DeepTrace: Improving US Pandemic Health Care through Health Disparity Identification and Determinant Tracing

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***Abstract*—This research provides a thorough analysis of health disparities in the US based on multiple COVID-19 datasets. We examine the structural, social, and constructural determinants of health in the US to assist in ascertaining why disparities occur in infection and death rates due to COVID-19 pandemic. Extensive experimental results show the effectiveness of DeepTrace. The Coronavirus disease 2019 (COVID-19) pandemic has severely impacted countries around the world with unprecedented mortality and economic devastation and has disproportionately and negatively impacted different communities—especially racial and ethnic minorities who are at a particular disadvantage as they are more likely to be the potential target of COVID-19 infection. Black Americans have a long-standing history of disadvantage (e.g., long-standing disparities in health outcomes) and are in a vulnerable position to experience the impact of this pandemic. Although some prior research indicates high-risk and vulnerability of the elderly and patients with underlying co-morbidities, little research paid attention to tracing the social and structural health determinants that yield disparities in this pandemic. The research provides new strategies for determining these health determinants to improve health care in the US.**

***Index Terms*—coronavirus, COVID-19, health disparity, race, ethnicity, minority, health determinants**

I. Introduction

The novel Coronavirus disease 2019 (COVID-19) was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 [1], and it has severely impacted and devastated the world. As of July 31, 2020, the virus has resulted globally in 17,452,358 confirmed cases and more than 675,000 deaths [2]. COVID-19 pandemic has disproportionally and negatively impacted people. On April 8, 2020, the Center for Disease Control and Prevention (CDC) published surveillance data of laboratory-confirmed COVID-19-associated hospitalizations in 14 US states [3]. Among those with data on race/ethnicity ($n = 580$), African Americans account for 33.1%, although 18% of individuals in the catchment population were African American [3]. The government statistics from the cities in the US show similar disparities (racial disparities). African Americans in Chicago account for only 14.6% of the state's population (population of Illinois), but as of April 9, 2020, 51.5% of COVID-positive patients and 67.3% ($n = 132$) of those who died were African American [4]. According to the 2019 US census, African Americans in Louisiana only account for 33% of the state's population. However, this community accounts for 55% of the COVID-19-related deaths [5]. In Michigan, black individuals account for 33% of the confirmed COVID-19 cases and 40% of attributed deaths despite making up only 14% of the state's population [6]. The states such as North Carolina, Alabama, and the cities St Louis and New York are other examples of disparities in COVID-19-related deaths and ethnicity. African Americans reported having higher death rates than Caucasians [5], [7]–[10]. Figure 1 shows the disparities in COVID-19 infection: different communities were disproportionately affected by COVID-19; racial and ethnic minorities, such as Black/African Americans, are more likely to be the potential target of COVID-19 infection.

Black American history is rooted in racial injustice. Black people are disproportionately affected by poverty [14], mass incarceration [15], infant mortality [16], limited healthcare access [17], and health-related conditions. Some conditions include heart disease [18], diabetes [19], stroke [20], kidney disease [21], respiratory illness [22], [23], and human immunodeficiency virus (HIV) [24].

Some recent studies indicate the high-risk groups (e.g., Black/African Americans) and the vulnerability of the elderly and patients with underlying co-morbidities of COVID-19. However, little research paid attention to tracing the social and structural determinants of health disparities in the COVID-19 pandemic for improving health care.

To address the problem, we investigate health disparities such as the social, structural, and constructural health determinants leading to disparities in COVID-19 infections and deaths. We first provide a thorough analysis of health disparities based on multiple COVID-19 datasets; then, we examine the social, structural, and constructural determinants of health disparities in COVID-19 pandemic for improving health care. We summarize the contribution of this work below.

- We provide a thorough analysis of US health disparities based on multiple COVID-19 datasets for deeply examining determinants of health disparities in COVID-19, and the analysis results confirm our conjecture.

Fig. 1: Disparities in COVID-19: Different communities were disproportionately affected by COVID-19 [11]–[13].

