Understanding the trends in race, sex, and age: an epidemiological descriptive study of socio-demographic factors for COVID-19 deaths and cases in Michigan

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Abstract

While disparities have been observed in the impacts of COVID-19 in the United States, there is limited literature available specific to the state of Michigan. The purpose of this study is to understand if the nationally observed disparities exist in Michigan. This study analyzed disparities by examining data from the Michigan Department of Health and Human Services (MDHHS) with attention to prevalence rates and case fatality rates for COVID-19 in Michigan. Analysis was done through the calculation of crude prevalence. Race-specific and sex-specific prevalences were calculated individually to highlight differences based on socio-demographic factors. Findings revealed that: (1) males are more likely to test positive and die from COVID-19 compared to females, (2) Black/African American individuals have higher fatality rates when compared to other racial groups, and (3) older adults are found to have higher death rates than younger adults. These findings are important as they tease out existing health disparities from COVID-19. This study suggests that COVID-19 mitigation efforts should focus on the socio-demographic factors that are most disproportionately affected by COVID-19.

Background

The first case of Severe Acute Respiratory Syndrome Coronavirus (SARS COV-2) in the United States was reported on January 20, 2020 [1]. According to the World Health Organization (WHO), COVID-19 has infected more than 33 million people in the United States and caused over 500,000 deaths [2]. National data suggests COVID-19 infection and mortality rates are disproportionately affecting marginalized populations and individuals of lower socioeconomic status. As of March 31, 2021, Johns Hopkins University School of Medicine reported the United States as the country with the most positive cases worldwide. On February 4, 2020, the secretary of Health and Human Services (HHS) gave emergency use authorization for in vitro diagnostic testing for SARS COV-2, but due to limitations on reagents and supplies, tests were limited solely to symptomatic patients [3]. Given this pattern of testing, the true prevalence rates were unknown. Michigan reported its first two cases on March 10, 2020, and declared a stay-at-home order in approximately two weeks for Michigan citizens not considered essential workers [4].

On March 19, with an increase in testing, the first spike in positive cases was reported [4]. In this first spike of positive cases, 254 cases were reported in a single day [4]. The rise of positive cases due to testing availability demonstrates the impact that the lack of testing has on true prevalence rates of COVID-19 cases [4]. By March 25, 2020, Michigan officially became the 5th state in the United States with the most positive cases [4]. As of September 7, 2020, there have been 961,953 confirmed total positive cases and 20,367 reported fatalities in the state of Michigan [4].

The goal of this study is to report prevalence rates and case fatality rates for COVID-19 in Michigan while adjusting for race, age, and sex. Data was obtained through the Michigan Department of Health and Human Services (MDHHS) Disease and Surveillance and obtained from March 2020 through March 2021 representing all Michigan counties.

Methods

Study Population and Data Collection

COVID-19 demographic data were abstracted from the Michigan Department of Health and Human Services (MDHHS). Data are reported to MDHHS via the Michigan Disease Surveillance System (MDSS). The data were provided as deidentified datasets for public use, foregoing the need for an IRB. Provisional death data are provided by the DHSS Division for Vital Records & Health

Statistics. It consisted of data regarding patient age, race, sex, COVID-related cases, and COVID-related deaths. The study population included a total of 598,911 cases and 15,634 deaths. Population-level data were abstracted from the U.S. Census, which reported population estimates for

Michigan, most recently updated on July 1, 2019. Both datasets were accessed on March 9, 2021; however, datasets represent a time frame of January 2020 through March 9, 2021.

Classification of Study Patients

The MDHHS defined confirmed cases as individuals who have had a positive diagnostic laboratory test for COVID-19. Probable cases included: 1) individuals who had symptoms consistent with COVID-19 and an epidemiologic link to a confirmed case, or a positive serology (antibody) test but did not have a positive diagnostic laboratory test for COVID-19 and 2) individuals with a positive serology (antibody) test for COVID-19 and an epidemiologic link to a confirmed case. In an effort to avoid introduction of biases related to the conflation of COVID-19 symptoms with other respiratory illnesses, probable cases were removed from our dataset and only confirmed cases remained. The MDHHS defined confirmed deaths to include individuals who meet one or more of the following conditions:

1. Have been identified as a confirmed case and classified as deceased as a result of a case investigation in the Michigan Disease Surveillance System (MDSS);

2. Have been identified as a confirmed case in MDSS had have a death certificate with COVID-19 listed as a cause of death;

3. Have been identified as a confirmed case in MDSS and died within 30 days of onset of COVID-19 infection and have a death certificate which classifies their manner of death as 'natural.'

Probable deaths include individuals who had COVID indicated as a cause of death on their death certificate but did not have a positive diagnostic laboratory test. In order to maintain consistency and prevent the introduction of erroneous bias, probable deaths were also removed from our dataset. Additionally, the MDSS suppressed data when the number of cases or deaths in a single category was between one and five in order to protect the confidentiality of individuals. Data analysis consisted of stratifying the cases and deaths by selected demographics, in hopes of providing a summary of COVID-19 trends in Michigan. In order to adjust for race and sex distribution, U.S. Census data were used to calculate the race-specific prevalence and sex-specific prevalence of COVID-19 cases.

Analysis

Prevalence data were reported from the MDSS public-use datasets. Crude prevalences were calculated using the following formula:

$$\frac{\textit{All new and pre-exisiting cases of COVID-19 for a specified demographic}}{\textit{Total population}}$$

The crude prevalence rates did not take into account the differences in population between races, so race-specific and sex-specific prevalences were calculated using the following formula:

$$\frac{\textit{All new and pre-exisiting cases of COVID-19 for a specified race or sex}}{\textit{Total population for the specified race or sex}}$$

The numerator for each rate remains the same, but the denominator changes so that we restrict the total population to only the specific population for each demographic group. This allows us to more faithfully compare prevalence rates, as we are adjusting for differences in population sizes between groups. Rates were not calculated for "other," "multiple," and "unknown" race groups because population data were not available for these groups. Adjusted rates were not calculated for "age" groups because population data were not readily available for these groups. All statistical analyses were conducted using SAS, version 9.4 (SAS Institute, NC).

