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RESEARCH ARTICLE

Understanding COVID-19's Wrath on the Populations of USA, India, and Brazil

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ABSTRACT

Background: As of March 2024, the populations of the USA, India, and Brazil have suffered over 2.4M combined COVID-19 deaths and are ranked as the top three countries in the world with the most fatalities due to the virus. Their populations differ significantly regarding their races/ethnicities, population densities, urbanization proportions, GDPs (Gross Domestic Products), age profiles, and COVID vaccinations. However, surprisingly they are bunched up at the top when it comes to the world's COVID-19 deaths.

Aims: This paper examines these populations, with a combined 194M infections and counting, to provide a comprehensive understanding and explore the social inferences of the virus.

The main objectives of this study are to comprehend similarities and differences of the three populations for race, age, income, population density, urbanization, and effectiveness of the COVID-19 vaccines.

Methods: To understand COVID-19's underlying deaths in a country, its demographic and economic data were analyzed.

Results: For the US, in terms of population proportion of a race, the Whites saw a higher percentage of COVID-19 deaths, while the Blacks' deaths were in line with its proportion but both the Hispanics and Asians saw lower COVID-caused deaths than their proportions. For the country, 90% of these deaths were for the ages of over 55 years. Surprisingly the 0-17 years age group saw only 0.15% of total 1.2M COVID-19 deaths.

Brazil did experience the second highest COVID-19 deaths in the world. 80% of these deaths occurred in 11 states out of the country's 26. The same states have 70% of Brazil's population creating 65% of the country's GDP.

India, the world's most populated country, experienced the third-highest COVID-19 deaths in the world. 87% of its COVID deaths came from 14 states out of the country's 28. These states have 85% of India's population produced 89% of the country's GDP. India's top five COVID-caused deaths producing states experienced 60% of these deaths.

Conclusions: The top five COVID-19 deaths-producing states for both the USA and Brazil were driven by population and GDP rankings. A blend of GDP, total population, urbanization, and median age were key drivers for India's COVID-19 deaths.

Keywords: COVID-19 deaths, Vaccination, Race, Age, GDP, USA, India, Brazil.

1. Introduction

The populations of the USA, Brazil, and India have a grim milestone of having the most deaths in the world caused by the COVID-19 virus.

In 2020, the US total deaths climbed by 600K from 2.8M in 2019. COVID-19 became a third leading cause of death killing 351K people. In 2021, the country experienced more than 3.4M deaths due to various causes which was a jump of 80K from 2020. In the same period, COVID-19 being the principal cause of death amplified 19% from 351K in 2020 to 417K in 2021. In 2022 the US witnessed about 3.3M total deaths with COVID-19 being a fourth underlying cause killing 187K[1-3].

The total number of deaths in India reached about 15M in 2021, which was an increase of about 50% from 2020 of 10.3M. The 2020 deaths in the country were a 400K increase from 9.9M in 2019. India's total deaths did drop to about 14.6M in 2022 and to 13.9M in 2023[4].

Brazil saw the highest number of total deaths 1.54M in 2020 from 1.41M in 2019. In 2021, the country's deaths reached about 1.49M which was a decline of 2.6% from the prior year. Brazil did see a further drop in number of fatalities to 1.46M in 2022 but a slight uptick to 1.49M in 2023[5].

This paper looks at each of the top three fatalities experienced in countries for their population demographics, urbanization, gross domestic product (GDP), and vaccination percentage to understand reasons for their COVID-19 deaths.

2. Materials and Methods

To comprehend better about COVID-19's underlying deaths for a country, its demographic and economic data are important pieces of the puzzle.

2.1. DATA RETRIEVAL

For mortality statistics, we used CDC's (Centers for Disease Control's) data for the USA[1-3], and 'GlobalData' for both India[4] and Brazil[5]. Additional data for COVID-19 cases and deaths were obtained from 'Worldometer' for these top three death-producing countries[6-8]. For the US, we retrieved race-based data from the CDC[9] and the population details from the U.S. Census Bureau[10]. The vaccination information for each country was obtained from John Hopkins University's data tracking[11].

We also retrieved each country's population[12], urbanization data[13], and Gross National Income (GNI) per Capita[14]. Population Pyramid databases provided us with the age breakdown of these three countries[15-17]. USA's COVID-19 deaths by state[18] and GDP by state[19] were obtained for micro-level understanding of the country. Brazil's COVID-19 state-wise deaths[20], population[21], and GDP[22] were obtained for micro-level understanding of the country. To perform India's micro-based analyses by states, COVID-19 cases and deaths[23], population[24], GDP[25], median age[26], and urbanization data[27] were obtained.

2.2. COVID-19 CASES AND DEATHS

Populations of the USA, India, and Brazil have experienced about 200M cases of COVID-19 infections over the past four years as depicted in Figure 1[6-8]. Fortunately, the cases have leveled off for these populations.