- We propose DeepTrace to identify diverse determinants (including the structural, social, and constructural health determinants) of health disparities in COVID-19 pandemic, which can help to improve pandemic health care.
- We identify a list of factors most likely correlate with health disparities in COVID-19 pandemic.

The remainder of this paper is organized as follows. Section II reviews the related work. Section III introduces multiple COVID-19 datasets. Section IV presents the experimental analysis based on the multiple COVID-19 datasets and the tracing of diverse determinants of health disparities. Section V concludes this paper with remarks on our future work.

II. Related Work

COVID-19 pandemic has disproportionately impacted people's health. Some recent studies reveal the health disparities in COVID-19. Laurencin *et al.* [25] presented the earliest available data in the peer-reviewed literature on the racial and ethnic distribution of COVID-19-confirmed cases and fatalities in the state of Connecticut. They sought to explode the myth of Black immunity to the virus. Finally, they called for a National Commission on COVID-19 Racial and Ethnic Health Disparities to further explore and respond to the unique challenges that the crisis presents for Black and Brown communities. Chowkwanyun *et al.* [26] contextualized the COVID-19 data incorporating the demographic detail, and provided an analysis of racial health disparities in COVID-19. Hooper *et al.* [27] indicated the health disparities and provided some explanation about the causes of health disparities. Gray *et al.* [28] examined social determinants of health and health outcomes during COVID-19, and they indicated: upstream social determinants of health (SDOH) are the root causes of health disparities at the population level; midstream SDOH are the result of upstream determinants and mediate the effects of upstream SDOH on downstream health outcomes; downstream health outcomes describe the health-related end points that result from upstream and midstream SDOH. Finally, they provided three key strategies for achieving health equity in the US. However, the above studies do not provide a thorough analysis of health disparities and experimentally examine diverse determinants (social, structural and constructural determinants) of health disparities in COVID-19.

To better show health disparities, some recent studies show the health disparity by providing some data analysis. Azar *et al.* [29] conducted a retrospective cohort analysis of COVID-19 patients at Sutter Health, a large integrated health system in northern California, to measure potential disparities. They observed that compared with non-Hispanic white patients, non-Hispanic African American patients had 2.7 times the odds of hospitalization, after adjustment for age, sex, comorbidities, and income. They explored possible explanations for the observation, including societal factors that either result in barriers to timely access to care or create circumstances in which patients view delaying care as the most sensible option. Selden *et al.* [30] examined historical patterns in health risk, job characteristics, and household composition in search of potential explanations for the large disparities being reported in COVID-19 outcomes. However, their data reflect employment before the onset of COVID-19, and their study therefore provides no insights into whether there have been racial/ethnic dimensions to the COVID-19 employment changes. Also, the above studies do not provide an in-depth analysis of health disparities and experimentally examine diverse determinants (social, structural, and constructural determinants) of health disparities in COVID-19.

Motivated by the problems in the existing literature, we propose DeepTrace to identify the diverse determinants of health disparities in COVID-19 pandemic for improving health care. We provide a thorough analysis of US health disparities based on multiple COVID-19 datasets for deeply examining determinants of health disparities in COVID-19. We also identify a list of factors most likely correlate with health disparities in COVID-19 pandemic.

III. Data Description

In this section, we provide the description of multiple COVID-19 datasets.

A. Dataset 1

We collected the representative data for our experimental analysis from healthdata.gov (https://healthdata.gov/). The dataset records the distribution of the confirmed cases and deaths over age periods, gender, race and ethnicity of each day from January 1, 2020 to July 18, 2020. The confirmed cases are counted on the date the test specimen was collected. Deaths are those occurring among confirmed cases based on the day of death. Demographic data are based on what is reported by medical providers.

