Exploring Ethnic Disparity of Coronavirus Death Rate During the Beginning Period of COVID-19

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Abstract

Analyzing the CDC COVID-19 Case Surveillance Public Use Data[1] which relates to the count of deaths caused by coronavirus, it is found that there were two peaks of death due to COVID-19 illness - one is in April 2020 and another is in January 2021. It is worth noticing that in April 2020, the death rates differed a lot by race, where Black has much higher death rate than other populations including Hispanic, Non-Hispanic American Indian or Alaska Native, Non-Hispanic Asian, and Non-Hispanic White. To further develop this finding, the main focus of this paper is to analyze which factors cause such a big difference in death rates between Black and other races during the beginning period of coronavirus. The factors that cause the difference are being divided into two subgroups, inherent factors which refer to biological difference between Black and other races and external factors which mean by factors that lead to inequality of treatment of COVID-19 across ethnic groups. Through the research, it is concluded that Black has disadvantages in both inherent and external factors, which might be the reason for their exceeded death [1]rate at the first peak of coronavirus deaths in April 2020.

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[1] CDC. COVID-19 Case Surveillance Public Use Data. (June 8, 2021). Retrieved from: https://data.cdc.gov/Case-Surveillance/COVID-19-Case-Surveillance-Public-Use-Data/vbim-akqf

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1	**I. BACKGROUND**
2	COVID-19, a pandemic with high infection and death rate, has unprecedentedly changed the
3	global situation only three months after its December outbreak in Wuhan, China. After a large-scale
4	shutdown of businesses, the most common policy established by governments all over the world is
5	the Stay-at-Home Order, asking people to have quarantine in their houses. Despite the fact that
6	quarantine has efficiently reduced the overall daily cases of COVID-19, it also exacerbates additional
7	problems such as unemployment and social inequality. The situation is more severe in the United
8	States, since people may suffer a higher infection rate due to the government's slow reaction - about
9	two months after the first coronavirus case found in the US, the California government became the
10	first one to issue a statewide Stay-at-Home Order. The higher risks of infection have in turn
11	widened the gap of social status because the inequality has now been reflected in the death rates.
12	
13	**II. INTRODUCTION**
14	Our research question was stimulated from plots (Figure 1 and Figure 2) which are visualized
15	according to the CDC COVID-19 Case Surveillance Public Use Data.[1] The data description and the
16	process of analysis will be shown in the VISUALIZATION OF COVID-19 CASES AND
17	DEATHS section. Figure 1 shows that at the beginning period of the pandemic, the number of
18	cases across all ethnic groups was gradually increasing. In April 2020, it shows that Black and
19	Hispanic have the highest incident cases of around 50 per 100,000 population, while Asian and
20	White have a lower number of cases around 20 per 100,000 population. These ethnic gaps in daily
21	cases in April are very narrow compared to their later gaps. It means that if we hold every factor to
22	be the same for all periods, we are supposed to notice a larger gap in death rates after April.

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[1] CDC. COVID-19 Case Surveillance Public Use Data. (June 8, 2021). Retrieved from: https://data.cdc.gov/Case-Surveillance/COVID-19-Case-Surveillance-Public-Use-Data/vbim-akqf

23   However, Figure 2 shows that the largest ethnic gaps in death cases happen exactly in that month,

24   with the death rate of Black largely surpassing that of other races. In addition, the death cases for

25   almost all ethnic groups have a relative peak in April 2020, which means that people infected with

26   coronavirus have a higher death rate in the beginning period of the pandemic. Hence, we can't help

27   asking: why does the largest gap in the death rate among different ethnic groups occur in the

28   beginning period of COVID-19? And what is the indication to us?
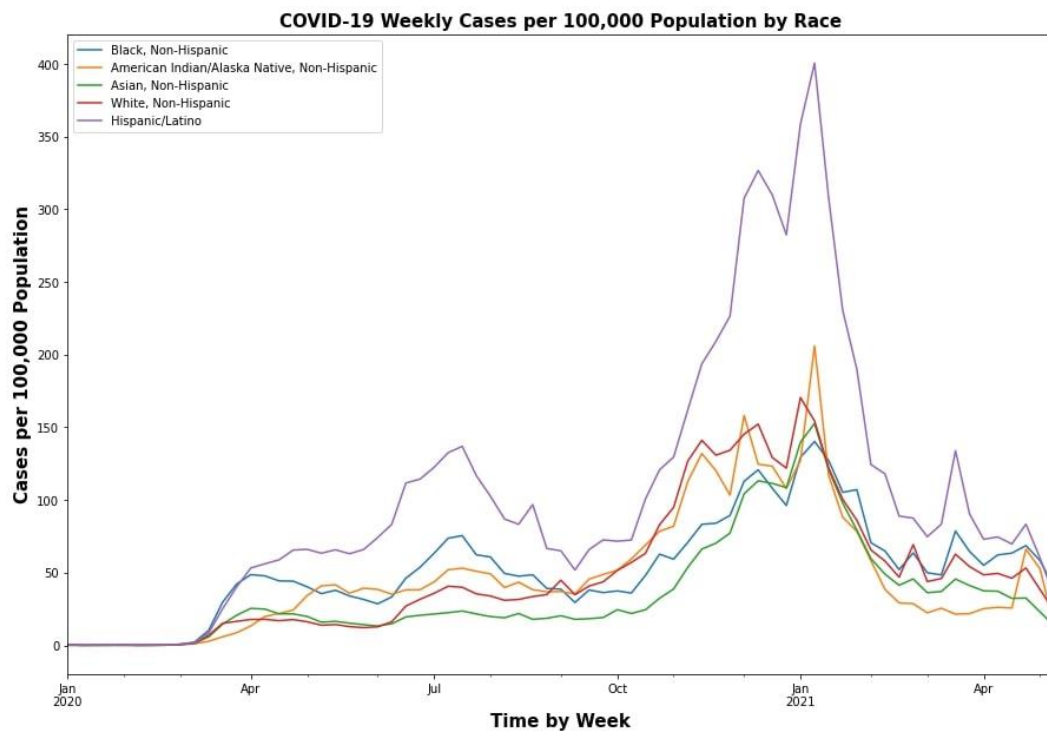
29

30   **FIGURE#1.jpg: COVID-19 Weekly Cases per 100,000 population across ethnic groups**

COVID-19 Weekly Deaths per 100,000 Population by Race

31
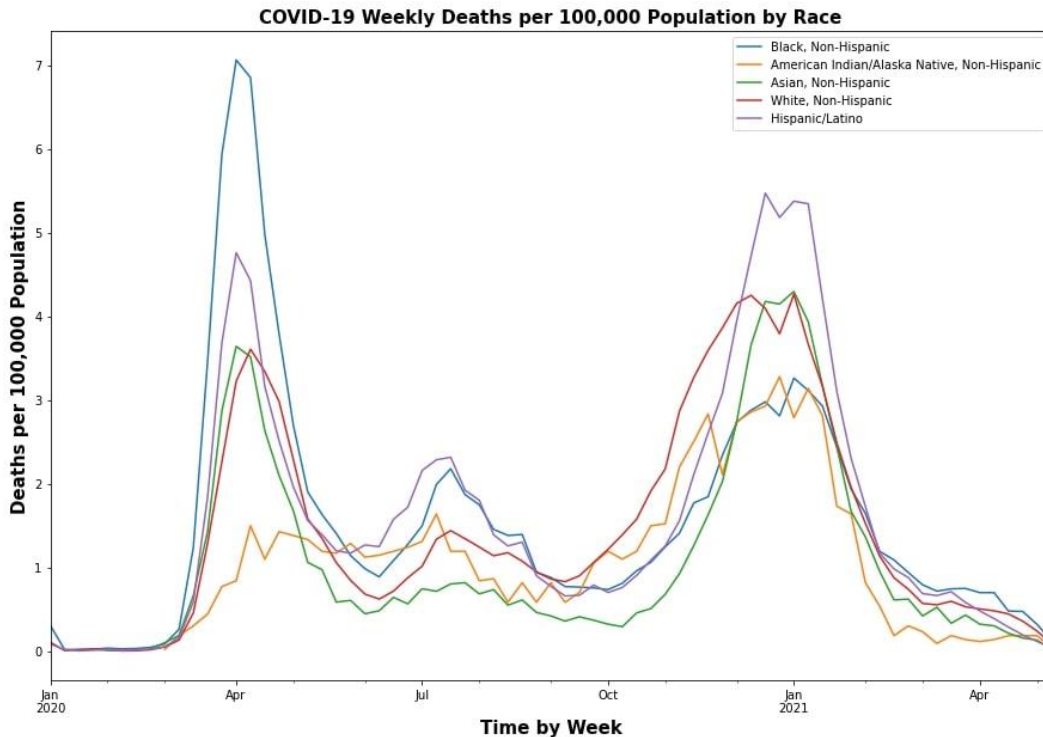
32   **FIGURE#2.jpg COVID-19 Weekly Deaths per 100,000 population across ethnic groups**

