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Racial/Ethnic Differences In COVID-19 Screening, Hospitalization, And Mortality In Southeast Wisconsin

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Abstract

This study aims to understand racial/ethnic differences in coronavirus disease 2019 (COVID-19) screening, symptom presentation, hospitalization, and mortality, using data from 31,549 adults tested for COVID-19 between March 1 and July 10, 2020, in Milwaukee and Southeast Wisconsin. Racial/ethnic differences existed in adults screening positive for COVID-19 (4.5 percent of non-Hispanic Whites, 14.9 percent of non-Hispanic Blacks, and 14.8 percent of Hispanics). After adjusting for demographics and comorbidities, minorities were more than three times more likely to screen positive and two times more likely to be hospitalized relative to non-Hispanic Whites, and Hispanics were two times more likely to die than non-Hispanic Whites. Given the long-standing history of structural racism, residential segregation, and social risk in the US and their role as contributors to poor health, we propose and discuss the part these issues play as explanatory factors for our findings.

As of September 30, 2020, the Centers for Disease Control and Prevention (CDC) reported that the US had had 7,129,313 total cases of coronavirus disease 2019 (COVID-19) and 204,598 deaths.¹ Demographic and clinical factors, such as older age and preexisting conditions, including diabetes, hypertension, and chronic lung disease, are associated with higher risk for severe disease and poor outcomes.^{2–4} Across the nation, the burden of COVID-19 has been disproportionately borne by some racial/ethnic minority groups.^{5–12} Nationally, Black Americans and Hispanics have COVID-19 hospitalization rates more than 4.6 times higher than non-Hispanic Whites.⁵ In New York City, an investigation into variation across the boroughs found that the highest rates of hospitalization and mortality were in the borough with the highest proportion of racial/ethnic minorities and the highest

rate of poverty.¹⁰ In Northern California, Black Americans had 2.7 times higher odds of hospitalization after adjustment for demographics, comorbidities, and income.¹¹

The reasons for differences in COVID-19 outcomes by race/ethnicity are likely multifaceted; however, an underlying driver is likely the structural racism that influences health disparities seen across diseases.^{13–15} Despite extensive evidence about structural racism as a contributor to racial health disparities, genetics and biology are discussed frequently as possible explanations for differences.¹³ This ignores how structural racism influences environmental exposures, the biological consequences of those exposures, access to information about health, and health outcomes themselves.^{13–15} Understanding the historical perspective of a region or city through its policies and institutions provides important context and is necessary to appreciate how structural racism, or the “ways in which societies foster racial discrimination through mutually reinforcing systems of housing, education, employment, earnings, benefits, credit, media, health care, and criminal justice,”¹⁵ influences disparities in health outcomes in that city or region.^{15,16}

Milwaukee, Wisconsin, is a highly segregated minority-majority city located in the Midwest.^{17–19} Redlining policies and racially restrictive covenants in the 1930s through the 1970s limited the options of prospective minority homeowners and created residential segregation patterns that continue through today.^{20,21} Banks refused loans for homes in predominantly Black neighborhoods and denied financial assistance to improve housing in already-poor neighborhoods.²⁰ At the same time, race-restrictive covenants ensured subsequent owners could not sell, lease, or convey property to non-White individuals.²¹ The resulting segregation resulted in Black Americans facing increasingly inadequate housing, poorly funded public schools, greater proximity to environmental hazards, and growing distance from adequate food options and medical services.²⁰ Social issues became racialized and led to financial inequalities and reduced opportunities for education and wealth accumulation, specifically within minority groups.²⁰

When the COVID-19 pandemic began, underlying segregation and the location of health systems within the region led to concerns that structural factors would lead to disparate outcomes. Unlike other major metropolitan areas, such as New York City, which experienced an early and severe wave of cases and deaths, Wisconsin experienced a slow growth of cases and health care systems were not overloaded. This study examines racial/ethnic differences in COVID-19 screening, symptom presentation, hospitalization, and mortality in Milwaukee and Southeastern Wisconsin. Given the widespread nature of the social factors noted earlier, results from this study offer information that is relevant for other urban communities with patterns similar to those seen in Milwaukee. On the basis of differences in the trajectory of the pandemic compared with other states and the underlying structural racism that has existed in Milwaukee and Wisconsin for decades, we hypothesized there would be significant racial/ethnic differences in screening rates, symptom presentation, hospitalization, and mortality related to COVID-19.

