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## Racial/ethnic disparities in COVID-19 disease burden & mortality among emergency department patients in a safety net health system

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### ABSTRACT

**Background:** We sought to examine racial and ethnic disparities in test positivity rate and mortality among emergency department (ED) patients tested for COVID-19 within an integrated public health system in Northern California.

**Methods:** In this retrospective study we analyzed data from patients seen at three EDs and tested for COVID-19 between April 6 through May 4, 2020. The primary outcome was the test positivity rate by race and ethnicity, and the secondary outcome was 30 day in-hospital mortality. We used multivariable logistic regression to examine associations with COVID-19 test positivity.

**Results:** There were 526 patients tested for COVID-19, of whom 95 (18.1%) tested positive. The mean age of patients tested was 54.2 years, 54.7% were male, and 76.1% had at least one medical comorbidity. Black patients accounted for 40.7% of those tested but 16.8% of the positive tests, and Latinx patients accounted for 26.4% of those tested but 58.9% of the positive tests. The test positivity rate among Latinx patients was 40.3% (56/139) compared with 10.1% (39/387) among non-Latinx patients ( $p < 0.001$ ). Latinx ethnicity was associated with COVID-19 test positivity (adjusted odds ratio 9.6, 95% confidence interval: 3.5–26.0). Mortality among Black patients was higher than non-Black patients (18.7% vs 1.3%,  $p < 0.001$ ).

**Conclusion:** We report a significant disparity in COVID-19 adjusted test positivity rate and crude mortality rate among Latinx and Black patients, respectively. Results from ED-based testing can identify racial and ethnic disparities in COVID-19 testing, test positivity rates, and mortality associated with COVID-19 infection and can be used by health departments to inform policy.

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## 1. Introduction

### 1.1. Background

In late December 2019 a novel coronavirus infection (COVID-19, SARS-CoV2) emerged from Wuhan, China and quickly became a pandemic with unprecedented impact on worldwide health care systems, social practices, and economies [1]. By September 2020, COVID-19 infected over 28 million people and resulted in nearly 975,000 deaths across 188 countries. The first known case in the United States (US) occurred in January 2020 and there are now more than 6.9 million cases and over 200,000 deaths nationally [1–3].

Early data from China and Europe suggests people with older age, hypertension, diabetes, and obesity are at increased risk of having a more serious illness course and death [4,5]. While US data reflects a

similar pattern of disease severity and mortality among older patients with pre-existing medical conditions, several reports also highlight a disproportionate burden of COVID-19 infection and related morbidity and mortality among racial and ethnic minorities [6]. As of June 2020, Black and Latinx people accounted for 22% and 33% of total COVID-19 cases in the US but make up only 13% and 16% of the total US population, respectively [7]. In addition limited preliminary data shows Latinx communities have a higher daily positivity rate in certain parts of Northeastern US including Baltimore, Maryland [8]. In New York City, the initial US epicenter of the pandemic, Latinx patients constituted 29% of the population but mortality was 34% with similar disparities among Blacks who made up 24% of the population but 28% of the mortality [9]. Compared to all other groups, Blacks have also been shown to have higher rates of hospitalization and mortality related to COVID-19 [10].

These statistics from national data are reflected in local communities within California. At the end of April 2020, the University of California, San Francisco (UCSF) performed COVID-19 tests on nearly 3000 residents and workers in the highly diverse Mission District of San Francisco and reported a 2.1% test positivity rate. Despite making up only 44% of

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those tested, Latinx patients accounted for 95% of those testing positive. This report also suggests that people who had lower annual income levels, greater household sizes and were unable to work from home, were more likely to test positive for COVID-19 [11,12]. Nonetheless overall disease prevalence is still likely underestimated in Black and Latinx communities due to notably poor access to testing for these populations [6].

Differences in COVID-19 health outcomes have been attributable to underlying racial and ethnic health disparities rooted in systemic racism and marginalization. These disparities have resulted in social and economic inequality including limited access to housing, healthy food options, healthcare facilities and health insurance. Language barriers and epigenetic health effects of racial bias have also been cited as major contributors [13–19]. Blacks have a higher rate of chronic health conditions at a younger age compared to the general population and have the highest rates of death from heart disease, cerebrovascular disease, cancer and HIV/AIDS compared to all other racial and ethnic groups in the US. Latinx Americans are almost twice as likely as their non-Latinx counterparts to die from diabetes [19,20]. These health disparities have been associated with increased risk of severe illness from COVID-19 infection [21].

### 1.2. Importance

As a safety net provider, EDs provide care to medically and socially vulnerable populations. Data has shown that significant number of symptomatic patients present to EDs for influenza-like illness (ILI) and testing for COVID-19 [22]. Safety net EDs have an important role in evaluating racial and ethnic minorities with ILI who have inequitable access to COVID-19 testing [23]. To our knowledge there is no existing literature on the racial and ethnic disparities in COVID-19 positivity among symptomatic patients tested for COVID-19 in the ED setting. Results from ED-based testing can identify racial and ethnic disparities in COVID-19 testing, test positivity rates, and morbidity and mortality that can be used by public health departments to inform policy and distribution of resources.

### 1.3. Goals of this investigation

We aim to examine racial and ethnic disparities in COVID-19 disease burden among patients tested in three EDs that are part of an integrated public healthcare system. We use multivariable logistic regression analysis to assess for demographic and clinical factors associated with COVID-19 test positivity, and we examine the 30-day in hospital mortality among patients admitted with COVID-19.

