

Socio-Economic Implications of COVID-19 Infections for the USA and India

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Abstract

As of August 2021 with over 1.6 M combined deaths, USA, India, and Brazil had the highest number of COVID-19 infections. This paper examines the populations of the USA and India, with a combined 70 M infections and counting, to provide a comprehensive overview and explore the social implications of COVID-19.

For the US, our multivariable regression model was statistically significant between COVID-19 deaths and age/race/residence-states. The trends in age and residence states were significant while the trend for gender was not. However, individual's age and residence state played a significant role in determining life or death? Socio-economic analysis confirmed the Qualitative socio-economic Logic based Cascade Hypotheses (QLCH) of education/occupation/income affecting race/ethnicity differently. For a given race/ethnicity, education drives occupation then income, where people lives, and in turn his/her access to healthcare coverage. Considering the QLCH framework, different races are poised for differing effects of COVID-19; specifically, Asians/Whites are in a stronger position to combat COVID-19 compared to Hispanics/Blacks.

For India, the residence-states were found to be statistically significant in a regression of nationality/residence states/and counts for total cases/deaths/and cured. A logistics regression model analyzing age/gender/nationality/and residence states was also statistically significant. Both sexes were affected equally by the virus while age/residence states played important roles in life/death. Higher urban populated states with higher GDP creation had the highest virus related deaths, explaining the forced avoidance of social distancing effect.

Keywords: COVID-19 • Socio-economic analysis • Demonstrating • Hospitalized individuals

Introduction

In 2017, the US experienced more than 2.8 M deaths due to various causes. Diseases of the heart were the number one cause with a count over 647,000. India in 2019 experienced 10 M deaths. By August 2020, due to the virus, the US saw 175,000+deaths while India experienced 75,000+deaths [1,2].

Ethnicity likely contributes to the spread of the virus in a community; cultural, behavioral, work and living differences due to socio-economic status, and health-seeking behavior could all contribute [3]. Rentsch found that Blacks/Hispanics veterans tested positive for COVID-19 at a higher rate than Caucasians [4]. Large US metropolitan areas (e.g. Chicago and Milwaukee), with higher concentrations of racial minorities and adverse social determinants, showed a higher rate of COVID-19 infections [5,6].

For India, Acharya computed the state's composite index of vulnerability based on domains of socioeconomic, demographic, housing, and hygiene. They observed similarities between vulnerability and concentration of COVID-19 cases at the state level [7]. Kamath list multiple challenges India faces for combating COVID-19, including being densely populated with a huge population, and millions having no access to clean water [8].

Methodology

COVID-19 problem

This paper specifically looks at demographic factors of age/race/gender/residence-states to find out which demographic factors contribute most to COVID-19 deaths.

Database selection

We used data collected by the CDC for the US analyses, limiting our dataset to the first eight months of 2020 including age/race/and residence-states with respect to COVID-19 deaths [9]. Our second analysis also included gender [10]. We used Kaggle data for both India population analyses, limiting to COVID-19 deaths for the first eight months for 2020. The first data set included nationality/residence-states/and counts for the total cases/deaths/cured. The second data set included factors of age/gender/nationality/residence-states/status of cured/hospitalized/dead [11,12].

Hypothesis testing

Statistical analyses of multiple regression and nominal logistics regression were performed with $\alpha=0.05$.

USA analysis

A visual display in Figure 1 demonstrates that Caucasians have experienced more variation of deaths followed by African Americans, Hispanics, and then Asians.

Figure 2 demonstrates an increase in the number of deaths versus age, and that individual <55 have a relatively smaller chance of death.

New Jersey, New York, Michigan, Pennsylvania, Florida, California, and Texas were found to have a large variation in deaths per Figure 3. A multiple linear regression analysis showed that residence state/race-except Blacks/age were all significant with COVID-19 deaths with p-value<0.0001.

Our second US model was found to be significant with a p-value<0.0001. Figure 4 demonstrates that both males and females experienced a similar variation in deaths. The analysis showed that age groups and residence-states were statistically significant (p-value<0.05), while gender was not.