33   There is no single factor that is fully responsible for the ethnic disparity in death rate, nor is

34   there any factor that suddenly appears to seriously affect the life quality of some ethnic groups. In

35   other words, the clue of the cause of the ethnic disparity should come from multiple phenomena,

36   and these phenomena must have existed for decades, or even centuries, whose effects finally burst

37   out during the pandemic. Many have attributed the ethnic differences in death rate to the economic

38   inequality, as it is germane to a racial divide in wealth and income.[2] If we think further, however,

39   economic inequality does not simply mean that some people don't have enough money to pay for

40   their hospitalization, but creates extra problems that make them have a lower chance to survive. In

41   the book *Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty,* [3] the author Esther

42   Duflo indicates that poverty lets people become myopic and make wrong decisions. For example,

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[2] Human Rights Watch. US: Address Impact of Covid-19 on Poor. (2020, March 19). Retrieved from: https://www.hrw.org/news/2020/03/19/us-address-impact-covid-19-poor#

[3] Abhijit V., Banerjeeand, and D. Esther. Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty. (2011)

43 poor people may refuse to take a vaccine because they would bear the opportunity cost in which

44 they could use their vaccination time to earn more money, otherwise they may not have enough

45 money to pay their meals; poor people may save money to buy a TV instead of having more healthy

46 and high-quality foods every day, because a TV can be an indispensable source of entertainment for

47 them. In a word, poor people are very careful decision makers in their lives, because every expense

48 that they make would affect their next meal, causing them to become short-sighted and unprepared

49 for a sudden catastrophe like COVID-19. Hence, we came to realize that there would be inherent

50 and external factors that may cause the ethnic disparity in death rates. Inherent factors, like having

51 diseases that deteriorate the severity of coronavirus symptoms, are accompanied with some ethnic

52 groups that are economically vulnerable. External factors, like inequalities in income and wealth,

53 health insurances, education level, job distributions, and hospitalization will divide ethnic groups

54 based on their economic status. These two factors, as you may have already noticed, are closely

55 related to the probability of infection and death with COVID-19, as well as people's decisions of

56 medical care in the pandemic.

57   In this research, we would consider the specialty of the beginning period of COVID-19, and

58 then explain the logic behind the ethnic disparity in death rate by exploratory data analysis with

59 respect to internal and external factors.

60

61 **III.   RELATED WORKS**

62   A thorough timeline of COVID-19 development is recorded in the AJMC website,[4] showing

63 that on March 13th, the US government started to officially declare the national urgency of COVID-

64 19. However, people didn't realize the efficient method until May 25th, after a report suggested

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[4] AJMC Staff. A Timeline of COVID-19 Developments in 2020. (January 2, 2021). Retrieved from: https://www.ajmc.com/view/a-timeline-of-covid19-developments-in-2020

65 business shutdown as a way to reduce daily cases. What made things even worse was the public

66 reaction of the virus - people are very unlikely to ask for medical care when they get "dry cough" or

67 a fever even though both are typical symptoms of coronavirus. An article from Gallup website has

68 also reported that the main reason for the phenomenon is the cost concerns, and "adults under 30,

69 non-whites, those with a high school education or less and those in households with incomes under

70 $40,000 per year".[5] Due to public indifference and cost concerns, the number of death cases passed

71 the 100,000 mark on May 28th.

72 Another reason for the peak of the death rate in April 2020 is the lack of medical resources. In

73 the article *Why do COVID death rates seem to be falling?* Heidi Ledford states that the treatment strategy

74 of coronavirus in the beginning period is inconsistent through different hospitals.[6] In other words,

75 some hospitals with good technology and doctors may have a more appropriate way to treat their

76 patients, while normal hospitals may not be able to come up with a good solution. Also, the

77 equipment for coronavirus treatment was in scarcity at the beginning. Sarah Kliff from New York

78 Times states that there aren't enough ventilators in many hospitals, since more and more patients

79 need hospitalization as the accumulative cases surge. This information provides us another insight of

80 the effect of economic inequality, since good hospitals are usually located in affluent neighborhoods,

81 and the price of ventilators became high enough (soars from $25,000 to %45,000) to exclude normal

82 hospitals from buying more because of the high demands.[7] Hence, it is explainable that the death

83 rate between different ethnic groups is so large at the initial stage of COVID-19. First of all, the

84 severe trend was deteriorated by people's indifference toward the virus, causing more cases and

85 more deaths every day. Then, after people suddenly realize the severity of the situation, the scarcity

[5] W. Dan. In U.S., 14% With Likely COVID-19 to Avoid Care Due to Cost. (April 28, 2020). Retrieved from:
https://news.gallup.com/poll/309224/avoid-care-likely-covid-due-cost.aspx

[6] L. Heidi. Why do COVID death rates seem to be falling? (November 11, 2020) Retrieved from: https://www.nature.com/articles/d41586-020-03132-4

[7] B. Andrew. Coronavirus: Cost of ventilators soars from $25,000 to $45,000 due to surge in demand, says New York governor. Retrieved from:
https://www.independent.co.uk/news/world/americas/coronavirus-ventilator-new-york-cases-andrew-cuomo-price-cost-a9431861.html

86   of medical resources magnifies the effect of economic inequality, which in turn is reflected in the

87   disparity of death rate among ethnic groups.

88   Many negative inherent factors that worsen the fatality of COVID-19 have also been found.

89   Laurens Holmes, Jr. investigated the "black-white risk differentials in COVID-19 transmission,

90   mortality and case fatality."[8] He found that the fatality risk of African American is consistently

91   higher than that of White in many different regions. Eboni G conducted an experiment to compare

92   the hospitalization and mortality among Black and White patients.[9] He suggested that obesity and

93   diabetes are more common among black population than white population and are related to the

94   severity of covid. Also, he found that of the 326 patients who died in hospital, 230 were black, with

95   the median length of hospitalization similar across all groups. CDC also shows a list of diseases that

96   may deteriorate the severity of coronavirus infection, and obesity, diabetes, as well as other common

97   illnesses are included.[10]

98   Apart from the innate factors that have been affecting vulnerable groups for long, external

99   factors coming with the change of society widen the coping capacity of different ethnic groups to a

100 larger extent. For example, the job distributions across all ethnic groups are suffering with different

101 levels of risks of getting coronavirus. Elise Gould in the article *Not Everybody Can Work From Home*

102 finds an uneven distribution of works that can be continued remotely (also known as telework)

103 across all ethnic groups. Specifically, Black and Hispanic groups are less likely to have telework after

104 the business shutdown, and hence there would be a larger income loss among these two groups than

105 other races.[11] The author also found that the wage of work is positively correlated to their availability

[8] H. Holmes, E. Michael, and W. Janille, 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. (June 17, 2020).Int. J. Environ. Res. Public Health 2020, 17(12), 4322. Retrieved from: https://doi.org/10.3390/ijerph17124322

[9] S. Leonardo, G. Eboni, and B. Jeffery, et al. Hospitalization and Mortality among Black Patients and White Patients with Covid-19. (June 25,2020) Retrieved from: https://www.nejm.org/doi/full/10.1056/NEJMsa2011686

[10] CDC. People with Certain Medical Conditions. (May 13, 2021). Retrieved from: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html

[11] G. Elise, S. Heidi. Not everybody can work from home: Black and Hispanic workers are much less likely to be able to telework. (March 19, 2020). Retrieved from: https://www.epi.org/blog/black-and-hispanic-workers-are-much-less-likely-to-be-able-to-work-from-home/

106   of teleworks, with "higher-wage workers (75th percentile and more) are six times as likely to be able

107   to work from home as lower-wage workers (25th percentile and less)". It indicates that the original

108   low-income groups fall into an even worse situation after COVID-19. Besides, a report from Urban

109   Institute indicates that Black and Hispanic groups also have a higher risk of infection prior to the

110   shutdown, since they have the largest share of workers who have to work face-to-face in essential

111   industries (44% - 45%), which is about 9% - 15% higher than the share of workers from other races

112   who work in person.[12] Furthermore, a research from Stanford University finds that Black and

113   Hispanic made up 53% of impatient deaths, probably due to the inability to afford the insurance and

114   the lack of knowledge to recognize the danger of coronavirus, in our common sense.[13]

115

116   **IV.   VISUALIZATION OF COVID-19 CASES AND DEATHS**

117   The data from which we recognized the ethnic gap of death rate is from CDC COVID-19 Case

118   Surveillance Public Use Data.[1] The data could be found in 1-COVID19DATA.csv, and the analysis

119   code could be found in 1-COVID19Cases&Deaths.ipynb. The Case Surveillance Public Use Data is

120   a very large database with each case as a row, hence there are more than 25 million rows of data.