Results

Demographics

The study population of 598,911 individuals included 49% males (N=290,884) and 51% females (N=304,756). More than half (58.38%) of individuals identified as White, 11.72% identified as Black/African American, 1.61% as Asian/Pacific Islander, 0.52% as American Indian/Alaskan Native, 4.02% as multiple races, 5.64% as other, and 18.11% as unknown. Ages ranged from 0-9 to 80+ with the 20-29 age group representing the highest percentage of cases.

Sex-Specific Prevalence vs. CFR

The crude prevalence of COVID-19 in Michigan among males was higher than that of females (crude prevalence: 3.05% vs 2.91%) (Table 3). After adjusting for Michigan's overall sex distribution, males still had a higher prevalence than females (sex-specific prevalence: 6.02% vs 5.91%) (Table 3).

Table 1. ***Michigan COVID-19 cases and deaths, stratified by selected demographic variables.***

	Cases		Deaths		Case-Fatality Rate
Characteristic	N	%	N	%	%
Total	598,911	--	15,634	--	
Sex					
Male	290,884	48.57	8,369	53.53	2.88
Female	304,756	50.89	7,265	46.47	2.38
Race					
White	349,664	58.38	10,518	67.28	3.01
Black/African American	70,176	11.72	3,457	22.11	4.93
Asian/Pacific Islander	9,620	1.61	158	1.01	1.64
American Indian/Alaskan Native	3,097	0.52	61	0.39	1.97
Multiple Races	24,079	4.02	240	1.54	1.00
Other	33,801	5.64	404	2.58	1.20
Unknown	108,474	18.11	796	5.09	0.73
Age					
0-9*	17,316	2.89	0	0	0
10-19*	58,832	9.82	0	0	0
20-29	112,858	18.84	58	0.37	0.05
30-39	90,054	15.04	103	0.66	0.11
40-49	86,774	14.49	366	2.34	0.42
50-59	92,313	15.41	1,046	6.69	1.13
60-69	70,354	11.75	2,546	16.29	3.62
70-79	41,128	6.87	4,233	27.08	10.29
80+	28,843	4.82	7,282	46.58	25.25
Unknown	439	0.07	0	0	0

**Data is suppressed when the number of cases or deaths in a single category is between one and five to protect the confidentiality of individuals.*

Additionally, the case-fatality rate was higher for males than females, at 2.88 vs. 2.38, respectively (Table 1). This illustrates that males are more likely than females to test positive for COVID-19, as well as die from it.

Race-Specific Prevalence vs. CFR

The prevalence of COVID-19 among the White population in Michigan is higher than that of the Black/African American, American Indian/Alaska Native, and Asian/Pacific Islander populations (crude prevalences: 3.50%, 0.70%, 0.03%, and 0.1%, respectively) (Table 2). After adjusting for Michigan's race distribution, the Black/African American population had the highest prevalence, followed by American Indian/Alaska Native, Whites, and Asian/Pacific Islander (race-specific prevalence 4.98%, 4.43%, 4.42%, and 2.83%, respectively) (Table 2). The case-fatality rate was significantly higher among Black/African Americans than the other racial groups at 4.93 (Figure 3). White Americans, American Indian/Alaska Natives, and Asian/Pacific Islanders had case-fatality rates of 3.01, 1.97, and 1.64, respectively (Figure 3). The prevalence of case fatality rate among Black/African American is the highest compared to Whites, Asian/Pacific Islander and American Indian/Alaskan Native (Table 2).

Table 2. ***Crude and Race-Specific Prevalences of COVID-19 case in Michigan***

Race	Crude Prevalence	Race-Specific Prevalence
Asian/Pacific Islander	0.10%	2.83%
American Indian/Alaska Native	0.03%	4.43%
Black/African American	0.70%	4.98%
White	3.50%	4.42%

**Race-specific prevalence was calculated using US Census data*

Table 3. ***Crude and Sex-Specific Prevalences of COVID-19 cases in Michigan***

Race	Crude Prevalence	Sex-Specific Prevalence
Female	3.05%	6.02%
Male	2.91%	5.91%

**Sex-specific prevalence was calculated using US Census data*

The prevalence of case fatality rate among Asian/Pacific Islander is the lowest compared to White, Black/African Americans and American Indian/Alaskan Native (Table 2).

Age-specific Prevalence vs. CFR

The age-specific case fatality rate (CFR) has a positive association with age brackets in this dataset (Table 1). CFR begins at 0 from years 0-19, increases to .05 in years 20-29, and is the highest at 25.25 in the 80+ age bracket. Age-specific prevalence, however, shows a different trend than age-specific CFR. The highest age-specific prevalence is within the 20-29 age group (18.84%) and remains at least 14% for all groups through age 59. This high prevalence in young adults is consistent with Centers for Disease Control and Prevention (CDC) COVID Data Tracker data, which shows that from June 2020-March 2021 that the 18-24 year old age bracket was highest in prevalence of disease [5]. As of March 24, 2021, the CDC COVID Data Tracker shows 22% of reported cases were in the 18-29 age group [5].

When comparing between age groups, we find that while prevalence is higher in younger adults, older adults were found to have a disproportionately higher death rate (46.58% death rate in the 80+ age bracket compared to the 0.37% mortality rate in the 20-29 age bracket) (Table 1).