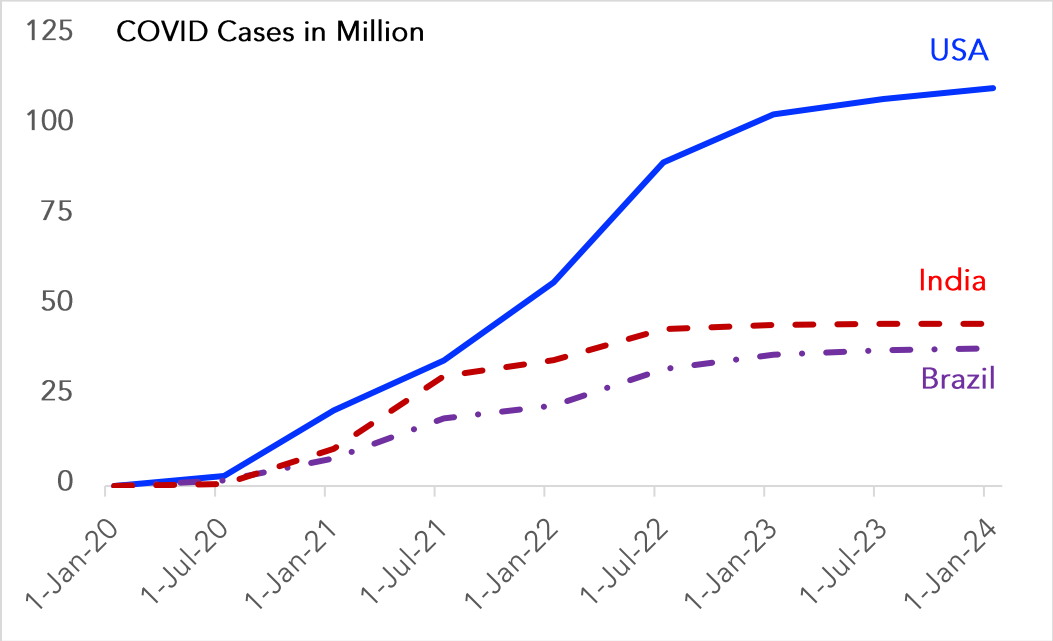

Figure 1. COVID-19 cases in the USA, India, and Brazil[6-8]

A visual display in Figure 2 demonstrates that the US population has experienced the most deaths due to the virus in the world totaling about 1.2M followed by Brazil and India[6-8].

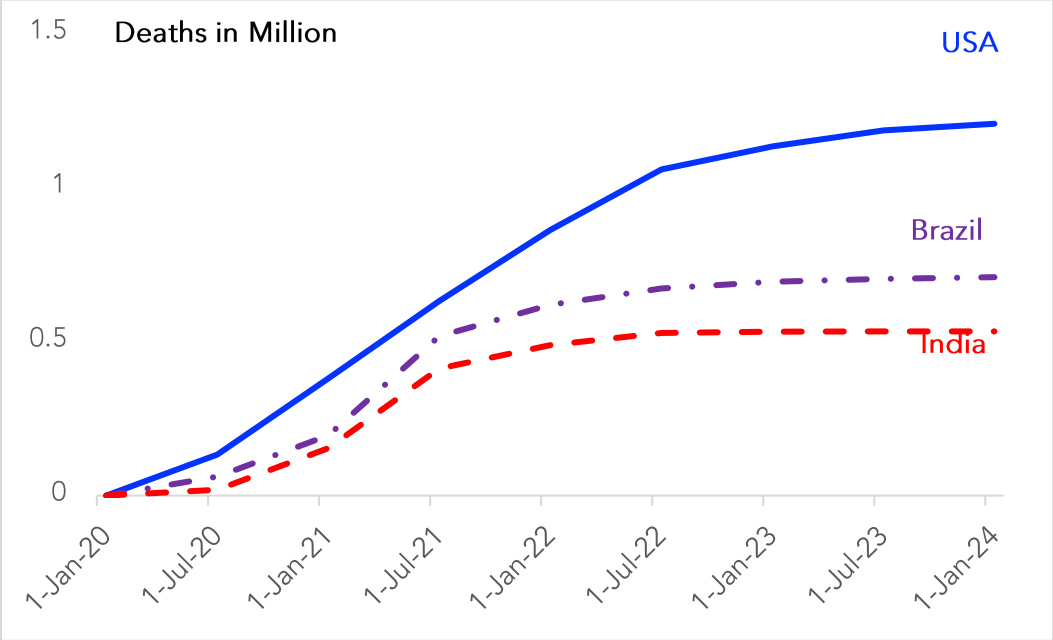

Figure 2. COVID-19 deaths in the USA, India, and Brazil[6-8]

In Figure 3, we depict the percentage of COVID-19 cases that caused deaths dropping significantly over the past four years[6-8]. USA population percentage deaths have dropped to India's level but surprisingly Brazil has not seen a similar drop.