121   Patients' basic information including sex, age group, and ethnicity are included in this data, and we

122   are able to know their coronavirus cases information such as clinical date, report date,

123   hospitalization status, and death status from the data. For laboratory-confirmed cases, we found

124   1,645,539 total cases for Black, Non-Hispanic, 145,562 total cases for American Indian/Alaska

125   Native, Non-Hispanic, 488,430 total cases for Asian, Non-Hispanic, 6,948,319 total cases for White,

126   Non-Hispanic, and 4,494,749 total cases for Hispanic/Latino. Similarly, for death cases, we found

[1] CDC. COVID-19 Case Surveillance Public Use Data. (June 8, 2021). Retrieved from: https://data.cdc.gov/Case-Surveillance/COVID-19-Case-Surveillance-Public-Use-Data/vbim-akqf

[12] D. Lisa, A. Joshua, B. K. Steven, at el. How Risk of Exposure to the Coronavirus at Work Varies by Race and Ethnicity and How to Protect the Health and Well-Being of Workers and Their Families. (December, 2020). Retrieved from: https://www.urban.org/sites/default/files/publication/103278/how-risk-of-exposure-to-the-coronavirus-at-work-varies.pdf

[13] Stanford Medicine. More than half of in-hospital deaths from COVID-19 among Black, Hispanic patients, study finds. (November 17, 2020), Retrieved from: https://med.stanford.edu/news/all-news/2020/11/deaths-from-covid-19-of-inpatients-by-race-and-ethnicity.html

127   49,735 total deaths for Black, Non-Hispanic, 3,133 total deaths for American Indian/Alaska Native,

128   Non-Hispanic, 14,904 total deaths for Asian, Non-Hispanic, 206,036 total deaths for White, Non-

129   Hispanic, and 69,987 total deaths for Hispanic/Latino.

130   To illustrate the risk of coronavirus infection for different races, we calculate the average cases

131   and deaths counts of each race for each week, and then divide them by their ethnic population

132   considering population differences across ethnic groups. The population estimates statistics are from

133   the Census Bureau in 2019, population estimate for Black, Non-Hispanic is 43,984,096, American

134   Indian/Alaska Native, Non-Hispanic is 4,267,113, Asian, Non-Hispanic is 19,366,131, White, Non-

135   Hispanic is 250,446,756, and Hispanic/Latino is 60,724,311.[14] So far we get the rate of infection and

136   death in each ethnic group, and now we can time the rate with 100,000, so we will get an index

137   about the number of cases and deaths per 100,000 ethnic population. For example, in the week of

138   April 5th, 2021, we observe that there are on average 62.23 Black COVID-19 laboratory-confirmed

139   cases per 100,000 Black population each day. The index gives us important information of the

140   coping capacity of coronavirus for each racial group, which brings us the first evidence of ethnic

141   disparity (Figure 1 and Figure 2), as we discussed in the INTRODUCTION section.

142

143   **V.   METHOD AND ANALYSIS**

144   **A. INHERENT FACTORS**

145   The dataset about inherent factors is from CDC's "AH Monthly Provisional Counts of

146   Deaths for Select Causes of Death by Sex, Age, and Race and Hispanic Origin," and it provides

147   information about the counts of death per month for different select types of diseases between 2019

148   and 2021 grouped by race, sex, and age.[15] There are 39 columns and 3,480 rows in this dataset. The

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[14] United States Census Bureau. Quick Facts. (July 1, 2019). Retrieved from: https://www.census.gov/quickfacts/fact/table/US/PST045219
[15] National Center for Health Statistics. AH Monthly Provisional Counts of Deaths for Select Causes of Death by Sex, Age, and Race and Hispanic Origin. (May 25, 2021). Retrieved from: https://data.cdc.gov/NCHS/AH-Monthly-Provisional-Counts-of-Deaths-for-Select/65mz-jvh5

149 columns included are date of analysis, death year, death month, sex, race/ethnicity, age group, total

150 number of deaths, and counts for deaths for each kind of disease. The dataset and the analysis code

151 could be found in 2-DiseaseDeathsData.csv and 2-DeathsCausedbyDiseases.ipynb. To find whether

152 black has a higher COVID-19 death rate than other race groups in April 2020 is because of the

153 biological difference between ethnic groups, death rates across different ethnic groups caused by

154 diseases which may increase the severity of COVID-19 illness are being analyzed. To narrow the

155 range of disease and find which actually increase the severity of coronavirus symptoms, we also

156 referred to CDC's article *Science Brief: Evidence used to update the list of underlying medical conditions that*

157 *increase a person's risk of severe illness from COVID-19.*[16] The article has provided information about a list

158 of diseases which might cause COVID-19 illness worse. Based on the dataset and the article, there

159 are four diseases included in the dataset that might increase the severity of coronavirus symptoms —

160 chronic disease, diabetes, cerebrovascular disease, and heart disease. We are going to analyze death

161 rates of these four diseases across ethnic groups.

162   We figured out the trend of deaths caused by chronic lower respiratory diseases, heart

163 diseases, cerebrovascular diseases, and diabetes mellitus for each ethnic group. For all of the data

164 above, we divided the population into five ethnic groups: Hispanic, Non-Hispanic American Indian

165 or Alaska Native, Non-Hispanic Asian, Non-Hispanic White, and Non-Hispanic Black. By

166 calculating the death counts and death rates for each disease, the count of death per 100,000 ethnic

167 population is being plotted in Figure 3-6.

168   Figure 3-6 suggests that White and Black people have a larger death rate than other race

169 populations caused by these four diseases. Especially for diabetes, where black has much higher

170 death rates than other populations (Figure 4). The result of plots suggests that due to higher risk of

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[16] CDC. Science Brief: Evidence used to update the list of underlying medical conditions that increase a person's risk of severe illness from COVID-19. (May 12, 2021) Retrieved from: https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/underlying-evidence-table.html

171   getting diseases which may worsen COVID-19 illness compared to other race populations, Black

172   and White might be at a higher risk of death caused by COVID-19 if we hold every other factor

173   constant. This might explain why the death rate of Black in April 2020 caused by COVID-19 was

174   much higher than other ethnic groups.

175   However, according to Figure 2, the death of White caused by COVID-19 is much lower

176   than that of the Black population, even though both are suffering from the same severe situation of

177   chronic lower respiratory diseases, heart diseases, cerebrovascular diseases, and diabetes mellitus.

178   This phenomenon indicates that although the inherent factor may help explain the high coronavirus

179   death rates among Black population, there must exist factors other than inherent factors that

180   distinguish the coronavirus death rates of Black and White. Hence in the following content, we are

181   going to explore external factors that may capture the difference in death rate among ethnic groups

182   from the angle of economic and social inequality.

183   **B. EXTERNAL FACTORS**

184   **1. Income**

185   First, we considered the factor of income and speculated that blacks had lower income due

186   to racial factors, which may have contributed to their higher death rate in the beginning of the

187   pandemic, even though they were infected, but were hindered from going to the hospital because

188   they did not have enough money. If we find data indicating that blacks in general receive lower

189   income in society, or that annual income growth is lower for blacks than for other races, we can

190   reasonably speculate that the reason blacks do not receive medical care is because they have lower

191   income. The data we found was about year household Income by race from 2015 to 2019 from the

192   Census Bureau.[17] The dataset and the analysis code could be found in 3-IncomeData.xlsx and 3-

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[17] United States Census Bureau. Selected Characteristics of People 15 Years and Over, by Total Money Income, Work Experience, Race, Hispanic Origin, and Sex. (2019). Retrieved from: https://www.census.gov/data/tables/time-series/demo/income-poverty/cps-pinc/pinc-01.html

193   Income.ipynb. Considering that median income is more meaningful than mean income, we finally

194   used the median income data of different ethnic groups in the last five years, including White, Black

195   and Asian.

196   After we plot the annual household income from 2015 to 2019 based on the data of race

197   (Figure 7), we can clearly see the annual income of black alone or in combination is much lower

198   than that of whites and other races. Not only during the pandemic, but also before the pandemic,

199   the income of blacks was lower than that of whites and other races. The annual income of Asians

200   was three times that of blacks, so we can deduce that one of the possible reasons why blacks had a

201   higher mortality rate during the pandemic was because their income was not enough to support

202   them to go to hospitals and get medical care.

203   **2. Wealth and Homeownership**

204   In addition to the ethnic difference in income, wealth is another economic factor that shows

205   great inequality among ethnic groups and influences black people's situation during the COVID-19

206   pandemic. The racial wealth division has been going on for a long time in the United States.

207   According to the Federal Reserve's data from the Survey of Consumer Finances from 1989 to

208   2019,[18] the difference in median wealth of households between white people and people of color is

209   surprising, and we make a visualization of racial wealth division in Figure 8. The data could be found

210   in 4-WealthData.csv, and the analysis code could be found in 4-Wealth&Education.ipynb. The data

211   here reports household financial statistics including variables like net worth, asset, and debt across

212   ethnic groups (Non-Hispanic White, Non-Hispanic Black, Hispanic, and Other) from 1989 to 2019.