B. Dataset 2

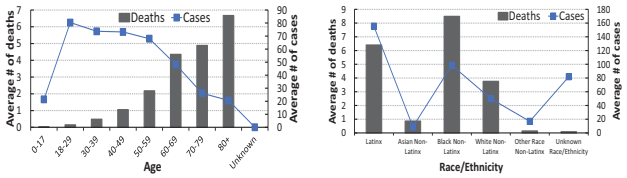
To trace the determinants of health disparities, we also collected the data from the U.S. Census Bureau and measured the household experience of different communities during the COVID-19 pandemic. We chose the dataset Household Pulse Survey Week 10 (https://www.census.gov/data/tables/2020/demo/hhp/hhp10.html). The dataset records the experiences of individuals in terms of employment status, spending patterns, food security, housing, physical and mental health, access to health care, and educational disruption during the COVID-19 pandemic.

C. Dataset 3

To further trace the determinants of health disparities, we also collected the data from the Imperial College London YouGov Covid 19 Behavior Tracker Data Hub (https://github.com/YouGov-Data/covid-19-tracker) [31]. The questions in the dataset, led by the Institute of Global Health Innovation (IGHI), cover data on testing, symptoms, self-isolating in response to symptoms and the ability and willingness to self-isolate if needed. It also looks at behaviors, including going outdoors, working outside the home, contact with others, hand washing and the extent of compliance with 20 common preventative measures. Contextual data includes: gender, age, region (within a country), number of people in the household, children in household, health conditions, working status and the date of the survey response. In the dataset, we focused on the data for the United States. We used the attribute i3_health to identify the people who tested positive for COVID-19.

IV. Experiments and Findings

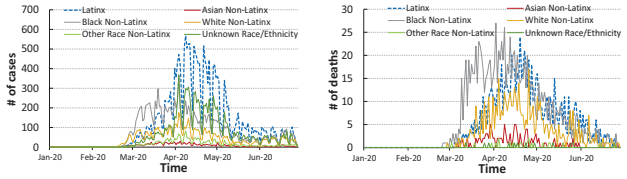
In Section III, we introduce multiple COVID-19 datasets. In this section, we provide the experimental analysis based on the multiple datasets, and trace the diverse determinants of health disparities.



(a) Average # of confirmed cases/deaths of the residents in different age periods

(b) Average # of confirmed cases/deaths of the residents in different communities

Fig. 2: Distribution of confirmed cases/deaths over age periods and race/ethnicity.



(a) Daily # of confirmed cases of the residents in different communities

(b) Daily # of confirmed deaths of the residents in different communities

Fig. 3: Distribution of daily # of confirmed cases/deaths over race/ethnicity.

A. Experimental Analysis Based on Dataset 1

1) Distribution of Confirmed Cases/Deaths over Age Periods, Race/Ethnicity and Gender: Below we analyze the relationship between the average # of confirmed cases/deaths and age and the relationship between the average # of confirmed cases/deaths and race/ethnicity. Figure 2(a) shows the average # of confirmed cases and deaths of Chicago residents in different age periods. In Figure 2(a), we see that the average # of confirmed cases in age period 18-29 is the highest among all age periods, however, the average # of deaths in the age period 80+ is the highest among all age periods and the average # of deaths increases as the age increases, suggesting that the elderly are more likely to be killed by COVID-19. The reason behind this is that the immune system changes with age, and young people usually have a younger immune system and older people are not as good at reacting to microorganisms they have not encountered before [32]–[34]. Figure 2(b) shows the average # of confirmed cases and deaths of Chicago residents in different communities. In Figure 2(b), we see that racial and ethnic minorities such as Latinx and Black Non-Latinx in general have a higher value of average # of confirmed cases and the average # of deaths in Black Non-Latinx is the highest among all the communities, and the average # of deaths in Latinx is the second highest. The result confirms our conjecture: racial and ethnic minorities are at a particular disadvantage, and they are more likely to be the potential target of COVID-19 infection due to the health disparities.