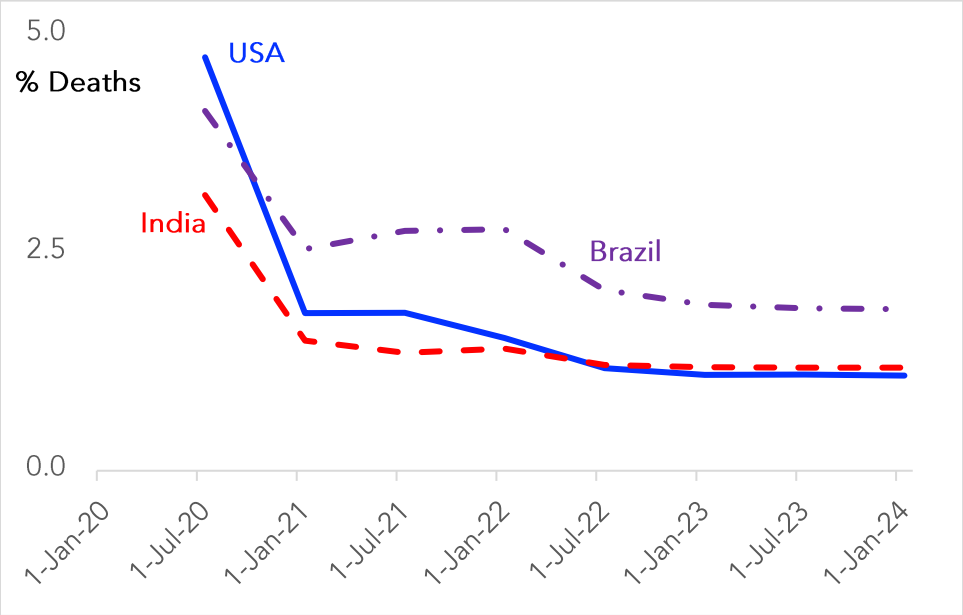

Figure 3. % of COVID-19 cases resulting in deaths in the USA, India, and Brazil[6-8]

2.3. COVID-19'S IMPACT ON THE US POPULATION

Based on the U.S. Government reports, Tables 1 through 4 show COVID-19 deaths by age groups and races[9, 10]. As per Table 1, the USA experienced 1.15M deaths due to the virus through September 2023. The Whites had 66.2% (759K) of these deaths, followed by 15% (172K) by the Hispanics, 13.7% (157K) by the Blacks, and 3.1% (36K) by the Asians. Compared to the July 2023 census data, the Whites 58.9% of the US population saw a higher percentage of COVID-19 deaths of 66.2%. The deaths of the Blacks' of 13.7% was in line with the country's population of 13.6%. Both Hispanics and Asians saw lower COVID-19 underlying deaths than their population proportions (Hispanics 19.1% of the population experienced 15% of fatalities while Asians 6.3% of the population saw 3.1% of deaths).

Table 1. USA: COVID-19 Deaths for All Age Groups (Jan. 2020-Sept. 2023)[9] vs. 2023 Census[10]

Age Group	Race	COVID Deaths	% of Total Covid Deaths	July 2023 Census
All Ages	Non-Hispanic White	759,258	66.21%	58.9%
All Ages	Non-Hispanic Black	157,169	13.71%	13.6%
All Ages	Non-Hispanic American Indian or Alaska Native	12,122	1.06%	1.3%
All Ages	Non-Hispanic Asian	35,967	3.14%	6.3%
All Ages	Non-Hispanic Native Hawaiian or Other Pacific Islander	2,323	0.20%	0.3%
All Ages	Non-Hispanic More than one race	4,419	0.39%	--

Age Group	Race	COVID Deaths	% of Total Covid Deaths	July 2023 Census
All Ages	Hispanic	172,235	15.02%	19.1%
All Ages	Unknown	3,194	0.28%	--
Total	**All Races**	1,146,687	**100%**	**100%**

Table 2 depicts COVID-19 deaths in the USA by Age Groups for all the races combined. The COVID-19-caused deaths were truly for the older population. 90% of these deaths were for the ages over 55 years while about 75% of them were for the ages of 65 and above.

Table 2. USA: COVID-19 Deaths for Races by Age Groups (Jan. 2020-Sept. 2023)[9]

Age Group	Race	COVID-19 Deaths	% Covid Deaths	% Cumulative Deaths
Under 1 year	All Races	516	0.04%	0.04%
1-4 years	All Races	286	0.02%	0.07%
5-14 years	All Races	508	0.04%	0.11%
15-24 years	All Races	3,018	0.26%	0.38%
25-34 years	All Races	12,398	1.08%	1.46%
35-44 years	All Races	30,097	2.62%	4.08%
45-54 years	All Races	71,391	6.23%	10.31%
55-64 years	All Races	159,703	13.93%	24.24%
65-74 years	All Races	256,787	22.39%	46.63%
75-84 years	All Races	300,140	26.17%	72.80%
85 years and over	All Races	311,843	27.20%	100.00%
All Ages	**All Races**	1,146,687	**100%**	**100%**

As per Table 3, for the US, the 0-17 years age group saw less than 1,700 COVID-19 deaths (0.15%) out of a total of 1.15M for all the age groups. The low death proportion for the younger population was truly independent of the race.