Study Data And Methods

Population

In this cross-sectional analysis, data were obtained from the Froedtert and the Medical College of Wisconsin Epic medical record (last updated July 10, 2020). The Froedtert/Medical College of Wisconsin system has conducted approximately a quarter of all COVID-19 testing in the State of Wisconsin to date. The primary hospital for the Froedtert/Medical College of Wisconsin system is located in Milwaukee County, a racially and ethnically diverse county located in Southeastern Wisconsin.¹⁷ Compared with the US population, Milwaukee County has a higher percentage of Black Americans (27.2 percent compared to 13.4 percent) and a similar percentage of persons of Hispanic or Latino origin (15.4 percent compared to 18.3 percent).¹⁷ Four additional hospitals within the Froedtert/Medical College of Wisconsin system are located in surrounding counties that have lower percentages of minority populations compared with Milwaukee County but are demographically more diverse than many counties within the state of Wisconsin. In addition to the five hospitals, the health network operates nearly forty health centers and clinics and is the only academic medical center in Southeastern Wisconsin.

This analysis included 31,549 adults tested within the Froedtert/Medical College of Wisconsin Health System who self-reported a race of non-Hispanic White, non-Hispanic Black, or Hispanic. All other races/ethnicities represented a small sample and were not included in this analysis. Criteria for testing changed over time on the basis of changes in guidelines from the CDC. During the initial phase of the pandemic, testing was provided only for individuals presenting with a history of shortness of breath or cough with or without fever. The list of symptoms considered for testing expanded over time according to updated CDC guidelines and now includes fever or chills, cough, shortness of breath, fatigue, muscle or body aches, headache, loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, and diarrhea. In addition, those eligible for tests expanded over time to include individuals exposed to COVID-19 and individuals coming to the health care system for other health needs. The guidelines for testing in place at the time of submission of this manuscript (August 21, 2020) recommended that the people who should be tested were symptomatic patients (any patient with clinical suspicion of COVID-19), patients being admitted to the hospital, patients being discharged to a skilled nursing facility, patients in ambulatory care settings where clinical decision would change as a result of the test, patients being scheduled for a procedure or scheduled for admission to the hospital, and health care workers and students suspected of exposure to COVID-19. Tests were not conducted on employees as a requirement for return to work. Although the racial/ethnic breakdown across hospitals and clinics within the system differs, criteria for COVID-19 screening and treatment were consistent regardless of location.

COVID-19 Status

COVID-19 testing was conducted by collecting two swabs from each patient—a nasopharyngeal specimen and oropharyngeal specimen—using a mini-tip and regular-size flocked swab (Copan Diagnostics, Murrieta, CA), respectively. Swabs were transported to the laboratory in viral transport media (M6, Thermo Fisher, Lenexa, KS). Testing was

performed using the approved CDC COVID-19 assay, with RNA extracted using the bioMérieux eMag (bioMérieux, Marcy-l'Étoile, France), and real-time polymerase chain reaction was performed on ABI 7500 Fast Dx thermal cyclers (Thermo Fisher, Waltham, MA) per the CDC protocol.²²

All patients with completed COVID-19 tests were identified using the medical record. Patients were considered positive cases if the initial, repeat, or follow-up test result was marked “Detected.”

Variables

Data were abstracted from the medical record using Structured Query Language for all individuals in the sample, including demographic information, past medical history, hospitalization, and mortality information. Individuals without race/ethnicity in the electronic medical records or who reported a race other than non-Hispanic White, non-Hispanic Black, or Hispanic were excluded from analyses.

Demographic information included sex (categorized as male or female); age (at date of COVID-19 test and based on birthdate, used as a continuous variable); race/ethnicity (based on self-report in the medical record and categorized as non-Hispanic White, non-Hispanic Black, and Hispanic); county of residence (based on ZIP code and categorized into Milwaukee County, Waukesha County located west of Milwaukee, Ozaukee/Washington counties located north of Milwaukee, Racine/Kenosha counties located south of Milwaukee, and other Wisconsin county/out of state); and primary payor (categorized as managed care/commercial, Medicare, Medicaid, and self-pay/uninsured).

Past medical history included tobacco use (categorized as nonsmoker, current smoker, and former smoker), body mass index (calculated from most recent height and weight), and comorbidities (investigated as a count). Comorbidities were defined on the basis of *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision, codes within the Enhanced Elixhauser categorization validated by Hude Quan and colleagues.²³ Counts using the Elixhauser coding structure captured burden of comorbidities by first identifying comorbidities for each individual. Then a count of comorbidities was created for each individual and categorized into zero, one to two, three to four, and five or more.

Patients with a positive COVID-19 test were identified as hospitalized or not hospitalized. COVID-19 was not required to be the primary diagnosis in the hospitalization. Initial symptoms from the hospitalization were collected based on the record within the first twenty-four hours of clinic visit check-in time or hospital arrival time. Symptoms investigated included cough, fever, shortness of breath, fatigue/weakness, and muscle pain. All-cause mortality was based on an indication of “deceased” in the medical record, which is deemed a reliable indicator of in-hospital, all-cause mortality.²⁴

Statistical Analyses

Descriptive statistics are presented to summarize sample characteristics. Three samples within the population of all tested adults were investigated: any individual tested, which

included both negative and positive results; any individual with a positive COVID-19 test result; and any individual with a positive COVID-19 test result who was also hospitalized. Analysis-of-variance, chi-square, and Fisher's exact tests were used to calculate differences between demographic and clinical factors by race/ethnicity.