Figure 3(a) and Figure 3(b) show the daily # of confirmed cases and the daily # of deaths of Chicago residents in different communities, respectively. In Figure 2(b), we see that racial and ethnic minorities such as Latinx and Black Non-Latinx in

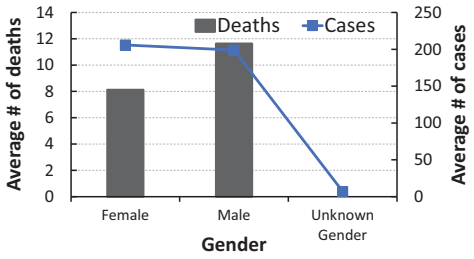
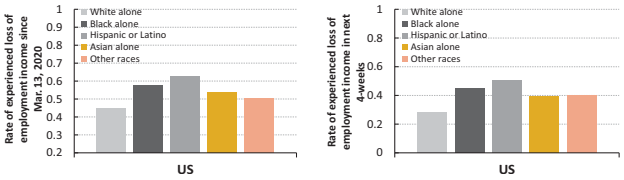


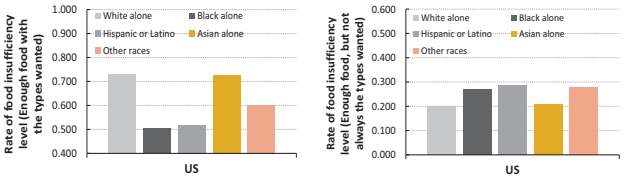
Fig. 4: Distribution of average # of confirmed cases/deaths over gender.



(a) Rate of experienced loss of employment income since Mar. 13, 2020

(b) Rate of experienced loss of employment income in next 4-weeks

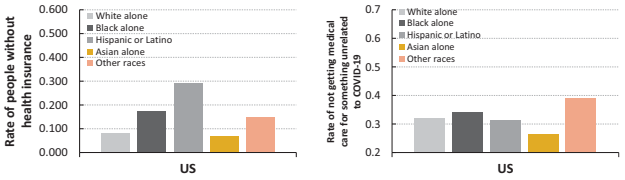
Fig. 5: Rate of experienced loss of employment income in different communities.



(a) Rate of enough of the types of food wanted

(b) Rate of often not enough food to eat

Fig. 6: Food sufficiency for household in different communities prior to March 13, 2020.



(a) Rate of people without health insurance

(b) Rate of not getting medical care for something unrelated to COVID-19 but needing it

Fig. 7: Health insurance status and access to medical care for COVID-19 pandemic related problems.

general have a higher value of daily # of confirmed cases and the daily # of deaths in Black Non-Latinx in general is the highest among all the communities, and the daily # of deaths in Latinx in general is the second highest. The results also confirm our conjecture.

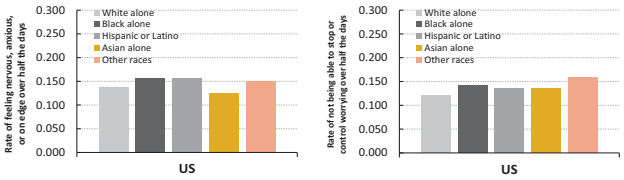
Figure 4 shows the distribution of the average # of confirmed cases and deaths of the Chicago residents over gender. In Figure 4, we see that the average # of confirmed cases in Males is almost the same as that in Females, but the average # of deaths in Males is higher than that of Females, suggesting the health disparities caused by gender. The possible reason behind this is that men tend to engage in more risky behavior such as ignoring physical distancing, and they do not take symptoms as seriously. Also, high blood pressure and liver disease are more prevalent in men and these all contribute to more negative outcomes with COVID-19 [35]–[38]. In addition, behaviors that impact lung health, such as smoking, also may play a role in the disease's deadly impact on men [39]–[41]. Male behavior during the pandemic also could be increasing their exposure to COVID-19.

B. Experimental Analysis Based on Dataset 2

1) Examining Household Experience of Different Communities During the COVID-19 Pandemic: Below we examine the household experience of different communities during the COVID-19 pandemic. Figure 5(a) shows the rate of experienced loss of employment income in different communities in the US since March 13, 2020. In Figure 5(a), we see that the racial/ethnic minorities such as Hispanic or Latino and Black alone have a higher rate of experienced loss of employment income since March 13, 2020. Figure 5(b) shows the rate of experienced loss of employment income in different communities in the US in the next four weeks. Similarly, we see that the racial/ethnic minorities such as Hispanic or Latino and Black alone have a higher rate of experienced loss of employment income in the next four weeks. The results are consistent with the result that we observed above: the racial/ethnic minorities such as Black alone and Hispanic and Latino are more likely to be affected by COVID-19.

