3.4), public health insurance (Medicaid: aOR 2.3, 95% CI 1.1–4.6; Medicare: aOR 3.1, 95% CI 1.4–7.1; Medicaid and Medicare: aOR 2.7, 95% CI 1.3–5.5),

The Bottom Line

Among nearly 1000 symptomatic patients presenting to a single emergency department with laboratory-confirmed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection between March and August 2020, patients requiring hospitalization were more likely to be Black or to have public insurance, and independent predictors of hospitalization included diabetes, hypertension, obesity, hyperlipidemia, and heart failure. Patients admitted to the ICU and those who died were more likely to be male and aged 65 years or older.

TABLE 1 Characteristics of COVID-19 patients who presented at the George Washington University Hospital Emergency Department in Washington, DC

Characteristic	Category 1 discharge (n = 551)	Category 2 hospital admission (n = 314)	Category 3ICU care/death (n = 129)	*P* value*	Combined total (n = 994)
Age, mean (SD)	43.7 (15.3)	60.3 (15.6)	68.4 (14.6)	<0.0001	52.1 (18.1)
Age group, n (%)					
< 65 years	502 (91.1)	190 (60.7)	45 (35.2)	<0.0001	737 (74.3)
≥ 65 years	49 (8.9)	123 (39.3)	83 (64.8)		255 (25.7)
Sex, n (%)					
Female	281 (51.0)	172 (54.8)	52 (40.3)	0.0215	505 (50.8)
Male	270 (49.0)	142 (45.2)	77 (59.7)		489 (49.2)
Race, n (%)					
Black or African American	306 (55.5)	227 (72.3)	94 (72.9)	<0.0001	627 (63.1)
White	60 (10.9)	16 (5.1)	6 (4.7)		82 (8.3)
Asian, American Indian, Alaska Native, or Other	185 (33.6)	71 (22.6)	29 (22.5)		285 (28.7)
Ethnicity, n (%)					
Non-Hispanic or -Latino	412 (77.0)	263 (85.9)	108 (85.7)	0.0022	783 (81.0)
Hispanic or Latino	123 (23.0)	43 (14.1)	18 (14.3)		184 (19.0)
Health insurance, n (%)					
Medicaid	62 (11.4)	69 (22.0)	26 (20.3)	<0.0001	157 (15.9)
Medicare	18 (3.3)	38 (12.1)	25 (19.5)		81 (8.2)
Medicaid and Medicare	31 (5.7)	86 (27.5)	58 (45.3)		175 (17.7)
Private, commercial, self-pay, or other	435 (79.7)	120 (38.3)	19 (14.8)		574 (58.2)
Diabetes mellitus, n (%)					
No	487 (89.0)	189 (60.4)	67 (51.9)	<0.0001	743 (75.1)
Yes	60 (11.0)	124 (39.6)	62 (48.1)		246 (24.9)
Smoker, n (%)					
No	479 (88.0)	278 (90.0)	109 (88.6)	0.6958	866 (88.7)
Yes	65 (12.0)	31 (10.0)	14 (11.4)		110 (11.3)
Systemic hypertension, n (%)					
No	418 (75.9)	108 (34.6)	31 (24.0)	<0.0001	557 (56.2)
Yes	133 (24.1)	204 (65.4)	98 (76.0)		435 (43.8)
Prior ischemic heart disease, n (%)					
No	537 (98.2)	288 (92.0)	116 (90.6)	<0.0001	941 (95.2)
Yes	10 (1.8)	28 (8.0)	12 (9.4)		47 (4.8)
Obesity, n (%)					
No	441 (80.0)	221 (70.6)	98 (76.0)	0.0071	760 (76.5)
Yes	110 (20.0)	92 (29.4)	31 (24.0)		233 (23.5)
Hyperlipidemias, n (%)					
No	497 (90.5)	193 (61.5)	77 (59.7)	<0.0001	767 (77.3)
Yes	52 (9.5)	121 (38.5)	52 (40.3)		225 (22.7)
Heart failure, n (%)					
No	546 (99.1)	287 (91.4)	102 (80.3)	<0.0001	935 (94.2)
Yes	5 (0.9)	27 (8.6)	25 (19.7)		57 (5.8)

