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The Effect of Race and Socioeconomic Status on Hospitalized Patients with COVID-19 Infection

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Abstract

Background: There have been varying impacts of COVID-19 on racial, ethnic, and socioeconomic communities in the US. Recent literature suggests that Black Americans have the highest unadjusted and adjusted mortality rates from COVID-19, while White Americans have the lowest unadjusted and adjusted rates. However, the role of socioeconomic status and comorbidities in these disparities in health outcomes from COVID-19 are unclear. Thus, the purpose of this study is to evaluate how socioeconomic status and race impact COVID-19 outcomes in patients hospitalized with COVID-19 in a large health care system in the Mid-Atlantic region.

Material and methods: We retrospectively analyzed the association of COVID-19 outcomes and race, ethnicity, and socioeconomic status using electronic medical records and the REDCap database from the time period of March 5, 2020 to June 3, 2020. The outcomes evaluated were intubation, ICU admission, and discharge destination. Multivariate logistic regression analysis was then performed to examine whether race and socioeconomic status were independent risk factors of mortality controlling for age, Charlson comorbidity index (CCI), and comorbidities.

Results: Race was not found to be an independent predictor for COVID-19 inpatient mortality. Race was found to be an independent risk factor for ICU admission with odds of ICU admission for Black patients to be 1.5 times higher (odds ratio (OR) 1.4 to 2.04) compared to Non-Black/Non-White (72.4% identifying as Hispanic) but no difference between Black and White races. Race was found not to be an independent risk factor for intubation nor was race an independent risk factor for increased length of ICU LOS, hospital LOS or intubation days. Socioeconomic status was not an independent risk factor for inpatient mortality although high income groups were significantly less likely to be admitted to the ICU compared to middle income patients.

Conclusion: Our cohort of patients in a large mid-Atlantic health system showed that there was no statistically significant difference between race or socioeconomic status and COVID-19 related inpatient mortality. However, Black patients and individuals in the lower to middle socioeconomic group had a higher rate of COVID-19 hospitalizations when accounting for age, sex, and comorbidities. With ongoing vaccination efforts, equitable administration of resources should focus on disproportionately affected populations.

Keywords: COVID-19, Race, Socioeconomic status, Mortality, Hospitalization

1. Introduction

The COVID-19 pandemic has taken its toll on the world, with 883,993 deaths in the United States, and 5,660,958 deaths worldwide as of January 30th, 2022.¹ Many factors have led to varying impacts of COVID-19 on racial, ethnic, and socioeconomic communities in the US.

Black Americans have the highest unadjusted and adjusted mortality rates from COVID-19, while White Americans have the lowest unadjusted and adjusted rates.² Adjusted hospitalization rates in Hispanics and Asians are also significantly higher than those of Whites. Although when adjusted for age, sex, neighborhood, and comorbidities, no racial differences were found for inpatient mortality or all-

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cause mortality.² Quan et al. expands on these COVID-19 impacts based on neighborhood income, finding that, after adjusting for age, sex, race, and comorbidities, higher neighborhood income is associated with less invasive mechanical ventilation (IMV) and fewer ICU admissions.³ Ogedegbe et al. further found that after adjusting for comorbidities and neighborhood qualities, Black patients were less likely than White patients to have critical illness or die from COVID-19.⁴ These findings suggest that social determinants of health may explain the higher rates of mortality from COVID-19 within the Black population.

The United States Center for Disease Control and Prevention (CDC) has noted that COVID-19 outcomes can be partially explained by the interconnections of race, socioeconomic status, and medical comorbidities.⁵ However, it remains unclear whether the disparities in health outcomes from COVID-19 are fully explained by socioeconomic status and comorbidities. As new variants continue to arise and spread through communities, it is important to identify populations at risk. The purpose of our study is to investigate the effect of socioeconomic status and race on COVID-19 outcomes in patients hospitalized with COVID-19 in a large health care system in the Mid-Atlantic region.

2. Methods

This retrospective cohort study was approved as exempt with HIPAA waiver by our institutional review board. Eligible patients were 18 years or older and admitted with symptomatic COVID-19 with a positive laboratory test for SARS-CoV-2, defined as a positive result on high-throughput sequencing or real-time reverse-transcriptase-PCR (RT-PCR) assay of nasal swab specimens. Patients were admitted to one of 10 acute care hospitals in a large mid-Atlantic health care system from March 5, 2020, to June 3, 2020. Patients were identified using International Classification of Diseases (ICD) 10 code of U07.1 (COVID-19). Patients were included if they had the COVID-19 ICD-10 code and were symptomatic with COVID-19. Patients were excluded if the chart did not include the COVID-19 ICD-10 code, did not specify the primary outcome, were determined to be asymptomatic, or did not include racial or zip code data.

