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Association of Black Race with Outcomes in COVID-19 Disease: A Retrospective Cohort Study

To the Editor:

Coronavirus disease (COVID-19) is an emergent threat to public health resulting from the novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The World Health Organization officially declared COVID-19 as a pandemic on March 12, 2020 (1).

Average global COVID-19 mortality is estimated at 4.0% but has varied significantly across countries (2). Inpatient mortality, as high as 28% in early reports from China and Italy, has driven worldwide efforts to identify poor prognostic factors (3, 4). Initial studies suggest older age and male sex are associated with COVID-19 infection and hospital mortality (4–8). Similarly, comorbidities, including hypertension, diabetes, and chronic lung disease, have been associated with poor outcomes (3, 7, 9–11).

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The U.S. Centers for Disease Control and Prevention provided the first study examining race, which suggested that Black patients were disproportionately overrepresented in hospitalized COVID-19 cases. However, data for COVID-19 mortality and cases not requiring hospitalization were lacking (12). As overrepresentation of Black individuals and other racial/ethnic minorities persists among infected, hospitalized, and deceased COVID-19 patients (13–18), we performed a retrospective cohort analysis to examine the association of race with SARS-CoV-2 infection and outcomes.

Methods

Study design, setting, and data sources. All patients who underwent nasopharyngeal swab and SARS-CoV-2 polymerase chain reaction assays after clinical screening (January 1, 2020 to April, 15, 2020) at the University of Chicago were included in this retrospective analysis. As no privacy-sensitive data were used, patient consent was not required (institutional review board waiver no. IRB20-0520). Survival status was imputed from the most recent electronic medical records. All deidentified data were obtained using the Self-Service cohort discovery tool (SEE Cohorts) from the Center for Research Informatics. Demographic information included age, self-identified sex, ethnicity, race, and partial home zip code. Individuals older than 90 years were assigned a maximum age of 90 for analysis ($n = 41$); one patient was excluded because of missing sex.

Statistical analysis. Data processing and analysis were performed using R statistical computing software (version 3.6.3;

Table 1. Demographic summary of patient cohort

	SARS-CoV-2–Positive (*n* = 785)	SARS-CoV-2–Negative (*n* = 3,628)	Total (*n* = 4,413)
Male	313 (20.1)	1,242 (79.9)	1,555
Female	472 (16.5)	2,386 (83.5)	2,858
Age, yr	52.0 ± 17.7	44.5 ± 18.5	45.8 ± 8.6
Race			
Black	619 (24.3)	1,924 (75.7)	2,543
White	75 (7.0)	996 (93.0)	1,071
Asian/Mideast Indian	16 (8.7)	168 (91.3)	184
Native Hawaiian/other Pacific Islander	0 (0)	6 (100)	6
American Indian or Alaska native	0 (0)	5 (100)	5
More than once race	26 (21.7)	94 (78.3)	120
Declined	4 (7.3)	51 (92.7)	55
Unknown	32 (13.0)	215 (87.0)	247
Not available	13 (7.1)	169 (92.9)	182
Ethnicity			
Hispanic or Latino	25 (9.8)	229 (90.2)	254
Not Hispanic or Latino	705 (19.3)	2,955 (80.7)	3,660
Declined	4 (7.7)	48 (92.3)	52
Not available	18 (9.1)	179 (90.9)	197
Unknown	33 (13.2)	217 (86.8)	250

Definition of abbreviation: SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
Data are *n* (%) or mean ± standard deviation.

R Foundation for Statistical Computing) and Stata software (2019.R.16; StataCorp). Variable comparisons were determined by two-sided *t* tests, Mann–Whitney *U* tests, or chi-square tests as appropriate. Logistic regression models were fitted for outcome assessment in univariate analyses, and results were assessed for robustness to analytical technique by reanalyzing the main outcomes with multivariable logistic regression (using age, sex, ethnicity, and zip code as covariates). Additional sensitivity analyses were performed using Poisson generalized linear models with maximum-likelihood estimation.