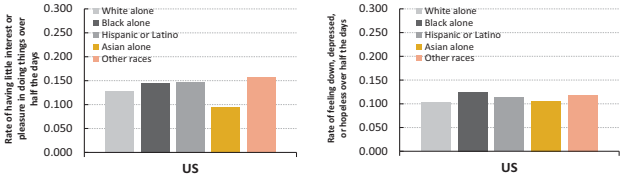
Figure 6(a) shows the rate of enough of the types of food wanted in different communities in the US prior to March 13, 2020. In Figure 6(a), we see that the racial/ethnic minority Black alone has the lowest rate of enough of the types of food wanted, and Hispanic or Latino has the second lowest rate of enough of the types of food wanted. Figure 6(b) shows the rate of often not enough food to eat in different communities in the US prior to March 13, 2020. Similarly, we see that the racial/ethnic minority Black alone has the highest rate of often not enough food to eat, and the racial/ethnic minority Hispanic or Latino has the second highest rate of often not enough food to eat. The results indicate that the racial/ethnic minorities such as Black alone and Hispanic or Latino suffer from food insufficiency, and thus they are more likely to be infected with COVID-19.

Figure 7(a) shows the rate of people without health insurance in different communities in the US. In Figure 7(a), we see that the racial/ethnic minorities such as Hispanic or Latino and Black alone have a higher rate than the other communities, suggesting that they have less chance to get health insurance. Figure 7(b) shows the rate of being unable to get medical care for something unrelated to COVID-19, but indeed needing the medical care in different communities in the last 4 weeks. In Figure 7(b), we see that communities such as Other races and Black alone have a higher rate, and they have less chance to get the medical care they need. The results in Figure 7(a) and Figure 7(b) indicate that different communities receive unequal healthcare services, and the racial/ethnic minorities have less



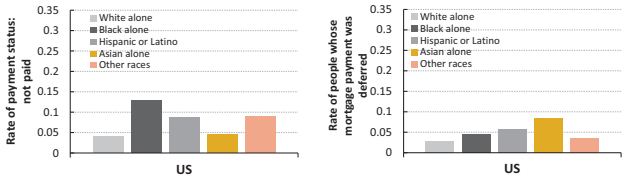
(a) Rate of feeling nervous, anxious, or on edge over half the days (b) Rate of not being able to stop or control worrying over half the days

Fig. 8: Symptoms of anxiety experienced in the last 7 days.



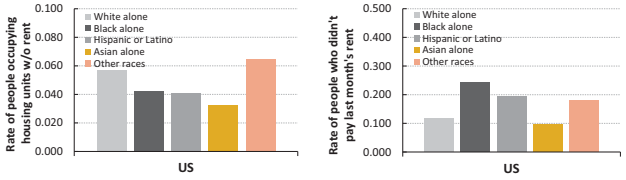
(a) Rate of having little interest or pleasure in doing things over half the days (b) Rate of feeling down, depressed, or hopeless over half the days

Fig. 9: Symptoms of depression experienced in the last 7 days.



(a) Rate of payment status: not Paid (b) Rate of people whose mortgage payment was deferred

Fig. 10: Last month's payment status for owner-occupied housing units.



(a) Rate of people occupying housing units w/o rent (b) Rate of people who did not pay last month's rent

Fig. 11: Last month's payment status for renter-occupied housing units.

chance to get health care service, and thus they are more likely to be infected with COVID-19.