## 2. Materials and methods

### 2.1. Study design

This is a retrospective cohort study of patients tested for COVID-19 at three EDs within the Alameda Health System (AHS) between April 6 to May 4, 2020. April 6 was chosen as the study start date because this is the date when COVID-19 testing first became available for ED patients at AHS. Prior to this time, only patients admitted to the hospital were eligible for COVID-19 testing. This study was approved by the AHS Institutional Review Board with a waiver of written informed consent as the study posed no more than minimal risk to patients. We adhered to STROBE guidelines for conducting observational studies in epidemiology.

### 2.2. Study outcomes

The primary outcome was COVID-19 test positivity rate stratified by race and ethnicity, and the secondary outcome was 30-day in hospital mortality. We also report descriptive data on the epidemiology of COVID-19 among patients presenting to AHS EDs.

### 2.3. Study setting and population

Alameda Health System is an integrated public health system with three medical EDs that geographically span Alameda County, California: 1) Highland Hospital is an urban teaching hospital in Oakland, with an accredited 4-year Emergency Medicine residency program, and an annual volume of 65,000 patients per year; 2) San Leandro Hospital is an urban community hospital in San Leandro, with an ED volume of 30,000 patients per year; 3) Alameda Hospital is a suburban community hospital in Alameda, with an annual ED volume of 20,000 patients per year. Across the three EDs, 2% of patients are less than 12 years of age; approximately 45% of patients are Black, 25% Latinx, 15% white; and 45% are female.

During the study period, guidelines for testing were issued by the AHS COVID-19 Testing Committee, a multidisciplinary working group of physicians from infectious disease, laboratory, emergency and internal medicine. Due to a limited supply of COVID-19 tests, testing was restricted to the ED, the Highland urgent care clinic, and the inpatient medicine service. Test eligibility criteria were agreed upon and distributed across the medical system. Eligible patients included: 1) those admitted to the medicine service for presumed COVID-19 infection; 2) ED patients with a clinical syndrome consistent with COVID-19 infection who did not require hospitalization, but determined by the treating physician to be of moderate to high risk for a severe illness course due to medical co-morbidities such as diabetes, heart disease, pulmonary disease, or kidney disease; or 3) any patient felt to be infected with COVID-19 who also had social factors impacting disease transmission and community spread, such as housing insecurity or congregate living. AHS is unable to accommodate direct inpatient admissions from the community or from other facilities; therefore, all patients admitted for COVID-19 were admitted through the ED. COVID-19 testing was performed using PCR assays and conducted at either the Alameda County Department of Public Health Laboratory or the UCSF Laboratory.

### 2.4. Selection of participants

All unique ED patients tested for COVID-19 were eligible for inclusion. We excluded tests performed as part of disease monitoring for previously diagnosed patients or assessments for viral clearance, tests performed after inpatient admission, and tests performed in the urgent care clinic. Only the index ED COVID-19 test was included in the analysis for patients who had multiple tests. Race and ethnicity were self-identified by patients during ED registration from fixed categories.

### 2.5. Data abstraction

We analyzed data from the electronic health record (EHR) and stored it in REDCap (a secure online data collection instrument). REDCap was used by the AHS ED COVID-19 public health team for follow-up and surveillance protocols. All patients who were tested for COVID-19 at an AHS ED were included in this dataset. Patients who tested positive for COVID-19 had past medical and social history documented in the dataset prospectively, and study investigators conducted a retrospective chart review for patients who tested negative for COVID-19. The past medical and social history in the REDCap data collection instrument included co-morbidities, social/epidemiological factors (homelessness, congregate living, behavioral health concerns), race, ethnicity, age, and primary care physicians' (PCP) information. We conducted a final review of admitted patients on June 4, 2020 to assess for 30-day in hospital mortality.

### 2.6. Data analysis

Descriptive analyses were performed for all variables. Categorical data are reported as numbers and percentages and continuous data

are reported as means with standard deviation (SD). Bivariate statistical tests, including the Wilcoxon rank sum test, the chi-square tests, or Fisher's exact test, were used to compare variables. We conducted a power analysis for the regression model to ensure adequate power of 0.8 as convention to detect a 6% difference in test positivity between racial and ethnic groups. To adequately power the study, we found we needed 457 unique patient encounters. We pre-specified the regression model to contain COVID-19 positivity as the dependent variable, with the following predictor variables: race and ethnicity; age; medical comorbidities (that may influence disease severity); documented epidemiologic concern (defined as congregating living, healthcare worker, or living with elderly family members); skilled nursing facility residence; whether or not a patient had a PCP (to control for access to medical care); and which AHS ED conducted the test to control for geographic and hospital site clustering. All analyses were performed in Stata version 13.1 (Statacorp, College Station, TX).

### 3. Results

#### 3.1. Characteristics of Study Subjects

There were 526 patients tested for COVID-19 in the AHS EDs from April 6 through May 4, 2020, of whom 95 (18.1%) tested positive. Demographics of patients tested for COVID-19 from the overall cohort, as well as from each ED, can be found in Table 1. While all three hospitals provide care for racial and ethnically diverse patient populations, Alameda Hospital cares for a higher proportion of Asian patients and patients with private insurance. Of patients tested, the mean age was 54.2 (standard deviation [SD] 18.5), 287 (54.6%) were male, 214 (40.7%) were Black, 139 (26.4%) were Latinx, 83 (15.8%) were white, and 265 (50.4%) were discharged from the ED. Overall, 400 (76.0%) had at least one medical comorbidity; 138 (26.2%) had diabetes, 233 (44.3%) had hypertension, 107 (20.3%) had heart disease, 78 (14.8%) had chronic

or end-stage renal disease, 133 (25.3%) of patients had chronic obstructive pulmonary disease or asthma, 130 (24.7%) smoked tobacco products, 65 (12.4%) lived in skilled nursing facilities, 90 (17.1%) were homeless, and 374 (71.1%) spoke English as their primary language.

