Received: 3 August 2021 | Revised: 24 September 2021 | Accepted: 27 September 2021

DOI: 10.1002/jmv.27365

RESEARCH ARTICLE

JOURNAL OF MEDICAL VIROLOGY WILEY

Association of race/ethnicity and socioeconomic status with COVID-19 30-day mortality at a Philadelphia medical center using a retrospective cohort study

Dianna R. Cheney-Peters[1] | Crystal Y. Lee[2] | Shuji Mitsuhashi[3] | Dina S. Zaret[2] | Joshua M. Riley[2] | Chantel M. Venkataraman[3] | Joseph W. Schaefer[2] | Brandon J. George[4] | Chris J. Li[2] | Christa M. Smaltz[3] | Conor G. Bradley[2] | Danielle M. Fitzpatrick[3] | David B. Ney[2] | Divya M. Chalikonda[3] | Joshua D. Mairose[2] | Kashyap Chauhan[3] | Margaret V. Szot[3] | Robert B. Jones[3] | Rukaiya Bashir-Hamidu[3] | Alan A. Kubey[1,5]

[1]Department of Medicine, Division of Hospital Medicine, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA

[2]Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, Pennsylvania, USA

[3] Department of Medicine, Internal Medicine Residency, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA

[4]Jefferson College of Population Health, Thomas Jefferson University, Philadelphia, Pennsylvania, USA

[5]Department of Internal Medicine, Division of Hospital Internal Medicine, Mayo Clinic, Rochester, Minnesota, USA

Correspondence

Alan A. Kubey, Department of Medicine, Division of Hospital Medicine, Thomas Jefferson University Hospital, 833 Chestnut St, Suite 701, Philadelphia, PA 19107 215-955-0735, USA.

Email: alan.kubey@jefferson.edu

Abstract

COVID-19 has disproportionately affected low-income communities and people of color. Previous studies demonstrated that race/ethnicity and socioeconomic status (SES) are not independently correlated with COVID-19 mortality. The purpose of our study is to determine the effect of race/ethnicity and SES on COVID-19 30-day mortality in a diverse, Philadelphian population. This is a retrospective cohort study in a single-center tertiary care hospital in Philadelphia, PA. The study includes adult patients hospitalized with polymerase-chain-reaction-confirmed COVID-19 between March 1, 2020 and June 6, 2020. The primary outcome was a composite of COVID-19 death or hospice discharge within 30 days of discharge. The secondary outcome was intensive care unit (ICU) admission. The study included 426 patients: 16.7% died, 3.3% were discharged to hospice, and 20.0% were admitted to the ICU. Using multivariable analysis, race/ethnicity was not associated with the primary nor secondary outcome. In Model 4, age greater than 75 (odds ratio [OR]: 11.01; 95% confidence interval [CI]: 1.96–61.97) and renal disease (OR: 2.78; 95% CI: 1.31–5.90) were associated with higher odds of the composite primary outcome. Living in a "very-low-income area" (OR: 0.29; 95% CI: 0.12–0.71) and body mass index (BMI) 30–35 (OR: 0.24; 95% CI: 0.08–0.69) were associated with lower odds of the primary outcome. When controlling for demographics, SES, and comorbidities, race/ethnicity was not independently associated with the composite primary outcome. Very-low SES, as extrapolated from census-tract-level income data, was associated with lower odds of the composite primary outcome.

KEYWORDS

biostatistics & bioinformatics, epidemiology, infection, pandemics, public policy, SARS coronavirus, social science, virus classification

Dianna R. Cheney-Peters and Crystal Y. Lee are co-first authors.

1 | INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 virus (SARS-CoV-2), responsible for COVID-19, has caused a pandemic with far-reaching implications worldwide. US-based studies have demonstrated a disproportionate number of infections and hospitalizations for COVID-19 in people of certain racial and ethnic backgrounds, such as Black and Hispanic persons, and people residing in low-income areas or experiencing homelessness.[1–7] Additionally, worldwide studies have attempted to identify other independent risk factors, such as comorbidities and patient demographics, for COVID-19 mortality and severe COVID-19. However, many of these studies utilized the International Statistical Classification of Disease and Related Health Problems, 10th Revision (ICD-10) codes, rather than chart review to assess for comorbidities, which facilitates data collection by integrating hospital billing data, but may not reflect the true number of patients' comorbidities.[8] This may have led to inaccurate proportions of covariates utilized in the studies' multivariable analysis.[8]

Philadelphia, a diverse city where 44% of the population identifies as Black or African American (hereafter "Black"), 34% non-Hispanic White ("White"), 15% Hispanic, and 8% Asian, has been significantly affected by COVID-19.[9] Through July 28, 2021, Black Philadelphians represented 45% of the known positive cases in which race/ethnicity was reported (83% of cases), while White, Hispanic, and Asian populations accounted for 34%, 14%, and 6%, respectively.[10,11] Hospitalization trends occurred in similar proportions.[12] COVID-19 mortality for Black, White, Hispanic, and Asian patients was 49%, 35%, 11%, and 5% of deaths, respectively.

Philadelphia has the highest poverty rate among the top 10 largest cities, with 23.3% of Philadelphians living below the poverty level with a median household income of $47,474.[9,13,14] In 2016, the poverty rate among Hispanics was 37.9%, the highest among racial and ethnic groups, followed by Blacks, which had the second-highest poverty rate at 30.8%; both groups are also more likely to live in areas of racially or ethnically concentrated high-poverty areas.[14] This highlights the complex interaction between race/ethnicity and poverty in Philadelphia, although it is important to extricate, as they both have distinct implications for policy and intervention. Furthermore, comparing case positivity rates and poverty level by zip code, data suggest that poorer Philadelphians are also disproportionately affected by COVID-19.[12,15] The extent to which SES, which is a combined factor of income, education, and occupation, affects mortality for hospitalized Philadelphians is not known. The objective of this study is to assess if Black, White, Hispanic, or Asian race/ethnicity, and/or SES are independent risk factors for mortality for patients hospitalized with COVID-19 at one Philadelphia hospital using manual chart review rather than ICD-10 codes.