(Continues)

TABLE 1 (Continued)

Characteristic	Category 1 discharge (n = 551)	Category 2 hospital admission (n = 314)	Category 3ICU care/death (n = 129)	*P* value*	Combined total (n = 994)
Atrial fibrillation, n (%)					
No	542 (98.4)	294 (93.6)	110 (85.9)	<0.0001	946 (95.3)
Yes	9 (1.6)	20 (6.4)	18 (14.1)		47 (4.7)
Cancer active or in remission, n (%)					
No	533 (96.9)	292 (93.0)	114 (89.1)	0.0005	939 (94.7)
Yes	17 (3.1)	22 (7.0)	14 (10.9)		53 (5.3)
COPD by history, n (%)					
No	540 (98.0)	288 (92.0)	108 (83.7)	<0.0001	936 (94.3)
Yes	11 (2.0)	25 (8.0)	21 (16.3)		57 (5.7)
Other lung disease, n (%)					
No	548 (99.5)	309 (98.4)	125 (96.9)	0.0335	982 (98.8)
Yes	3 (0.5)	5 (1.6)	4 (3.1)		12 (1.2)
Asthma, n (%)					
No	484 (87.8)	267 (85.3)	108 (83.7)	0.3525	859 (86.5)
Yes	67 (12.2)	46 (14.7)	21 (16.3)		134 (13.5)

Abbreviations: COPD, chronic obstructive pulmonary disease; COVID-19, coronavirus disease 2019.
**P* values are calculated using the chi-square or Fisher's Exact test and analysis of variance based on type of data.

and heart failure (aOR 2.4, 95% CI 1.3–4.6) were independent predictors of ICU care/death.

4 | DISCUSSION

In this cohort study of 994 patients presenting to an ED with symptomatic COVID-19, we identified both comorbidities and public insurance as predictors of illness severity. More specifically, a history of hypertension, diabetes, heart failure, and hyperlipidemia were significant predictors of more severe disease. Although Black patients were disproportionately represented in the cohort of patients requiring hospital admission or ICU care, this association was less evident after adjusting for insurance status and comorbidities.

Prior literature has shown that Black and Hispanic/Latino patients may have more severe disease than Whites with COVID-19 and other sources suggest a bio-racial differential in immune response as the impetus for this disparity.[6,11–14] Our models suggest that the association of COVID-19 severity with race may be due, in part, to associations of race with social determinants of health and chronic diseases such as hypertension, diabetes, and hyperlipidemia.[15,16] However, other study designs would be necessary to explore causal factors (among comorbidities, social determinants of health, the impact of systemic racism and other factors) associated with the increased burden of COVID-19 among Black and Hispanic/Latino individuals.

In our population, public insurance, specifically Medicare or Medicaid, was an independent risk factor for severe COVID-19. The association between insurance type and severe COVID-19 was persistent even when controlling for comorbidities. There are several possible reasons for this association. First, it is possible that patients on public insurance may have more poorly controlled chronic conditions compared to patients with private insurance. Second, patients who experience poverty and therefore are more likely to rely on Medicaid or Medicare public insurance, may present later to the ED than those with private insurance in part because of decreased accessibility to outpatient health care.[17–19] Third, public insurance may be associated with other unmeasured social determinants of health related to concerns about lost employment time, need for childcare, increased distance from the ED, and lack of transportation.[20–23] Future studies include possibility of surveying admitted patients to inquire further about reasons behind variability in medical treatment of comorbidities and their home environments.

When comparing the 2 models, we identified multiple independent risk factors for predicting need for admission versus discharge that were not identified when predicting need for general hospital admission versus ICU care. It is possible that patients who are sick enough to meet the threshold for general hospital admission (moderate severity) have similar risk factors to the patients who meet the higher threshold of ICU care (high severity). It is also possible that if the sample size for admitted patients was larger, we would see similar predictors for need for ICU care as we saw for hospital admission.