213   Here, to generate an overview of racial disparity in wealth before COVID-19, we use net worth

214   statistics for Non-Hispanic White, Non-Hispanic Black, and Hispanic in 2010, 2013, 2016, and

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[18] Federal Reserve. Survey of Consumer Finances. (September 28, 2020). Retrieved from:
https://www.federalreserve.gov/econres/scf/dataviz/scf/table/#series:Net_Worth;demographic:racecl4;population:all;units:median;range:1989,2019

215 2019. From Figure 8, in 2010, the median wealth of white households was about 150,000 dollars,

216 which was more than six times of median wealth owned by Blacks or Hispanics. From 2010 to 2019,

217 white families' median wealth has grown by about 25,000 dollars. However, median wealth owned

218 by people of color grows very slowly, especially for Black families, which is still around 25,000

219 dollars in 2019. The difference in household wealth is surprisingly large, and it is still getting larger

220 over time.

221   Another similar factor is the homeownership, which is an important factor that influences

222 people's economic status. According to the Federal Reserve's Report on the Economic Well-Being

223 of the U.S. Households from 2020 to May 2021[19], the homeownership rate for White is 71%, while

224 for Black and Hispanic are 51% and 50%. The homeownership rate is again highly skewed to White,

225 and it shows another great racial inequality of economic status.

226   Without the backing of wealth and homeownership, people of color lack high-quality

227 medical resources, as medical resources in the United States are expensive. In addition, at the

228 beginning of the pandemic, only a limited number of hospitals had enough technology and machines

229 for the coronavirus treatment. With disadvantages in economic status, people of color could not

230 afford those expensive resources, and they are also unlikely to have a high-quality treatment in the

231 beginning period when the systematic strategy of coping with covid is inconsistent and unstable. The

232 racial division in wealth and homeownership also causes a series of inequality issues that will

233 influence the situation of blacks in the pandemic such as education resources and health insurance.

234 Those problems together caused the disadvantages of blacks during the pandemic, which might lead

235 to a higher death rate for blacks in April 2020.

236   **3. Insurance**

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[19] Federal Reserve. Report on the Economic Well-Being of U.S. Households in 2020 - May 2021. (May 19, 2021). Retrieved from: https://www.federalreserve.gov/publications/2021-economic-well-being-of-us-households-in-2020-accessible-version.htm#xfigure25-homeownershipratebyraceeth-b3159ab7

237   The third external factor we considered that may affect the initial death rate of blacks is the

238   insured rates. If the black race in general has lower insured rates, they may not seek timely medical

239   care because they are not covered by insurance companies, resulting in a higher initial mortality rate.

240   According to the data from KFF,[20] we plot the histogram of uninsured rates for the nonelderly by

241   race/ethnicity in 2018 and 2019 (Figure 9). The data includes a survey of uninsured rates for

242   different ethnic groups in 2018 and 2019, including White, Black, Hispanic, Asian/Native Hawaiian

243   and Pacific Islander, American Indian/Alaska Native, and multiple races. The dataset and analysis

244   code could be found in 5-InsuranceData.xlsx and 5-Insurance.ipynb.

245   From Figure 9, we found that the uninsured rates of blacks are not the lowest among the

246   ethnic groups. The percentage of uninsured rates of Black, Hispanic and American Indian were

247   around 11%, 18%, and 21%. However, compared to the uninsured rate of White population (7.8%),

248   Black population has a much higher uninsured rate. It may help explain why there exists a large gap

249   of COVID-19 death between White and Black, while both ethnic groups are suffering from a severe

250   status of related diseases such as heart diseases and diabetes. Since other ethnic groups are not in

251   such a severe disease status as White and Black have, the uninsurance may hit the Black population

252   harder than other groups.

253   Also, a lower insured rate is a result of the inequality of total wealth and income status, since

254   insurance becomes a larger burden to families with lower affordability. By now, according to the

255   three external factors we have mentioned (income, wealth, and insurance), we have noticed a

256   deteriorating cycle of economically vulnerable groups. Ethnic groups with low income would have

257   less total wealth, which makes them less likely to buy insurance. When a contingent incidence like

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[20] State Health Facts. Uninsured Rates for the Nonelderly by Race/Ethnicity. (2019). Retrieved from: https://www.kff.org/uninsured/state-indicator/nonelderly-uninsured-rate-by-raceethnicity

258 COVID-19 infection occurs, the sudden disaster would cause them into a hopeless situation,

259 creating a higher death rate of coronavirus.

260   **4. Education Level**

261   Education level is also a significant factor that will affect people's choices in the pandemic.

262 People with higher education level pay more attention to the coronavirus and the quarantine.[21] From

263 a news article in USC Dornsife, it shows that there is a substantial gap between more-and-less

264 educated U.S. residents on their willingness to get vaccines.[21] According to the Census Bureau's data

265 of educational attainment in the United States in 2019,[22] we also found a great racial division in the

266 education level (Figure 10). The original data could be found in 6(1)-EducationDataAsian.xlsx, 6(2)-

267 EducationDataBlack.xlsx, 6(3)-EducationDataHispanic.xlsx, 6(4)-EducationDataNon-

268 HispanicWhite.xlsx, and 6(5)-EducationDataWhite.xlsx, and the visualization code could be found

269 in 4-Wealth&Education.ipynb. These datasets include the number of people who achieved each

270 education level for each ethnic group above 18 years old. We calculate the percentage of achieving

271 each education level (high school or more, college or more, Associate's degree or more, Bachelor's

272 degree or more, and advanced degree) for each ethnic group.

273   From Figure 10, we could clearly see that the lines of Black and Hispanic are below the lines

274 of other races. At any education level, the percentages of Black or Hispanic that achieve the degrees

275 are lower than other races. About 55% of Asian alone achieve the Bachelor's degree, and about 34%

276 of White alone achieve the Bachelor's degree, while the percentages for Black and Hispanic are

277 about 24% and 17%. The differences in the education level show another inequality in the

278 educational resource.

[21] M. Jenesse. Education is now a bigger factor than race in desire for COVID-19 vaccine. (February 25, 2021). Retrieved from: https://dornsife.usc.edu/news/stories/3410/covid-19-vaccine-acceptance-education-bigger-factor-than-race/

[22] United States Census Bureau. Educational Attainment in the United States: 2019. (March 30, 2020). Retrieved from: https://www.census.gov/data/tables/2019/demo/educational-attainment/cps-detailed-tables.html

279   For people who achieve higher education levels, they believe more in science, which makes

280   them more likely to comply with the coronavirus preventions, for example, they are more likely to

281   wear masks and pay attention to stay-at-home quarantine and disinfection. In this way, blacks are

282   more likely not to pay attention to the protection in the pandemic and not to get the treatment in

283   time at the beginning of the pandemic.

284   **5. Telework**

285   The fifth factor we considered that may affect the initial death rate of blacks is the telework

286   rates. As we mentioned before, Elise Gould in the article *Not Everybody Can Work From Home* finds

287   an uneven distribution of works that can be continued remotely (also known as telework) across all

288   ethnic groups.[11] Black and Hispanic groups are less likely to have telework after the business

289   shutdown, and hence it would cause two problems: 1) there would be a larger income loss among

290   these two groups than other races.[10] 2) jobs that are unable do telework are usually face-to-face,

291   meaning that Black and Hispanic are more likely to be infected before the business shut down.

292   To confirm this conjecture, we found data from the Economic Policy Institute about the

293   percentage of workers who can telework by race from 2017 to 2018 including White, Black and

294   Asian.[11] The dataset and the visualization code could be found in 7-TeleworkData.xlsx and 6-

295   Telework&Hospitalization.ipynb. The histogram is listed below in Figure 11. The graph shows the

296   percentage of black workers who can telework was 10% lower than White and 18% lower than

297   Asian. Asian telework percentage is the highest one from the histogram, reaching a value around

298   35%, almost twice as much as the black. That shows the income situation of blacks will become

299   worse during the pandemic, we can also infer that the higher death rate of blacks in the initial period

300   may be affected by their lower rate of telework.

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[10] CDC. People with Certain Medical Conditions. (May 13, 2021). Retrieved from: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html

[11] G. Elise, S. Heidi. Not everybody can work from home: Black and Hispanic workers are much less likely to be able to telework. (March 19, 2020). Retrieved from: https://www.epi.org/blog/black-and-hispanic-workers-are-much-less-likely-to-be-able-to-work-from-home/

301   **6. Hospitalization**

302   The Coronavirus Disease 2019 (COVID-19)-Associated Hospitalization Surveillance

303 Network (COVID-NET) hospitalization data[23] from CDC provides us a thorough look of the

304 hospitalization rate by ethnic groups. According to their data description, "COVID-NET conducts

305 population-based surveillance for laboratory-confirmed COVID-19-associated hospitalizations in

306 children (less than 18 years of age) and adults. COVID-NET covers nearly 100 counties in the 10

307 Emerging Infections Program (EIP) states (CA, CO, CT, GA, MD, MN, NM, NY, OR, TN) and

308 four Influenza Hospitalization Surveillance Project (IHSP) states (IA, MI, OH, and UT)." The

309 dataset and the analysis code could be found in 8-HospitalizationData.xlsx and 6-

310 Telework&Hospitalization.ipynb.

311   Because our study was conducted on the black mortality rate at the beginning of the

312 epidemic, we selected the weekly rate of hospitalization from March to May 2020 for better

313 observation. The line graphs can better show the hospitalization data of White, Black, Hispanic,

314 Asian and American Indian. Unexpectedly, the information given by the data is different from what

315 we noticed from the related work in which Black is reported as a group with a lack of

316 hospitalization. According to the news article from Stanford Medicine[13], the higher death rate of

317 Black is due to the delay of hospitalization, so that people won't go to hospital until they are sick

318 enough. From Figure 12, we noticed that the hospitalization rate of Black was the highest from

319 March 2020 to May 2020 among all ethnic groups. It indicates that Black coronavirus infected

320 patients have enough chances to be hospitalized and their hospitalization is timely, since their

321 hospitalization rate is initially high.