Discussion

In this study, we have analyzed the prevalence of COVID-19 in Michigan with respect to sex, race, and age. We found that demographic characteristics were in fact determinants of COVID-19. The data showed that there were health disparities in Michigan and that vulnerable populations were disproportionately affected by COVID-19.

The study of sex revealed that males are more likely to contract and die from COVID-19 in comparison to females. The findings among sex are supported by Harvard University's GenderSci Lab, "US Geneder/Sex COVID-19 Data Tracker." In Michigan, the data show that males tested positive for COVID-19 at a rate of 51% whereas females tested positive at a rate of 48% [6]. Although the data from Michigan and WHO revealed that males are more likely to contract COVID-19 compared to females, findings from the CDC and neighboring states show an opposite trend. For example, the CDC reported a 47.8%

positivity rate among males and a 52.2% rate for females [5]. Furthermore, in the neighboring state of Indiana, the positivity rate for COVID-19 among males was 45.1%, whereas females represented 53.5% [7]. In addition, the state of Ohio reported 53% for females and 46% for males who tested positive for COVID-19 [8]. The analysis demonstrated that the association between sex COVID-19 in Michigan was not consistent with data from the CDC.

From analyzing race, our findings revealed that Black/African Americans are more likely to contract and die from COVID-19. This is consistent with the finding from MDHHS, which showed Black/African Americans represent 40% of the coronavirus deaths despite accounting for 14% of the population [9]. The high mortality rate among Black/African Americans may be due to several factors, such as living in highly segregated neighborhoods with high social vulnerability, high levels of poverty, lower levels of education, and lower income [10-14]. These factors expose the Black/African American community to a higher COVID-19 risk [15]. This is evidenced by several studies, including findings from the U.S. and the United Kingdom. In the United Kingdom, researchers conducted a study on COVID-19-related mortality risk and found that the risk is higher among the Black/African American and South Asian demographics compared to Whites. Furthermore, the National Urban League analyzed data from Johns Hopkins University and found that Black/African Americans are three times more likely to get COVID-19 compared to White Americans [16]. The infection rate for Black/African Americans is 62 per 10,000 compared with 23 per 10,000 for Whites. These data demonstrate how powerfully ingrained medical racism is within our health infrastructure and how it continues to lend itself to COVID-19 deaths among marginalized communities. To further prevent deaths from COVID-19 within the Black/African American community, we need to work together to address inequities in the social determinants of health. Public health professionals need to implement more programs that ensure fair access to quality education, housing, transportation, childcare, health, and more services.

When analyzing the age and prevalence of COVID-19, the data demonstrated that older people (80+ years) were more likely to die from COVID-19 than younger people (0-29 years). This finding is consistent with a study that states that older age is an independent predictor to in-hospital mortality for COVID-19 patients [17]. Furthermore for younger people, the findings are consistent with the data provided by the MDHHS, which show that COVID-19 patients in the age group of 20-29 years represented 0.44% of total deaths, compared to the 80+ year population who represent 44% of COVID-19-related deaths [9].The findings are also supported by Hoffman et al. (2020) research, which aimed to evaluate the association between older age groups and country-specific case fatality rates of COVID-19 in Europe, the U.S., and Canada [18]. Hoffmann et al. found a strong linear relationship between ages older than 75 and a corresponding increase in overall CFR in several countries [18]. Suárez et al. (2020) carried out a study of COVID-19-related deaths and found that young people (25-29) represented 1.48% of death while older people (80-84) made up 33.33% of death within the age group. These findings support our findings that death due to COVID-19 disproportionally affects older people than younger people [19].

In addition to the analysis of COVID-19 on age, findings showed that young people are more likely to contract COVID-19 than older people. There is a lack of data that correlates with the prevalence of age and COVID-19. However, theories about COVID-19 mitigation behaviors might give some insight into the relationship between age and COVID-19. In a study carried out by Hutchins et al. [20], they found that younger people (18-29 years) had the lowest mitigation behavior (i.e., handwashing, social distancing, and avoiding public or crowded places) compared to older people (60+ years). Because mitigation behaviors were recorded less with young people, it might provide insight into why more young people contract COVID-19 compared to older people. In terms of COVID-19 deaths, our findings were consistent with the CDC's report of older people dying at a higher rate than younger people. According to the CDC, young people under age 45 represented 2.9% of deaths, while 81.0% represented people over the age of 65 [21]. While the basis for the greater susceptibility of younger people to COVID-19 infection remains theoretical, Michigan's data is consistent with that of the CDC's. This high prevalence in young adults is consistent with CDC COVID Data Tracker data, which shows from June 2020-March 2021 that the 18-24 year old age bracket had the highest prevalence of disease. As of March 24, 2021, the CDC COVID Data Tracker showed 22% of reported cases were in the 18-29 age group [5]. This disparity in CFR between the ≥80 year age bracket and the 20-29 age bracket can, likely in part, be explained by the higher prevalence of comorbidities with age. The literature shows that comorbidities, such as hypertension and diabetes, have higher prevalence in older age brackets. Severe disease cases are also associated with higher prevalence of comorbidities [22].