In Table 2, the point estimates of OR for need for admission for Black patients change from being highly significant (OR 2.9, 95% CI 1.7–4.8) in the univariate model to being excluded in the logistic regression

TABLE 2 Logistic regression models for hospital admission/death versus discharge

	UnivariateLogistic regression Crude OR (95% CI)	*P**	Logistic regression using stepwise selection Adjusted OR (95% CI)[a]	*P* value*
Age group, n (%)				<0.0001
< 65 years	1.0 [Ref.]	<0.0001	1.0 [Ref.]	
≥ 65 years	9.0 [6.3, 12.7]		3.0 [1.8, 4.9]	
Sex, n (%)				
Male	1.0 [0.8, 1.3]	0.8918	—	—
Female	1.0 [Ref.]			
Race, n (%)				
Black or African American	2.9 [1.7, 4.8]	<0.0001	—	—
White	1.0 [Ref.]			
Asian, American Indian, Alaska Native, or Other	1.5 [0.9, 2.5]	0.1633		
Ethnicity, n (%)				
Hispanic or Latino	0.6 [0.4, 0.8]	0.0005	—	—
Non-Hispanic or -Latino	1.0 [Ref.]			
Health insurance, n (%)				
Medicaid	4.8 [3.3, 7.0]	<0.0001	4.1 [2.7, 6.3]	<0.0001
Medicare	11.0 [6.3, 19.1]	<0.0001	3.2 [1.5, 6.5]	0.0016
Medicaid and Medicare	14.5 [9.4, 22.4]	<0.0001	4.1 [2.4, 7.0]	<0.0001
Private, commercial, self-pay, or other	1.0 [Ref.]		1.0 [Ref.]	
Diabetes mellitus, n (%)				
No	1.0 [Ref.]	<0.0001	1.0 [Ref.]	0.0038
Yes	5.9 [4.2, 8.2]		1.9 [1.2, 2.9]	
Systemic hypertension, n (%)				
No	1.0 [Ref.]	<0.0001	1.0 [Ref.]	<0.0001
Yes	6.8 [5.2, 9.0]		2.4 [1.6, 3.4]	
Obesity, n (%)				
No	1.0 [Ref.]	0.0038	1.0 [Ref.]	0.0102
Yes	1.5 [1.2, 2.1]		1.6 [1.1, 2.4]	
Hyperlipidemias, n (%)				
No	1.0 [Ref.]	<0.0001	1.0 [Ref.]	0.0035
Yes	6.1 [4.3, 8.6]		1.9 [1.2, 3.0]	
Heart failure, n (%)				
No	1.0 [Ref.]	<0.0001	1.0 [Ref.]	0.0059
Yes	14.6 [5.8, 36.9]		4.2 [1.5, 11.7]	
Smoker, n (%)				
No	1.0 [Ref.]	0.4526	—	—
Yes	0.9 [0.6, 1.3]			
Prior ischemic heart disease, n (%)				
No	1.0 [Ref.]	<0.0001	—	—
Yes	4.9 [2.4, 10.0]			
Atrial fibrillation, n (%)				
No	1.0 [Ref.]	<0.0001	—	—
Yes	5.7 [2.7, 11.8]			

(Continues)

TABLE 2 (Continued)

	UnivariateLogistic regression Crude OR (95% CI)	*P**	Logistic regression using stepwise selection Adjusted OR (95% CI)[a]	*P* value*
Cancer active or in remission, n (%)				
No	1.0 [Ref.]	0.0007	—	—
Yes	2.8 [1.5, 5.0]			
COPD by history, n (%)				
No	1.0 [Ref.]	<0.0001	—	—
Yes	5.7 [2.9, 11.1]			
Other lung disease, n (%)				
No	1.0 [Ref.]	0.0469	—	—
Yes	3.8 [1.1, 14.0]			
Asthma, n (%)				
No	1.0 [Ref.]	0.1700	—	—
Yes	1.3 [0.9, 1.9]			

Abbreviations: CI, confidence interval; COPD, chronic obstructive pulmonary disease; OR, odds ratio; Ref., reference.

[a]Adjusted for age, health insurance, diabetes mellitus, systemic hypertension, obesity, hyperlipidemias, and heart failure, using stepwise selection in logistic regression. The adjusted model was calibrated well ($P = 0.1057$, Hosmer-Lemeshow) and had good discrimination with a c-statistic (area under the curve) of 0.846.