[13] Stanford Medicine. More than half of in-hospital deaths from COVID-19 among Black, Hispanic patients, study finds. (November 17, 2020), Retrieved from: https://med.stanford.edu/news/all-news/2020/11/deaths-from-covid-19-of-inpatients-by-race-and-ethnicity.html
[23] CDC. Laboratory-Confirmed COVID-19 Associated Hospitalization. Retrieved from: https://gis.cdc.gov/grasp/COVIDNet/COVID19_3.html
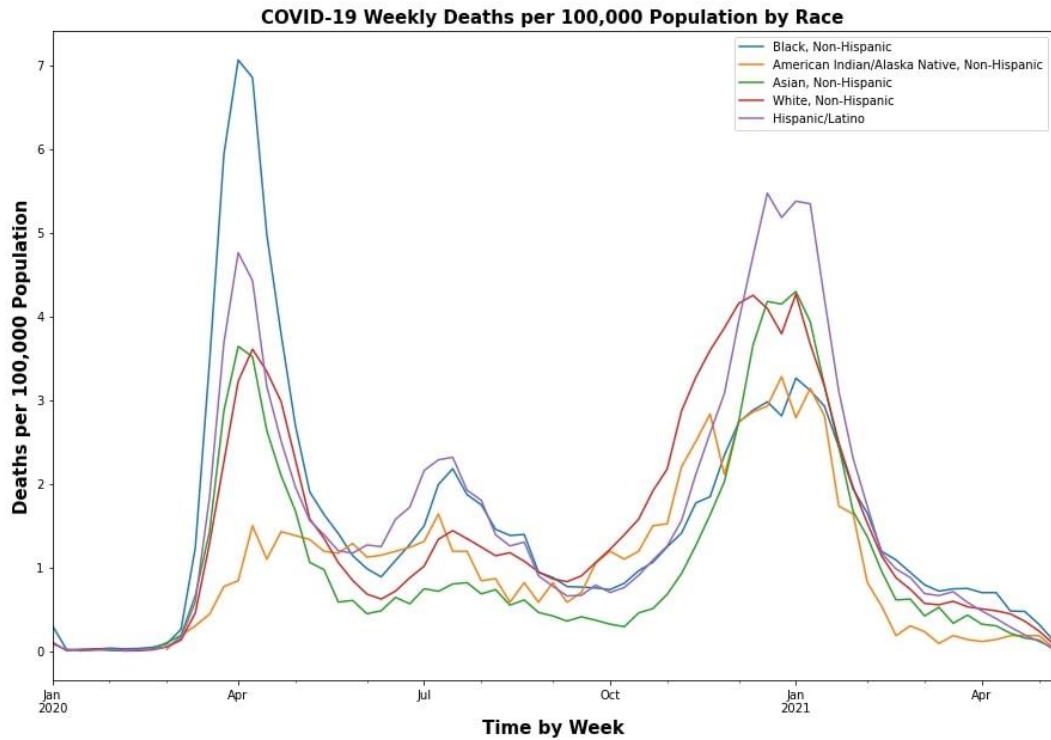
322   However, this cannot prove that blacks received effective medical care at the beginning

323   period of COVID-19. As we mentioned before, there are limited medical machines and hospitals

324   that could deal with coronavirus during the initial period of pandemic. With the results we generated

325   above, blacks have lower income, wealth, and insured rate. Those factors might prevent them from

326   receiving effective but expensive treatments. In addition, as people probably do not go to hospitals

327   until they are sick enough, the higher hospitalization rate of blacks also indicates that blacks suffered

328   more and had more severe symptoms during the initial period of pandemic. Hence, we can exclude

329   the failure of hospitalization as a reason for the higher death rate among Black population, but

330   higher hospitalization rate does not mean that blacks could get effective treatments in the beginning

331   period of COVID-19. In this way, the death rate for Black population is still higher than other

332   ethnic groups in April 2020.

333

334   **VI.   TABLES, FIGURES, MULTIMEDIA, AND SUPPLEMENTARY FILES**
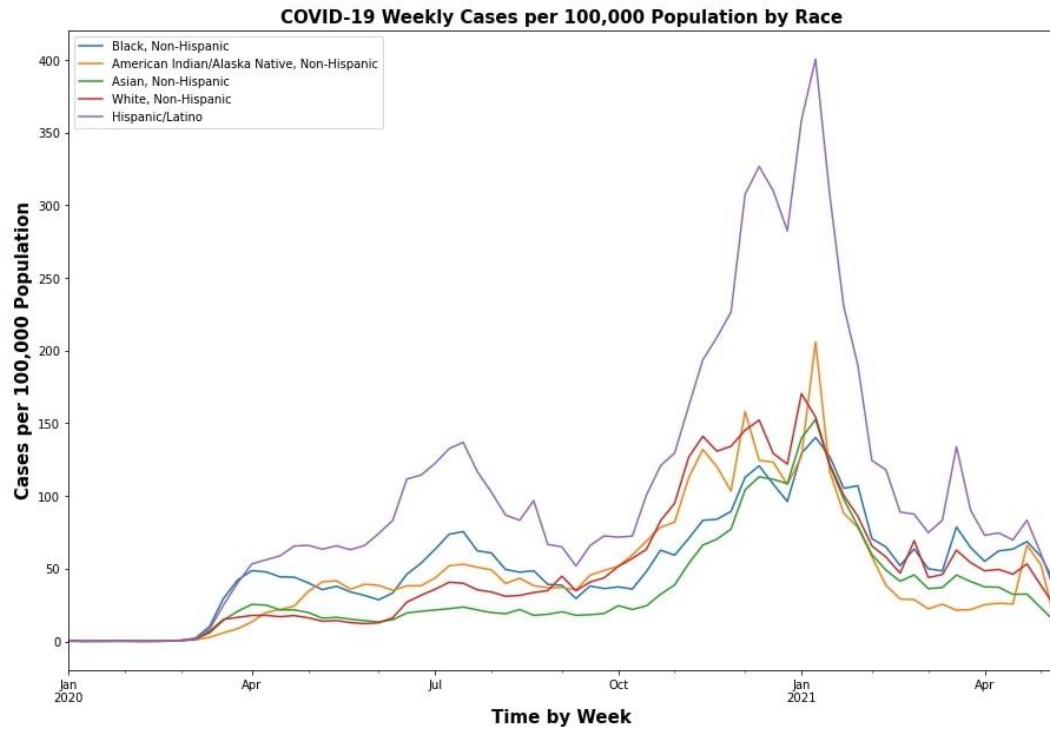
335   **A. Figures**

COVID-19 Weekly Cases per 100,000 Population by Race

336

337   **FIGURE#1.jpg: COVID-19 Weekly Cases per 100,000 population across ethnic**

338   **groups**

COVID-19 Weekly Deaths per 100,000 Population by Race

339

340   **FIGURE#2.jpg COVID-19 Weekly Deaths per 100,000 population across ethnic**

341   **groups**

death per 100,000 population caused by Diseases of heart (I00-I09,I11,I13,I20-I51)