Unadjusted and adjusted logistic regression and Cox proportional hazard models were run to understand the independent relationship between race/ethnicity and COVID-19-related outcomes. The first model estimated the odds of having a positive COVID-19 case by race/ethnicity among all adults tested within the health system, using a logistic model. The second model estimated the odds of hospitalization by race/ethnicity among adults with a positive COVID-19 test, using a logistic model. The third model estimated the hazard ratio for mortality by race/ethnicity among adults with a positive COVID-19 test, using a Cox proportional hazard model. Covariates included sex, age, geographic location, primary payor, tobacco use, and comorbidity count. Covariates were selected on the basis of known confounding within the disparities literature or factors found to be statistically significantly different by race/ethnicity in preliminary bivariate analyses. SAS version 9.4 was used for all analyses. Two-sided tests were conducted and $p < 0.05$ was considered statistically significant. The Medical College of Wisconsin Institutional Review Board approved the study before data abstraction or statistical procedures were conducted.

Limitations

The primary limitation of this study is inclusion of patients from a single center in the Midwest US. However, this is also a strength of the study, in that it provides much-needed information on an understudied part of the nation deeply affected by residential segregation and structural racism and can be generalized to other highly segregated cities. Second, as data were collected from the medical record, we could not account for social factors not captured in the record. Third, all data available in the record were used in this analysis, with no further investigation for false-positive results. Fourth, given the sample size, risk for mortality may be limited by power. Fifth, starting in May, testing guidelines allowed health care workers and students to be tested if they had been exposed to COVID-19 as part of health system surveillance. As they were less likely to have chronic conditions, but more likely to have health care exposure, this may have influenced the likelihood of COVID-19 positivity for younger individuals with low comorbidity count. Finally, these data are cross-sectional and cannot speak to causality. Longitudinal follow-up with individuals is needed to inform the course of disease and long-term outcomes.

Study Results

COVID-19 Screening

Overall, 2,219 (7.0 percent) of the 31,549 individuals screened tested positive for COVID-19. Although 75.4 percent of those tested were non-Hispanic White, they made up only 48.1 percent of the positive cases. Only 19.8 percent of those tested were non-Hispanic Black, yet they made up 41.8 percent of the positive cases; just 4.8 percent of those tested were Hispanic ethnicity, but they made up 10.1 percent of the positive cases (see exhibit 1). Screen positive rates differed by race/ethnicity, with 4.5 percent of non-Hispanic White, 14.9

percent of non-Hispanic Black, and 14.8 percent of Hispanic adults screening positive ($p < 0.0001$) (data not shown).

Among the total sample of those screened, adults who screened positive were more likely to be men ($p = 0.006$), minority race/ethnicity ($p < 0.0001$), residing in Milwaukee County ($p < 0.0001$), self-pay/uninsured or Medicaid ($p < 0.0001$); have a higher BMI ($p = 0.005$), and have type 2 diabetes ($p = 0.01$). Comorbidity count was significantly associated with screening result, with individuals who screened positive more likely to have fewer comorbidities (see exhibit 1).

Demographic Characteristics And Symptom Presentation

Among the 2,219 adults who screened positive for COVID-19, there were significant differences by race/ethnicity in nearly all demographic and clinical factors in unadjusted analyses (see exhibit 2). These differences included younger age of Hispanic adults (mean $\pm$ standard deviation: 44.3 ± 17.0 compared with 50.1 ± 19.2 for non-Hispanic White and 48.1 ± 18.4 for non-Hispanic Black adults), minorities primarily living in Milwaukee County (89.9 percent of non-Hispanic Black and 64.3 percent of Hispanic compared with 39.9 percent of non-Hispanic White adults), higher Medicaid enrollment for non-Hispanic Blacks and Hispanics (28.6 percent and 23.7 percent, respectively, compared with 4.6 percent for non-Hispanic Whites), higher self-pay/uninsured in Hispanics (17.4 percent compared with 6.7 percent in non-Hispanic Whites), and more current smokers among non-Hispanic Blacks (10.0 percent compared with 6.2 percent non-Hispanic White and 6.8 percent Hispanic). Non-Hispanic Black adults also were more likely to have congestive heart failure, hypertension, chronic pulmonary disease, diabetes, renal failure, fluid and electrolyte disorders, and anemia, and were more likely to have five or more comorbidities (23.3 percent compared with 15.1 percent non-Hispanic White and 11.2 percent Hispanic adults) (see exhibit 2).