#### 3.2. Main results

Fig. 1 shows the COVID-19 testing rates and test-positivity rates stratified by race and ethnicity. Black patients accounted for 40.7% (214/526) of all patients tested but only 16.8% (16/95) of the positive tests, while Latinx patients accounted for 26.4% (139/526) of all patients tested but 58.9% (56/95) of the positive tests. The test positivity rate among Latinx patients was 40.3% (56/139) compared with the test positivity rate of 10.1% (39/387) among non-Latinx patients ( $p < 0.001$ ). The mean age among Latinx patients who tested positive was 46.2 (SD 14.7) compared to 64.4 (SD 21.9) for non-Latinx patients ( $p < 0.001$ ). 50.0% of Latinx patients with COVID-19 had at least one medical comorbidity compared with 79.5% of non-Latinx patients ( $p < 0.036$ ). The test positivity rate among patients with Spanish as their primary language was 46.8% (52/111) compared with the test positivity rate of 10.4% (43/415) among non-Spanish speakers. There were 35 Latinx patients whose primary language was English, of whom 8 (22.9%) tested positive for COVID-19.

The test positivity rate among Black patients was 7.5% (16/214) compared with the test positivity rate of 25.3% (79/312) among non-Black patients ( $p < 0.001$ ). The test positivity rate among white patients was 9.6% (8/83) compared with a test positivity rate of 19.6% (87/443) among non-white patients ( $P = 0.03$ ). The test positivity rate among Asian patients was 14.3% (6/42) compared with the test positivity rate of 18.4% (89/484) among non-Asian patients ( $p < 0.51$ ).

Factors associated with COVID-19 test positivity are shown in Table 2. In the results of the multivariable logistic regression model, Latinx ethnicity, unknown race or ethnicity, lack of primary care

**Table 1**  
Characteristics of patients tested for COVID-19 in Alameda Health System emergency departments from 4/6/2020 to 5/4/2020.

	All AHS tested COVID-19 N = 526 (%)	All AHS positive COVID-19 N = 95 (%)	HGH ED tested COVID-19 N = 358 (%)	HGH ED positive COVID-19 N = 71 (%)	SLH ED tested COVID-19 N = 90 (%)	SLH ED positive COVID-19 N = 22 (%)	ALH ED tested COVID-19 N = 78 (%)	ALH ED positive COVID-19 N = 2 (%)
Age, mean (SD), y	54.2 (18.5)	53.7 (20.0)	52.5 (17.2)	51.2 (20.2)	59.5 (17.7)	64.0 (15.3)	55.8 (23.2)	27.5 (2.1)
Age 18–34	88 (16.7)	19 (20.0)	63 (17.6)	17 (23.9)	9 (10.0)	0	16 (20.5)	2 (100)
Age 35–54	165 (31.4)	31 (32.6)	121 (33.8)	25 (35.2)	25 (27.8)	6 (27.3)	19 (24.4)	0
Age 55–74	204 (38.8)	30 (31.6)	141 (39.4)	19 (26.8)	40 (44.4)	11 (50.0)	23 (29.5)	0
Age 75+	69 (13.1)	15 (15.8)	33 (9.2)	10 (14.1)	16 (17.8)	5 (22.7)	20 (25.6)	0
Age 85+	35 (6.7)	10 (10.5)	14 (3.9)	6 (8.5)	9 (10.0)	4 (18.2)	12 (15.4)	0
Race/ethnicity								
Black	214 (40.7)	16 (16.8)	160 (44.7)	11 (15.5)	34 (37.8)	5 (22.7)	20 (28.6)	0
Latinx	139 (26.4)	56 (58.9)	105 (29.3)	45 (63.4)	24 (26.7)	10 (45.5)	10 (12.8)	1 (50.0)
White	83 (15.8)	8 (8.4)	45 (12.6)	7 (9.9)	18 (20.0)	1 (1.46)	20 (25.6)	0
Asian	41 (7.8)	6 (6.3)	20 (5.6)	2 (2.8)	5 (5.6)	3 (13.6)	16 (20.5)	1 (50.0)
Other	14 (2.7)	0	8 (2.2)	0	2 (2.2)	0	4 (5.1)	0
Unknown	35 (6.7)	9 (9.5)	20 (5.6)	6 (8.5)	7 (7.8)	3 (13.6)	8 (10.2)	0
Gender								
Female	238 (45.2)	43 (45.3)	155 (43.3)	32 (45.1)	42 (46.7)	10 (45.5)	42 (53.9)	1 (50.0)
Male	287 (54.6)	52 (54.7)	203 (56.7)	39 (54.9)	48 (53.3)	12 (54.5)	36 (46.2)	1 (50.0)
Disposition								
Admit/transfer	265 (50.4)	52 (54.7)	162 (45.3)	36 (50.7)	62 (68.9)	15 (68.2)	41 (52.3)	1 (50.0)
Discharge	261 (49.6)	43 (45.3)	196 (54.8)	35 (49.3)	28 (31.1)	7 (31.8)	37 (47.4)	1 (50.0)
Primary care provider								
Yes	337 (64.1)	44 (46.3)	220 (61.5)	30 (42.3)	57 (63.3)	13 (59.1)	60 (76.9)	1 (50.0)
No	189 (35.9)	51 (53.7)	138 (38.5)	41 (57.8)	33 (36.7)	9 (40.9)	18 (23.1)	1 (50.0)
Insurance								
Medicaid or county plan	216 (41.1)	35 (36.8)	153 (42.7)	26 (36.6)	26 (28.9)	8 (36.4)	27 (34.6)	1 (50.0)
Medicare	157 (29.8)	23 (24.2)	94 (26.3)	14 (19.7)	39 (43.3)	9 (40.9)	24 (30.8)	0
Uninsured	50 (9.5)	13 (13.7)	40 (11.2)	9 (12.7)	5 (5.6)	3 (13.6)	5 (6.4)	1 (50.0)
Private	72 (13.7)	8 (8.4)	40 (11.2)	8 (11.3)	7 (7.8)	0	17 (21.8)	0

Ethnicity non-Latinx unless specified.