342
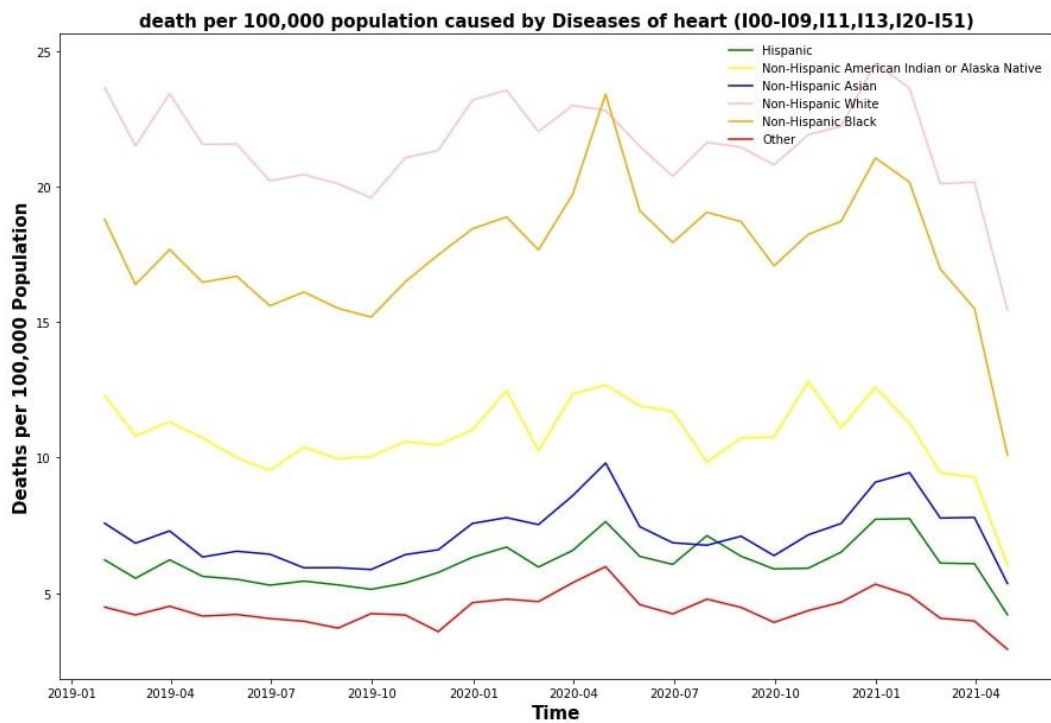
343   **FIGURE#3.jpg Deaths per 100,000 population each race caused by heart disease**

death per 100,000 population caused by Diabetes mellitus (E10-E14)

344
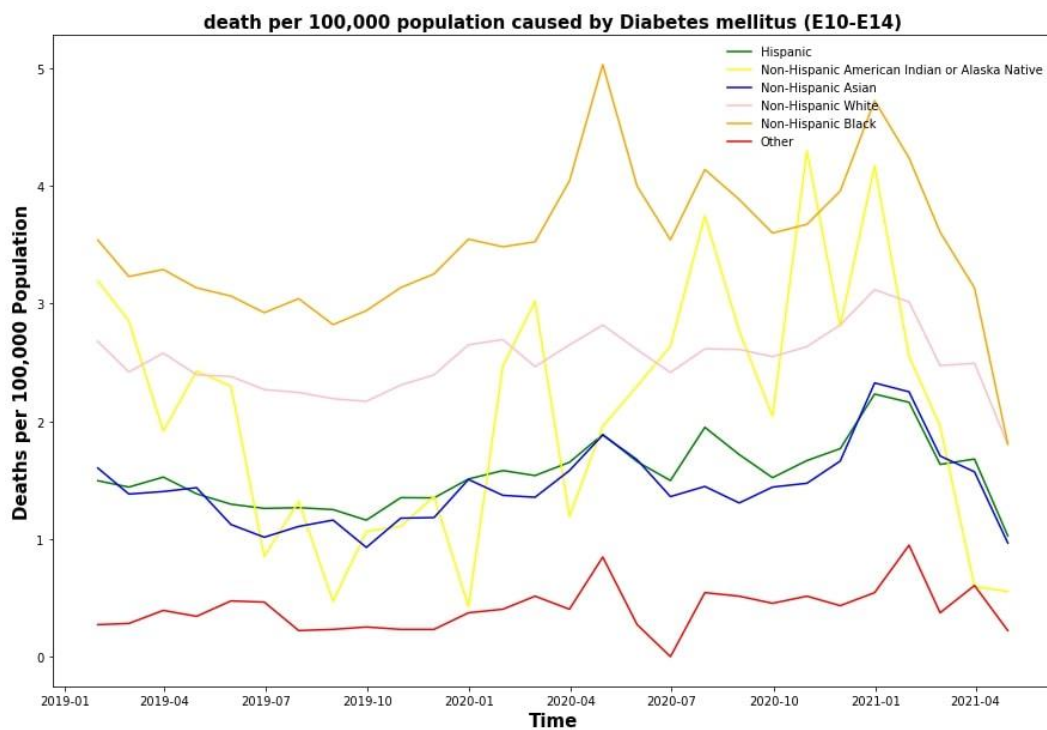
345   **FIGURE#4.jpg Deaths per 100,000 population each race caused by diabetes**

death per 100,000 population caused by Cerebrovascular diseases (I60-I69)

346
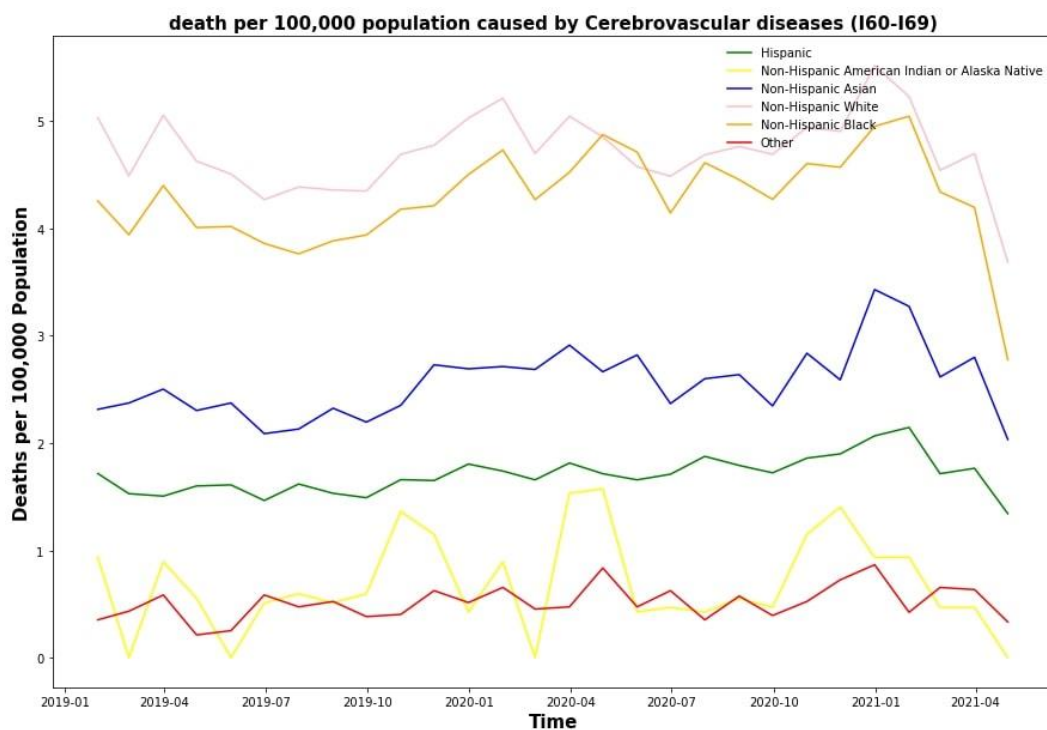
347   **FIGURE#5.jpg Deaths per 100,000 population each race caused by**

348   **cerebrovascular disease**

death per 100,000 population caused by Chronic lower respiratory diseases

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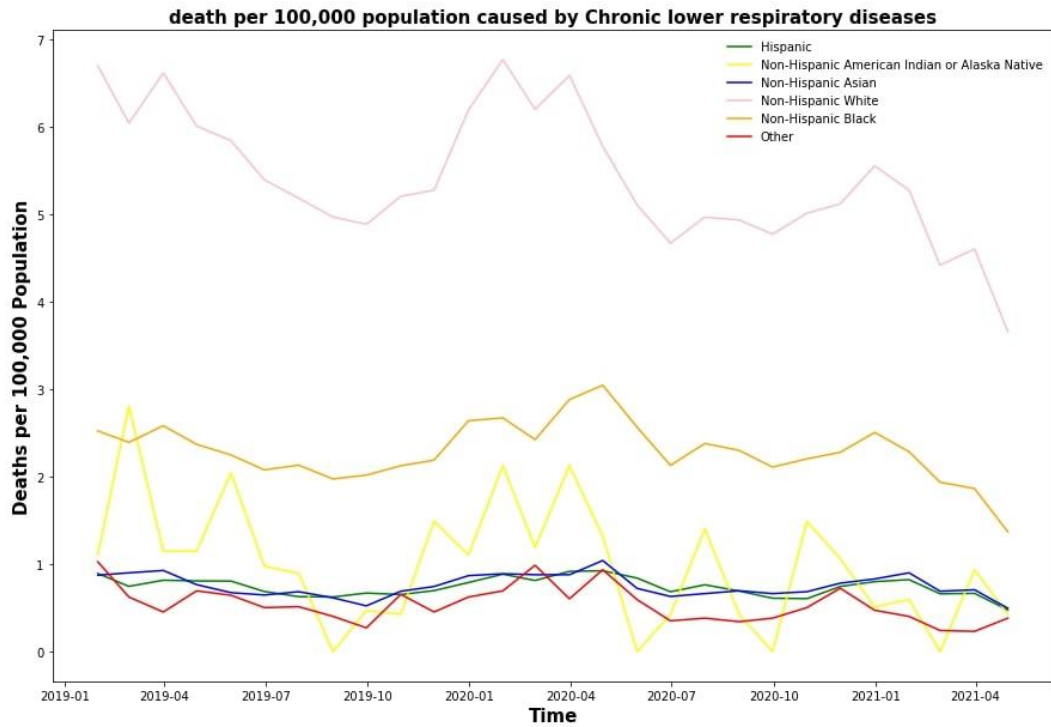
350   **FIGURE#6.jpg Deaths per 100,000 population each race caused by chronic**

