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

Coronavirus disease-2019 (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 3/12/2020\(^1\).

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 outcome\(^3,7,9-11\).

The US Centers for Disease Control and Prevention provided the first study examining race, which suggested that Black patients were disproportionately over-represented in hospitalized COVID-19 cases. However, data for COVID-19 mortality and cases not requiring hospitalization were lacking\(^12\). As over-representation of Blacks 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 PCR assays after clinical screening (1/1/2020-4/15/2020) at the University of Chicago were included in this retrospective analysis. As no privacy-sensitive data was utilized,
patient consent was not required (IRB waiver#IRB20-0520). Survival status was imputed from
the most recent electronic medical records. All de-identified data were obtained from 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 due to missing sex.

**Statistical analysis.** Data processing and analysis were performed using R statistical
computing software (R-Foundation, v.3.6.3, Austria) and Stata (StataCorp 2019.R.16, TX, USA).
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 outcomes 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 towards older patients, we utilized age proportions from the 2000 US Census to derive
an age-adjusted dataset. Combining SARS-CoV-2 positivity rates with reference population
proportions 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 US
population.
Results

**Cohort demographics.** Of 4413 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 (52.0yrs vs. 44.5yrs, \( P<0.0001 \)), 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%, \( P=0.01 \)) 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 disease with outcomes.** SARS-CoV-2 positive subjects had a higher fatality rate when compared to SARS-CoV-2 negative subjects overall (2.5% vs. 1.2%; \( P=0.005 \)), and amongst 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 (OR=3.30, 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.** SARS-CoV-2 infection rate was 10-fold higher among subjects aged 30-50yrs than for those aged 0-18yrs (0.05 vs. 0.005; Figure 1). Age-adjusted SARS-CoV-2 positive rate (0.14) remained higher in Blacks compared to non-Blacks (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 Blacks are more likely to test positive and be hospitalized with SARS-CoV-2; however, we found no difference in mortality for Blacks vs non-Blacks. Possible hypotheses for these disproportionally high rates among Blacks 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\textsuperscript{17,20}. Crowded home settings, care facilities for the elderly, over-representation in lower-wage public service occupations, and underlying comorbidities could conceivably increase the susceptibility of Black subjects to SARS-CoV-2 infection, raising the pre-test 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 health care disparities and environmental risk factors more closely than any perceived biological differences\textsuperscript{21}.

Our study was limited by unavailable datapoints 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. While these factors may at least partially account for the observed disparities in infection and hospitalization rates, they are also highly co-linear, posing substantial challenges to any risk determination of race as an independent factor in outcomes. Also, 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/ethnic categories in the larger population\textsuperscript{22,23}. Additionally, 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.

Further, 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. Also, while most subjects in our cohort were from the greater Chicago area, the proportion of Blacks in our cohort (57.6\%) substantially exceeds that of Chicago (30.1\%) and the US (13.4\%)\textsuperscript{24}. However, as access to care is generally lower for Blacks, these subjects are likely to be sicker and undergo testing at a higher threshold than Whites. Importantly, our results, which project a total SARS-CoV-2 infection rate of 140 per 1000 patients, and mostly affects Blacks, could guide decision-making in COVID19 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 Blacks in the United States.

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**Table 1.** Demographic summary of patient cohort.

|                               | SARS-CoV-2 Positive (n=785) | SARS-CoV-2 Negative (n=3628) | Total (n=4413) |
|-------------------------------|-----------------------------|-----------------------------|-----------------|
| Male, n (%)                   | 313 (20.1)                  | 1242 (79.9)                 | 1555           |
| Female, n (%)                 | 472 (16.5)                  | 2386 (83.5)                 | 2858           |
| Age, mean±SD, years           | 52.0±17.7                   | 44.5±18.5                   | 45.8± 8.6      |
| Race (%)                      |                             |                             |                 |
| Black                         | 619 (24.3)                  | 1924 (75.7)                 | 2543           |
| White                         | 75 (7.0)                    | 996 (93.0)                  | 1071           |
| 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)                  | 2955 (80.7)                 | 3660           |
| 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            |
Table 2. Univariate and Multivariable logistic regression analyses of SARS-CoV-2 infection and all-cause mortality

| Patient Characteristic | 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\(^a\) | | | | |
| 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)\(^b\)  | 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 |

| Hospitalization in SARS-CoV-2-positive | Mortality in Hospitalized 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 hospitalizations and hospital mortality\(^a\) | | | | |
| 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)\(^b\)                 | 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 |