Table 3. USA: COVID-19 Deaths for 0-17 Years Age Group (Jan. 2020-Sept. 2023)[9]

Age Group	Race	COVID Deaths	Total COVID Deaths	% Covid Deaths
0-17 years	Non-Hispanic White	642	759,258	0.08%
0-17 years	Non-Hispanic Black	437	157,169	0.28%
0-17 years	Non-Hispanic American Indian or Alaska Native	29	12,122	0.24%
0-17 years	Non-Hispanic Asian	61	35,967	0.17%
0-17 years	Non-Hispanic Native Hawaiian or Other Pacific Islander	16	2,323	0.69%
0-17 years	Non-Hispanic More than one race	55	4,419	1.24%
0-17 years	Hispanic	445	172,235	0.26%
0-17 years	Unknown	8	3,194	0.25%
Total	All Races	1,693	1,146,687	0.15%

To understand Table 2 further for the 0-54 years age group deaths of being 10.31% of the overall deaths for all races combined, we tabulated Table 4 for the individual races. The Whites had a lower proportion of deaths 6.66%, while the Blacks and the Hispanics had higher proportions of deaths 15.75% and 20.18% respectively. The Asians had 9.56% deaths for the age group which was in line with the overall death of 10.31%. The last column in the table shows the deaths for ages of 55 years and above. For the 5 years and above age group, the Whites had higher than average deaths, while both the Blacks and Hispanics had lower than average deaths for the county of 90%.

Table 4. USA: COVID-19 Deaths for 0-54 And 55+ Years Age Groups (Jan. 2020-Sept. 2023)[9]

Age Group	Race	COVID Deaths 0-54 Years	COVID Deaths All Ages Total	% of COVID Deaths 0-54 Years	% of COVID Deaths 55 Years and above
0-54 years	Non-Hispanic White	50,572	759,258	6.66%	93.34%
0-54 years	Non-Hispanic Black	24,759	157,169	15.75%	84.25%
0-54 years	Non-Hispanic American Indian or Alaska Native	2,726	12,122	22.49%	77.51%
0-54 years	Non-Hispanic Asian	3,440	35,967	9.56%	90.44%

Age Group	Race	COVID Deaths 0-54 Years	COVID Deaths All Ages Total	% of COVID Deaths 0-54 Years	% of COVID Deaths 55 Years and above
0-54 years	Non-Hispanic Native Hawaiian or Other Pacific Islander	734	2,323	31.60%	68.40%
0-54 years	Non-Hispanic More than one race	934	4,419	21.14%	78.86%
0-54 years	Hispanic	34,759	172,235	20.18%	79.82%
0-54 years	Unknown	290	3,194	9.08%	90.92%
Total	All Races	118,214	1,146,687	10.31%	89.69%

2.4. UNDERSTANDING EFFECTS OF COVID-19 VACCINATIONS

Our world saw the development of many vaccines to fight against the COVID-19 virus. About 82% of the US population have received at least one vaccine dose so far while the number is 89% and 75% for Brazil and India respectively as shown in Figure 4[11, 12].

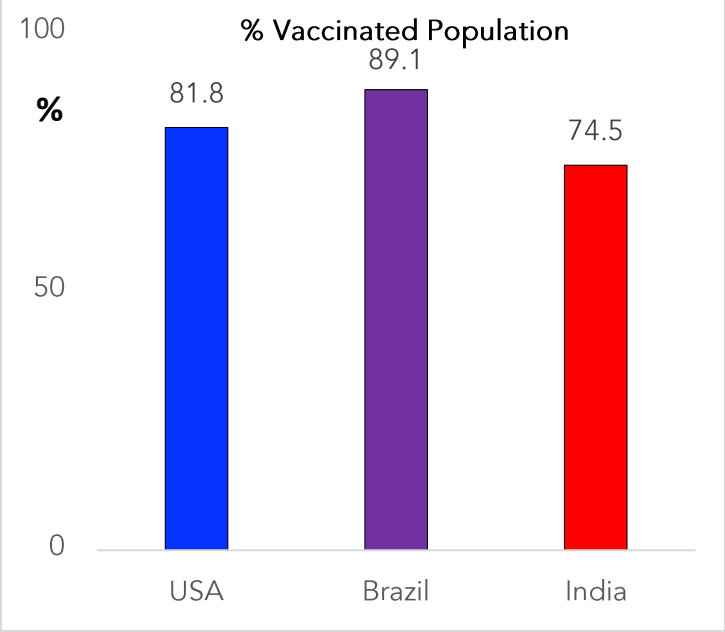

Figure 4. % population getting at least one vaccination dose[11,12]

Considering the populations[12] of the top three COVID-19 underlying deaths countries[6-8], the percentage dying due to the virus is the highest in the US at 0.36 while 0.33 in Brazil and only 0.04 for India as depicted in Figure 5. India with the lowest vaccination proportion, compared to both the USA and Brazil proportions, surprisingly has the lowest death percentage in its population due to the virus.