We performed additional analyses to improve the generalizability of our findings beyond age-specific adjustments in multivariable models. Recognizing that our cohort was skewed toward older patients, we used age proportions from the 2000 U.S. Census to derive an age-adjusted data set (19). Combining SARS-CoV-2 positivity rates with reference-population proportions

Table 2. Univariate and multivariable logistic regression analyses of SARS-CoV-2 infection and all-cause mortality

Patient Characteristics	SARS-CoV-2 Infection			Mortality among SARS-CoV-2–Positive		
	Odds Ratio (95% CI)	Adj Odds Ratio (95% CI)	*P* Value	Odds Ratio (95% CI)	Adj Odds Ratio (95% CI)	*P* Value
SARS-CoV-2 infection and mortality*						
Black race	3.30 (2.75–3.97)	2.16 (1.73–2.70)	<0.001	2.46 (0.56–10.69)	1.01 (0.20–5.04)	0.99
Age, continuous	1.02 (1.01–1.03)	1.01 (1.00–1.01)	0.01	1.07 (1.03–1.10)	1.05 (1.02–1.09)	0.001
Sex, male	1.27 (1.09–1.49)	1.01 (0.83–1.22)	0.96	1.52 (0.63–3.71)	1.22 (0.48–3.11)	0.68
Ethnicity, Hispanic	0.49 (0.32–0.74)	1.00 (0.61–1.63)	0.99	—	—	0.48
Zip code, 606†	1.98 (1.63–2.41)	1.20 (0.96–1.52)	0.11	2.02 (0.46–8.79)	1.05 (0.22–5.10)	0.95
Hospitalization	—	—	0.94	8.29 (2.74–25.05)	4.67 (1.46–14.91)	0.01
SARS-CoV-2 hospitalizations and hospital mortality*						
Black race	3.77 (2.38–5.99)	1.51 (1.03–1.05)	<0.001	0.68 (0.14–3.18)	0.68 (0.12–3.72)	0.66
Age, decile	1.04 (1.03–1.05)	1.04 (1.03–1.05)	<0.001	1.04 (1.01–1.08)	1.04 (1.01–1.08)	0.001
Sex, male	1.95 (1.44–2.63)	2.25 (1.62–3.13)	<0.001	1.28 (0.46–3.53)	1.34 (0.47–3.84)	0.58
Ethnicity, Hispanic	0.48 (0.18–1.3)	1.44 (0.46–4.51)	0.53	—	—	0.99
Zip code, 606†	2.38 (1.53–3.7)	1.51 (0.93–2.46)	0.10	0.82 (0.18–3.79)	0.72 (0.14–3.81)	0.70

Definition of abbreviations: Adj = adjusted/multivariable model with adjustments for covariates; CI = confidence interval; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
All *P* values depicted were for adjusted odds ratios and were two-sided; a level of 0.05 was considered statistically significant.
*Adjusted/multivariable models include race, age, sex, ethnicity, partial zip code of residence, hospitalization status, and SARS-CoV-2–positive status.
†Denotes geographic boundary roughly equivalent to the city of Chicago.

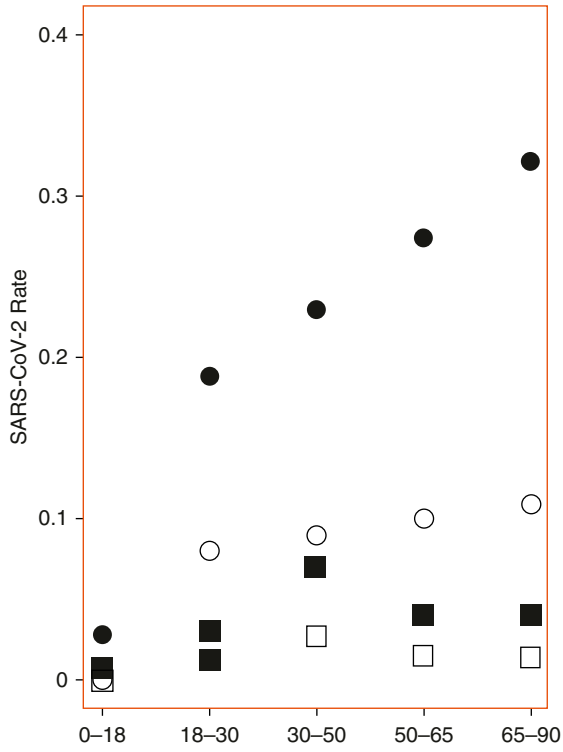

Figure 1. Comparison of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection rates. Dot plots of observed and age-adjusted SARS-CoV-2 infection based on race. Observed (circles) and age-adjusted (squares) infection rates in Black (solid circles/squares) and non-Black (open circles/squares) cohort patients.

allowed us to examine observed and expected differences among patients stratified by age group and race. We evaluated the population-derived age-adjusted SARS-CoV-2 infection rates, which enabled the prediction of the largest affected age group in the U.S. population.