2 | METHODS

2.1 | Study design, setting, and population

This retrospective cohort study included all adults (age ≥18 years) admitted with COVID-19 to Thomas Jefferson University Hospital in Philadelphia from March 1 to June 6, 2020. COVID-19 was defined as a positive SARS-CoV-2 qualitative polymerase chain reaction. We excluded patients who were transferred from another institution, pregnant, or incarcerated. Outcomes of interest were determined through chart review from the date of admission through September 1, 2020, which included a review of subsequent admissions at our institution or admissions to hospitals in the Philadelphia area available in the common electronic health record (EHR), Epic. The Thomas Jefferson University Hospital institutional review board approved this study. Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research. This study follows the reporting guidelines outlined in Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).[16]

2.2 | Data collection

Two independent reviewers extracted relevant information via manual EHR chart review, including demographics (age, sex, race/ethnicity, address, residence before admission [home, skilled nursing facility, shelter/street, other]), date of admission, date of symptom onset, comorbidities of interest, home medications of interest (Table 1), and outcomes. Race/ethnicity was self-identified on admission and categorized in the EHR as Asian, Black/African American (Black), Hispanic/Latino (Hispanic), White/Caucasian (White), or unknown/other (other). Comorbidities were included that were listed in emergency department notes, admission notes, previous discharge notes (if existed), and/or the problem list. Comorbidities of interest were chosen through an April 2020 literature review of independent risk factors for COVID-19 mortality. Symptoms were included if reported in emergency department notes or admission notes. Days since symptom onset was calculated as an average of days reported in the emergency department and admission notes. The primary outcome of interest, "30-day mortality," was defined as a composite of death noted in the EHR or discharge to hospice that occurred during the index hospitalization or within 30 days of discharge. The secondary outcome was defined as ICU admission during the index hospitalization.

For data validation, when two reviewers disagreed, a third independent reviewer adjudicated discrepancies. For variables for which discrete data could be exported from the EHR (e.g., BMI), data was verified through comparison of the manual extraction to an automated export. For the purpose of comparing the manual chart review to an automated ICD-10-based export, comorbidities for which reliable ICD-10 code mapping existed were exported.

2.3 | Geographic information systems analysis

Although SES is often measured as a combination of many different elements, income data is readily available and standardizable. As a proxy for SES, we established if patients lived in very-low or low-income areas using the US Housing and Urban Development

TABLE 1 Characteristics of 426 COVID-19 positive patients hospitalized between March 17 and June 6, 2020

Demographic characteristics	Black (*N* = 232)	White (*N* = 109)	Hispanic/Asian/other (*N* = 85)
Age, years (95% CI)	62.6 (60.5–64.7)	71.1 (67.9–74.3)	60.6 (56.5–64.8)
Age, no. (%)			
<45	37 (16.0)	8 (7.3)	18 (21.2)
45–64	84 (36.2)	30 (27.5)	32 (37.7)
65–74	59 (25.4)	22 (20.2)	11 (12.9)
≥75	52 (22.4)	49 (45.0)	24 (28.2)
Sex, no. (%)			
Male	128 (55.2)	59 (54.1)	54 (63.5)
Female	104 (44.8)	50 (45.9)	31 (36.5)
SES by census tract, no. (%)			
>80%	38 (16.4)	58 (53.2)	33 (38.8)
>50 and ≤80%	45 (19.4)	21 (19.3)	16 (18.8)
≤50%	149 (64.2)	30 (27.5)	34 (40.0)
Unidentified	0 (0)	0 (0)	2 (2.4)
Population density by census tract, no. (%)			
Low	85 (36.6)	48 (44.0)	20 (23.5)
Medium	74 (31.9)	33 (30.3)	20 (23.5)
High	71 (30.6)	28 (25.7)	41 (48.2)
Unidentified	2 (0.9)	0 (0)	4 (4.7)
Residence refore admission, no. (%)			
Home	159 (68.5)	52 (47.7)	57 (67.1)
SNF	42 (18.1)	44 (40.4)	20 (23.5)
Shelter/Street	31 (13.4)	13 (11.9)	7 (8.2)
Other	0 (0)	0 (0)	1 (1.2)
Clinical characteristics			
Date of admissions, no. (%)			
March 17 to April 6, 2020	57 (24.6)	29 (26.6)	17 (20.0)
April 7 to April 26, 2020	79 (34.1)	39 (35.8)	21 (24.7)
April 27 to May 14, 2020	67 (28.9)	33 (30.3)	36 (42.4)
May 15 to June 6, 2020	29 (12.5)	8 (7.3)	11 (12.9)
Days since symptom onset to presentation, no. (%)			
<3	62 (26.7)	39 (35.8)	19 (22.4)
≥3 and <8	103 (44.4)	34 (31.2)	38 (44.7)
≥8 and <10	21 (9.1)	3 (2.8)	7 (8.2)
≥10 and <14	12 (5.2)	7 (6.4)	9 (10.6)
≥14	17 (7.3)	11 (10.1)	9 (10.6)
Unidentified	17 (7.3)	15 (13.8)	3 (3.5)
Body mass index, no. (%)			
<30	115 (49.6)	72 (66.1)	63 (74.1)
30–35	54 (23.3)	15 (13.8)	10 (11.8)

TABLE 1 (Continued)

Demographic characteristics	Black (*N* = 232)	White (*N* = 109)	Hispanic/Asian/other (*N* = 85)
35.01–40	30 (12.9)	14 (12.8)	5 (5.9)
>40	33 (14.2)	6 (5.5)	5 (5.9)
Unidentified	0 (0)	2 (1.8)	2 (2.4)
Comorbidities, no. (%)			
Asthma	44 (19.0)	16 (14.7)	9 (10.6)
Cancer (active)	15 (6.5)	7 (6.4)	6 (7.1)
Cancer history (heme)	4 (1.7)	4 (3.7)	2 (2.4)
Cancer history (solid organ)	26 (11.2)	20 (18.4)	10 (11.8)
CVD	40 (17.2)	28 (25.7)	13 (15.3)
CKD	58 (25.0)	19 (17.4)	17 (20.0)
COPD	30 (12.9)	11 (10.1)	14 (16.5)
Cirrhosis	6 (2.6)	3 (2.8)	4 (4.7)
CAD	44 (19.0)	27 (24.8)	13 (15.3)
Diabetes (Type 2)	96 (41.4)	34 (31.2)	31 (36.5)
Diabetes on insulin	33 (14.2)	18 (16.5)	13 (15.3)
ESRD	15 (6.5)	3 (2.8)	0 (0)
Heart failure	53 (22.8)	18 (16.5)	9 (10.6)
HIV	9 (3.9)	1 (0.9)	0 (0)
HTN	178 (76.7)	72 (66.1)	51 (60.0)
ILD	7 (3.0)	2 (1.8)	0 (0)
Kidney transplant	6 (2.6)	2 (1.8)	0 (0)
NAFLD	1 (0.4)	1 (0.9)	2 (2.4)
Liver transplant	0 (0)	0 (0)	1 (1.2)
Other pulmonary disease	15 (6.5)	7 (6.4)	5 (5.9)
OSA	45 (19.4)	16 (14.7)	5 (5.9)
RA	7 (3.0)	1 (0.9)	3 (3.5)
Restrictive lung disease	4 (1.7)	1 (0.9)	1 (1.2)
Current smoker	30 (12.9)	11 (10.1)	4 (4.7)
Active substance use disorder	17 (7.3)	6 (5.5)	2 (2.4)
Solid organ cancer	19 (8.2)	11 (10.1)	6 (7.1)
SLE	4 (1.7)	1 (0.9)	1 (1.2)
Home medications before admission, no. (%)			
ACEi	51 (22.0)	20 (18.4)	13 (15.3)
ARB	35 (15.1)	15 (13.8)	10 (11.8)
Biologics	8 (3.5)	6 (5.5)	4 (4.7)
NSAID	19 (8.2)	8 (7.3)	7 (8.2)
Chronic Steroids	11 (4.8)	5 (4.6)	5 (5.9)