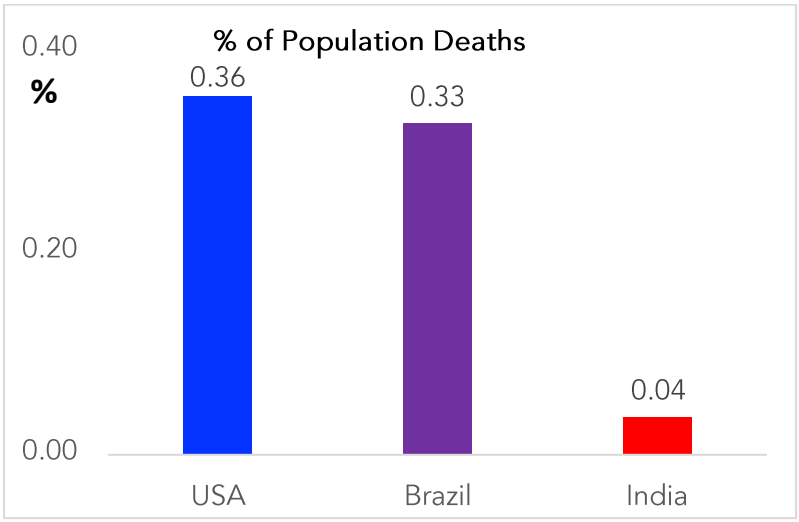

Figure 5. % of population deaths in the USA, India, and Brazil[6-8,12]

3. Effects of urbanization and economic activities on COVID-19 deaths

We next look at the urbanization of these three countries since the percentage of vaccinated population (Figure 4) does not correlate with the percent deaths for them. The USA and Brazil have above 80% urbanization while India lags significantly with only 36%[13]. The urbanization proportions, similar to the vaccination proportion thus do not correlate percent deaths for these countries.

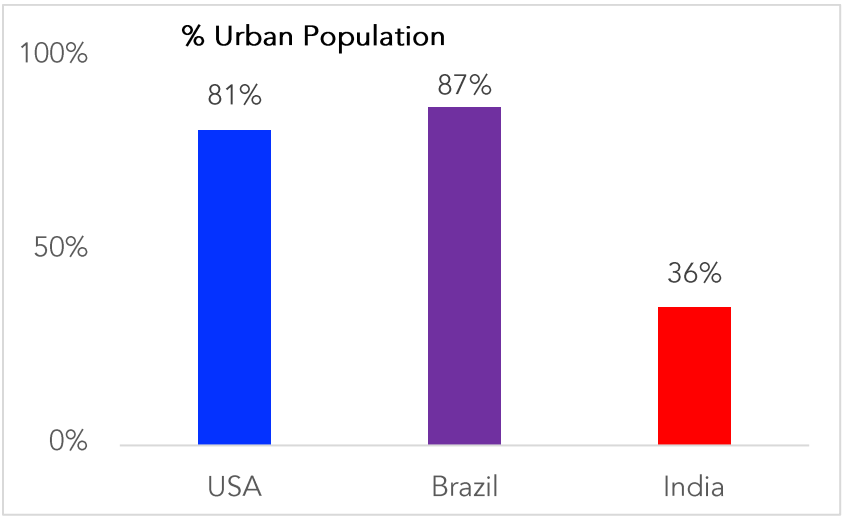

Figure 6. % urban population in the USA, India, and Brazil[13]

Economic activities bring people together. Close interactions of people have a high potential for COVID-19 transmission. Gross National Product (GNP) per Capita is significantly higher for the USA ($76.8K) compared to both Brazil ($8.1K) and India ($2.4K)[14]. The combination of urbanization with GNP/Capita does follow the percent population deaths in these three countries.