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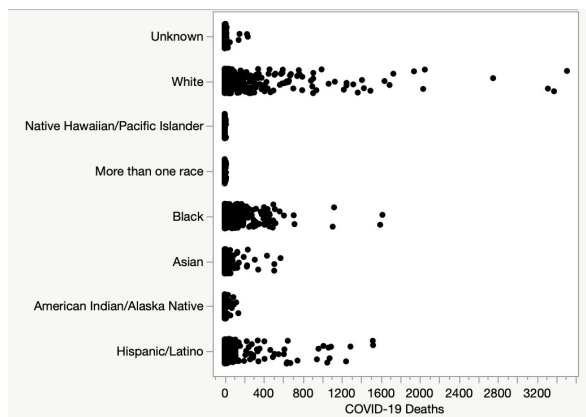


Figure 1. Race-deaths scatterplot.

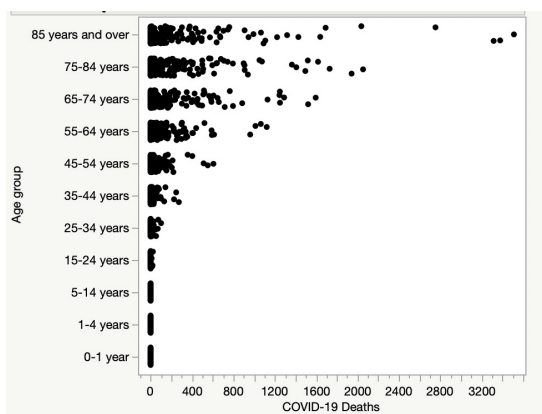


Figure 2. Age-deaths scatterplot.

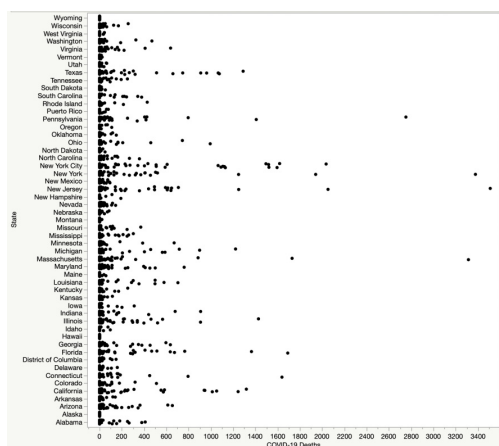


Figure 3. States-deaths scatterplot in USA.

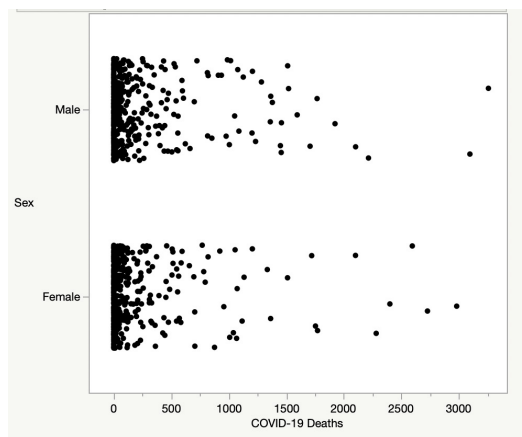


Figure 4. Gender-deaths scatterplot.

India analysis

For India, Figure 5 scatterplot shows variations between state/territory and COVID-19 deaths demonstrating that Maharashtra experienced higher deaths.

A linear regression analysis showed that states/territories were significant with deaths with a p-value<0.0001 while Figure 6 shows both Males and Females experiencing similar variations.

Figure 7 shows an increase in the number of deaths as a function of age confirming that for the age<40 your chance of death is very small.

Figure 8 shows the Receiver-Operating-Characteristics (ROC) plot. The area under the curve is the indicator of the goodness of fit. All three curves show area closer to 1 meaning a very good fit; a value=1 indicates a perfect fit.