**P* value is based on the Wald chi-square test.

model using stepwise selection. The decrease in point estimate with the inclusion of more variables suggests that the association between being Black and the need for hospital admission might be partially mediated or confounded by insurance status and comorbidities. In Table 3, admitted Black patients were less likely to need ICU care than admitted White patients (univariate: ORs 1.1, 95% CI 0.4–2.9), though the 95% CI of the estimate included 1.0. This observation surprised us given that Black patients were more likely to be on Medicaid and have comorbidities in our sample. A possible explanation is that transfer to ICU is a physician-mediated outcome and systemic racism might contribute to White patients disproportionately receiving a higher level of care. More research is needed to explain this phenomenon.

In comparison, when we examined the point estimates of OR of hospital admission for Medicaid patients, they are minimally changed from the univariate (OR 4.8, 95% CI 3.3–7.0) to the multivariable model (aOR 4.1, 95% CI 2.7–6.3), suggesting minimal dependence or confounding of other variables. In Table 3, Medicaid is similarly associated with ICU care in univariate analysis (OR 2.4, 95% CI 1.2–4.6) and in multivariable model (aOR 2.3, 95% CI 1.1–4.6). Medicaid is closely associated with low income status and has been linked with other social determinants of health.[24]

The actual mechanisms behind why certain comorbidities are associated with more severe outcomes are not yet well understood. Regarding diabetes's association, deglycation has been proposed to play a role in weakening the immune response.[4,25–27] The mechanistic relationship between uncontrolled hypertension and worse COVID-19 prognoses is not defined but hypertension has been associated with an increase in inflammatory markers and may be related to dysregulation of the renin-angiotensin-aldosterone axis.[28–32] The severity of COVID-19 is likely the result of a complex interaction between viral load, host sex, host age, host comorbidities, social determinants, and host and viral genetic factors. The higher rates of COVID-19 in Black and Hispanic/Latino populations has raised the suggestion that genetic susceptibility may play a role in severity. Systemic racism resulting in reduced access to care, increased exposure to SARS-CoV-2, and delays in identification of infectious status may also contribute to disparities. There have been limited studies suggesting a genetic predisposition to disease severity. One case report described SARS-CoV-2 deaths in 3 previously healthy adult brothers suggesting a genetic predisposition because of familial clustering.[33] A second case report of SARS-CoV-2 of a large family cluster with more severe disease compared to other patients presenting at the same time also suggested a genetic predisposition because of apparent familial clustering of severity.[32] Further research is needed to describe the role that host genetic factors play a role in disease susceptibility.[34–35]

4.1 | Strengths/Limitations

One strength of our study is the diverse characteristics of the patient population in terms of age, race, ethnicity, and health insurance status. In addition, we only included patients with symptoms of illness and a laboratory-confirmed positive test. All patients who presented to the ED presented for symptoms related to COVID-19 and do not reflect incidental positives or asymptomatic carriers. Moreover, the dataset was relatively complete with few missing elements. Finally,

TABLE 3 Logistic regression models for ICU care/death versus general ward admission