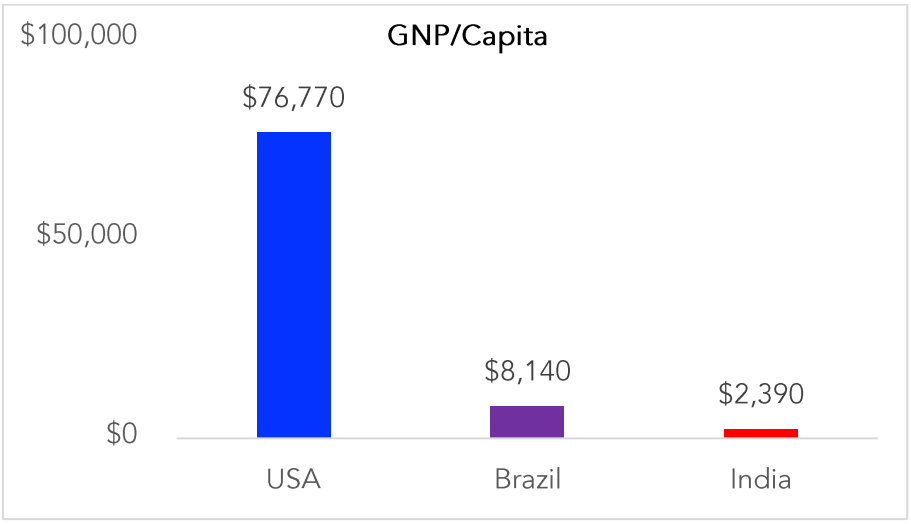

Figure 7. GNP/Capita in the USA, India, and Brazil[14]

4. Age and COVID-19 deaths

In this section we will study how COVID-19 deaths are linked with a country's population age.

4.1 UNDERSTANDING USA'S POPULATION

Based on the US data in Tables 1 through 4, age is an important factor for the COVID-19 underlying deaths. Regardless of race, ages below 54 years have seen about 10% of the fatalities and ages above 55 have seen 90% of these deaths. In this regard population age analysis is important for the three nations.

USA's 2023 population by age groups, as shown in Figure 8, peaks for the age group of 30-34 years and is relatively constant from 0-4 years through 65-69 years groups[15]. The cumulative population proportion derived from Figure 8 is displayed in Figure 9 showing that the median age is 39 years for the country.

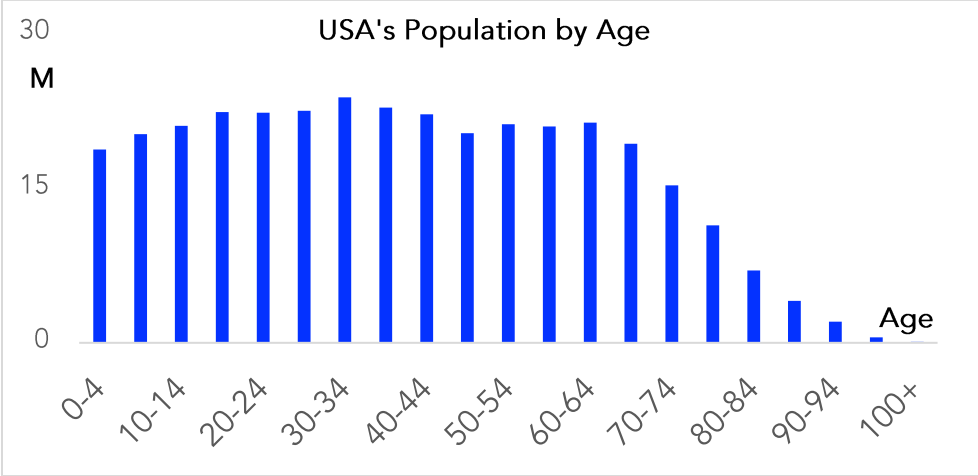

Figure 8. USA's 2023 population by age[15]

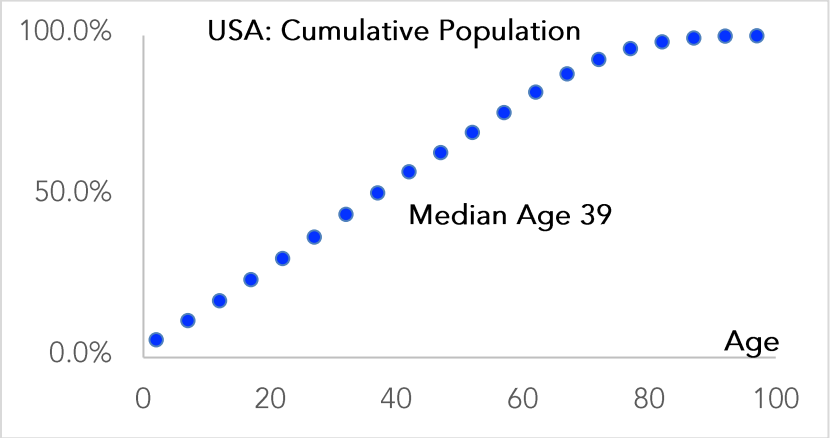

Figure 9. USA's 2023 cumulative population by age[15]

4.2 UNDERSTANDING INDIA'S POPULATION

India's 2023 population by age groups, shown in Figure 10, peaks for the 20-24 years group[16]. The cumulative population proportion derived from Figure 10 is displayed in Figure 11 showing that India's median age is 28 years.