The second data set was run again for nominal logistics regression as shown in Figure 9. The lower curve shows the predictive probability of individual being diseased due to the virus versus the age. The rising of the lower curve shows the higher the age, the higher the predictive probability of being diseased. The upper curve shows the predictive probability of diseased or hospitalized individuals.

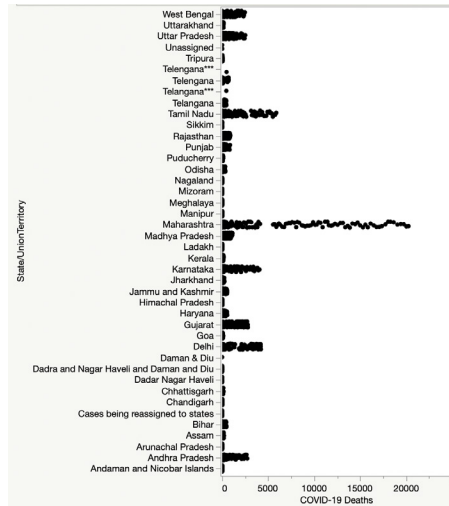


Figure 5. States-deaths scatterplot in India.

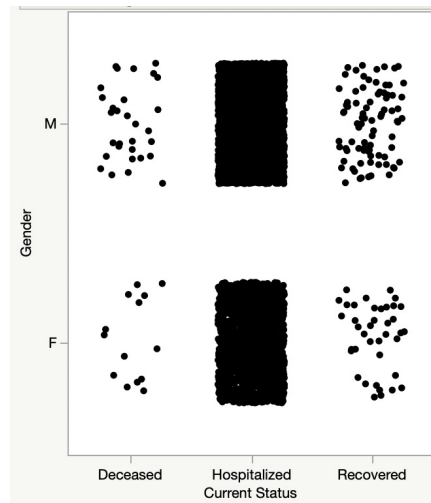


Figure 6. Gender current-status scatterplot.

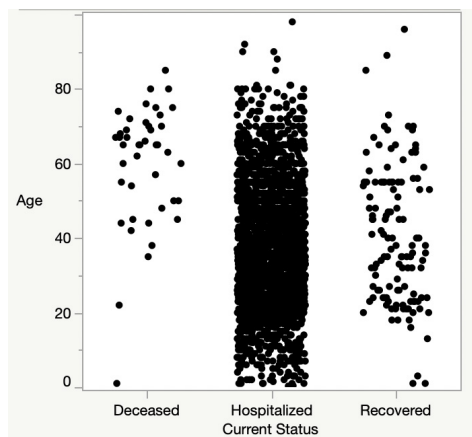


Figure 7. Age-current status scatterplot.

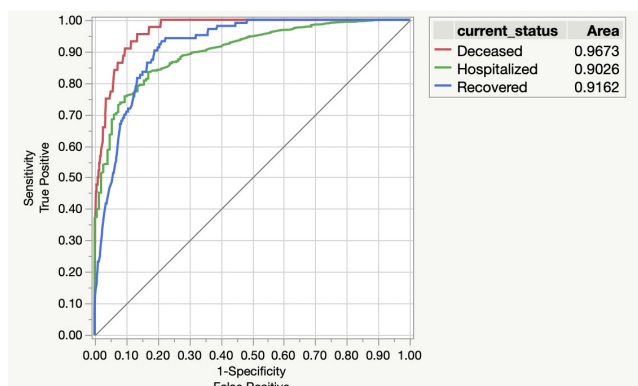


Figure 8. ROC (Receiver-Operating-Characteristics).