Abbreviations: ACEi, angiotensin-converting enzyme inhibitors; ARB, angiotensin II receptor blocker; CAD, coronary artery disease; CI, confidence interval; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; ESRD, end-stage renal disease; HIV, human immunodeficiency virus; HTN, hypertension; ILD, interstitial lung disease; NAFLD, nonalcoholic fatty liver disease; NSAID, nonsteroidal anti-inflammatory drug; OSA, obstructive sleep apnea; RA, rheumatoid arthritis; SES, socioeconomic status; SLE, systemic lupus erythematosus; SNF, skilled nursing facility.

definitions.[17,18] Through PolicyMap, a data and mapping program, we used the median income of a patient's census tract, as determined by 2010 census data, and compared it to the median income of the Philadelphia metropolitan area (area median income, "AMI") as a whole, using data from 2014 to 2018 American Community Survey (ACS).[19,20] Patients living in census tracts with <50% of the AMI were coded as very-low-income, <80% were coded as low-income, and >80% were coded as not living in a low-income area. We also coded patients who were homeless or lived in a shelter in the very low-income group, regardless of their address. We determined the patient's neighborhood population density by extrapolating from the 2010 census tract and 2014–2018 ACS data through PolicyMap.

2.4 | Statistical analysis methods

Age was grouped into four categories: <45, 45–64, 65–74, and >75 years. BMI was categorized into four subgroups: <30, 30–35, 35.01–40, >40 kg/m^2. Both binning choices were made based on common thresholds used in other studies. Date of admission was split into four groups to capture large changes in treatment approach during the pandemic: the beginning of the pandemic (March 17, 2020, to April 6, 2020), implementation of a standardized "smart phrase"-based tool to guide consistent best-evidenced-based COVID-19 care at our institution (April 7, 2020, to April 26, 2020), de-emphasis of hydroxychloroquine use (April 27, 2020, to May 14, 2020), and the start of remdesivir use (May 15, 2020, to June 6, 2020). Days since symptom onset was grouped into five categories: <3, 3–<8, 8–<10, 10–<14, 14+ to capture very early viral phase, viral phase, early inflammatory phase, inflammatory phase, and late-stage disease, respectively, to account for the impact of presentation timing on hospital care efficacy and outcomes. SES was split into three categories: very-low, low, and not-low income. We grouped our study population into low, medium, and high-density population groups based on terciles.

Demographic and clinical characteristics were reported as proportions (Table 1). χ^2 tests were used to analyze the relationship between categorical variables and outcomes (primary and secondary). Outcomes were assessed with unadjusted and adjusted logistic regression models. The unadjusted regression observed individual factors that correlated with primary and secondary outcomes without accounting for covariates. The four adjusted regression models sought to progressively identify individual factors that affect outcomes while balancing for mediating variables, which would allow us to interpret the residual effect of race/ethnicity and SES. Model 1 included demographics (age, sex, and race/ethnicity). Model 2 then added SES factors (residency before admission, population density, and residence in a low-income area). Model 3 included variables in Model 2 with the addition of predetermined comorbidities selected through a review of prior published research. We included the top five comorbidities that were significant in at least three studies and had the highest effect size for risk of death: obesity, coronary artery disease, active cancer, renal disease (chronic kidney disease or end-stage renal disease), and cerebrovascular disease.[6,21–33] Last, Model 4 included variables in Model 3 with the addition of any significant associations ($p < 0.05$) determined in the bivariate analysis. For our secondary outcome, admission to ICU, we used the same models for Models 1, 2, and 3 and the same methods for Model 4 to determine independent variables associated with odds of ICU admission. There were a limited number of missing variables, so a complete case analysis was done. All statistical analyses were performed using STATA statistical software 14.2.

3 | RESULTS

A total of 426 patients were admitted for COVID-19 from March 17 to June 6, 2020, at Thomas Jefferson University Hospital (Philadelphia, PA), an academic tertiary care center. Primary and secondary outcomes, subcategorized by demographic and clinical characteristics, are presented in Table 2 and Table S1, respectively. For all patients admitted to the hospital with COVID-19, 16.7% ($n = 71$) died, 3.3% ($n = 14$) were discharged to hospice, and 20% ($n = 85$) were admitted to the ICU. Of the 83 patients who died or were discharged to hospice, 45.8% ($n = 38$) were Black, 36.1% ($n = 30$) were White, 4.8% ($n = 4$) were Hispanic, 9.6% ($n = 8$) were Asian, and 3.6% ($n = 3$) were other, which was statistically significant in the unadjusted analysis ($p = 0.029$).

Table 3 displays the bivariate and multivariable analyses for the variables of interest to assess for association with the 30-day mortality or discharge to hospice. For the bivariate analysis, age 65–74 and ≥75 had increased ORs (Table 3). This association persisted for age ≥75 in Models 1–4 when progressively adjusting for additional factors, with an OR of 11.01 (95% CI: 1.96–61.97) versus age <45 in Model 4. Risk factors of coronary artery disease, renal disease, cerebrovascular disease, chronic obstructive pulmonary disease, and heart failure were associated with increased OR, and active smoking was associated with a decreased OR with bivariate analysis, but only renal disease was significant in Model 4 with an OR of 2.78 (95% CI: 1.31–5.90). BMI 30–35 had decreased odds with OR in Model 4 of 0.24 (95% CI: 0.08–0.69) versus BMI < 30. In Model 4, there was no significant difference in mortality comparing the four different admission time frames nor presentation timing.