AHS, Alameda Health System (includes all three emergency departments); ED, emergency department; HGH, Highland Hospital; SLH, San Leandro Hospital; ALH, Alameda Hospital; CI, confidence interval; SD, Standard Deviation; IQR, interquartile range.

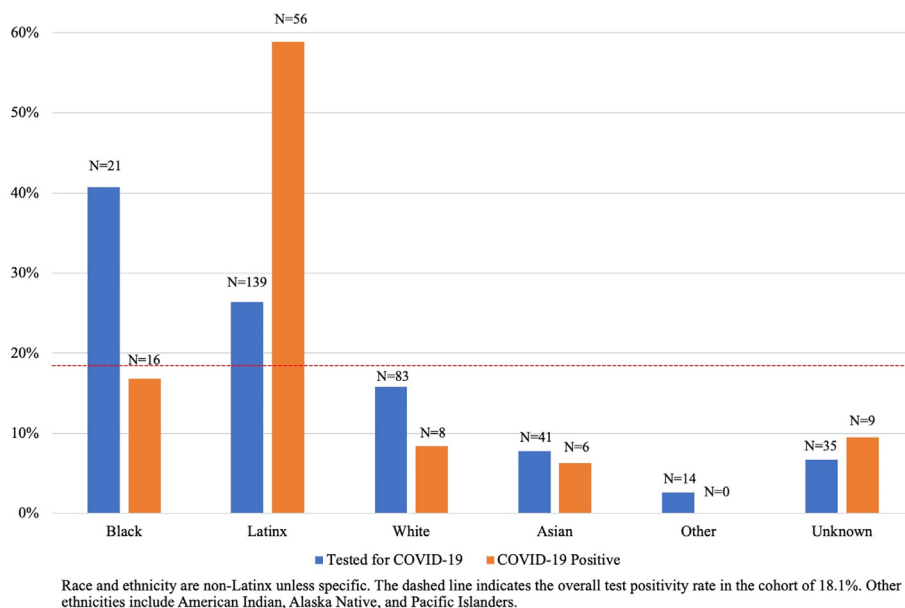


Fig. 1. Rates of testing and test positivity rate by race and ethnicity among Alameda Health System Emergency department patients, 4/6/2020 to 5/4/2020.

Table 2

Factors associated with positive COVID-19 test result and predictive margins.

	Tested COVID-19 N = 526	Positive COVID-19 N = 95	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	Predictive margin (95% CI)
Age category, N (%)					
Age 18–24	31	9 (29.0)	1.9 (0.9–4.4)	1.0	0.22 (0.10–0.34)
Age 25–34	57	10 (17.5)	1.0 (0.5–2.0)	0.4 (0.1–1.4)	0.13 (0.06–0.20)
Age 35–44	77	16 (20.8)	1.2 (0.7–2.2)	0.7 (0.2–2.3)	0.18 (0.11–0.26)
Age 45–54	88	15 (17.0)	0.9 (0.5–1.7)	0.8 (0.3–2.6)	0.20 (0.12–0.27)
Age 55–64	119	16 (13.4)	0.6 (0.3–1.1)	0.6 (0.2–2.0)	0.16 (0.09–0.22)
Age 65–74	85	17 (20.0)	1.0 (0.5–1.8)	1.1 (0.3–4.0)	0.23 (0.14–0.32)
Age 75–85	34	5 (14.7)	0.8 (0.3–2.0)	0.6 (0.1–3.1)	0.17 (0.04–0.29)
Age 85+	35	10 (28.6)	1.9 (0.9–4.1)	1.4 (0.3–6.1)	0.26 (0.13–0.39)
Race/ethnicity, N (%)					
White	83	8 (9.6)	0.4 (0.2–0.9)	1.0	0.10 (0.04–0.15)
Black	214	16 (7.5)	0.2 (0.1–0.4)	0.7 (0.3–2.0)	0.07 (0.04–0.11)
Latinx	139	56 (40.3)	6.0 (3.7–9.7)	9.6 (3.5–26.0)	0.39 (0.31–0.46)
Asian	41	6 (14.6)	0.7 (0.3–1.8)	1.1 (0.3–4.6)	0.11 (0.02–0.19)
Other	14	0 (0)	–	–	–
Unknown	35	9 (25.7)	1.6 (0.7–3.6)	4.5 (1.3–15.7)	0.26 (0.13–0.39)
Gender, N (%)					
Female	238	43 (18.1)	1.0 (0.6–1.5)	1.0	0.17 (0.13–0.21)
Male	287	52 (18.1)	1.0 (0.6–1.6)	1.2 (0.7–2.1)	0.20 (0.16–0.24)
AHS ED, N (%)					
Highland Hospital	358	71 (19.8)	1.5 (0.9–2.5)	1.0	0.20 (0.16–0.23)
San Leandro Hospital	90	22 (24.4)	1.6 (0.9–2.8)	1.5 (0.7–2.8)	0.25 (0.17–0.32)
Alameda Hospital	78	2 (2.6)	0.1 (0.0–0.4)	0.1 (0.0–0.4)	0.03 (0.0–0.07)
Primary care doctor, N (%)					
Yes	337	51 (15.1)	0.4 (0.3–0.6)	1.0	0.15 (0.12–0.19)
No	189	44 (23.2)	2.5 (1.6–3.9)	2.0 (1.1–3.4)	0.23 (0.18–0.28)
Skilled nursing facility, N (%)					
No	461	69 (15.0)	0.3 (0.2–0.5)	1.0	0.15 (0.12–0.18)
Yes	65	26 (40.0)	3.4 (2.2–6.6)	10.6 (4.6–24.6)	0.46 (0.35–0.58)
Epidemiologic concern (any), N (%)					
No	482	85 (17.6)	0.7 (0.3–1.4)	1.0	0.18 (0.15–0.21)
Yes	44	10 (22.7)	1.4 (0.7–2.9)	0.9 (0.4–2.3)	0.19 (0.10–0.29)
Medical co-morbidity (any), N (%)					
No	400	59 (14.8)	2.5 (1.4–6.7)	1.0	0.16 (0.13–0.20)
Yes	126	36 (28.6)	0.4 (0.3–0.7)	1.7 (0.9–3.4)	0.23 (0.16–0.29)