	UnivariateLogistic regression Crude OR (95% CI)	*P**	Logistic regression using stepwise selection Adjusted OR (95% CI)[a]	*P* value*
Age group, n (%)				
< 65 years	1.0 [Ref.]	<0.0001	1.0 [Ref.]	0.0156
≥ 65 years	2.8 [1.9, 4.4]		2.0 [1.1, 3.4]	
Sex, n (%)				
Male	1.8 [1.2, 2.7]	0.0059	2.1 [1.3, 3.4]	0.0022
Female	1.0 [Ref.]		1.0 [Ref.]	
Race, n (%)				
Black or African American	1.1 [0.4, 2.9]	0.8409	—	—
White	1.0 [Ref.]			
Asian, American Indian, Alaska Native, or Other	1.1 [0.4, 3.1]	0.8712		
Ethnicity, n (%)				
Hispanic or Latino	1.0 [0.6, 1.8]	0.9494	—	—
Non-Hispanic or -Latino	1.0 [Ref.]			
Health insurance, n (%)				
Medicaid	2.4 [1.2, 4.6]	0.0102	2.3 [1.1, 4.6]	0.0237
Medicare	4.2 [2.1, 8.4]	<0.0001	3.1 [1.4, 7.1]	0.0070
Medicaid and Medicare	4.3 [2.4, 7.7]	<0.0001	2.7 [1.3, 5.5]	0.0053
Private, commercial, self-pay, or other	1.0 [Ref.]		1.0 [Ref.]	
COPD by history, n (%)				
No	1.0 [Ref.]	0.0109	—	—
Yes	2.2 [1.2, 4.2]			
Diabetes mellitus, n (%)				
No	1.0 [Ref.]	0.1027	—	—
Yes	1.4 [0.9, 2.1]			
Systemic hypertension, n (%)				
No	1.0 [Ref.]	0.0305	—	—
Yes	1.7 [1.1, 2.7]			
Obesity, n (%)				
No	1.0 [Ref.]	0.2536	—	—
Yes	0.8 [0.5, 1.2]			
Hyperlipidemias, n (%)				
No	1.0 [Ref.]	0.7279	—	—
Yes	1.1 [0.7, 1.6]			
Heart failure, n (%)				
No	1.0 [Ref.]	0.0014	1.0 [Ref.]	0.0077
Yes	2.6 [1.4, 4.7]		2.4 [1.3, 4.6]	
Smoker, n (%)				
No	1.0 [Ref.]	0.6787	—	—
Yes	1.2 [0.6, 2.2]			
Prior ischemic heart disease, n (%)				
No	1.0 [Ref.]	0.6336	—	—
Yes	1.2 [0.6, 2.5]			

(Continues)

TABLE 3 (Continued)

	UnivariateLogistic regression Crude OR (95% CI)	*P**	Logistic regression using stepwise selection Adjusted OR (95% CI)[a]	*P* value*
Atrial fibrillation, n (%)				
No	1.0 [Ref.]	0.0106	—	—
Yes	2.4 [1.2, 4.7]			
Cancer active or in remission, n (%)				
No	1.0 [Ref.]	0.1737	—	—
Yes	1.6 [0.8, 3.3]			
Other lung disease, n (%)				
No	1.0 [Ref.]	0.3152	—	—
Yes	2.0 [0.5, 7.5]			
Asthma, n (%)				
No	1.0 [Ref.]	0.6733	—	—
Yes	1.1 [0.6, 2.0]			

Abbreviations: CI, confidence interval; COPD, chronic obstructive pulmonary disease; OR, odds ratio; Ref., reference.

[a]Adjusted for age, sex, health insurance, and heart failure using stepwise selection in logistic regression. The adjusted model was calibrated well ($P = 0.8226$, Hosmer-Lemeshow) and had fair discrimination with a c-statistic (area under the curve) of 0.721.

**P* value is based on the Wald chi-square test.

we have high confidence in the data abstraction methods and used easily abstracted variables in order to remove ambiguity subjectivity present in typical chart abstraction. This study has several important limitations. First, this study was reliant on documentation in the EHR of a single ED. In addition, we did not collect detailed socioeconomic data such as household income, educational attainment, and presence of primary care.

Finally, we were unable to capture the severity and treatment status of comorbid conditions from chart review and, therefore, our results may not reflect the impact of underlying health conditions on the severity of COVID-19 for individual patients.

5 | CONCLUSION

Predictors of disease severity for ED patients who present with COVID-19 include age, Medicaid or Medicare public insurance, diabetes mellitus, hypertension, obesity, hyperlipidemia, and heart failure. Greater understanding of the factors that contribute to clinical variability in COVID-19 severity will assist in early identification of high-risk patients and enhance the precision of public health interventions.

CONFLICTS OF INTEREST

SN, BZ, JF, SM, AH, KA, MM, NMV, JSC, DATC, YM, ACM report no conflicts of interest.

AUTHOR CONTRIBUTIONS

ACM, SN, BZ, SM, AH, KA, and MM contributed to study concept and design, acquisition of the data. ACM, YM, and JF contributed to analysis and interpretation of the data. YM and JF contributed statistical expertise. SN, BZ, KA, MM, ACM, JF, NMV, YM, RS, JSC, and DATC contributed to drafting and critical revision of the manuscript. ACM takes responsibility for the paper as a whole.

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