Among 489 hospitalized patients with COVID-19, the only racial/ethnic differences in symptom presentation were that non-Hispanic Blacks were more likely to present with cough ($p = 0.01$) and Hispanics were more likely to have no symptom on record for all five symptoms investigated (see online appendix 1).²⁵

Hospitalization And Mortality

Unadjusted proportions for hospitalization by race were 22.0 percent overall (95% confidence interval, 20.3, 23.8) and 16.1 percent for non-Hispanic White (95% CI, 13.9, 18.3), 29.0 percent for non-Hispanic Black (95% CI, 26.1, 31.9), and 21.4 percent for Hispanic (95% CI, 16.1, 26.8) adults ($p < 0.001$). Unadjusted proportions for an intensive care unit stay during hospitalization by race were 10.0 percent overall (95% CI, 8.8, 11.3) and 7.8 percent for non-Hispanic White (95% CI, 6.2, 9.4), 12.5 percent for non-Hispanic Black (95% CI, 10.4, 14.6), and 10.3 percent for Hispanic (95% CI, 6.3, 14.2) adults ($p = 0.002$). Unadjusted proportions for mortality by race were 5.4 percent overall (95% CI, 4.5, 6.4) and 4.5 percent for non-Hispanic White (95% CI 3.3, 5.7), 6.3 percent for non-Hispanic Black (95% CI, 4.7, 7.8), and 6.3 percent for Hispanic (95% CI, 3.1, 9.4) adults (see exhibit 2).

Adjusted Models For Racial/Ethnic Differences In Outcomes

In adjusted analyses, non-Hispanic Black adults were 3.7 times more likely (odds ratio, 3.65; 95% CI, 3.23, 4.13) and Hispanic adults were 3.1 times more likely (OR, 3.07; 95% CI, 2.57, 3.66) to have a positive COVID-19 test compared with non-Hispanic Whites. In addition, men were more likely to screen positive (OR, 1.28; 95% CI, 1.16, 1.41) than women, and self-pay/uninsured individuals were more likely to screen positive compared with those with a managed care/commercial payor (OR, 1.34; 95% CI, 1.09, 1.64). Individuals living in Milwaukee County and the counties immediately surrounding it were also more likely to screen positive compared with those in other counties that have primarily rural, White populations (OR, 2.21; 95% CI, 1.64, 2.99) (see exhibit 3).

Among those who had a positive COVID-19 test, minorities were two times more likely to be hospitalized (non-Hispanic Black OR, 2.15 [95% CI, 1.56, 2.98]; Hispanic OR, 2.03 [95% CI, 1.25, 3.28]) compared with non-Hispanic White adults after adjusting for demographics and comorbidities. In unadjusted models, there was no significant difference in mortality by race/ethnicity (non-Hispanic Black hazard ratio, 1.32; 95% CI, 0.90, 1.94; Hispanic HR, 1.35; 95% CI, 0.74, 2.45). After adjustment, compared with non-Hispanic Whites, Hispanics were two times more likely to die (HR, 2.09; 95% CI, 1.04, 4.16) and there was a small but statistically nonsignificant difference for non-Hispanic Blacks (HR, 1.11; 95% CI, 0.68, 1.82) (see exhibit 4).

Discussion

In this study from a large health system in Milwaukee and Southeastern Wisconsin, non-Hispanic Blacks and Hispanics were statistically significantly more likely to screen positive for COVID-19 and have higher hospitalization rates among those who tested positive for COVID-19 when compared with non-Hispanic Whites. Differences by race/ethnicity were independent of sex, age, county of residence, payor, smoking status, and comorbidity count. Limited differences existed in symptom presentation by race/ethnicity. Finally, Hispanics had higher mortality compared with non-Hispanic Whites for COVID-19-positive individuals, whereas non-Hispanic Blacks had a small but not statistically significant difference in mortality.

This study adds to the growing body of literature about racial/ethnic differences in COVID-19 by providing results for a highly segregated city in the Midwestern US that experienced a slower rate of growth in COVID-19 cases than elsewhere in the country. Results showed that racial/ethnic minorities were more likely to screen positive for COVID-19, which is consistent with prior studies from other regions of the US.^{8,9,11,26} Findings are also consistent with national case surveillance reports indicating that non-Hispanic Black and Hispanic adults are disproportionately affected by the COVID-19 pandemic.²⁷ Given the amount of missing data in national surveillance information,²⁷ these findings add to the growing body of literature that uses local data with more complete race/ethnicity information.^{9,11,26}

Results from this study are also consistent with those from one study in Northern California, which found that non-Hispanic Black adults were more than twice as likely to be

hospitalized.¹¹ A second study conducted in New Orleans found that although non-Hispanic Black adults made up a higher proportion of confirmed cases, once hospitalized, race/ethnicity was not associated with higher in-hospital mortality.⁹ A recent analysis found a strong relationship between minority race and population-level COVID-19 mortality, although these differences varied widely across states.²⁸ Our results regarding mortality were similar to the study conducted in New Orleans, which, was also based on data from electronic medical records. The mixed results with regard to mortality in our sample were probably a result of the low event rate and because the group predominantly comprised individuals with access to medical care. Therefore, ongoing tracking and monitoring for disparities in mortality across states should continue.