Proportions are based on the denominator in each row.

Ethnicity is non-Latinx unless specified.

Epidemiologic concern (as documented in the medical record) defined by: congregate living, living with family member(s) over 60 years old, living with family member(s) with chronic diseases (diabetes, lung disease, heart disease), healthcare workers, other essential service worker.

Medical co-morbidity (as documented in the medical record) defined by: diabetes, hypertension, chronic or end stage kidney disease, human immunodeficiency virus, chronic obstructive pulmonary disease or asthma, active cancer, history of stroke, or current smoker.

CI, confidence interval; AHS, Alameda Health System; ED, emergency department.

physicians, and skilled nursing facility residence were associated with higher odds of COVID-19 test positivity; Alameda Hospital site of testing was associated with a lower adjusted odds of COVID-19 test positivity. Latinx patients had an adjusted odds ratio (aOR) of 9.6 (95% CI: 3.5–26.0; predictive margin 0.39); unknown race or ethnicity had an aOR of 4.5 (95% CI: 1.3–15.7; predictive margin 0.26); lack of a primary care physician had an aOR of 2.0 (95% CI: 1.1–3.4, predictive margin 0.23); skilled nursing facility residence had an aOR of 10.6 (4.6–24.6; predictive margin 0.46); and patients at Alameda Hospital had an aOR of 0.1 (95% CI: 0.0–0.4; predictive margin 0.03) of COVID-19 test positivity.

Table 3 shows the rates of hospital admission and in-hospital mortality for patients who tested positive for COVID-19. Of the 95 patients with COVID-19, 52 (54.7%) were admitted (17 required ICU care), 4 (4.2%) died, and 2 (2.1%) were still in the hospital as of June 4th 2020. Of the two patients remaining in the hospital, 1 was white and 1 was Latinx. The mean age of patients admitted to the ICU was 63.7 (SD 14.6) and the mean age of those who died was 82.5 (SD 8.4). All 4 patients who died lived in a skilled nursing facility and had >3 chronic medical conditions. Crude mortality among Black patients was significantly higher than for non-Black patients (18.7% vs 1.3%,  $p < 0.01$ ).

**Table 3**  
Rates of intensive care and in-hospital mortality among emergency department patients with COVID-19 admitted to Alameda Health System hospitals from 4/6/2020 to 5/4/2020.

	COVID-19 positive N = 95	Non-ICU admission N = 35	ICU admission N = 17	In-hospital mortality N = 4
Age category, N (%)				
Age 18–34 (%)	19	4 (21.0)	0	0
Age 35–54	31	13 (41.9)	5 (16.1)	0
Age 55–74	30	8 (26.7)	9 (30.0)	1 (3.3)
Age 75+	15	10 (66.7)	3 (20.0)	3 (20.0)
Race/ethnicity <sup>a</sup> , N (%)				
Black	16	7 (43.8)	4 (25.0)	3 (18.8)
Latinx	56	17 (30.4)	9 (16.1)	0
White	8	5 (62.5)	2 (25.0)	0
Asian	6	3 (50.0)	1 (16.7)	1 (16.7)
Other	0	0	0	0
Unknown	9	3 (33.3)	1 (11.1)	0
Medical comorbidities <sup>b</sup> , N (%)				
Diabetes	29	11 (37.9)	9 (31.0)	2 (6.9)
Hypertension	34	15 (44.1)	8 (23.5)	3 (8.8)
Heart Disease	9	3 (33.3)	4 (44.4)	2 (22.2)
Renal Disease (CKD or ESRD)	8	2 (25.0)	2 (25.0)	2 (25.0)
COPD or Asthma	5	2 (40.0)	1 (20.0)	1 (20.0)
Skilled Nursing Facility Resident	26	14 (53.8)	6 (23.1)	4 (15.4)
Gender, N (%)				
Female	43	16 (37.2)	5 (11.6)	1 (2.3)
Male	52	19 (36.5)	12 (23.1)	3 (5.8)
AHS site, N (%)				
Highland Hospital	71	25 (35.2)	11 (15.5)	4 (100)
San Leandro Hospital	22	9 (40.9)	6 (27.3)	0
Alameda Hospital	2	1 (50.0)	0	0
Primary care provider, N (%)				
Yes	51	14 (27.5)	6 (11.8)	0
No	44	21 (47.7)	11 (25.0)	4 (9.1)
Insurance, N (%)				
Medical or county health plan	35	12 (34.3)	7 (20.0)	1 (2.9)
Medicare	23	12 (52.2)	5 (21.7)	3 (13.0)
Uninsured	13	1 (7.7)	3 (23.1)	0
Private	8	4 (50.0)	0	0

2 patients remain admitted as of 6/4/2020. Intensive care admission and mortality rates are based on the row variable as the denominator.