Although Black and Hispanic race/ethnicity were both associated with decreased odds of the death or discharge to hospice in bivariate analysis, in all adjusted models, there was no association. The effect noted in the bivariate analysis was attenuated in Model 1 when controlling for age and sex as well as in Model 2 when accounting for SES features. Living in very-low-income areas and residences before admission at a shelter or street were both associated with decreased OR of the primary outcome in bivariate analysis. This effect was attenuated in Model 2 when accounting for age, sex, and other SES variables. In Models 3 and 4, however, for patients living in very-low-income areas, the effect returned with an OR of 0.29 (95% CI: 0.12–0.71) in Model 4.

TABLE 2 Demographic and clinical characteristics of 30-day mortality or discharge to hospice in COVID-19 patients

Demographic characteristics	Alive (*N* = 343)	30-day death or Hospice discharge (*N* = 83)	*p* value*
Age, no. (%)			**<0.0001**
<45	61 (96.8)	2 (3.2)	
45–64	134 (91.8)	12 (8.2)	
65–74	78 (84.8)	14 (15.2)	
≥75	70 (56.0)	55 (44.0)	
Sex, no. (%)			0.466
Male	197 (81.7)	44 (18.3)	
Female	146 (78.9)	39 (21.1)	
Race/ethnicity, no. (%)			**0.029**
Black	194 (83.6)	38 (16.4)	
White	79 (72.5)	30 (27.5)	
Hispanics	41 (91.1)	4 (8.9)	
Asian	21 (72.4)	8 (27.6)	
Other	8 (72.7)	3 (27.3)	
SES by census tract, no. (%)			**0.001**
>80%	90 (69.8)	39 (30.2)	
>50 and ≤80%	66 (80.5)	16 (19.5)	
≤50%	185 (86.9)	28 (13.2)	
Population density by census tract, no. (%)			0.633
Low	121 (79.1)	32 (20.9)	
Medium	100 (78.7)	27 (21.3)	
High	116 (82.9)	24 (17.1)	
Residence before admission, no. (%)			**<0.0001**
Home	224 (83.6)	44 (16.4)	
SNF	68 (64.2)	38 (35.9)	
Shelter/street	50 (98.0)	1 (2.0)	
Other	1 (100.0)	0 (0)	
Clinical characteristics			
Date of admissions, no. (%)			0.469
March 17 to April 6, 2020	78 (75.7)	25 (24.3)	
April 7 to April 26, 2020	112 (80.6)	27 (19.4)	
April 27 to May 14, 2020	112 (82.4)	24 (17.7)	
May 15 to June 6, 2020	41 (85.4)	7 (14.6)	
Days since symptom onset to presentation, no. (%)			**0.008**
<3	85 (70.8)	35 (29.2)	
≥3 and <8	147 (84.0)	28 (16.0)	
≥8 and <10	28 (90.3)	3 (9.7)	
≥10 and <14	25 (89.3)	3 (10.7)	
≥14	33 (89.2)	4 (10.8)	
Body mass index, no. (%)			0.055
<30	191 (76.4)	59 (23.6)	

(Continues)

TABLE 2 (Continued)

Demographic characteristics	Alive (*N* = 343)	30-day death or Hospice discharge (*N* = 83)	*p* value*
30–35	70 (88.6)	9 (11.4)	
35.01–40	43 (87.8)	6 (12.2)	
>40	35 (79.6)	9 (20.5)	
Comorbidities, no. (%)			
Asthma	59 (85.5)	10 (14.5)	0.253
Cancer (active)	20 (71.4)	8 (28.6)	0.209
Cancer history (heme)	8 (80.0)	2 (20.0)	0.967
Cancer history (solid organ)	41 (73.2)	15 (26.8)	0.139
CVD	56 (69.1)	25 (30.9)	**0.004**
CKD	56 (59.6)	38 (40.4)	**<0.0001**
COPD	34 (61.8)	21 (38.2)	**<0.0001**
Cirrhosis	9 (69.2)	4 (30.8)	0.297
CAD	58 (69.1)	26 (30.9)	**0.003**
Diabetes (Type 2)	123 (76.4)	38 (23.6)	0.094
Diabetes on insulin	48 (75.0)	16 (25.0)	0.227
ESRD	10 (55.6)	8 (44.4)	**0.006**
Heart failure	51 (63.8)	29 (36.2)	**<0.0001**
HIV	9 (90.0)	1 (10.0)	0.444
HTN	235 (78.1)	66 (21.9)	**0.048**
ILD	7 (77.8)	2 (22.2)	0.834
Kidney transplant	6 (75.0)	2 (25.0)	0.691
NAFLD	3 (75.0)	1 (25.0)	0.780
Liver transplant	1 (100.0)	0 (0)	0.622
Other pulmonary disease	23 (85.2)	4 (14.8)	0.527
OSA	53 (80.3)	13 (19.7)	0.962
RA	10 (90.9)	1 (9.1)	0.378
Restrictive lung disease	4 (66.7)	2 (33.3)	0.388
Current smoker	43 (95.6)	2 (4.44)	**0.007**
Active substance use disorder	23 (92.0)	2 (8.0)	0.135
Solid organ cancer	27 (75.0)	9 (25.0)	0.382
SLE	4 (66.7)	2 (33.3)	0.388
Home medications Before admission, no. (%)			
ACEi	67 (79.8)	17 (20.2)	0.846
ARB	47 (78.3)	13 (21.7)	0.645
Biologics	14 (77.8)	4 (22.2)	0.764
NSAID	33 (97.1)	1 (2.9)	**0.011**
Chronic steroids	18 (85.7)	3 (14.3)	0.534

Note: Bold text indicates significant difference with a $p < 0.05$.

Abbreviations: ACEi, angiotensin-converting enzyme inhibitors; ARB, angiotensin II receptor blocker; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; ESRD, end-stage renal disease; HIV, human immunodeficiency virus; HTN, hypertension; ILD, interstitial lung disease; NAFLD, nonalcoholic fatty liver disease; NSAID, nonsteroidal anti-inflammatory drug; OSA, obstructive sleep apnea; RA, rheumatoid arthritis; SES, socioeconomic status; SLE, systemic lupus erythematosus; SNF, skilled nursing facility.

*p value: Pearson's design-based χ^2 test.