Given the independent associations between race/ethnicity and COVID-19 outcomes, some of the social and structural factors not available in our data set are likely important drivers of these findings. On the basis of the long-standing history of systemic racism in the Milwaukee and Southeast Wisconsin area that existed before the COVID-19 pandemic, structural racism is one factor that could have contributed to the current findings.^{12–15} As previously noted, the socioeconomic and political context of a community heavily influences the social position and material circumstances of individuals.²⁹ Therefore, to comprehensively address disparities that have been magnified by COVID-19, it is necessary to target policy efforts toward the overarching structural systems that perpetuate health inequities. These policies can include influencing the distribution of wealth, instituting policies that increase economic empowerment, funding programs that enhance neighborhood stability, and deploying targeted interventions that address social risk factors.³⁰

A recent community-based case study conducted in Milwaukee identified a new paradigm for addressing health disparities in inner-city environments.³¹ The study suggests that mass incarceration, residential segregation, state-sanctioned violence, housing instability, food insecurity, intergenerational poverty, and the limited educational opportunities that characterize the lived experience of inner-city African Americans create a state of chronic stress, which leads to poor health and increased disability and ultimately leads to decreased human capital (defined as the intangible, yet integral, economically productive aspects of individuals). That study also proposes a new paradigm that posits that inner-city challenges are a result of manmade disasters, and as such, solutions should be based on well-established disaster response models and include investments that help individuals meet social needs, expand economic and educational opportunities, and meet health needs in a way that improves human capital and economic productivity. Built on feedback from inner-city African Americans, this framework can inform larger policy efforts by combining support for programs that address the most pressing basic and social needs and creating systems that build long-term capacity within the inner city.³¹

Finally, future research is needed that incorporates detailed information on social determinants of health that is currently not available in the medical records to allow more robust and detailed examination of pathways and mechanisms, as well as helping to inform where best to target policy changes. For example, emerging evidence suggests that being employed as essential workers and living in multigenerational housing structures may explain the higher COVID-19 positivity rates in ethnic minorities,^{4,6,7,9} but these types of

data are not readily available in the electronic medical record and need to be included in future analyses as efforts continue to mitigate the current disparities in COVID-19 outcomes.

Conclusion

This study examined racial/ethnic differences in COVID-19 screening, symptom presentation, hospitalization, and mortality. Minorities were more than three times more likely to screen positive for COVID-19 and two times more likely to be hospitalized, and Hispanics were two times more likely to die compared with non-Hispanic Whites. Given the long-standing history of structural racism, residential segregation, and social risk in the US and their role as contributors to poor health, efforts to mitigate these disparities should incorporate new frameworks and policies that address structural racism and evaluation of mechanisms and pathways that are not currently available in analyses that use data from electronic medical records.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Notes

1. Centers for Disease Control and Prevention. Cases, data, and surveillance [Internet]. Atlanta (GA): CDC; [last updated 2020 Sep 30; cited 2020 Sep 30]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/index.html>
2. Dudley JP, Lee NT. Disparities in age-specific morbidity and mortality from SARS-CoV-2 in China and the Republic of Korea. *Clin Infect Dis* 2020;71(15):863–5 [PubMed: 32232322]

3. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al., the Northwell COVID-19 Research Consortium. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York City area. *JAMA* 2020;323(20):2052–9 [PubMed: 32320003]
4. CDC COVID-19 Response Team. Preliminary estimates of the prevalence of selected underlying health conditions among patients with coronavirus disease 2019—United States, February 12–March 28, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(13):382–6 [PubMed: 32240123]
5. Centers for Disease Control and Prevention. COVIDView: a weekly surveillance summary of US COVID-19 activity [Internet]. Atlanta (GA): CDC; [last updated 2020 Sep 30; cited 2020 Sep 30]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/index.html>
6. Laurencin CT, McClinton A. The COVID-19 pandemic: a call to action to identify and address racial and ethnic disparities. *J Racial Ethn Health Disparities*. 2020;7(3):398–402 [PubMed: 32306369]
7. Bibbins-Domingo K This time must be different: disparities during the COVID-19 pandemic. *Ann Intern Med* 2020;173(3):233–4 [PubMed: 32343767]
8. Dorn AV, Cooney RE, Sabin ML. COVID-19 exacerbating inequalities in the US. *Lancet* 2020;395(10232):1243–4 [PubMed: 32305087]
9. 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):2534–43 [PubMed: 32459916]
10. Wadhwa RK, Wadhwa P, Gaba P, Figueroa JF, Joynt Maddox KE, Yeh RW, et al. Variation in COVID-19 hospitalizations and deaths across New York City boroughs. *JAMA* 2020;323(21):2192–5 [PubMed: 32347898]
11. Azar KMJ, Shen Z, Romanelli RJ, Lockhart SH, Smits K, Robinson S, et al. Disparities in outcomes among COVID-19 patients in a large health care system In California. *Health Aff (Millwood)*. 2020;39(7):1253–62 [PubMed: 32437224]
12. Millett GA, Jones AT, Benkeser D, Baral S, Mercer L, Beyrer C, et al. Assessing differential impacts of COVID-19 on black communities. *Ann Epidemiol* 2020;47:37–44 [PubMed: 32419766]
13. Boyd RW, Lindo EG, Weeks LD, McLemore MR. On racism: a new standard for publishing on racial health inequities. *Health Affairs Blog* [blog on the Internet]. 2020 7 2 [cited 2020 Sep 17]. Available from: <https://www.healthaffairs.org/do/10.1377/hblog20200630.939347/full/>
14. Paradies Y, Ben J, Denson N, Elias A, Priest N, Pieterse A, et al. Racism as a determinant of health: a systematic review and meta-analysis. *PLoS One*. 2015;10(9):e0138511 [PubMed: 26398658]
15. Bailey ZD, Krieger N, Agénor M, Graves J, Linos N, Bassett MT. Structural racism and health inequities in the USA: evidence and interventions. *Lancet* 2017;389(10077):1453–63 [PubMed: 28402827]
16. Rast J Why history (still) matters: time and temporality in urban political analysis. *Urban Aff Rev* Thousand Oaks Calif 2012;48(1):3–36.
17. United States Census Bureau. Quick Facts [Internet]. Washington (DC): Department of Commerce; [cited 2020 Sep 30]. Available from: <https://www.census.gov/quickfacts/fact/table/milwaukeecountywisconsin,US/PST045219>
18. Logan JR, Stults BJ. The persistence of segregation in the metropolis: new findings from the 2010 Census [Internet]. Providence (RI): Brown University; 2011 3 24 [cited 2020 Sep 17]. Available from: <https://s4.ad.brown.edu/Projects/Diversity/Data/Report/report2.pdf>
19. Jacobs H, Kiersz A, Lubin G. The 25 most segregated cities in America. *Business Insider* [serial on the Internet]. 2013 11 22 [cited 2020 Sep 17]. Available from: <https://www.businessinsider.com/most-segregated-cities-in-america-2013-11>
20. Foltman L, Jones M. How redlining continues to shape racial segregation in Milwaukee [Internet]. Madison (WI): UW Applied Population Lab; 2019 2 28 [cited 2020 Sep 17]. Available from: <https://www.wiscontext.org/how-redlining-continues-shape-racial-segregation-milwaukee>
21. Quinn LM. Racially restrictive covenants: the making of all-White suburbs in Milwaukee County. *ETI Publications* [serial on the Internet]. 1979 [cited 2020 Sep 17]. Available from: https://dc.uwm.edu/eti_pubs/178

22. Centers for Disease Control and Prevention. Information for laboratories about coronavirus (COVID-19) [Internet]. Atlanta (GA): CDC; 2020 8 16 [cited 2020 Sep 17]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/lab/index.html>
23. Quan H, Sundararajan V, Halfon P, Fong A, Burnand B, Luthi JC, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care*. 2005;43(11):1130–9 [PubMed: 16224307]
24. Agency for Healthcare Research and Quality. AHRQ quality indicators: guide to inpatient quality indicators: quality of care in hospitals—volume, mortality, and utilization [Internet]. Rockville (MD): AHRQ; 2002 6 [cited 2020 Sep 17]. (AHRQ Pub No. 02-R0204). Available from: https://www.ahrq.gov/downloads/pub/inpatqi/iqui_guide.pdf
25. To access the appendix, click on the Details tab of the article online.
26. Gold JAW, Wong KK, Szablewski CM, Patel PR, Rossow J, da Silva J, et al. Characteristics and clinical outcomes of adult patients hospitalized with COVID-19—Georgia, March 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(18):545–50 [PubMed: 32379729]
27. Stokes EK, Zambrano LD, Anderson KN, Marder EP, Raz KM, El Burai Felix S, et al. Coronavirus disease 2019 case surveillance—United States, January 22–May 30, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(24):759–65 [PubMed: 32555134]
28. Gross CP, Essien UR, Pasha S, Gross JR, Wang SY, Nunez-Smith M. Racial and ethnic disparities in population-level COVID-19 mortality. *J Gen Intern Med* 2020 8 4.
29. Solar O, Irwin A. Social determinants, political contexts and civil society action: a historical perspective on the Commission on Social Determinants of Health. *Health Promot J Austr* 2006;17(3):180–5 [PubMed: 17176231]
30. Egede LE, Walker RJ. Structural racism, social risk factors, and COVID-19—a dangerous convergence for Black Americans. *N Engl J Med* 2020;383(12):e77 [PubMed: 32706952]
31. Egede LE, Walker RJ, Campbell JA, Dawson AZ, Davidson T. A new paradigm for addressing health disparities in inner-city environments: adopting a disaster zone approach. *J Racial Ethn Health Disparities*. 2020;