ICU: Intensive Care Unit; SD, Standard Deviation; CKD, chronic kidney disease; ESRD, end-stage renal disease; COPD, chronic obstructive pulmonary disease; AHS, Alameda Health System.

<sup>a</sup> Ethnicity non-Latinx unless specified.

<sup>b</sup> Many patients had more than one co-morbidity.

#### 4. Limitations

Our study reports the outcomes of ED-based COVID-19 testing within a single health care system in Northern California and may not be generalizable to other care settings. Importantly, COVID-19 testing was driven by an institutionally defined policy, determined by local expert consensus to test vulnerable populations with severe symptoms, and influenced, in part, by test availability. Our data does not report the prevalence of COVID-19 within our ED population, but rather the positivity rate among a selected group of symptomatic and vulnerable patients.

Our data does not allow for the comparison of patients with cough, fever, or ILI who may have met our eligibility criteria for COVID-19 testing, but who were not tested. During the time-period of this study we did not have a diagnosis code for suspected COVID-19 and our EHR screening tool was based on travel history. How the role of race, ethnicity, and other factors, such as language barriers, bias COVID-19 testing requires further study.

Lastly, given the small numbers of deaths in our study population using a 30-day inpatient mortality outcome, we were unable to control for factors associated with mortality, such as medical comorbidities, race/ethnicity, or socioeconomic variables.

#### 5. Discussion

Among patients tested across three urban EDs in an integrated public health system in Northern California, we found significantly higher COVID-19 test positivity rate in the Latinx community. While ED testing within an integrated public health system is not necessarily representative of Alameda County, our results are consistent with other studies showing a disproportionate COVID-19 disease burden in the Latinx population in the San Francisco Bay Area and California [10]. One definition of a healthcare disparity is defined as a difference in outcome by race or ethnicity not attributable to access to care [24]. A strength of our study is that we demonstrate the disparity in COVID-19 test positivity rate to be significant even after controlling for access to care, age, medical comorbidities, social factors and site of testing. This analysis helps frame the discussion around healthcare disparities and can focus responses tailored to specific communities during this pandemic.

The higher rate of positivity in Latinx patients may be explained by socioeconomic factors that put these communities at greater risk for exposure to infection. Of the nearly 3000 people tested for COVID-19 in the San Francisco Mission study, 62 were positive, 95% of whom were Latinx. Of the 62 patients who tested positive for COVID-19 in this study, 90% stated they were unable to work from home, 89.9% reported a household income of <\$50,000 per year, 59.6% report a total household size of 3–5 people and 28.8% of >5 people [11,12]. These factors may hold true in our population as well, although we did not examine the contribution of socioeconomic status and COVID-19 test positivity in our study. Racial and ethnic minorities are more likely to live in densely populated areas, in multi-generational group homes, and have a higher representation in congregate living settings including jails, prisons and detention centers [25]. In addition, many racial and ethnic minorities are more likely to work as essential workers in the service industry. These include positions in agriculture, in meat packing plants, as day laborers, and as caretakers where maintaining social distancing is difficult. One such example is the recent outbreak of COVID-19 in workers in the meat-packing industry, most of whom are Latinx, that was significant enough to cause a national decrease in the US meat supply [26,27]. Moreover, Latinx have the lowest rates of paid sick leave and may not be financially able to take time off work when they or a family member gets sick with COVID-19 [28]. In our study, we found that the median age of Latinx patients who tested positive for COVID-19 to be nearly 20 years younger than non-Latinx patients, suggesting that this community may be more likely to be working and unable to shelter in place at home due to financial obligations.

Within AHS, Highland and San Leandro Hospitals had higher test positivity rates of COVID-19 (19.8% and 24.4% respectively) compared to Alameda Hospital (2.6%), which cares for a slightly less diverse patient population with a higher proportion of patients that have private insurance. These findings highlight the unequal impact on hospitals caring for vulnerable populations and the disparate impact of COVID-19 geographically, even within integrated health systems.

While our sample size is relatively small, we did find a higher unadjusted mortality rate among Black patients. This disparity is consistent with other published data from the COVID-19 pandemic, but is difficult to interpret due to the small overall number of deaths at AHS during the study period [6–9,30]. A recent study of 3626 patients in a large cohort in Louisiana revealed that 70.6% of patients hospitalized for COVID-19 who died were Black even though they comprised only 31% of the population [29]. Our findings suggest that future work should not only take into account disparities in disease burden within a health system, but also disparities in mortality within each community. Despite the higher test positivity rate among Latinx patients, the relatively lower mortality and ICU admission rates may be age related; among our cohort, Latinx patients diagnosed with COVID-19 were significantly younger than non-Latinx patients. These findings highlight the need for focused interventions that target both the Black and Latinx communities.

Emergency departments have a history of engaging in public health and epidemiology, shaping screening recommendations and detecting outbreaks for influenza, HIV, and hepatitis C virus infections [31–33]. A similar approach should be implemented among EDs during the COVID-19 pandemic. As a part of integrated public health programs, EDs can monitor for outbreaks and disparities in disease burden as well as implement targeted and culturally appropriate responses. The data collected as part of ED surveillance has helped to inform local public health policies: including prioritizing stand-up testing sites in neighborhoods with high proportions of Latinx citizens and identifying the need for isolation housing for patients living in households with high numbers of people. In the time since this study period ended, the ED public health team contributed data to the county identifying an emerging outbreak among Mexican and Guatemalan communities who primarily speak Mayan indigenous languages, and the AHS ED public health team collaborated with the newly formed Alameda County COVID-19 Latinx Task Force.