TABLE 3 Odds ratio of 30-day mortality or discharge to hospice in COVID-19 patients

	Unadjusted[a] OR (95% CI)	Model 1[b] OR (95% CI)	Model 2[c] OR (95% CI)	Model 3[d] OR (95% CI)	Model 4[e] OR (95% CI)
Demographic characteristics					
Age					
<45	1	1	1	1	1
45–64	2.73 (0.59–12.58)	2.74 (0.59–12.73)	2.33 (0.49–11.07)	1.78 (0.34–9.36)	1.61 (0.30–8.56)
65–74	**5.47 (1.20–25.00)***	**5.49 (1.18–25.51)***	3.91 (0.82–18.61)	2.77 (0.49–15.68)	2.46 (0.43–14.01)
≥75	**23.96 (5.61–102.37)*****	**23.56 (5.38–103.11)*****	**15.81 (3.51–71.23)****	**12.03 (2.16–67.03)****	**11.01 (1.96–61.97)****
Female sex	1.20 (0.74–1.94)	0.92 (0.54–1.58)	0.80 (0.46–1.39)	0.77 (0.40–1.48)	0.77 (0.40–1.49)
Ethnicity/race					
Black	1	1	1	1	1
White	**1.94 (1.12–3.35)***	1.24 (0.68–2.26)	0.91 (0.46–1.82)	1.18 (0.53–2.66)	1.21 (0.54–2.73)
Hispanic	0.50 (0.17–1.47)	0.54 (0.17–1.73)	0.50 (0.15–1.62)	0.35 (0.08–1.57)	0.35 (0.08–1.61)
Asian	1.94 (0.80–4.71)	1.29 (0.48–3.43)	1.08 (0.39–3.02)	1.02 (0.28–3.69)	1.11 (0.29–4.21)
Other	1.91 (0.49–7.55)	3.03 (0.64–14.40)	2.81 (0.53–14.95)	2.25 (0.35–14.39)	2.05 (0.30–14.02)
SES by census tract					
>80%			1	1	1
>50 and ≤80%	0.56 (0.29–1.09)		0.69 (0.32–1.46)	0.41 (0.16–1.04)	0.39 (0.15–1.00)
≤50%	**0.35 (0.20–0.60)*****		0.56 (0.27–1.14)	**0.31 (0.13–0.75)***	**0.29 (0.12–0.71)****
Population density by census tract					
Low	1		1	1	1
Medium	1.02 (0.57–1.82)		0.73 (0.37–1.46)	0.67 (0.29–1.54)	0.65 (0.28–1.50)
High	0.78 (0.43–1.41)		0.68 (0.33–1.40)	0.50 (0.21–1.19)	0.51 (0.21–1.21)
Residence before admission					
Home	1		1	1	1
SNF	**2.84 (1.71–4.75)*****		1.40 (0.75–2.60)	0.69 (0.30–1.60)	0.68 (0.29–1.60)
Shelter/street	**0.10 (0.01–0.76)***		0.20 (0.02–1.58)	0.25 (0.03–2.19)	0.26 (0.03–2.38)
Clinical characteristics					
Date of admissions					
March 17 to April 6, 2020	1			1	1
April 7 to April 26, 2020	0.75 (0.41–1.39)			0.54 (0.23–1.26)	0.57 (0.24–1.35)
April 27 to May 14, 2020	0.67 (0.36–1.26)			1.39 (0.59–3.25)	1.46 (0.61–3.46)
May 15 to June 6, 2020	0.53 (0.21–1.34)			044 (0.13–1.47)	0.44 (0.13–1.47)
Days since symptom onset to presentation					
<3	1			1	1
≥3 and <8	**0.46 (0.26–0.81)****			0.72 (0.34–1.51)	0.76 (0.36–1.62)
≥8 and <10	**0.26 (0.07–0.91)***			0.30 (0.06–1.59)	0.28 (0.05–1.47)
≥10 and <14	0.29 (0.08–1.03)			0.46 (0.10–1.98)	0.45 (0.10–2.03)
≥14	**0.29 (0.10–0.89)***			0.35 (0.09–1.37)	0.34 (0.09–1.34)

(Continues)

TABLE 3 (Continued)

	Unadjusted[a] OR (95% CI)	Model 1[b] OR (95% CI)	Model 2[c] OR (95% CI)	Model 3[d] OR (95% CI)	Model 4[e] OR (95% CI)
BMI					
<30	1			1	1
30–35	**0.42 (0.19–0.88)***			**0.24 (0.08–0.69)****	**0.24 (0.08–0.69)****
35.01–40	0.45 (0.18–1.11)			0.61 (0.17–2.10)	0.63 (0.18–2.20)
>40	0.83 (0.38–1.83)			2.38 (0.76–7.46)	2.17 (0.67–6.97)
Comorbidities					
CAD	**2.24 (1.30–3.86)****			1.39 (0.66–2.89)	1.17 (0.53–2.58)
Active cancer	1.54 (0.78–3.04)			1.05 (0.41–2.74)	1.05 (0.41–2.71)
Renal disease (CKD, ESRD)	**4.54 (2.71–7.62)*****			**3.33 (1.66–6.72)****	**2.78 (1.31–5.90)****
CVD	**2.21 (1.28–3.83)****			1.15 (0.53–2.51)	1.14 (0.52–2.50)
COPD	**3.08 (1.68–5.66)*****				1.55 (0.63–3.85)
Heart failure	**3.07 (1.79–5.28)*****				1.51 (0.63–3.65)
HTN	1.78 (1.00–3.19)				
Active smoker	**0.17 (0.04–0.73)***				1.02 (0.19–5.49)

Note: Bold text indicates significant difference.

Abbreviations: BMI, body mass index; CAD, coronary artery disease; CI, confidence interval; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; ESRD, end-stage renal disease; HTN, hypertension; OR, odds ratio; SES, socioeconomic status; SNF, skilled nursing facility.

[a]Unadjusted regression without accounting for covariables.

[b]Model 1 adjusted with demographics (age, female sex, and ethnicity/race).

[c]Model 2 adjusted with demographics and SES factors (residence in a low-income area, population density, and residency before admission).

[d]Model 3 adjusted with variables in Model 2 with additional predetermined comorbidities (date of admissions, days since symptoms onset to presentation, BMI, CAD, active cancer, renal disease, CVD).

[e]Model 4 adjusted with variables in Model 3 with additional covariates of COPD, heart failure, and active smoker).