Exhibit 1:

Characteristics of 31,549 adults tested for coronavirus disease 2019 (COVID-19) in Milwaukee and Southeast Wisconsin

Variable	Total (n = 31,549)	COVID-19 negative (n = 29,330)	COVID-19 positive (n = 2,219)	P value
Sex (%)				0.006
Female	59.3	59.5	56.6	
Male	40.7	40.5	43.4	
Age, mean (SD)	52.8 (19.0)	53.1 (18.9)	48.7 (18.8)	<0.0001
Race/ethnicity (%)				<0.0001
Non-Hispanic White	75.4	77.5	48.1	
Non-Hispanic Black	19.8	18.1	41.8	
Hispanic	4.8	4.4	10.1	
Location (%)				<0.0001
Milwaukee County	44.5	43.0	63.2	
Waukesha County	18.9	19.3	13.2	
Washington/Ozaukee County	18.5	19.2	9.4	
Racine/Kenosha County	12.1	12.1	11.5	
Other county/out of state	6.0	6.3	2.6	
Primary payor (%)				<0.0001
Managed care/commercial	46.3	46.1	48.5	
Medicare	35.9	36.6	26.7	
Medicaid	13.1	12.9	16.5	
Self-pay/uninsured	4.7	4.4	8.2	
Tobacco use status (%)				<0.0001
Nonsmoker	53.3	52.5	65.1	
Current smoker	14.5	15.0	7.9	
Former smoker	32.2	32.6	27.1	
BMI, mean (SD)	30.6 (26.8)	30.5 (27.5)	32.4 (8.8)	0.005
Comorbidity (%)				
Congestive heart failure	8.2	8.3	7.0	0.04
Cardiac arrhythmias	15.6	16.0	11.0	<0.0001
Hypertension	35.2	35.4	32.8	0.02
Chronic pulmonary disease	23.5	23.7	20.7	0.002
Diabetes	16.6	16.4	18.6	0.01
Renal failure	9.6	9.6	9.2	0.56
Cancer	14.1	14.5	8.5	<0.0001
Fluid and electrolyte disorders	16.9	17.1	14.4	0.001
Anemia	9.4	9.5	8.5	0.15
Depression	24.3	24.7	18.2	<0.0001
Count of comorbidities (%)				<0.0001

Variable	Total (<i>n</i> = 31,549)	COVID-19 negative (<i>n</i> = 29,330)	COVID-19 positive (<i>n</i> = 2,219)	<i>P</i> value
0	25.8	25.1	35.4	
1–2	33.2	33.4	30.3	
3–4	18.8	19.0	16.1	
5+	22.1	22.4	18.2	

SOURCE The Froedtert and the Medical College of Wisconsin Epic medical record. NOTE analysis-of-variance, chi-square, and Fisher's exact tests were used to produce *p* values. SD is standard deviation.

Exhibit 2:

Characteristics of 2,219 positive coronavirus disease 2019 cases by race/ethnicity in Milwaukee and Southeast Wisconsin

Variable	Total (n = 2,219)	Non-Hispanic White (n = 1,068)	Non-Hispanic Black (n = 927)	Hispanic (n = 224)	P value
Sex (%)					0.002
Female	56.6	52.7	60.6	58.0	
Male	43.4	47.3	39.4	42.0	
Age, mean (SD)	48.7 (18.8)	50.1 (19.2)	48.1 (18.4)	44.3 (17.0)	<0.0001
Location (%)					<0.0001
Milwaukee County	63.2	39.9	89.9	64.3	
Waukesha County	13.2	23.5	3.1	6.3	
Washington/Ozaukee County	9.4	17.4	1.3	4.9	
Racine/Kenosha County	11.5	15.7	4.4	21.0	
Other county/out of state	2.6	3.5	1.3	3.6	
Primary payor (%)					<0.0001
Managed care/commercial	48.5	61.7	34.6	42.9	
Medicare	26.7	27.0	29.0	16.1	
Medicaid	16.5	4.6	28.6	23.7	
Self-pay/uninsured	8.2	6.7	7.8	17.4	
Tobacco use status (%)					0.0001
Nonsmoker	65.1	62.7	66.5	70.5	
Current smoker	7.9	6.2	10.0	6.8	
Former smoker	27.1	31.1	23.5	22.7	
BMI, mean (SD)	32.4(8.8)	31.1 (7.9)	33.6 (9.4)	32.7 (8.7)	<0.0001
Comorbidity (%)					
Congestive heart failure	7.0	5.3	9.7	3.7	0.0002
Cardiac arrhythmias	11.0	11.6	11.6	5.3	0.03
Hypertension	32.8	30.6	38.5	19.3	<0.0001
Chronic pulmonary disease	20.7	18.7	24.0	16.6	0.007
Diabetes	18.6	12.7	24.6	23.0	<0.0001
Renal failure	9.2	6.1	13.6	6.4	<0.0001
Cancer	8.5	8.5	8.5	8.0	0.97
Fluid and electrolyte disorders	14.4	13.1	17.2	8.6	0.003
Anemia	8.5	7.0	10.8	5.9	0.006
Depression	18.2	19.3%	17.8	13.9	0.20
Count of comorbidities (%)					<0.0001
0	35.4	36.1	32.8	43.9	
1–2	30.3	31.6	28.1	33.7	
3–4	16.1	17.2	15.8	11.2	