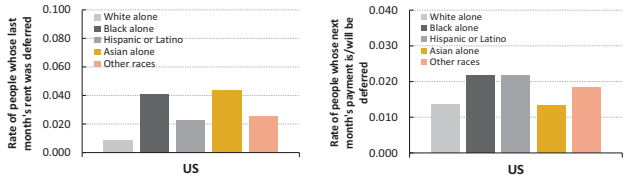
Figure 8(a) shows the rate of feeling nervous, anxious, or on edge over half the days in different communities. From Figure 8(a), we find that the racial/ethnic minorities such as Black alone and Hispanic or Latino have a higher chance of feeling nervous, anxious, or on edge over half the days. Figure 8(b) shows the rate of not being able to stop or control worrying over half the days. Similarly, from Figure 8(b), we also find that the communities Black alone and Other races have a higher chance of not being able to stop or control worrying. The result in both figures suggests that the racial/ethnic minorities have less chance of getting mental health aid and they are more likely to have a mental health problem, which makes it easier for them to be infected with COVID-19 [42].

Figure 9(a) shows the rate of having little interest or pleasure in doing things over half the days in different communities. In Figure 9(a), we see that the communities Black alone, Hispanic or Latino and Other races have a higher chance of losing interest or pleasure in doing things. Figure 9(b) shows the rate of feeling down, depressed, or hopeless over half the days in different communities. Similarly, from Figure 9(b), we find that the communities Black alone, Hispanic or Latino and Other races have a higher chance of feeling down, depressed, or hopeless. The results in Figure 9(a) and Figure 9(b) also indicate that the racial/ethnic minorities have less chance of getting mental health aid, which makes it easier for them to be infected with COVID-19 [42].

Figure 10(a) shows the rate of last month's payment status (not paid) for owner-occupied housing units in different communities in the US. In Figure10(a), we see that the community Black alone has the highest chance of being unable to afford the last month's payment, and the communities Hispanic or Latino and Other races have almost the second highest rate of being unable to afford the last month's payment. The community White alone has the lowest rate. Figure 10(b) shows the rate of people whose mortgage payment was deferred. In Figure 10(b), we observe similar result. The community White alone has the lowest rate, and the communities Black alone, Hispanic or Latino and Asian alone have a relatively higher rate. The results in Figure 10(a) and Figure 10(b) suggest that communities such as Black alone and Hispanic or Latino have less chance of being able to afford the payment for owner-occupied housing units, which can increase the chance for them to be infected with COVID-19.

Figure 11(a) shows the rate of people occupying housing units without rent in different communities. In Figure 11(a), we see that the communities Black alone, Hispanic or Latino and Asian alone have less chance of occupying housing units without rent. Figure 11(b) shows the rate of people who did not pay last month's rent. In Figure 11(b), we see that the community Black alone has the highest rate among all the communities and the community Hispanic or Latino has the second highest rate. The results in Figure 11(a) and Figure 11(b) indicate that the communities such as Black alone and Hispanic or Latino have less chance of occupying housing units without rent and being able to afford the payment for renter-occupied housing units, which can increase the chance for them to be infected with COVID-19.

Figure 12(a) shows the rate of people whose last month's rent for renter-occupied housing units was deferred in different communities. In Figure 12(a), we see that the communities Black alone and Other races have a higher rate. Figure 12(b) shows the rate of people whose next month's payment is (or will be) deferred. From Figure 12(b), we see that Black alone and Hispanic or Latino have a higher rate than the other communities. The results in Figure 12(a) and Figure 12(b) also indicate that the communities such as Black alone have less chance of being able to afford the payment, which can



(a) Rate of people whose last month's rent was deferred

(b) Rate of people whose next month's payment is/will be deferred

Fig. 12: Payment for owner-occupied housing units.

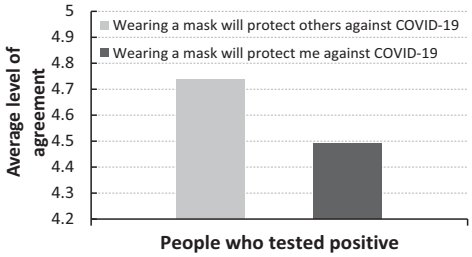


Fig. 13: Average level agreement of wearing masks based on the people who tested positive in the last seven days.