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

For the secondary outcome, admission to the ICU, diabetes had an OR of 3.09 (95% CI: 1.57–6.09) in Model 4. Living in a median or high-population-density area (OR: 0.33, 95% CI: 0.15–0.73) (OR: 0.40, 95% CI: 0.18–0.90), respectively, and admission date of April 27 to May 14 (OR: 0.37, 95% CI: 0.15–0.87) were protective in Model 4. Race/ethnicity and SES were not associated with the secondary outcome in bivariate nor multivariable analysis (Table S2).

4 | DISCUSSION

In this retrospective cohort study including 426 racially and ethnically diverse patients at a tertiary academic center in Philadelphia, we demonstrate that race/ethnicity is not independently associated with 30-day mortality or discharge to hospice from COVID-19 when using multivariable analysis controlling for age, sex, living in a low-income area, population density, type of residence before hospitalization, the time frame of admission, days since symptom onset, and comorbidities. From our review of the literature, this is one of a limited number of studies thus far to assess risk factors for COVID-19 using a more accurate approach with manual chart review rather than ICD-10 codes.[31] Furthermore, this is one of the first studies to assess the effects of race/ethnicity on 30-day mortality for hospitalized patients with COVID-19 in the Philadelphia region.[3]

A major strength of this study is the use of manual chart review to determine comorbidities, which distinguishes this study from most others that used ICD-10 codes in analyses of 30-day mortality from COVID-19. A post hoc analysis of our data suggested that the manual chart review was more sensitive than ICD-10 based methods with ICD-10-based data set comorbidity agreement ranging from 44% (renal disease) to 87% (diabetes). An additional strength is the use of census tract-level data rather than zip code for mean area income, our proxy for SES. This may be a better representation of SES as it is comparatively more homogenous regarding the economic position and living conditions, which is especially important in Philadelphia given its unique urban geography in which very poor and affluent census tracts are frequently adjacent. A limitation of our study is that we did not collect patient data on other aspects of SES, such as

occupation, highest education, number of household members, or access to healthcare; these factors may elucidate further disparities in COVID-19 infection and mortality and should be considered in future studies. Another limitation of our study is that deaths that occurred outside of the hospital setting or at hospitals not participating in our EHR sharing service, Care Everywhere, were not captured in this study. This may lead to an underestimation of mortality that occurred within the study period. Both a strength and a limitation of this study is that it occurred at a single institution. This is a limitation regarding sample size and generalizability, but this also is a strength as it allowed for homogeneity of care received by our patients pertaining to protocols for treatments, escalation of care, and timing of non-invasive and mechanical ventilation.

To best target our efforts at reducing disparate COVID-19 infection rates in the United States, it is helpful to know where along the disease course the disparities occur most frequently. National and city data have repeatedly shown that Black people in the United States have borne the largest burden of COVID-19 cases and fatalities. From the Department of Public Health data, Black citizens in Philadelphia, like other areas of the country, have been similarly affected by COVID-19, representing 45% of positive cases and 49% of deaths through July 28, 2021, while composing 44% of the Philadelphia population.[12] Our findings confirm similar trends at hospital presentation given 54% of patients were Black. Once hospitalized, however, poor outcomes did not vary by race/ethnicity when corrected for covariates; this is consistent with similar prior studies in the United States.[4,6,26,34] Our findings indicate that variation in mortality by race/ethnicity in Philadelphians is related to factors occurring before hospitalization that affect exposure to COVID-19 and worse outcomes. For example, a study by Mutambudzi et al. showed that essential workers in healthcare professionals, medical support, social care, and transportation had the highest risk of severe COVID-19, which was even greater in non-White essential workers.[35] Other factors that could contribute to disparities are the number of household members, limited access to healthcare, weathering, structural and systemic racism, and discrimination.[36–38] A subsequent study could investigate the role of these and similar upstream effects on rates of infection and hospitalization.

Although Black patients in the present study were disproportionately representative of COVID-19 hospitalizations ($p < 0.002$), 16.4% of Black patients died in the hospital compared to 27.6% of Asian patients, 27.5% of White patients, and 8.9% of Hispanic patients. Black and Hispanic race/ethnicity were found to be protective in bivariate analysis. This protective effect, however, was no longer significant in Model 1 when controlling for age and sex or Models 2–4 when controlling for SES and comorbidities. Our analysis suggests this is because hospitalized Black and Hispanic patients were younger (mean age: 62.6 and 57.1, respectively; White patients, 71.1), leading to the protective effect in bivariate analysis that was no longer significant when controlling for age.

We were surprised to find that living in very low-income neighborhoods was protective for death or discharge to hospice, but not ICU admission across Models 3 and 4. This may be an artifact of the level of data used (census tract rather than household and/or individual). For instance, in a preprint study, Cerami et al. demonstrate that high household living density is associated with a higher risk of secondary household transmission, which also occurred more frequently in non-White and Hispanic households than White households.[39] Alternatively, if this effect is not truly protective, it is possible that the aspect of SES we chose for analysis (income) might have other prehospital effects and/or hospitalization effects that warrant further research in combination with other aspects of SES. Our study similarly found that homelessness conferred a protective effect for poor outcomes in the bivariate analysis (OR: 0.10, 95% CI: 0.01–0.76).

We included homelessness/shelter status to account for the practice to admit patients experiencing homelessness to the hospital while awaiting safe housing placement to slow the spread of COVID-19 in the shelter system. The apparent protective effect in the bivariate analysis may be a result of how many of them likely did not meet the same admission standard of patients not experiencing homelessness. The average hospital stay for patients experiencing homelessness was 4.6 days (range: 1–32; interquartile range: 4.0) for 51 patients, which highlights the difficulty of discharging patients to safe housing due to resource and logistical constraints. Despite the well-intended nature of this intervention, admitting patients for the sole purpose of quarantine is not an efficient use of hospital resources, poses an increased risk of COVID-19 infection for healthcare workers and fellow patients and hospital-acquired infections for these patients, and, during a pandemic in which acute-care hospital bed capacity has at times been insufficient, effectively reduces the capacity to care for patients at higher risk for morbidity and mortality. This highlights the need for more effective multidisciplinary emergency preparedness, particularly as it pertains to sheltering vulnerable individuals, and highlights the broader need for effective shelter interventions during a pandemic and beyond in Philadelphia.