While community testing sites have increased significantly since the onset of the pandemic, EDs will remain high-volume testing locations for COVID-19 for the most symptomatic patients, as well as patients coming from disadvantaged communities. Safety-net EDs may be more sensitive to the early detection of outbreaks in vulnerable populations, including immigrant communities, patients experiencing homelessness, as well as those with significant psychiatric and substance use disorders. Close attention to these communities is critical to COVID-19 public health responses, and EDs should leverage any existing public health infrastructure for these purposes. For example, staff from the AHS HIV and hepatitis C virus screening program were re-tailored to facilitate COVID-19 follow up, wellness checks, and care coordination with primary care and the public health department using pre-existing relationships and workflows. Additional AHS emergency medicine public health collaborations have included stand-up community testing sites under the direction of an EM physician working with the county public health department for neighborhoods disproportionately impacted by COVID-19, while another EM physician has spearheaded efforts to house patients experiencing homelessness affected by COVID-19 [34,35]. Lastly, as the COVID-19 pandemic ebbs and flows, there will be an increased role for ED testing of both symptomatic and asymptomatic patients. Close coordination with public health departments and contact tracing programs will be critical to sustaining low rates of transmission within communities.

## 6. Conclusion

Among three EDs in an integrated public health system, we report a significant disparity in COVID-19 disease burden in the Latinx

community, and disproportionate mortality among Black patients. These findings are consistent with other regional and national data and suggest that where racial and ethnic minorities live and work contributes to a greater risk of infection with COVID-19. These communities are often less able to shelter in place, work from home or financially maintain work furloughs. Emergency departments have an important role interfacing with the community and public health departments in the detection of outbreaks, disparities in disease burden, and surveillance of COVID-19.

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## Author contributions

BP, DAEW and ESA conceived the study design, supervised data collection and creation of the manuscript. NM, BP, KB, EFH, BB, KK and ESA managed chart review. NM and BP drafted the manuscript, and all authors contributed substantially to its revision. DAEW and ESA provided statistical advice on study design and analyzed the data. NM and ESA take responsibility for the paper as a whole.

## Declaration of Competing Interest

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## References

- [1] Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. *New Engl J of Med.* 2020;382(8):727–33. <https://doi.org/10.1056/nejmoa2001017>.
- [2] Coronavirus COVID-19 global cases. The Center for Systems Science and Engineering (CSSE) at Johns Hopkins University; 2020. <https://coronavirus.jhu.edu/map.html> (Accessed September 10, 2020).
- [3] Holshue ML, DeBolt C, Lindquist S, et al. First case of 2019 novel coronavirus in the United States. *New Engl J Med.* 2020;382(10):929–36. <https://doi.org/10.1056/nejmoa2001191>.
- [4] 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):1054–62. [https://doi.org/10.1016/s0140-6736\(20\)30566-3](https://doi.org/10.1016/s0140-6736(20)30566-3).
- [5] Huang I, Lim MA, Pranata R. Diabetes mellitus is associated with increased mortality and severity of disease in COVID-19 pneumonia – a systematic review, meta-analysis, and meta-regression. *Diabetes Metab Syndr Clin Res Rev.* 2020;14(4): 395–403. <https://doi.org/10.1016/j.dsx.2020.04.018>.
- [6] Schmitt-Grohé S, Teoh K, Uribe M. Covid-19: testing inequality in New York City; April 2020. <https://doi.org/10.3386/w27019>.
- [7] Cases in the U.S. Centers for Disease Control and Prevention; June 5, 2020. <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html> (Accessed June 8, 2020).
- [8] Olmes L, Enwere M, Williams J, et al. Black–White risk differentials in COVID-19 (SARS-CoV2) transmission, mortality and case fatality in the United States: translational epidemiologic perspective and challenges. *International Journal of Environmental Research and Public Health.* 2020;17(12):4322. <https://doi.org/10.3390/ijerph17124322>.
- [9] Martinez DA, Hinson JS, Klein EY, et al. SARS-CoV-2 positivity rate for Latinos in the Baltimore–Washington, DC Region. *Jama.* 2020;324(4):392. <https://doi.org/10.1001/jama.2020.11374>.
- [10] 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 Morbid Mortal Weekly Rep.* 2020;69(15):458–64. <https://doi.org/10.15585/mmwr.mm6915e3>.
- [11] Initial results of mission district COVID-19 testing announced. UC San Francisco: Initial Results of Mission District COVID-19 Testing Announced; June 4, 2020. <https://www.ucsf.edu/news/2020/05/417356/initial-results-mission-district-covid-19-testing-announced> (Accessed June 8, 2020).
- [12] Mission District (The Mission) neighborhood in San Francisco, California (CA), 94103, 94110 detailed profile. Retrieved May 15, 2020. <http://www.city-data.com/neighborhood/Mission-District-San-Francisco-CA.html>
- [13] Wisniewski JM, Walker B. Association of simulated patient race/ethnicity with scheduling of primary care appointments. *JAMA Network Open.* 2020;3(1). <https://doi.org/10.1001/jamanetworkopen.2019.20010>.