Data collection was performed using electronic medical records and the REDCap database. In total, 2902 patients were identified, of which 1672 were reviewed and 567 were excluded using the previously stated inclusion and exclusion criteria, leaving 1105 charts for the race analysis. An additional 14

charts were excluded for the socioeconomic analysis due to lack of zip code data.

The primary investigator reviewed abstraction accuracy in approximately 10% of the charts. The primary outcome measure was in-hospital mortality, and secondary outcome measures included intensive care unit (ICU) admission, intubation, days intubated, ICU length of stay (LOS), and discharge destination. The electronic medical record lists race information into 6 categories: Black or African American, Asian, American Indian, White, other or unknown. Ethnicity is captured as Hispanic or Latino, non-Hispanic or Latino or unknown. Socioeconomic status was stratified by median income of the patient's zip code, based on data from the 2019 United States Census Bureau.⁶ We defined socioeconomic status by mean household income as a surrogate, whereby the top 25% of household incomes were considered high income (\$86,847 mean annual income or higher), 26–74% of household mean annual incomes (\$46,958 to \$86,584) were denoted middle income, and the lowest 25% household annual mean income (\$45,958 or lower) was the low-income group. Median zip code income has been validated in previous studies, such as that by Berkowitz et al. as a surrogate of socioeconomic status.⁷

2.1. Statistical methods

Summary statistics including mean and standard deviation or median and interquartile range for continuous data and proportion for categorical data were calculated for patients overall and for subgroups based on race and socioeconomic group. ANOVA and Kruskal–Wallis tests as appropriate were used to examine differences in the averages of continuous variables between the groups. Chi-square test was used to investigate differences for categorical variables. Logistic regression analysis was conducted to examine the association between race/socioeconomic status and mortality, and multivariate logistic regression analysis was performed to examine whether race and socioeconomic status was an independent risk factor of mortality controlling for age, Charlson comorbidity index (CCI), and comorbidities that were found significant in the bivariate analysis. Similar analyses were performed for other outcomes (intubation, ICU admission, and discharge destination). Multivariate linear regression analysis was performed to examine whether race and socioeconomic status were an independent predictor of days intubated, while controlling for age, CCI, and comorbidities

that were found to be significant in the bivariate analysis. Similar analyses were performed for outcome ICU LOS. Statistical significance was defined as $p < 0.05$. Statistical Analysis System software version 9.4 (SAS Institute Inc., Cary, NC, USA) was used.

3. Results

Mean age of the study population was 62.6 years \pm standard deviation (SD) of 16 years (Table 1). The majority of patients were Black ($n = 683$, 61.8%). Of the population identified as Non-Black/Non-White, the majority identified as Hispanic ($n = 192$, 72.4%). Hypertension was the most common comorbid condition (64.6%), followed by diabetes (13.8% on insulin, 22.9% not on insulin). Among the study population, 13.4% had congestive heart failure, and 8.5% had end stage renal disease. Most patients (74.8%) presented from home; while 13.2% were nursing home residents. 46.5% of patients had Medicare, 25.2% were Medicaid beneficiaries, and 23.5% had commercial insurance. The White patients as a group were older, and a larger percentage of them originated from a nursing home.

The primary outcome, in-hospital death, occurred in 234 (21.2%) patients (Table 3). Among them, 68.8% were Black, 17.9% White and 13.2% Non-Black/Non-White. Multivariate logistic regression analysis did not find race to be an independent predictor for COVID-19 inpatient mortality. Among the study population, 406 patients (36.7%) needed ICU admission, with 256 patients (23.2%) requiring mechanical ventilation. Backward selection analysis in the final multivariate model found race to be an independent risk factor for ICU admission ($p = 0.047$) with odds of ICU admission for Black

patients to be 1.5 times higher (odds ratio (OR) 1.4, 1.07 to 2.04) compared to Non-Black/Non-White but no difference between Black and White races. Race was found not to be an independent risk factor for intubation nor was race an independent risk factor for increased length of ICU LOS, hospital LOS or intubation days. In the study cohort, 636 patients (57.6%) were discharged to home, and race was an independent predictor of discharge destination to home. The odds of discharge destination to home was 3.2 (CI 1.88–4.97) times higher for Non-Black/Non-White ($p < 0.0001$) and no difference was noted between White and Black patients ($p = 0.095$).