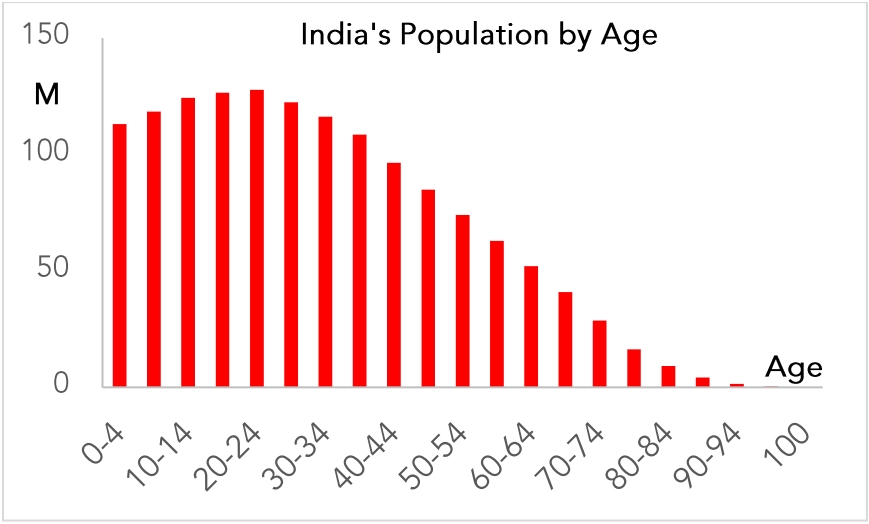

Figure 10. India's 2023 population by age[16]

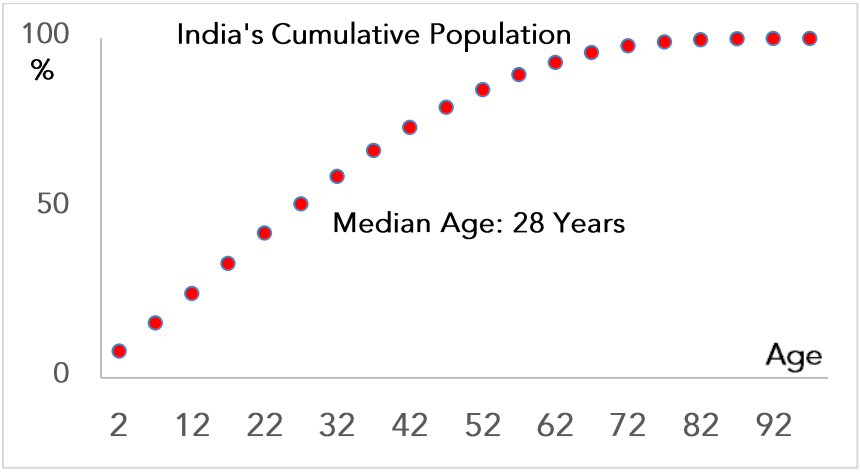

Figure 11. India's 2023 cumulative population by age[16]

4.3 UNDERSTANDING BRAZIL'S POPULATION

Brazil's 2023 population by age groups, shown in Figure 12, peaks for the 35-39 years age group[17]. The cumulative population proportion derived from Figure 12 is displayed in Figure 13 which shows that Brazil's median age is 34 years.

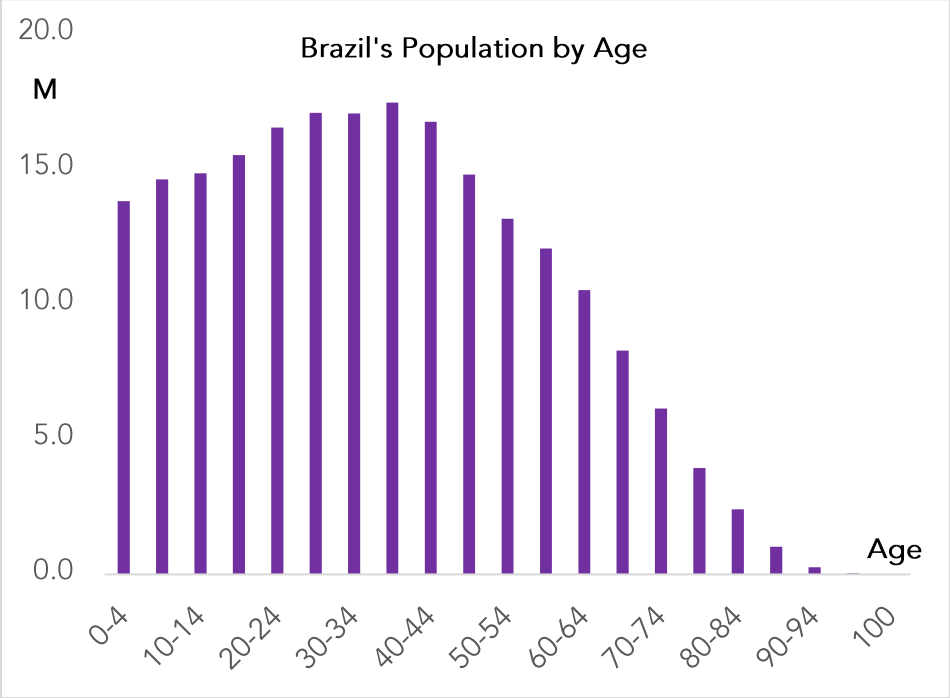

Figure 12. Brazil's 2023 population by age[17]