- [14] Buchmueller TC, Levy HG. The ACA's impact on racial and ethnic disparities in health insurance coverage and access to care. *Health Aff.* 2020;39(3):395–402. <https://doi.org/10.1377/hlthaff.2019.01394>.
- [15] Manuel JI. Racial/ethnic and gender disparities in health care use and access. *Health Serv Res.* 2017;53(3):1407–29. <https://doi.org/10.1111/1475-6773.12705>.
- [16] Fernandez A, Schillinger D, Warton EM, et al. Language barriers, physician-patient language concordance, and glycemic control among insured Latinos with diabetes: the Diabetes Study of Northern California (DISTANCE). *J Gen Intern Med.* 2010;26(2):170–6. <https://doi.org/10.1007/s11606-010-1507-6>.
- [17] Ngo-Metzger Q, Sorkin DH, Phillips RS, et al. Providing high-quality care for limited english proficient patients: the importance of language concordance and interpreter use. *J Gen Intern Med.* 2007;22(S2):324–30. <https://doi.org/10.1007/s11606-007-0340-z>.
- [18] Williams DR, Lawrence JA, Davis BA, Vu C. Understanding how discrimination can affect health. *Health Serv Res.* 2019;54(S2):1374–88. <https://doi.org/10.1111/1475-6773.13222>.
- [19] Artiga S, Garfield R, Orgera K. Communities of Color at Higher Risk for Health and Economic Challenges due to COVID-19. KFF. <https://www.kff.org/disparities-policy/issue-brief/communities-of-color-at-higher-risk-for-health-and-economic-challenges-due-to-covid-19/>; April 8, 2020.
- [20] Smedley B, Stith A, Nelson A. Unequal treatment. Institute of Medicine: National Center for Biotechnology Information; 2003. <https://www.ncbi.nlm.nih.gov/books/NBK220358/> (Accessed June 8, 2020).
- [21] Long B, Brady WJ, Koyfman A, Gottlieb M. Cardiovascular complications in COVID-19. *Am J Emerg Med.* 2020;38(7):1504–7. <https://doi.org/10.1016/j.ajem.2020.04.048>.
- [22] Emergency department visits percentage of visits for COVID-19-like illness (CLI) or influenza-like illness (ILI). Centers for Disease Control and Prevention; May 15, 2020 <https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/05152020/covid-like-illness.html>.
- [23] Schmitt-Grohe S, Teoh K, Uribe M. Covid-19: testing inequality in New York City. NBER Working Papers. Working Paper 27019 <http://www.nber.org/papers/w27019>; 2020.
- [24] Yancy CW. COVID-19 and African Americans. *JAMA.* 2020;323(19):1891–2. <https://doi.org/10.1001/jama.2020.6548>.
- [25] COVID-19 in racial and ethnic minority groups. Centers for Disease Control and Prevention; June 4, 2020. <https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/racial-ethnic-minorities.html>.
- [26] Dyal JW, Grant MP, Broadwater K, et al. COVID-19 Among workers in meat and poultry processing facilities — 19 States, April 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:557–61. <https://doi.org/10.15585/mmwr.mm6918e3>.
- [27] 2002 EEO-1 aggregate report for meat packing plants. U.S. Equal Employment Opportunity Commission; March 17, 2004. <https://www.eeoc.gov/eo-1/2002-eeo-1-aggregate-report-meat-packing-plants> (Accessed June 8, 2020).
- [28] Bartel A, Kim K, Nam J. Racial and ethnic disparities in access to and use of paid family and medical leave: evidence from four nationally representative datasets: monthly labor review. U.S. Bureau of Labor Statistics; January 1, 2019. <https://www.bls.gov/opub/mlr/2019/article/racial-and-ethnic-disparities-in-access-to-and-use-of-paid-family-and-medical-leave.htm> (Accessed June 8, 2020).
- [29] Price-Haywood EG, Burton J, Fort D, Seoane L. Hospitalization and mortality among Black patients and White patients with Covid-19. *New Engl J Med.* May 2020. <https://doi.org/10.1056/nejmsa2011686>.
- [30] Egbert A, Clary B. COVID-19 deaths analyzed by race and ethnicity. *APM Research Lab*; May 27, 2020. <https://www.apmresearchlab.org/covid/deaths-by-race> (Accessed June 8, 2020).
- [31] Dugas A, Hsieh Y-H, Levin S, et al. Google flu trends: correlation with emergency department influenza rates and crowding metrics. *Emerg Health Threats J.* 2012;4(0). <https://doi.org/10.3402/ehth.v4i0.11187>.
- [32] Centers for Disease Control and Prevention (CDC). Rapid HIV testing in emergency departments—three U.S. sites, January 2005–March 2006. *MMWR Morbid Mortal Week Rep.* June 22, 2007;56(24):597–601 (Accessed June 8, 2020).
- [33] Galbraith JW, Anderson ES, Hsieh Y, Franco R, Donnelly J, Rodgers J, et al. High prevalence of hepatitis C infection among adult patients at four urban emergency departments – Birmingham, Alabama; Oakland, California; Baltimore, Maryland; and Boston, Massachusetts, 2015–2017. *MMWR Morb Mortal Wkly Rep.* 2020;69:569–74. <https://doi.org/10.15585/mmwr.mm6919a1>.
- [34] Lin S. Coronavirus test sites are opening in East Oakland's most impacted neighborhoods. *Berkeleyside*; May 7, 2020. <https://www.berkeleyside.com/2020/05/06/roots-community-health-clinic-is-offering-free-testing-starting-tomorrow-and-allen-temple-baptist-church-and-lifelong-medical-care-plans-to-open-another-test-site-soon> (Accessed June 8, 2020).
- [35] Alameda county COVID-19 isolation and social distancing emergency housing. *ACPHD*. <http://www.acphd.org/2019-ncov/isolation-housing.aspx>. (Accessed June 8, 2020).