The majority of patients admitted to the hospital were from middle ($n = 654$, 60%) or lower income neighborhoods ($n = 354$, 32.4%) (Table 2). Socioeconomic status was not an independent risk factor for inpatient mortality (Table 4). Black patients made up the majority of the lower income group. High income groups were significantly less likely to be admitted to the ICU with OR 0.56 (CI 0.31 to 0.96; $p = 0.03$) compared to middle income patients. The lower income group was more likely to be discharged to home OR 1.45 (CI 1.1 to 1.9; $p = 0.01$) compared only to the middle-income group.

4. Discussion

In this primarily Black patient population, race and socioeconomic status were not found to be an independent risk factor for inpatient mortality. Our findings are similar to that of Louisiana,⁸ California,⁹ and New York⁴ reports all of which found no increased risk of in-hospital mortality of Black patients when compared to White patients. The lack of increased risk of inpatient mortality by race with COVID-19 was also corroborated by the Quan

Table 1. Baseline characteristics by race.

Factor	Overall (n = 1105)	Black (n = 683)	Non-Black/ Non-White (n = 265)	White (n = 157)	
Age, y \pm SD	62.6 \pm 16.0	64.4 \pm 14.8	53.4 \pm 15.6	70.3 \pm 14.9	<.0001
Sex					.0007
Female, n (%)	524 (47.4)	349 (51.1)	99 (37.4)	76 (48.4)	
Male, n (%)	581 (52.6)	334 (48.9)	166 (62.6)	81 (51.6)	
Current smoker, n (%)	63 (5.7)	42 (6.1)	9 (3.4)	12 (7.6)	<.0001
Location prior to hospital, n (%)					<.0001
Home	827 (74.8)	496 (72.6)	243 (91.7)	88 (56.1)	
Nursing home	146 (13.2)	103 (15.1)	3 (1.1)	40 (25.5)	
Hypertension	714 (64.6)	506 (74.1)	103 (38.9)	105 (66.9)	<.0001
Diabetes on insulin	152 (13.8)	114 (16.7)	22 (8.3)	16 (10.2)	.0013
Diabetes not on insulin	253 (22.9)	170 (24.9)	53 (20)	30 (19.1)	.1305
Charlson Comorbidity Index, mean \pm SD	3.46 \pm 2.6	3.9 \pm 2.7	1.9 \pm 2.1	4.2 \pm 2.2	<.0001

Table 2. Baseline characteristics by income.

Factor	Overall (n = 1091)	High Income (n = 83)	Middle Income (n = 654)	Low Income (n = 354)	
Age, y±SD	62.6 ± 16.0	61.8 ± 17.2	62.9 ± 16	62.2 ± 15.7	.7070
Sex					.2078
Female, n (%)	521 (47.8)	42 (50.6)	298 (45.6)	181 (51.1)	
Male, n (%)	570 (52.2)	41 (49.4)	356 (54.4)	173 (48.9)	
Race					<.0001
Black	677 (62.1)	32 (38.6)	371 (56.7)	274 (77.4)	
White	258 (23.6)	179 (27.4)	26 (31)	53 (15)	
NonBlack/NonWhite	156 (14.3)	25 (30)	104 (15.9)	27 (7.6)	
Current smoker, n (%)	63 (5.8)	1 (1.2)	39 (6.0)	23 (6.5)	.0420
Location prior to hospital, n (%)					.0340
Home	815 (74.7)	67 (80.7)	476 (72.8)	272 (76.8)	
Nursing home	145 (13.3)	3 (3.6)	102 (15.6)	40 (11.3)	
Hypertension	708 (64.9)	35 (42.2)	427 (65.3)	246 (69.5)	<.0001
Diabetes on insulin	149 (13.7)	7 (8.4)	90 (13.8)	52 (14.7)	.3253
Diabetes not on insulin	249 (22.8)	15 (18.1)	150 (22.9)	84 (23.7)	.5398
Charlson Comorbidity Index, mean ± SD	3.5 ± 2.6	3.3 ± 2.5	3.4 ± 2.7	3.5 ± 2.6	.7319

Table 3. Unadjusted primary and secondary outcomes by race.

Factor	Overall (n = 1105)	Black (n = 683)	Non-Black/ Non-White (n = 265)	White (n = 157)	
In-hospital mortality, n (%)	234 (21.2)	161 (23.6)	31 (11.7)	42 (26.8)	<.0001
ICU admission, n (%)	406 (36.7)	274 (67.5)	82 (11.7)	50 (12.3)	.0123
Intubation, n (%)	256 (23.2)	174 (25.5)	48 (18.1)	34 (21.7)	.0486
Discharge home	636 (57.6)	358 (52.4)	214 (80.8)	64 (40.8)	<.0001

Table 4. Unadjusted primary and secondary outcomes by income.