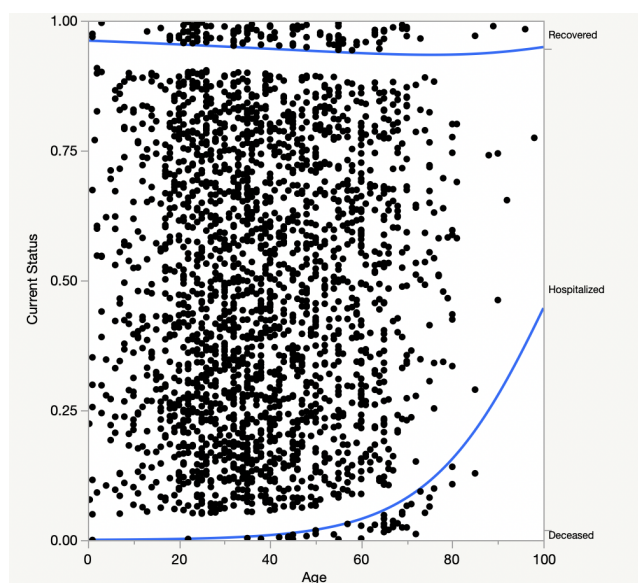


Figure 9. Logistics curve.

Table 1. Graduation and jobs percentages by race in the US: 2016.

Graduation and jobs	Percentage			
	White	Black	Asian	Hispanic
High school dropout rate	5	6	2	9
High school completion rate	94	92	97	89
High school dropouts who are full time job holders	58	39	78	65
High school graduates who are full time job holders	68	66	80	72
College enrollment rate	42	36	58	39
Bachelor's awarded in STEM	18	12	33	15

*STEM: Science/Technology/Engineering/and Mathematics

Table 2. U.S. Bureau of labor statistics - 2019.

Occupation	M, Total employed	Percent total employed					
		Female	Male	White	Black	Asian	Hispanic
Total (16 years and over)	157.5	47.0	53.0	77.7	12.3	6.5	17.6
1) Management/professional	64.2	51.8	48.2	79.0	9.6	8.7	10.1
2) Service: Total	27.0	57.6	42.4	72.2	17.1	5.9	25.0
2.1) Healthcare support	3.8	86.9	13.1	64.2	26.7	5.1	19.1
2.2) Protective service	3.1	22.1	77.9	73.9	20.3	2.2	15.3
2.3) Food preparation and serving	8.4	54.5	45.5	73.7	13.9	6.9	27.0
2.4) Building and grounds cleaning/maintenance	5.7	42.0	58.0	77.3	14.9	2.9	38.2
2.5) Personal care and service	6.0	76.9	23.1	69.4	16.1	10.1	18.2
3) Sales and office	33.4	60.6	39.4	78.1	13.0	5.2	17.1
4) Natural resources, construction, and maintenance	14.3	5.4	94.6	86.2	7.7	2.2	31.9
5) Production, transportation, and material	18.6	23.0	77.0	74.2	16.9	5.0	23.0

Table 3. Health insurance coverage in the United States: 2018.

Coverage	Percentage			
	White	Black	Asian	Hispanic
Health insurance	94.6	90.3	93.2	82.2
Private insurance	74.8	55.4	73.1	49.6
Public insurance	33.2	41.2	26.1	36.5

Table 4. Life expectancy by race: 2017.

Age	Life expectancy in years			
	All races	White	Black	Hispanic
At birth	78.6	78.5	74.9	81.8
At age 55	27.4	27.3	25.2	29.8

Results

USA-Social implications

First, we propose Qualitative socio-economic Logic based Cascade Hypotheses (QLCH) related to education/occupation/and income. Second, we extend them to 'COVID-19 deaths related to race' hypotheses. We next look at US government's socio-economic data of education/occupation/income/and residence place in reference to race/ethnicity to validate these hypotheses.

QLCH for a race

QLCH1: A race with lower Highschool dropouts will have higher college education.

QLCH2: A race with higher college enrollment will have higher Bachelor's in STEM (Science/ Technology/Engineering/and Mathematics).

QLCH3: A race with higher Bachelor's in STEM will have higher proportions of Management/professional jobs instead of Service jobs (including essential-work-hospitals/transportation/farm/grocery stores).

QLCH4: A race with a higher proportion of Management/professional jobs will earn higher median incomes.

QLCH to COVID-19

QLCH5: A race with higher median incomes will have higher percentage of private health coverage.