Figure 1. Michigan COVID-19 Cases by Race

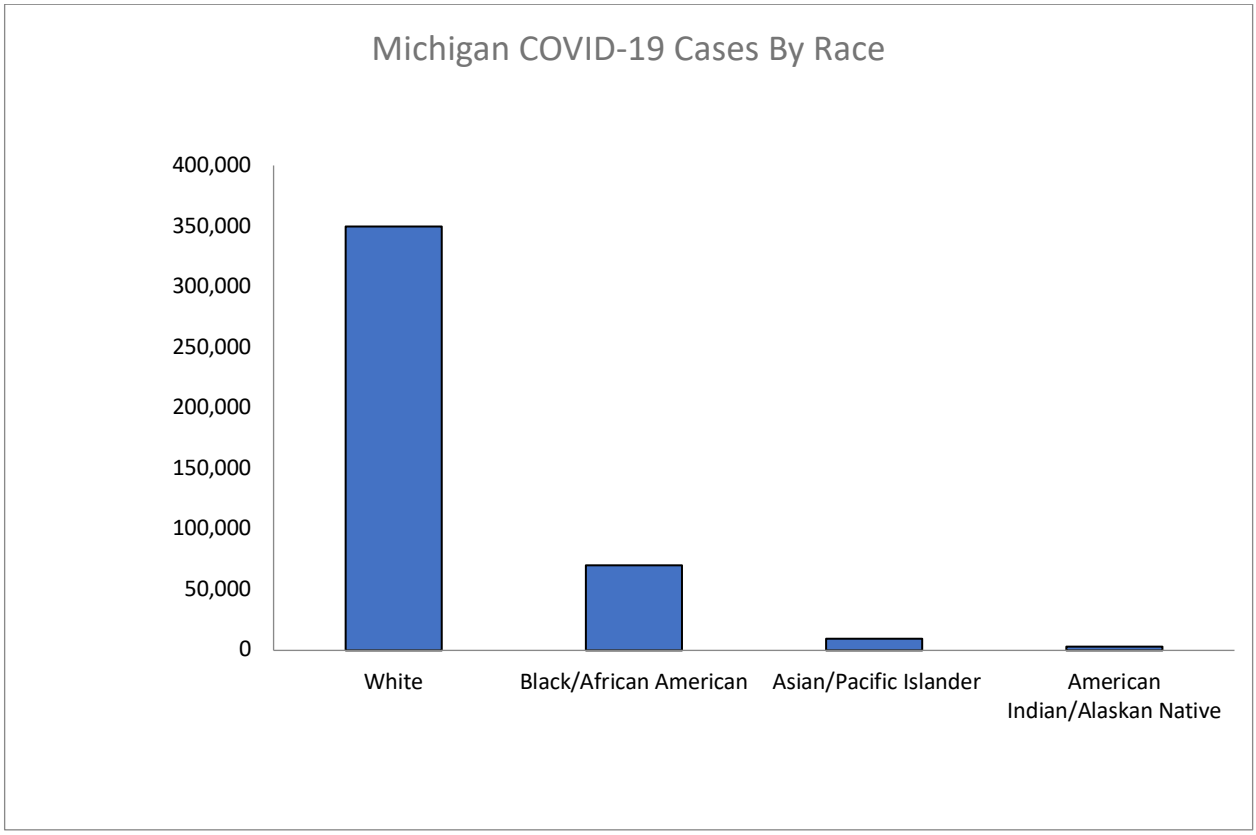


Figure 2. Michigan COVID-19 Deaths by Race

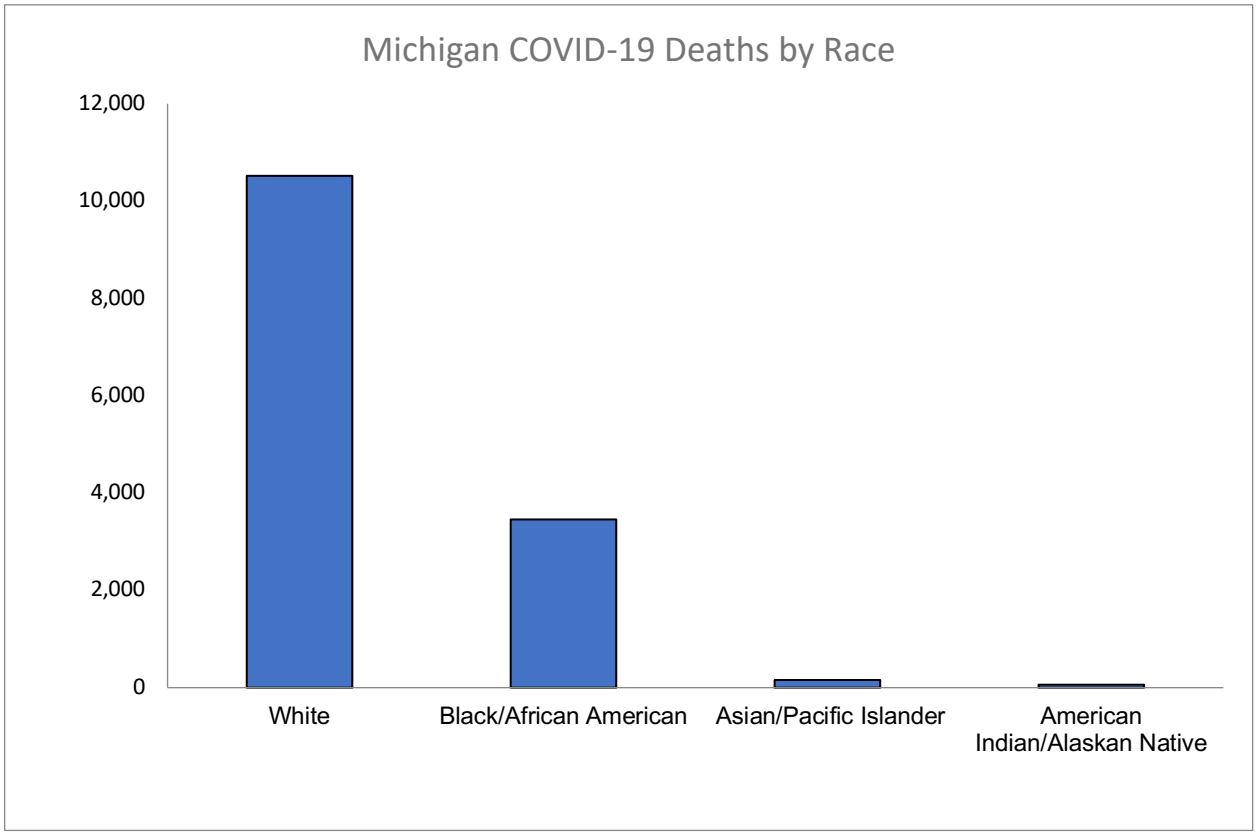


Figure 3. Michigan COVID-19 Case Fatality Rate by Race

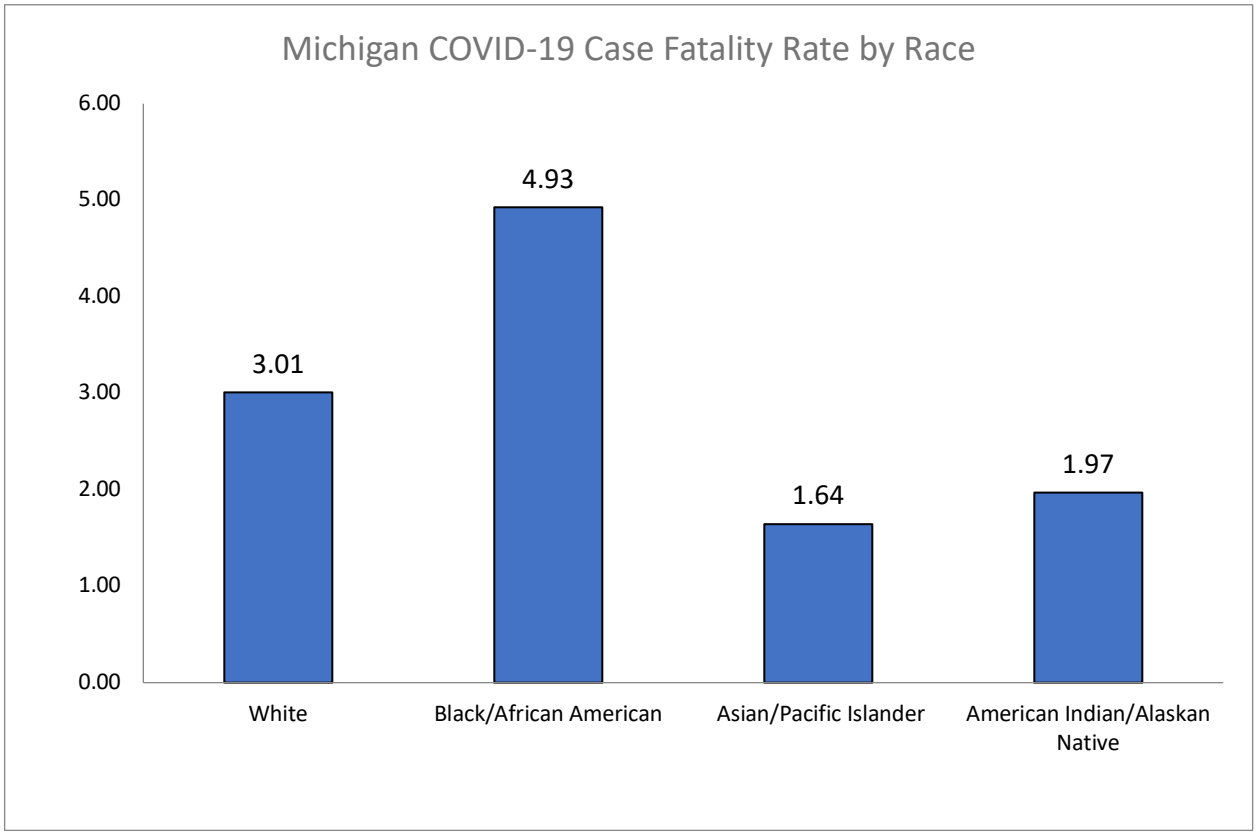


Figure 4. Crude and Race-Specific Prevalence for COVID-19 in Michigan

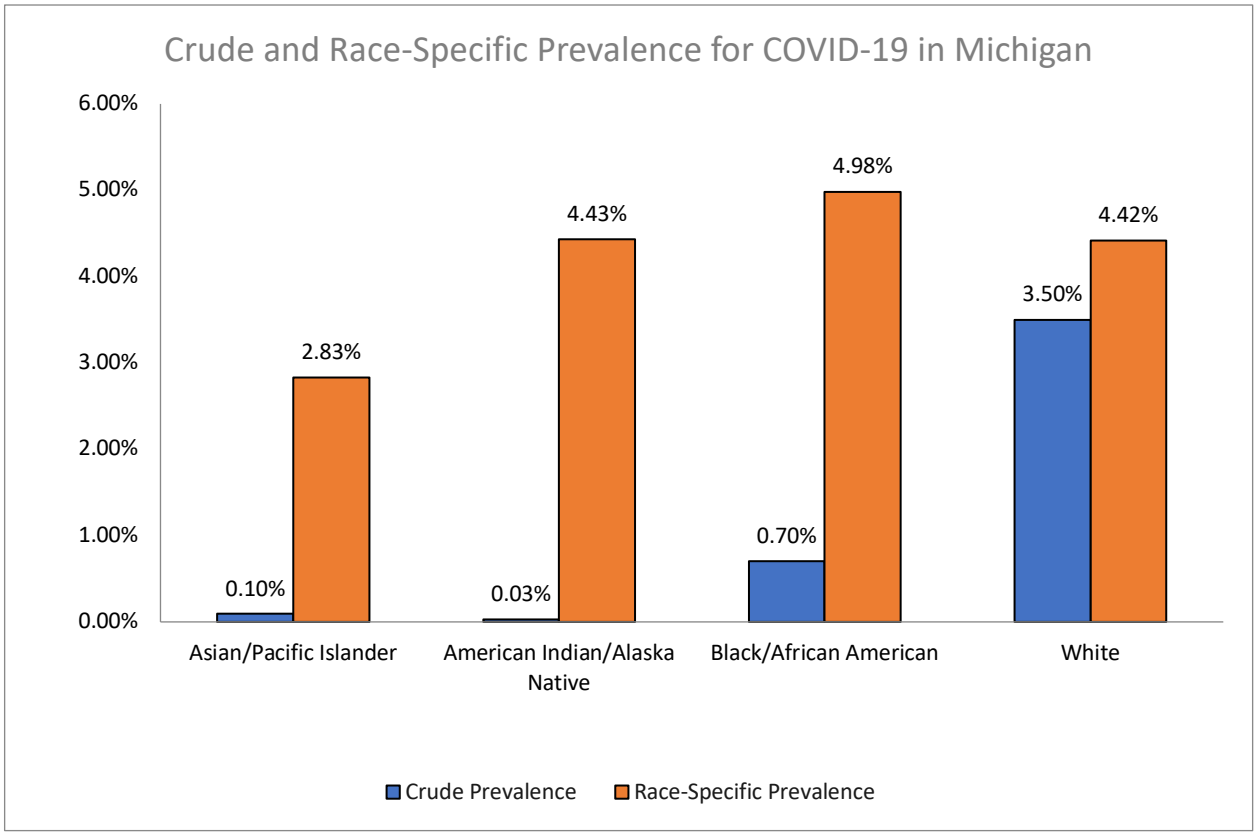


Figure 5. Michigan COVID-19 Cases by Age

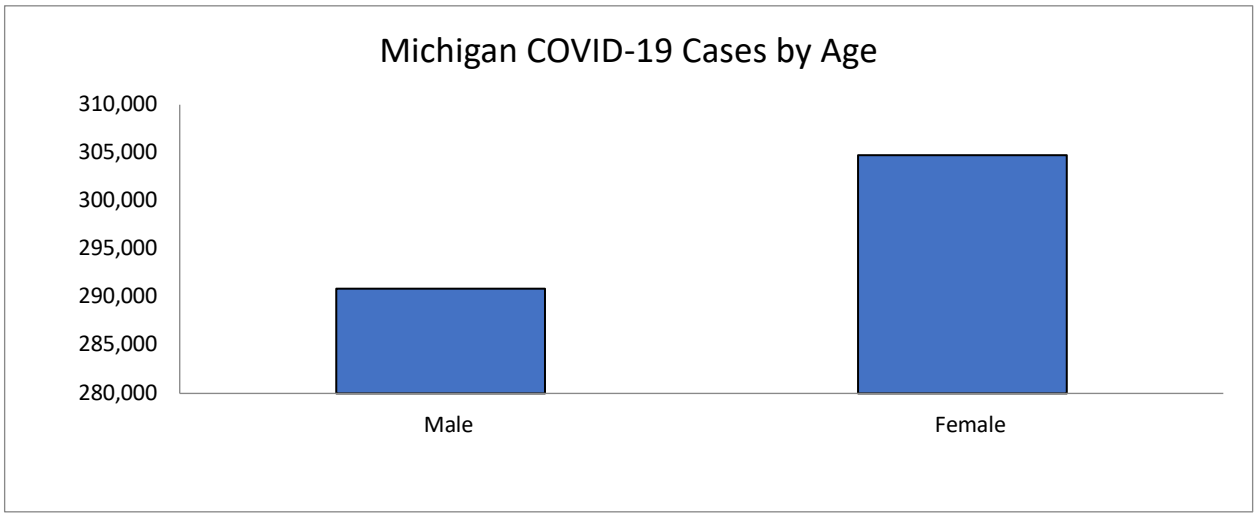


Figure 6. Michigan COVID-19 Deaths by Age

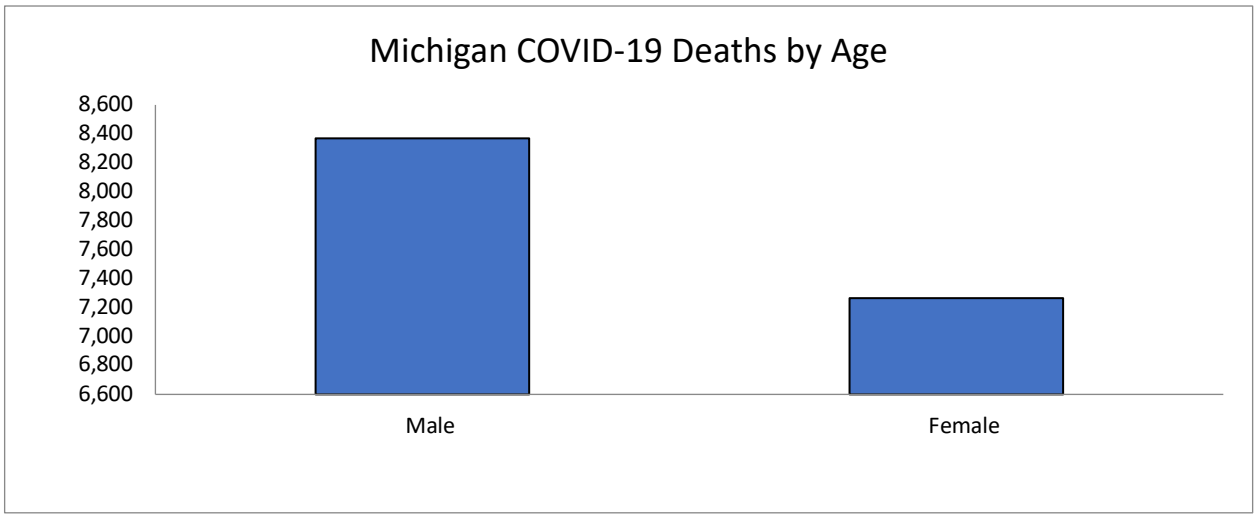


Figure 7. Michigan COVID-19 Case Fatality Rate by Age

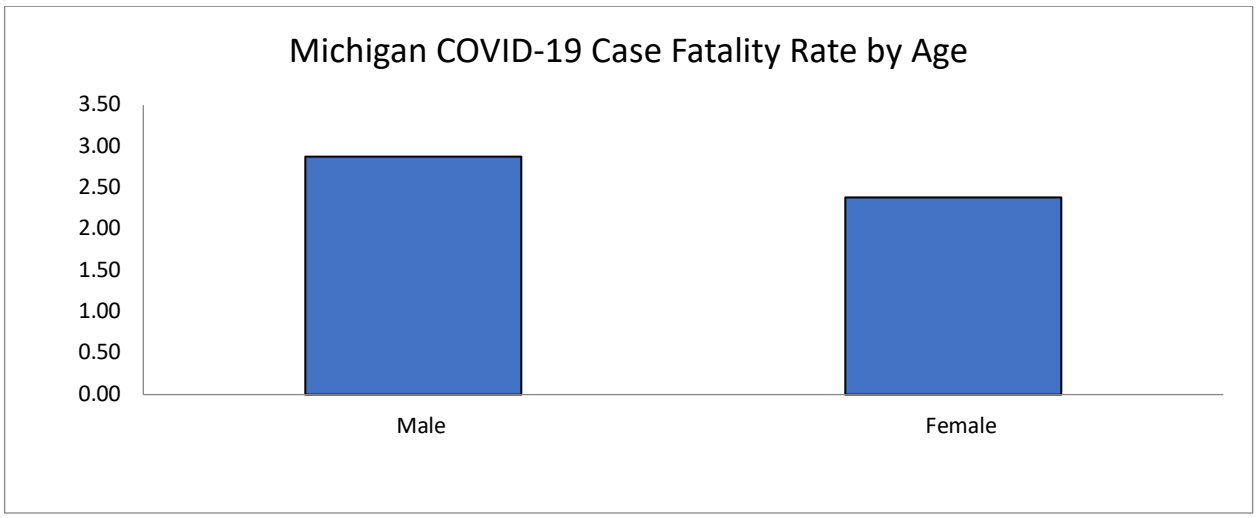


Figure 8. Crude and Sex-Specific Prevalence for COVID-19 in Michigan

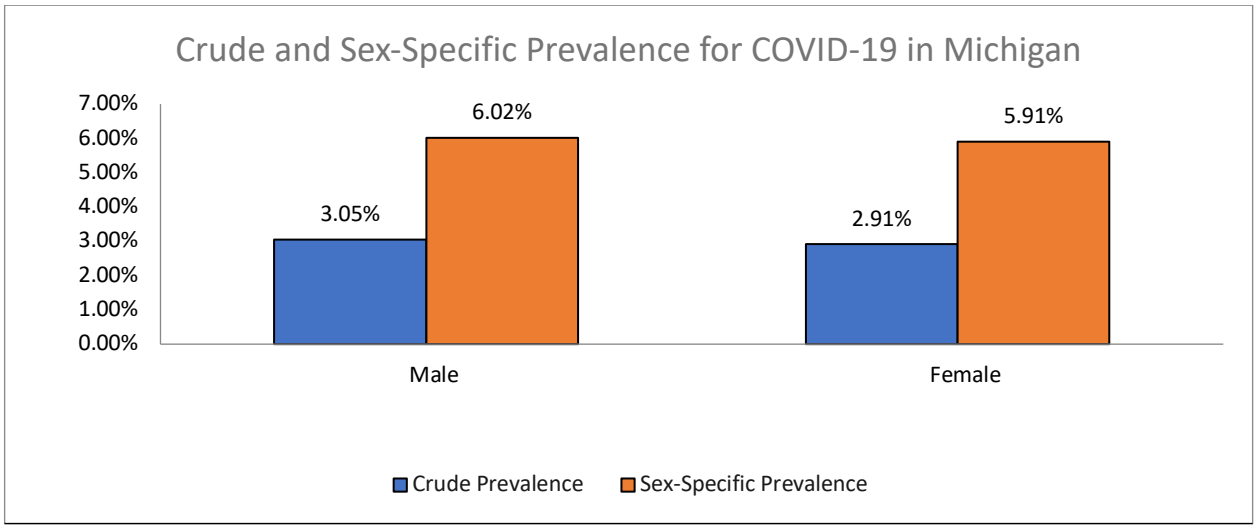