Variable	Total (n = 2,219)	Non-Hispanic White (n = 1,068)	Non-Hispanic Black (n = 927)	Hispanic (n = 224)	P value
5+	18.2	15.1	23.3	11.2	
Hospitalization	22.0	16.1	29.0	21.4	<0.0001
ICU stay	10.0	7.8	12.5	10.3	0.002
Mortality	5.4	4.5	6.3	6.3	0.19

SOURCE The Froedtert and the Medical College of Wisconsin Epic medical record. NOTES analysis-of-variance, chi-square, and Fisher's exact tests were used to produce *p* values. SD is standard deviation.

Exhibit 3:

Association between race/ethnicity and odds of positive screen for coronavirus disease 2019 infection ($n = 31,549$)

Variable	Adjusted odds ratio ^a
Race/ethnicity	
Non-Hispanic White	Ref
Non-Hispanic Black	3.65 ****
Hispanic	3.07 ****
Sex	
Female	Ref
Male	1.28 ****
Age	1.00
Location	
Milwaukee County	2.21 ****
Waukesha County	1.71 ****
Washington/Ozaukee County	1.43 **
Racine/Kenosha County	1.96 ****
Other county/out of state	Ref
Primary payor	
Managed care/commercial	Ref
Medicare	0.72 ****
Medicaid	0.80 ****
Self-pay/uninsured	1.34 ****
Tobacco use status	
Nonsmoker	Ref
Current smoker	0.34 ****
Former smoker	0.79 ****
Count of comorbidities	
0	Ref
1–2	0.73 ****
3–4	0.72 ****
5+	0.66 ****

SOURCE The Froedtert and the Medical College of Wisconsin Epic medical record.

NOTE

^a Unadjusted odds ratios for model limited to race/ethnicity variables: non-Hispanic White, reference; non-Hispanic Black, 3.72 ($p < 0.001$); Hispanic, 3.68 ($p < 0.001$).

**
 $p < 0.05$

 $p < 0.01$

 $p < 0.001$

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Exhibit 4:

Association between race/ethnicity and odds of hospitalization or hazards of death in patients with positive coronavirus disease 2019 infection

Variable	Hospitalization adjusted odds ratio ($n = 2,219$) ^a	Mortality adjusted hazard ratio, ($n = 2,219$) ^b
Race/ethnicity		
Non-Hispanic White	Ref	Ref
Non-Hispanic Black	2.15 ****	1.11
Hispanic	2.03 ***	2.09 **
Sex		
Female	Ref	Ref
Male	1.66 ****	1.02
Age	1.05 ****	1.07 ****
Location		
Milwaukee County	0.65	1.46
Waukesha County	0.61	1.21
Washington/Ozaukee County	0.59	0.47
Racine/Kenosha County	0.34 **	1.35
Other county/out of state	Ref	Ref
Primary payor		
Managed care/commercial	Ref	Ref
Medicare	3.83 ****	1.75
Medicaid	4.71 ****	1.91
Self-pay/uninsured	1.66	1.13
Tobacco use status		
Nonsmoker	Ref	Ref
Current smoker	1.60 **	0.71
Former smoker	1.35 **	1.47 *
Count of comorbidities		
0	Ref	Ref
1–2	0.85	0.59
3–4	0.54 ****	0.73
5+	0.72 *	1.25

SOURCE The Froedtert and the Medical College of Wisconsin Epic medical record.

NOTE

^aUnadjusted odds ratios for model limited to race/ethnicity variables: non-Hispanic White, reference; non-Hispanic Black, 2.13 ($p < 0.001$); Hispanic, 1.42 ($p < 0.10$).

^bUnadjusted hazard ratios for model limited to race/ethnicity variables: non-Hispanic White, reference; non-Hispanic Black, 1.32 ($p > 0.10$); Hispanic, 1.35 ($p > 0.10$).

*
 $p < 0.10$

**
 $p < 0.05$

 $p < 0.01$

 $p < 0.001$

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