QLCH6: A race with higher proportions of Management/professional jobs has a better capacity to social distance by working from home.

QLCH7: A race with higher proportions of Management/professional jobs has a better capacity to social distance by living in non-crowded neighborhoods like suburbs.

QLCH8: A race with higher proportions of living in suburbs instead of cities will have better healthcare.

USA socio-economic data

Table 1 Through 5 displays socio-economic data from various U.S. Government reports [13-17].

The QLCH1 and QLCH2 apply well as shown in Table 1 [13] to all four races and profoundly to Asians.

The data in Table 2 [14] shows that all races do follow QCH3.

For all four races QLCH5 applies well per Table 3 [15].

Table 4 It Shows CDC's life expectancy by race at birth and at 55 years [16]. Blacks had the lowest life expectancy, while Hispanics had the highest life expectancy.

Table 5 displays real median household income from the U.S. Census

Bureau's Current Population Survey [17].

From Table 5, we converted real median household income in terms of Asians as shown in Table 6. Over a 30 year period, Blacks made 51 cents on a dollar, Hispanics made 62 cents on a dollar, and Whites made 87 cents on a dollar versus Asians. Thus QLCH4 applies well to all four races.

Socio-economic implications of race and living location to COVID-19

Applying QLCH6, Asians/Whites with higher proportions of Management/professional jobs instead of Service jobs do have better capacity to social distance by working from home while the opposite is true for Blacks/Hispanics.

Considering QLCH7, Asians/Whites with higher proportions of Management/professional jobs do have better capacity to social distance by living in non-crowded neighborhoods like suburbs versus Blacks/Hispanics.

Utilizing QLCH8, Asians/Whites with higher proportions living in non-crowded neighborhoods, such as more suburban areas, have better healthcare access versus Blacks/Hispanics.

Figure 10 Summarizes race/ethnicity based socio-economic implications for COVID-19. In Figure 10a Asians/Whites versus Hispanics/Blacks have higher percentages in education including STEM leading to higher percentages in Management/professional jobs instead of Service/essential jobs, leading to higher median incomes. Higher median incomes give them the choice of living in more suburban areas. This allows higher percentage of Asians/Whites, versus Hispanics/Blacks, the ability to social distance by living in suburbs as well as working from home (Figure 10b). This leads to Asians/Whites being better positioned to combat COVID-19 (Figure 10c).

Comparison of regression analyses with socio-economic analysis

Our two regression analyses showed that where you live/state and race are statistically significant with COVID-19 deaths for the US. These analyses are in concert with the QLCH analyses based conclusions for both race/ethnicity and residence-states supported by (Tables 1-5).

Discussion

Understanding Indian socio-economic conditions

Table 7 Depicts India's top populated states with ranking based on urban population [12].

We created Table 8 with the COVID-19 death rankings derived from Figure 5 and added GDP rankings [13]. These rankings for the residence-states match well with urban population and GDP rankings. GDP creation requires people to interact with others as close proximity realized in higher urban density setting would exacerbate the social distancing issues faced by the population.

Table 5. Real median household income by race in 2017 dollars.

Year	Median income				
	All races	White	Black	Asian	Hispanic
2017	\$61,400	\$68,200	\$40,300	\$81,400	\$50,500
2002	\$58,000	\$64,500	\$40,300	\$72,000	\$45,000
1987	\$53,000	\$57,500	\$32,000	\$67,000	\$40,000
2002-2017 Annual Growth	0.38%	0.37%	0.00%	0.82%	0.77%

Table 6. Real median household income-relative to Asians.