Figure 9. Michigan COVID-19 Cases by Age

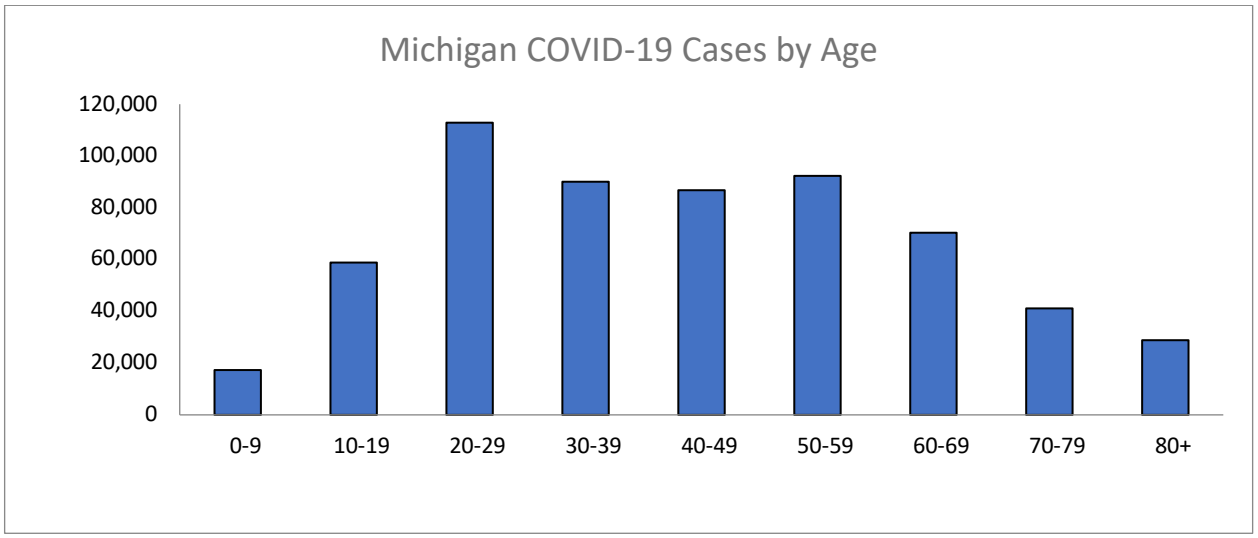
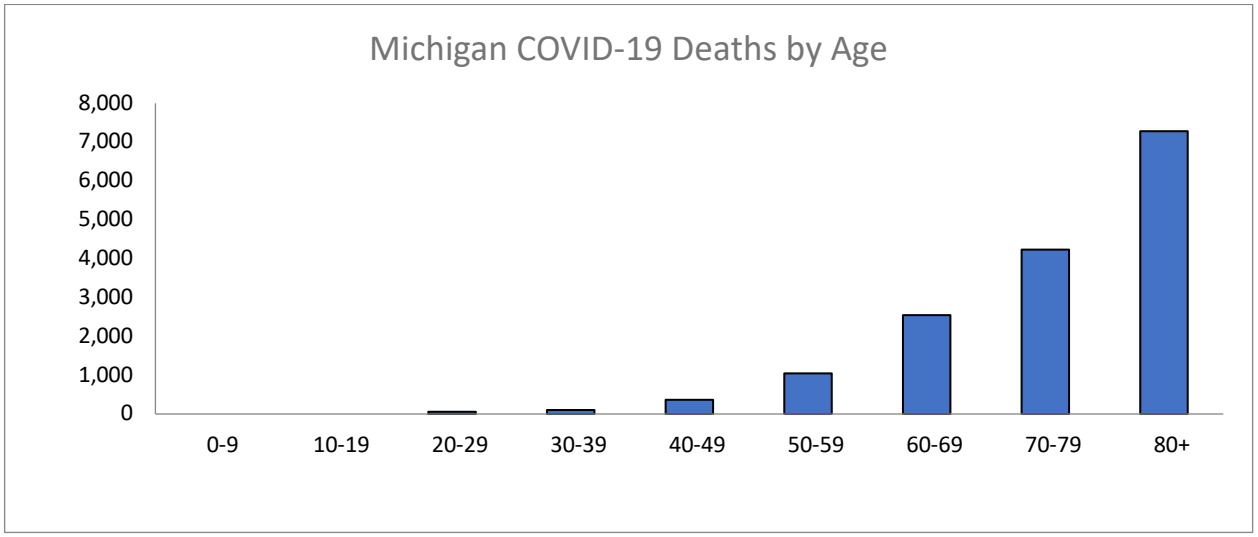


Figure 10. Michigan COVID-19 Deaths by Age



Study Limitations

This study has potential limitations. The results of this study are directly taken from the data provided by the MDHHS. At the time of publication, the COVID-19 pandemic was still ongoing. The data is limited by practices at the time of data gathering, and the exclusion of individuals with positive serology in the absence of a positive diagnostic test was consistent with data reporting practices by the MDHHS. There is also a lack of literature pertaining to the State of Michigan and COVID-19, which might prevent a more involved analysis of prevalence of COVID-19 