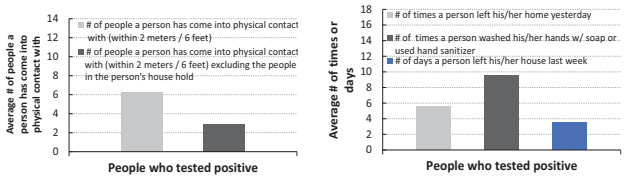
increase the chance for them to be infected with COVID-19.

C. Experimental Analysis Based on Dataset 3

1) Examining People's Behaviors in Response to COVID-19: The underlying causes of health disparities are complex and include social and structural determinants of health, racism and discrimination, economic and educational disadvantages, health care access and quality, individual behavior, and biology [27]. A simulation study of agent-based influenza showed that small changes in behavior can have a significant effect on transmission patterns during epidemics [43], [44]. People's behaviours could result in non-communicable diseases such as diabetes, hypertension, etc. when they engage in health-risking behaviour (e.g., smoking, substance abuse, not exercising or not eating correctly). People's behavior can indicate and affect people's health [43], [45], [46]. Below we focus on people's behaviors in response to COVID-19 and examine the determinants of health disparities in COVID-19 pandemic.

Figure 13 shows the average level agreement of wearing masks based on the people who tested positive (for COVID-19) in the last seven days. The range of the level is from 1 to 7. In Figure 13, we see that both average levels of agreement are higher than 4.425, suggesting that people believe that wearing a mask will protect them and others against COVID-19.

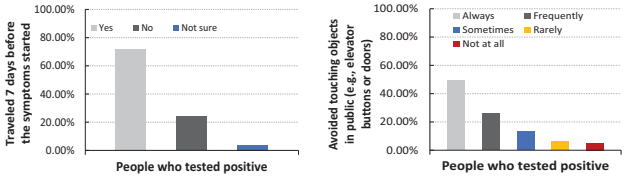
Figure 14(a) shows the average number of people a person has come into physical contact with (within 2 meters / 6 feet) and the average number of people a person has come into physical contact with (within 2 meters / 6 feet) excluding the people in the person's house hold. In Figure 14(a), we see that the people who tested positive did have physically contacted with (within 2 meters / 6 feet) others, which can increase the probability of a person being infected with COVID-19. This suggests that the social distance policy can help to prevent the spread of COVID-19 and should not be ignored. Figure 14(b) shows average # of times a person left his/her home yesterday,



(a) Average # of people a person has come into physical contact with (within 2 meters / 6 feet)

(b) Average # of times a person left his/her home, average # of times a person washed his/her hands with soap or used hand sanitizer yesterday, and average # of days a person left his/her house last week

Fig. 14: People's (people who tested positive) behaviors in physically contacting others, leaving home, and washing hands or using hand sanitizer.



(a) Whether a person traveled to a location where coronavirus has been reported 7 days before the person's symptoms started

(b) Avoided touching objects in public (e.g. elevator buttons or doors)

Fig. 15: Status of traveling and touching objects in public (e.g. elevator buttons or doors).

average # of times a person washed his/her hands with soap or used hand sanitizer yesterday, and average # of days a person left his/her house last week. In Figure 14(b), we see that people who tested positive in general left their home more than 4 times yesterday and left their house more than 3 days last week, which can increase the probability that they are infected with COVID-19. We also find that the average # of times a person washed his/her hands with soap or used hand sanitizer is around 10, which indicates that people who tested positive pay attention to washing hands with soap or used hand sanitizer and it has been accepted that washing hands with soap or using hand sanitizer can help to prevent the spread of COVID-19.

Figure 15(a) shows whether a person traveled to a location where coronavirus has been reported 7 days before the person's symptoms started. In Figure 15(a), we see that over 71% of the people who tested positive traveled to a location where coronavirus has been reported, which suggests that traveling can facilitate the spread of COVID-19 and increase the probability of a person being infected with COVID-19, and travel restrictions can be useful for preventing the spread of COVID-19. Figure 15(b) shows how frequently people who tested positive avoid touching objects in public (e.g. elevator buttons or doors). In Figure15(b), we see that around 50% of people always avoid touching objects in public (e.g. elevator buttons or doors), over 26% of the people frequently avoid touching objects in public (e.g. elevator buttons or doors). This indicates that most of the people believe that touching objects in public can increase the risk of being infected with COVID-19. Therefore avoiding touching objects in public (e.g. elevator

TABLE I: A list of factors most likely correlate with health disparities in COVID-19.