351   **disease**

Year household Income by race from 2015 to 2019

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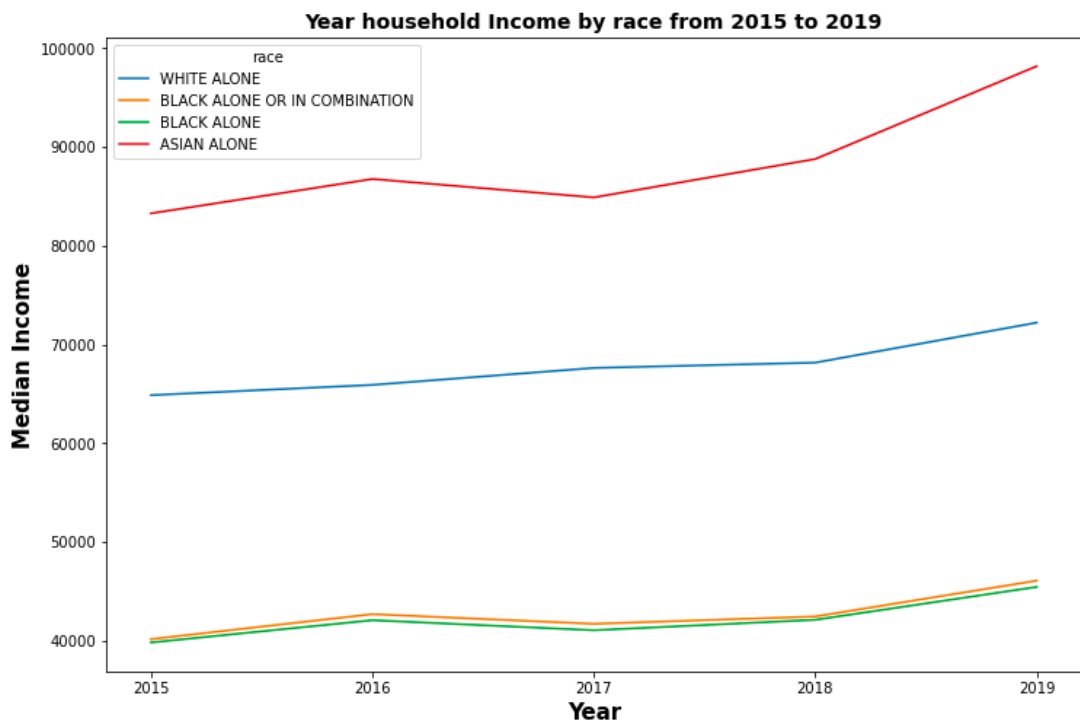
353   **FIGURE#7.jpg Year household median income by race from 2015 to 2019**

Median Wealth by Races in US$ Thousands from 2010 to 2019

354
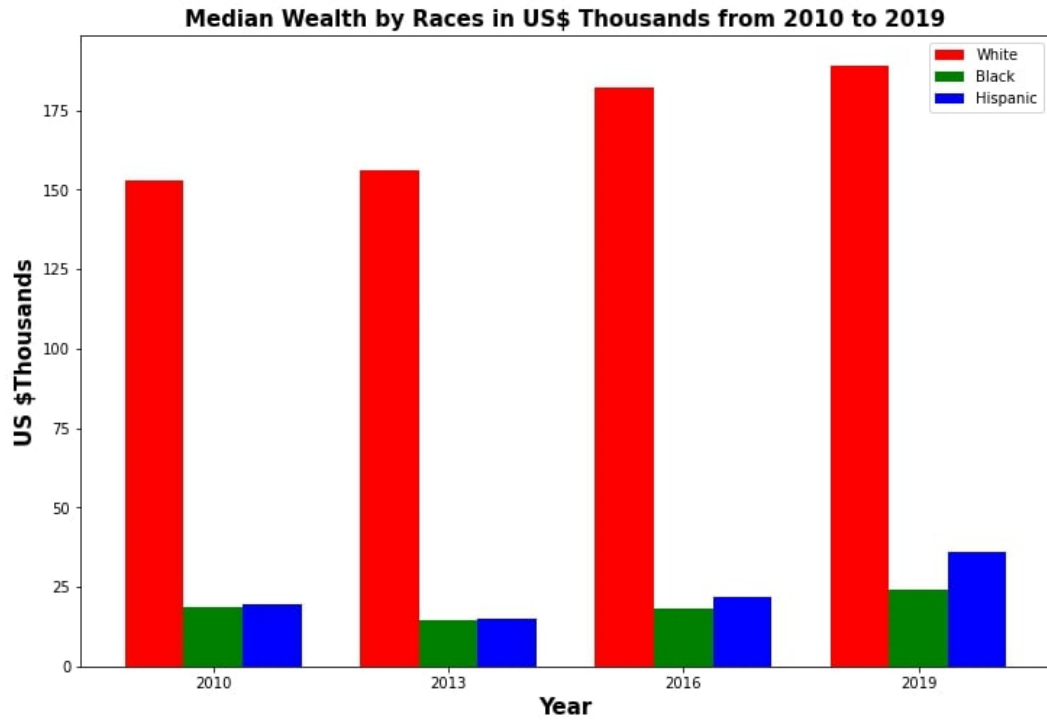
355   **FIGURE#8.jpg Median wealth by races in US$ thousands from 2010 to 2019**

Uninsured Rates for the Nonelderly by Race from 2018 to 2019

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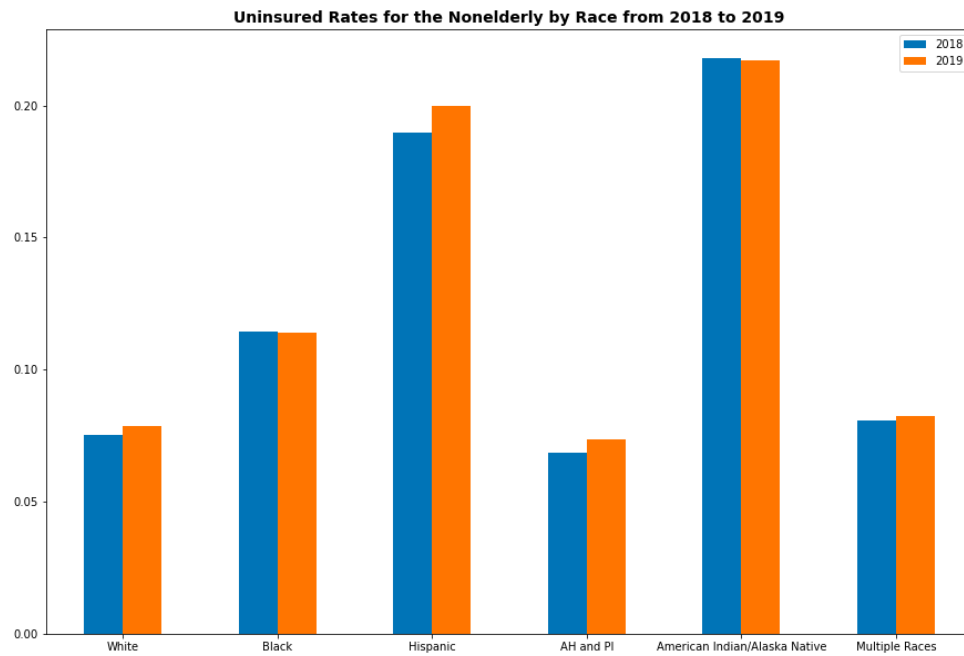
357   **FIGURE#9.jpg Uninsured Rates for the Nonelderly by race from 2018 to 2019**