With respect to age and comorbidities, our study demonstrated an OR of 11.01 (95% CI: 1.96–61.97) for the composite primary outcome for patients age ≥75, which is similar to prior research.[21,23,24,26,27,29,32,33] We do note, however, that the 45–64 and 65–74 age groups did not show a distinct risk as expected. Those with renal disease had an OR of 2.78 (95% CI: 1.31–5.90) for the composite primary outcome, which was similarly demonstrated by Yehia et al. and Williamson et al.[26,29] We note that several comorbidities found in other studies did not have clear effects in our multivariable models including coronary artery disease, cancer, cerebral vascular disease, chronic obstructive pulmonary disease, heart failure, and hypertension.[21,23,24,26,27,29,32,33] Other studies have demonstrated an increased odds of death in those with elevated BMIs, but the present study reflects a protective effect with an OR: 0.24 (95% CI: 0.08–0.69) in those with BMI: 30–35, and a trend toward a *U*-shaped curve (e.g., BMI: 30–40 lower risk, BMI < 30 or >40 higher risk), which may be a product of grouping all BMIs < 30 but warrants further investigation.[21,25,29] Finally, while living in a high-density area has previously been demonstrated to increase risk of hospitalization in COVID-19, in the present study we did not demonstrate increase odds of death or discharge to hospice for patients living in densely populated

areas who were hospitalized with COVID-19; this outcome may also have been an artifact of census-level tract data as noted above.[34,39]

5 | CONCLUSIONS

Our study demonstrates that among patients hospitalized for COVID-19, after controlling for mediating variables, self-reported race and ethnicity were not independent predictors of mortality while living in very-low income neighborhoods was protective against death or hospice discharge from COVID-19.

ACKNOWLEDGMENTS

The team would like to acknowledge and thank Anita M. Rawls, PhD, Katherine T. Berg, MD, MPH, Lily L. Ackermann, MD, and Sarah E. Rosenberg, MD, for their selfless and important contributions to this study. This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

AUTHOR CONTRIBUTIONS

Dianna R. Cheney-Peters, Robert B. Jones, and Alan A. Kubey conceived of the presented idea and contributed to study design. Data collection and analyses were performed by Dianna R. Cheney-Peters, Crystal Y. Lee, Shuji Mitsuhashi, Dina S. Zaret, Joshua M. Riley, Chantel M. Venkataraman, Joseph W. Schaefer, Brandon J. George, Chris J. Li, Christa M. Smaltz, Conor G. Bradley, Danielle M. Fitzpatrick, David B. Ney, Divya M. Chalikonda, Joshua D. Mairose, Kashyap Chauhan, Margaret V. Szot, Robert B. Jones, Rukaiya Bashir-Hamidu, and Alan A. Kubey. Dianna R. Cheney-Peters, Crystal Y. Lee, Shuji Mitsuhashi, Dina S. Zaret, and Alan A. Kubey led the writing of the initial manuscript. Dianna R. Cheney-Peters, Crystal Y. Lee, Shuji Mitsuhashi, Dina S. Zaret, Joshua M. Riley, Chantel M. Venkataraman, Joseph W. Schaefer, Brandon J. George, Chris J. Li, Christa M. Smaltz, Conor G. Bradley, Danielle M. Fitzpatrick, David B. Ney, Divya M. Chalikonda, Joshua D. Mairose, Kashyap Chauhan, Margaret V. Szot, Robert B. Jones, Rukaiya Bashir-Hamidu, and Alan A. Kubey reviewed, edited, and finalized the manuscript, providing critical feedback and changes before submission.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Joshua M. Riley http://orcid.org/0000-0001-6544-1606
Alan A. Kubey https://orcid.org/0000-0002-8742-9381

REFERENCES

1. Garg S, Kim L, Whitaker M, et al. Hospitalization rates and characteristics of patients hospitalized with laboratory-confirmed coronavirus disease 2019. *MMWR Morb Mortal Wkly Rep*. 2020; 69(15):458-464. doi:10.15585/mmwr.mm6915e3
2. Wang Z, Zheutlin A, Kao YH, et al. Hospitalised COVID-19 patients of the Mount Sinai Health System: a retrospective observational study using the electronic medical records. *BMJ Open*. 2020. 10(10): e040441. doi:10.1136/bmjopen-2020-040441
3. Salacup G, Lo KB, Gul F, et al. Characteristics and clinical outcomes of COVID-19 patients in an underserved-inner city population: a single tertiary center cohort. *J Med Virol*. 2020;93:416-423. doi:10.1002/jmv.26252
4. Rodriguez-Diaz CE, Guilamo-Ramos V, Mena L, et al. Risk for COVID-19 infection and death among Latinos in the United States: examining heterogeneity in transmission dynamics. *Ann Epidemiol*. 2020;52:46-53.e2. doi:10.1016/j.annepidem.2020.07.007
5. Webb Hooper M, Nápoles AM, Pérez-Stable EJ. COVID-19 and racial/ethnic disparities. *JAMA*. 2020;323(24):2466-2467. doi:10.1001/jama.2020.8598
6. 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;382(26):2534-2543. doi:10.1056/NEJMsa2011686
7. Hsu HE, Ashe EM, Silverstein M, et al. Race/ethnicity, underlying medical conditions, homelessness, and hospitalization status of adult patients with COVID-19 at an urban safety-net medical center. *MMWR Morb Mortal Wkly Rep*. 2020;69(27):864-869. doi:10.15585/mmwr.mm6927a3
8. Wei MY, Luster JE, Chan C-L, Min L. Comprehensive review of ICD-9 code accuracies to measure multimorbidity in administrative data. *BMC Health Serv Res*. 2020;20(1):489. doi:10.1186/s12913-020-05207-4
9. US Census Bureau. U.S. Census Bureau QuickFacts: Philadelphia County, Pennsylvania. US Census Bureau; 2019. Accessed December 18, 2020. https://www.census.gov/quickfacts/fact/table/philadelphiacountypennsylvania/PST045216
10. Department of Public Health, City of Philadelphia. Testing and Data; 2020. Accessed September 8, 2020. https://www.phila.gov/programs/coronavirus-disease-2019-covid-19/testing-and-data/
11. OpenDataPhilly. COVID Cumulative Historical Snapshots; 2020. Accessed January 12, 2021. https://www.opendataphilly.org/dataset/covid-cumulative-historical-data
12. Department of Public Health. City of Philadelphia COVID-19 Overview; 2020. Accessed July 28, 2021. https://www.phila.gov/programs/coronavirus-disease-2019-covid-19/testing-and-data/#/
13. US Census Bureau. 2019: ACS 1-Year Estimates Data Profiles. US Census Bureau Tables; 2020. Accessed December 19, 2020. https://data.census.gov/cedsci/table?g=0400000US42_1600000US4260000%26tid=ACSDP1Y2019.DP03
14. Howell O, Eichel L. Philadelphia's poor: who they are, where they live, and how that has change. *The Pew Charitable Trusts*. 2017;71: 497-505.
15. Evans C COVID-19: Data Shows Coronavirus Hit Philadelphia's Browner, Poorer Neighborhoods Hardest. Philadelphia Neighborhoods; 2020. Accessed December 19, 2020. https://philadelphianeighborhoods.com/2020/08/12/covid-19-data-shows-coronavirus-hit-philadelphias-browner-poorer-neighborhoods-hardest/
16. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol*. 2008;61(4):344-349. doi:10.1016/j.jclinepi.2007.11.008
17. US Department of Housing and Urban Development. Transmittal of Fiscal Year (FY) 1998 Public Housing/Section 8 Income Limits. Accessed August 26, 2020. https://www.huduser.gov/portal/datasets/il/fmr98/sect8.html
18. Rhone A, Ploeg M, Williams R, Breneman V. Understanding low-income and low-access census tracts across the nation: subnational