Results

Cohort demographics. Of 4,413 individuals in our cohort, 17.8% tested positive, 57.6% were Black, and 24.3% were white (Table 1). SARS-CoV-2–positive individuals were more likely to be male (20.1% vs. 16.5%; $P = 0.003$), older (52.0 yr vs. 44.5 yr; $P < 0.0001$), and Black (24.3% vs. 8.9%; $P < 0.0001$); however, SARS-CoV-2–positive Black patients were disproportionately female (62.5% vs. 51.2%; $P = 0.01$), which is all consistent with published data (6, 9, 18). Overall mortality differed between Black and non-Black subjects (1.9% vs. 0.8%; $P = 0.002$).

Clinical association of COVID-19 with outcomes. SARS-CoV-2–positive subjects had a higher fatality rate when compared with SARS-CoV-2–negative subjects overall (2.5% vs. 1.2%; $P = 0.005$) and among those hospitalized (6.0% vs. 1.2%; $P < 0.0001$). There were no observed sex or racial differences in mortality among all SARS-CoV-2–positive patients in the entire cohort ($P = 0.48$ and $P = 0.34$, respectively). Analyses using univariate logistic regression models demonstrated that Black race was associated with SARS-CoV-2 infection (odds ratio [OR], 3.30; 95% confidence interval [95% CI], 2.75–3.97) and hospitalization (OR, 3.77; 95% CI, 2.38–5.99) but not mortality. These results remained consistent in multivariable logistic regression models (OR, 2.16; 95% CI, 1.73–2.70 and OR, 1.51; 95% CI, 1.03–1.05, respectively; Table 2) and in sensitivity analyses with Poisson generalized linear models using maximum-likelihood estimation (data not shown).

Age-adjusted SARS-CoV-2 infection rates in Black and non-Black patients. The SARS-CoV-2 infection rate was 10-fold higher among subjects aged 30–50 years than for those aged 0–18 years (0.05 vs. 0.005; Figure 1). The age-adjusted SARS-CoV-2 positivity rate (0.14) remained higher in Black individuals compared with non-Black individuals (0.19 vs. 0.07).

Discussion

Our study examines the association of race with SARS-CoV-2 infection, hospitalization, and mortality among all subjects tested for SARS-CoV-2. These data suggest that Black individuals are more likely to test positive and be hospitalized with SARS-CoV-2; however, we found no difference in mortality for Black individuals versus non-Black individuals. Possible hypotheses for these disproportionally high rates among Black individuals include disparities in predisposing medical conditions, health-insurance status, and access to medical care. Although we adjusted for residential zip code, we were unable to adjust for preexisting inequities of socioeconomic status and other critical social determinants of health, which could account for these findings (17, 20). Crowded home settings, care facilities for the elderly, overrepresentation in lower-wage public-service occupations, and underlying comorbidities could conceivably increase the susceptibility of Black subjects to SARS-CoV-2 infection, raising the pretest probability of death from severe COVID-19. Despite this higher risk, the absence of actual racial differences in mortality may imply that our conceptual categories of race reflect healthcare disparities and environmental risk factors more closely than any perceived biological differences (21).

Our study was limited by unavailable data points such as socioeconomic status, health insurance, comorbidities, and medication history, which could have enabled us to test the independent association of these outcomes with Black race and fully assess potential confounders. Although these factors may at least partially account for the observed disparities in infection and hospitalization rates, they are also highly colinear, posing substantial challenges to any risk determination of race as an independent factor in outcomes. In addition, as race and ethnicity are complex socially defined constructs that are inherently imprecise, individually self-identified race may evolve or have different connotations that could impact the reliability of assignment to racial and/or ethnic categories in the larger population (22, 23). In addition, our reliance on the electronic medical record for vital-status verification may have underestimated mortality for patients treated outside of our health system. However, this systemic bias would not be expected to affect our final results.

Furthermore, as individuals tend to associate more frequently with others of the same race, socioeconomic status, geographical location, and age, screening close contacts of persons with COVID-19 for SARS-CoV-2 positivity would likely violate statistical assumptions of independence for any associations of race with outcomes. In addition, although most subjects in our cohort were

from the greater Chicago area, the proportion of Black individuals in our cohort (57.6%) substantially exceeds that of Chicago (30.1%) and the United States (13.4%) (24). However, as access to care is generally lower for Black individuals, these subjects are likely to be sicker and undergo testing at a higher threshold than white individuals. Importantly, our results, which project a total SARS-CoV-2 infection rate of 140 per 1,000 patients, and mostly affect Black individuals, could guide decision-making in COVID-19 testing and health policy.

In conclusion, Black race was associated with SARS-CoV-2 infection and hospitalization. These findings may support the prevalence of racial disparities of health that disproportionately affect Black individuals in the United States.

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