Factors	Description
Age	The age of an individual (e.g., a patient)
Gender	The gender of an individual
Obesity	The status of obesity of an individual
Food sufficiency	Whether the individual's food is sufficient
Housing unit	The status of an individual's housing unit
Employment status	The employment status of an individual
Education status	The education status of an individual
Income	The income of an individual
Health insurance availability	The status of health insurance of an individual
Medical care availability	The availability of medical care of an individual
Feeling nervous, anxious, or on edge	The status of feeling nervous, anxious, or on edge
Feeling down, depressed or hopeless	The status of feeling down, depressed or hopeless
Not being able to stop or control worrying	The status of not being able to stop or control worrying
Hypertension	The status of hypertension of an individual
Tobacco use	The status of tobacco use of an individual
Wearing mask	The status of wearing mask of an individual
Washing hands	How frequently a person washes his/her hands
Using hand sanitizer	How frequently a person uses hand sanitizer
Frequently of going outside	How frequently a person going outside
Ignorance of social distance policy	Ignorance (or violation) of social distance policy
Contact_other_covid	The status of contacting some other person infected with COVID-19
Touching objects in public	Touching objects in public (e.g., elevator buttons, doors, etc.)
Traveling_covid	The traveling status of an individual
Pregnancy	An individual's status of pregnancy
Diabetes	The status of diabetes of an individual
Copd	The status of Copd of an individual
Asthma	The status of asthma of an nidividual
Renal_chronic	The status of renal chronic of an individual
Cardiovascular	The status of cardiovascular of an individual
Blood disorder	Whether an individual has blood disorder

buttons or doors) can help to prevent the spread of COVID-19.

In addition to the above experimental results and findings, we provide a list of factors (determinants) that mostly likely correlate with health disparities in COVID-19 based on information obtained from the COVID-19 data. Table I shows a list of factors that are likely to be correlated with health disparities in COVID-19. In our future work, we will consider proposing a machine learning based approach to experimentally verify those factors.

V. Conclusions

The COVID-19 pandemic has disproportionately and negatively impacted different communities. The racial and ethnic minorities are at a particular disadvantage and are more likely to be the target of COVID-19 infection. Black Americans are especially vulnerable to experience the impact of COVID-19 due to the long-standing history of disadvantages. Examining health determinants (e.g. structural, social and constructural health) assist in ascertaining why disparities occur with higher infection and death rates and in turn eventually help to improve pandemic health care. From a thorough analysis of health disparities [based on multiple COVID-19 datasets] we demonstrate that racial and ethnic minorities [such as Black Americans] have a higher rate of infections and deaths in comparison to other communities. Our analysis highlights the fact that race and ethnicity play a pivotal role in determining how and when care is accessed, and what the outcome might be. Examining health determinants assist in ascertaining why disparities occur. Our findings suggest that the determinants are diverse. Determinants such as age, employment status, food sufficiency, health insurance status, access to medical care, symptoms of depression, symptoms of anxiety, payment status of housing units (or rent) significantly contribute to the health disparities in this pandemic and hence COVID-19, as a disease, may potentially have devastating effects on communities of color. The virus itself does not discriminate, but America's history of discrimination creates potential longer-term scenarios. For now we provide new strategies for determining diverse health determinants, and new findings on health determinants for understanding health disparities. In the future, we will consider using machine learning algorithms to experimentally examine diverse health determinants. Also, we will compare our approach with state-of-the-art to fully verify the performance of our approach. In addition, we will collect the health data prior to COVID-19, and compare the experimental results based on the COVID-19 data and that of the health data prior to COVID-19 to further verify that the disparities are showing due to COVID-19. Finally, we will expand the dataset to further improve the performance of our approach.

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