and subpopulation estimates of access to healthy food. *United States Department of Agriculture*. 2019
19. PolicyMap. Local Median Household Income as a share of Area Median Household Income between 2014-2018. PolicyMap. Accessed September 6, 2020. https://www.policymap.com/maps
20. Nelson K. 2020. A Primer on Low-Mod. Policymap; 2013. Accessed December 17. https://www.policymap.com/2013/08/a-primer-on-low-mod/
21. Gupta S, Hayek SS, Wang W, et al. Factors associated with death in critically ill patients with coronavirus disease 2019 in the US. *JAMA Intern Med*. 2020;180(11):1436-1447. doi:10.1001/jamainternmed.2020.3596
22. Anderson MR, Geleris J, Anderson DR, et al. Body mass index and risk for intubation or death in sars-cov-2 infection: a retrospective cohort study. *Ann Intern Med*. 2020;173(10):782-790. doi:10.7326/M20-3214
23. Lombardi CM, Carubelli V, Iorio A, et al. Association of troponin levels with mortality in Italian patients hospitalized with coronavirus disease 2019: results of a multicenter study. *JAMA Cardiol*. 2020;5(11):1274-1280. doi:10.1001/jamacardio.2020.3538
24. Petrilli CM, Jones SA, Yang J, et al. Factors associated with hospital admission and critical illness among 5279 people with coronavirus disease 2019 in New York City: prospective cohort study. *BMJ*. 2020;369:m1966. doi:10.1136/bmj.m1966
25. Tartof SY, Qian L, Hong V, et al. Obesity and mortality among patients diagnosed with COVID-19: results from an integrated health care organization. *Ann Intern Med*. 2020;173(10):773-781. doi:10.7326/M20-3742
26. Yehia BR, Winegar A, Fogel R, et al. Association of race with mortality among patients hospitalized with coronavirus disease 2019 (COVID-19) at 92 US hospitals. *JAMA Netw Open*. 2020;3(8):e2018039. doi:10.1001/jamanetworkopen.2020.18039
27. Grasselli G, Greco M, Zanella A, et al. Risk factors associated with mortality among patients with COVID-19 in intensive care units in Lombardy, Italy. *JAMA Intern Med*. 2020;180(10):1345-1355. doi:10.1001/jamainternmed.2020.3539
28. Shi S, Qin M, Shen B, et al. Association of cardiac injury with mortality in hospitalized patients with COVID-19 in Wuhan, China. *JAMA Cardiol*. 2020;5(7):802-810. doi:10.1001/jamacardio.2020.0950
29. The OpenSAFELY Collaborative, Williamson E, Walker AJ, et al. OpenSAFELY: factors associated with COVID-19-related hospital death in the linked electronic health records of 17 million adult NHS patients. *medRxiv*. 2020. doi:10.1101/2020.05.06.20092999.
30. Manocha KK, Kirzner J, Ying X, et al. Troponin and other biomarker levels and outcomes among patients hospitalized with COVID-19: derivation and validation of the HA2T2 COVID-19 mortality risk score. *J Am Heart Assoc*. 2020;10:e018477. doi:10.1161/JAHA.120.018477
31. Elias P, Poterucha TJ, Jain SS, et al. The prognostic value of electrocardiogram at presentation to emergency department in patients with COVID-19. *Mayo Clin Proc*. 2020;95(10):2099-2109. doi:10.1016/j.mayocp.2020.07.028
32. Chen R, Liang W, Jiang M, et al. Risk factors of fatal outcome in hospitalized subjects with coronavirus disease 2019 from a nationwide analysis in China. *Chest*. 2020;158(1):97-105. doi:10.1016/j.chest.2020.04.010.
33. 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. doi:10.1016/S0140-6736(20)30566-3
34. Gu T, Mack JA, Salvatore M, et al. Characteristics associated with racial/ethnic disparities in COVID-19 outcomes in an academic health care system. *JAMA Netw Open*. 2020;3(10):e2025197. doi:10.1001/jamanetworkopen.2020.25197
35. Mutambudzi M, Niedwiedz C, Macdonald EB, et al. Occupation and risk of severe COVID-19: prospective cohort study of 120 075 UK Biobank participants. *Occup Environ Med*. 2020. doi:10.1136/oemed-2020-106731
36. Gould E, Wilson V. Black workers face two of the most lethal preexisting conditions for coronavirus—racism and economic inequality. *Economic Policy Institute*; 2020. Accessed December 19, 2020. https://www.epi.org/publication/black-workers-covid/
37. Centers for Disease Control and Prevention. Health Equity Considerations and Racial and Ethnic Minority Groups. *COVID-19 (Coronavirus Disease)*; 2020. Accessed December 17, 2020. https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/race-ethnicity.html
38. US Census Bureau. America's Families and Living Arrangements: 2016; 2018. Accessed December 17, 2020. https://www.census.gov/data/tables/2016/demo/families/cps-2016.html
39. Cerami C, Rapp T, Lin F-C, et al. High household transmission of SARS-CoV-2 in the United States: living density, viral load, and disproportionate impact on communities of color. *medRxiv*. 2021. doi:10.1101/2021.03.10.21253173

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Cheney-Peters DR, Lee CY, Mitsuhashi S, et al. Association of race/ethnicity and socioeconomic status with COVID-19 30-day mortality at a Philadelphia medical center using a retrospective cohort study. *J Med Virol*. 2022;94:906-917. doi:10.1002/jmv.27365