and can incorporate population density and changing vaccination rates. The analysis of gender only included male and female, and it did not examine non-binary, transgender, and other gender identities. The results pertaining to race only examined demographics that reported one racial identity and did not take into account multiracial demographics. The inception of the vaccine rollout coincided with the tail end of our data period (January 2021-March 2021), which may have impacted the distribution of the data. However, given the limited rollout of the vaccine, a large part of the general population had not received the vaccine at the time of analysis.

Conclusions/Recommendations

This research analyzed the impact of social determinants on COVID mortality rates in Michigan. The analysis showed in regards to sex males are more likely to contract and die from COVID-19, relative to females. In regards to race, it was found that Black/African American individuals had the highest probability of COVID-19 fatality than other racial groups. The prevalence of COVID-19 in relation to age showed that younger individuals were more likely to contract the disease, however older individuals had a higher likelihood of death due to COVID-19. By analyzing these socio-demographics, we present data that demonstrates the impacts of social health determinants on COVID-19-related outcomes, which necessitate further analysis. These findings also indicate that there is crucial work required at community and government levels to protect vulnerable populations with respect to COVID-19. We urge that mitigation efforts of COVID-19 focus on the demographic groups most affected by the COVID-19 pandemic. It would be prudent to analyze how vaccination rates influence COVID-19-related outcomes as our data period only included the first two months of a limited vaccine rollout.

Data sharing

Individual-level data used in this study cannot be made publicly available but aggregated COVID-19 data provided by MDHHS is freely available to the public. ASP, AP, IM, and LM had access to the data used in the study.

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Declaration of Competing Interest

All authors have nothing to disclose.

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