Abbreviations: Adj=adjusted/multivariable model with adjustments for covariates.
\(^a\)Adjusted/multivariable models include race, age, sex, ethnicity, partial zip code of residence, hospitalization status, and SARS-CoV-2 positive status.
\(^b\)Denotes geographic boundary roughly equivalent to the City of Chicago.
All p-values depicted were for adjusted odds ratios and were two-sided; a level of 0.05 was considered statistically significant.
Figure Legend:

**Figure 1.** Comparison of 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 (filled black circles/squares) and non-Black cohort patients (white open circles/squares).
References

1. WHO Announces COVID-19 Outbreak a Pandemic. *World Health Organization*. 2020;[http://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic](http://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic).

2. Gaye B, Fanidi A, Jouven X. Denominator matters in estimating COVID-19 mortality rates. *Eur Heart J*. 2020.

3. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet*. 2020;395(10229):1054-1062.

4. Grasselli G, Zanrillo A, Zanella A, et al. Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy. *JAMA*. 2020.

5. Lippi G, Mattiuzzi C, Sanchis-Gomar F, Henry BM. Clinical and demographic characteristics of patients dying from COVID-19 in Italy versus China. *J Med Virol*. 2020.

6. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet*. 2020;395(10223):507-513.

7. Richardson S, Hirsch JS, Narasimhan M, et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. *JAMA*. 2020.

8. Rosenberg ES, Dufort EM, Udo T, et al. Association of Treatment With Hydroxychloroquine or Azithromycin With In-Hospital Mortality in Patients With COVID-19 in New York State. *JAMA*. 2020.

9. Wang D, Hu B, Hu C, et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA*. 2020.

10. Yang J, Zheng Y, Gou X, et al. Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: a systematic review and meta-analysis. *Int J Infect Dis*. 2020.

11. Guan WJ, Liang WH, Zhao Y, et al. Comorbidity and its impact on 1590 patients with Covid-19 in China: A Nationwide Analysis. *Eur Respir J*. 2020.

12. Garg S, Kim L, Whitaker M, et al. Hospitalization Rates and Characteristics of Patients Hospitalized with Laboratory-Confirmed Coronavirus Disease 2019 - COVID-NET, 14 States, March 1-30, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(15):458-464.

13. COVID-19: Cases in the US. 2020;[https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html#demographic-characteristics](https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html#demographic-characteristics).

14. Deslatte M. Louisiana data: Virus hits blacks pwhUNWRA, 2020. 2020.
15. Reyes C HN, Gutowski C, St. Clair S, Pratt G. Chicago’s coronavirus disparity: black Chicagoans are dying at nearly six times the rate of white residents, data show. Chicago Tribune. April 7, 2020. 2020.

16. Thebault R BTA, Williams V. The coronavirus is infecting and killing black Americans at an alarmingly high rate. Washington Post. April 7, 2020. 2020.

17. Yancy CW. COVID-19 and African Americans. *JAMA*. 2020.

18. Price-Haywood EG, Burton J, Fort D, Seoane L. Hospitalization and Mortality among Black Patients and White Patients with Covid-19. *N Engl J Med*. 2020.

19. Klein RJ. Age Adjustment Using the 2000 Projected US Population. Department of Health & Human Services CfDCaP, National Center for Health Statistics.; 2001. 2001.

20. Xiao Wu RCN, Benjamin M. Sabath, Danielle Braun, Francesca Dominici. Exposure to air pollution and COVID-19 mortality in the United States. *medRxiv 2020.04.05.20054502*. 2020.

21. COVID-19: Investing in black lives and livelihoods. April 2020;https://www.mckinsey.com/industries/public-sector/our-insights/covid-19-investing-in-black-lives-and-livelihoods.

22. Kaplan JB, Bennett T. Use of race and ethnicity in biomedical publication. *JAMA*. 2003;289(20):2709-2716.

23. Adegunsoye A, Oldham JM, Bellam SK, et al. African-American race and mortality in interstitial lung disease: a multicentre propensity-matched analysis. *Eur Respir J*. 2018;51(6).

24. United States Census Bureau. *American Fact Finder [Internet]. Available from:* (https://www.census.gov/quickfacts/fact/table/US/PST045219).