358
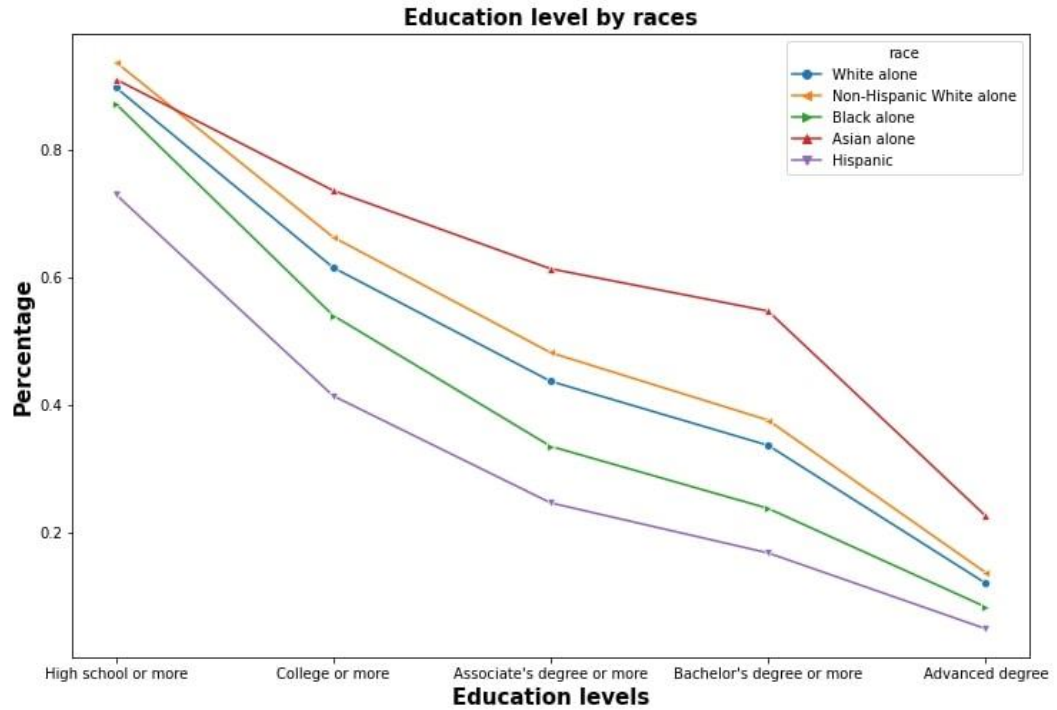
359   **FIGURE#10.jpg Education level by races**

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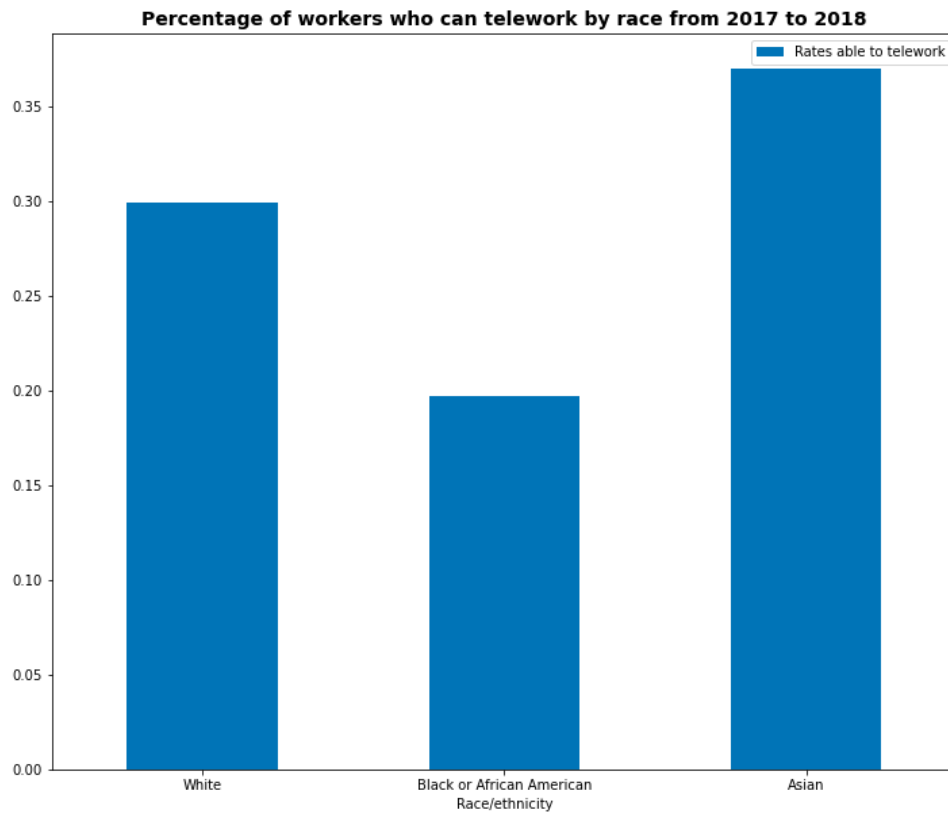
361   **FIGURE#11.jpg Percentage of workers who can telework by race from 2017 to 2018**

Rates of Covid 19 Hospitalization

362
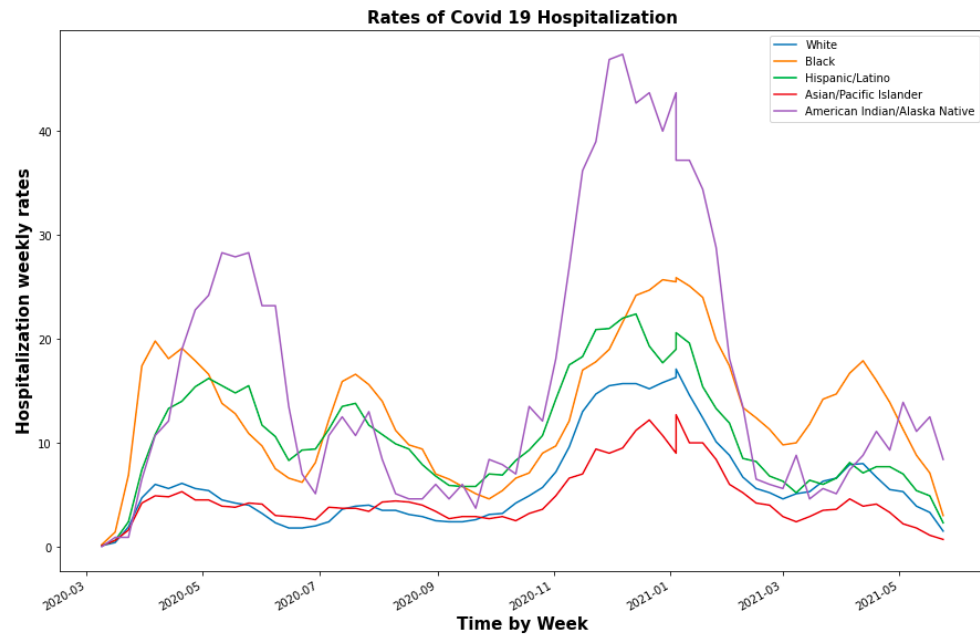
363   **FIGURE#12.jpg Weekly Rates of COVID 19 Hospitalization**

364

365   **VII.   CONCLUSION AND DISCUSSION**

366   From the factors mentioned above, we have built a general idea of how inherent and social

367   issues affect the death rates of COVID-19. One reason that we observe a higher death rate of Black

368   population at the beginning of COVID-19, from our observation, is due to the inherent factors such

369   as the high disease incidence of chronic lower respiratory diseases, heart diseases, cerebrovascular

370   diseases, and diabetes mellitus. This factor causes the death rate of Black people to exceed that of

371   Asian, Hispanic, and American Indian. While White people are suffering from the similar severe

372   condition of these diseases, White have distinct advantages in social factors, such as income,

373   education and the availability of telework. Black population, on the other hand, are at distinct

374   disadvantages in both inherent and external factors, and hence is at the worst condition among all

375   ethnic groups. Furthermore, the lack of subsidy, medical equipment and consistent medical

376   treatment at the beginning period of COVID-19 is also responsible for explaining the large gap in

377 death rates. Without the intervention of the US government, we might observe a similar larger gap

378 in death rates after the beginning period.

379   The inherent factors and external factors are not isolated, instead they have interactions with

380 each other. To our common sense, the most explicit and direct factor that affects the death rate is

381 probably poverty, since people would have a much higher chance to survive if they can afford all

382 high-quality treatment. However, falling into poverty also means that poor people are stuck in a

383 negative cycle, in which people become more vulnerable to handle contingent events. One example

384 is that poor people in the US are more likely to get obesity,[24] either because they didn't realize the

385 importance of exercise or because their time costs of working out is too large for them to make their

386 living. In another word, disparities of inherent factors like obesity are caused by the external factors

387 like income and education levels, which are closely related to the outcome of poverty.

388   Our research also has its limitations. Even though we have found some data of insurance

389 and hospitalization, these data cannot fully explain their effects on death rates, especially when we

390 don't have enough information of their quality of insurance and hospitalization. Also, when

391 exploring inherent factors, the death rate of related diseases like diabetes may not be able to explain

392 the disease incidence, because we are not sure whether the death rate is highly correlated with the

393 disease incidence. The COVID-19 data provided by CDC only includes basic information like sex,

394 age, and ethnicity of each infected patient considering privacy, so we are not allowed to explore

395 more information about those patients. In a word, we may need more data to help us make a more

396 thorough analysis of the ethnic disparity in COVID-19, especially for modeling.

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