Factor	Overall (n = 1091)	High Income (n = 83)	Middle Income (n = 654)	Low Income (n = 354)	
In-hospital mortality, n (%)	230 (21.2)	13 (15.7)	145 (22.2)	72 (20.3)	.3590
ICU admission, n (%)	398 (36.5)	20 (24.1)	242 (37)	136 (38.4)	.046
Intubation, n (%)	251 (23)	12 (14.5)	156 (23.9)	83 (23.4)	.1551
Discharge home	626 (57.6)	55 (66.3)	355 (54.3)	218 (61.6)	.0203

study.³ In addition, we found Black patients to be as likely as White patients to be admitted to the ICU, but 1.5 times more likely when compared to Non-Black/Non-White patients. Non-Black/Non-White patients, of which 72.4% identified as Hispanic, were on average younger and with fewer comorbidities likely accounting for the statistic difference in discharge to home and decreased admission to the ICU. Although not statistically significant, there was a trend of decreased in-hospital mortality of Non-Black/Non-White patients compared to Blacks or Whites. These findings strengthen the hypothesis that significant comorbidities are the main factor in predicting COVID-19 outcomes. Furthermore, there were no significant differences in regards to rates of intubation, ICU LOS, and hospital LOS between racial groups.

In this study cohort, 62% of COVID-19 hospital admissions were Black, 14.2% White, and 24% Non-Black/Non-White (majority Hispanic) patients. This is in contrast to the breakdown of all hospital admissions from the same health system in 2019, as 47% percent of patients were Black, 40% were White, and 5% were Hispanic. These findings revealed increased hospitalization with COVID-19 symptoms and burden of the disease on certain communities. This is supported by other reports in which Black patients were more likely to be hospitalized with COVID-19 than their White counterparts.^{3,4,8,10,11} Price-Haywood et al. found that Black patients were two times more likely to be hospitalized with COVID-19 as White patients after adjustment for age, sex, and comorbidities,⁸ and Azar et al. analogously found Black patients were 2.7 times more likely to be hospitalized.⁹ This discrepancy

between hospitalizations has been hypothesized to be due to higher likelihood of comorbidities in minority groups.⁸ Our study found similar CCI scores between Black and White patients (3.9 vs 4.2, respectively) with significantly lower CCI scores in the Hispanic group (1.9 $p < 0.001$) that were hospitalized with COVID-19. Overall, this finding supports the hypothesis that increased levels of comorbidities in certain racial populations may be important factors in increased hospitalizations of COVID-19.

The relationship between socioeconomic status and mortality has been well described with the Preston Curve showing the relationship between life expectancy and income per person, by country.¹² This relationship has been shown for various illnesses, including HIV,¹³ myocardial infarction,¹⁴ and stroke.¹⁵ Our study disputes previous reports of increased inpatient mortality levels of COVID-19 patients in lower socioeconomic patients as seen in New York, where COVID-19 mortality was highest in the lower income Burroughs.¹⁰ In addition, we did not find increased risk of mechanical ventilation and ICU admissions in any income group, as was seen by the study conducted by Quan.³ Although it did not appear to have an impact on hospitalization outcomes, socioeconomic status may play a role in COVID-19 hospitalizations. Only 7.6% of total admissions were patients of high socioeconomic status (\$86,847 mean annual income or higher). This is in contrast to 60% ($n = 654$) and 32% ($n = 354$) for middle and low income patients, respectively. This is comparable to the study by Azar et al. who found that COVID-19 positive patients with higher relative income were less likely to be admitted.⁹ Black patients, comprising the majority of the present study, were significantly more likely to be of lower income socioeconomic status (comprising 77.4% of the group).

Limitations of this study include the observational design and selection bias. Resource limitations prevented the inclusion of all patients, but all patients were consecutive in discrete time spans within the study period. The health system and patient data come from only one part of the country and therefore patient factors and outcomes may differ in different environments.

Overall, our findings indicate that the Black and lower to middle socioeconomic status population have an increased risk in hospitalization due to COVID-19. Comorbidity appears to be the main factor contributing to inpatient mortality, LOS, and discharge outcomes. In considering the findings of this study and ongoing efforts to curtail community spread of COVID-19 by resource allocation and

vaccination, focusing resources on the communities with increased burden would be most beneficial to decrease the spread of disease, overall hospitalization, and mortality in all populations.

5. Conclusion

Our cohort study of patients in a large mid-Atlantic health system showed that there was no statistically significant difference between race and socioeconomic status and COVID-19 related inpatient mortality. However, Black patients and individuals in the lower to middle socioeconomic group had a higher rate of COVID-19 hospitalizations. With the ongoing vaccination effort, equitable vaccine administration should focus on these patients.

Conflict of interest

None of the authors have a conflict of interest.

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