Year	Median income				
	All races	White	Black	Asian	Hispanic
2017	0.75	0.84	0.50	1.00	0.62
2002	0.81	0.90	0.56	1.00	0.63
1987	0.79	0.86	0.48	1.00	0.60
Average	0.78	0.87	0.51	1.00	0.62

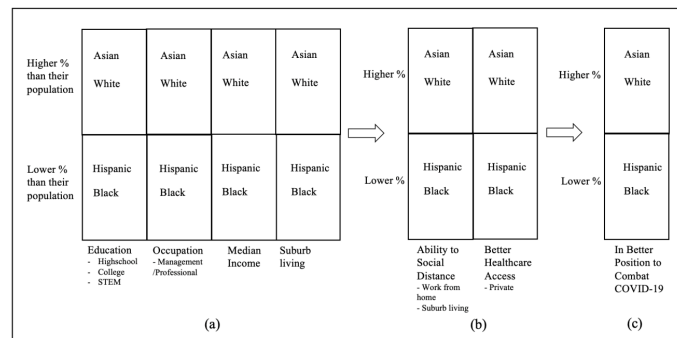


Figure 10. Race/Ethnicity based socio-economic implications for COVID-19[(a)- Education including STEM leading to higher percentages in Management/professional jobs instead of Service/essential jobs, leading to higher median incomes, (b)- The ability to social distance by living in suburbs as well as working from home and (c)- In better positioned to combat COVID-19].Characteristics).

Table 7. India's top 10 populated states.

State	Urban rank	Urban population	Total population
Maharashtra	1	50.8 M	112.4 M
Uttar Pradesh	2	44.5 M	199.8 M
Tamil Nadu	3	34.9 M	72.1 M
West Bengal	4	29.1 M	91.3 M
Gujarat	5	25.7 M	60.4 M
Karnataka	6	23.6 M	61.1 M
Madhya Pradesh	7	20.1 M	72.6 M
Rajasthan	8	17.0 M	68.5 M
Andhra Pradesh	9	14.6 M	49.6 M
Bihar	10	11.8 M	104.1 M

Table 8. India's top 10 COVID-19 death states.

State	Urban rank	Urban population	Total population
Maharashtra	1	1	1
Uttar Pradesh	2	5	6
Tamil Nadu	3	2	2
West Bengal	4	6	7
Gujarat	5	3	4
Karnataka	6	4	3
Madhya Pradesh	7	11	8
Rajasthan	8	8	9
Andhra Pradesh	9	7	5
Bihar	10	15	10

Conclusion

For the US, by July 2021, COVID-19 deaths have already exceeded 620,000. Demographic factors of age groups/race/residence state were found to be statistically significant in our analyses. The virus does affect both genders equally and an individual's age is a critical variable deciding life/death, for age of 55 and above. Race/ethnicity seems to play an important

role also, as Blacks and Hispanic death proportions are higher than their respective population proportions. Bigger population states with high minority populations have seen higher deaths. Thus, inequality in socio-economic conditions is an important determinant affecting health conditions of an individual and, more importantly, his/her ability to social distance at work or at home. Socio-economic analysis for the US population shows that QLCH of education/occupation/and income affects race/ethnicity differently.

For a given race/ethnicity, education drives occupation then income, living location, and in turns his/her access to healthcare. Considering the US socio-economic data in the QLCH framework, we conclude that different races are poised for differing effects of COVID-19. In particular, Asians/Whites are in a better position to combat COVID-19 compared to Hispanics/Blacks.

India with 0.73% death rate witnessed about 10 M total deaths in 2020. The COVID-19 deaths by August 2021 have exceeded 420 K. We observed that the residence-states/territories are a significant factor. The top 10 states experiencing deaths are found to be in top 10 urban population ranked states coupled with top 15 GDP creations. Case in point is Maharashtra with urban population rank 1st and GDP rank 1st had highest COVID-19 caused deaths in the country. The state of Tamil Nadu with urban population rank of 3rd and GDP rank of 2nd had the second highest deaths. Forced avoidance of social distancing in larger urban and high GDP creating states may be the driver in getting higher COVID-19 infections. Factors of age, and residence-states were found statistically significant using logistical regression, however, gender was found to be not. The data showed that virus does not spare any gender over other. The age is a critical variable that decides death over life and is pronounced especially for age>40. Focusing solely on 420 K deaths due to COVID-19 through August 2021 misses the remaining bigger picture of 10 M annual deaths caused by many other issues in India.

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