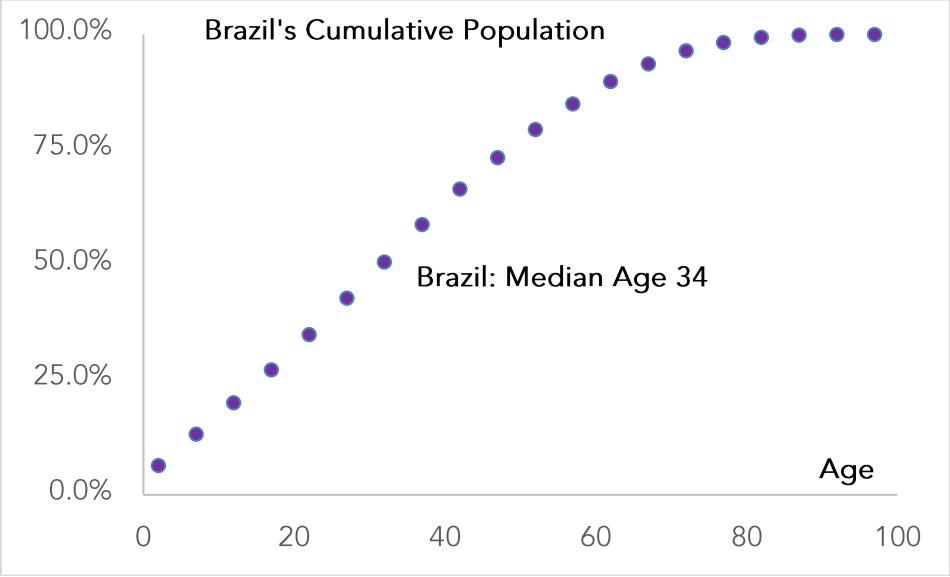

Figure 13. Brazil's 2023 cumulative population by age[17]

4.4 COMPARING MEDIAN AGES OF USA, BRAZIL, AND INDIA

The top three COVID-19 deaths producing countries of the USA, Brazil, and India, shown in Figure 14, do track well with the % of population deaths displayed in Figure 5. This confirms that the older the proportional population (e.g. USA w/ 39 years median age

yielding 0.36% of population deaths) the higher the deaths and vice versa (e.g. India w/ 28 years median age yielding 0.04% of population deaths). Brazil's statistics are between the other two nations.

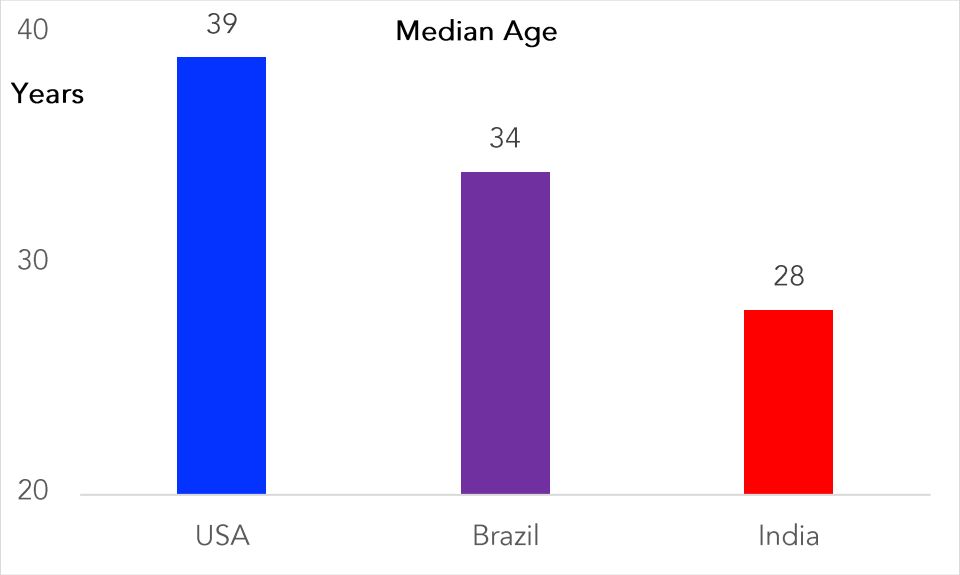

Figure 14. Median ages in the USA, Brazil, and India[15-17]

5. Understanding state level GDP, Population and COVID deaths

In this section will attempt to further understand relationships between GDP, population, and COVID deaths but at the state level in each of the three countries of interest.

5.1 ANALYSIS OF GDP, POPULATION, AND COVID-19 DEATHS AT THE STATE LEVEL FOR THE USA

The USA ranks number one in the world with its GDP of $26 Trillion and has a population of 340M. This highest GDP-producing country did experience the most COVID-19 underlying deaths in the world. Table 5 shows the USA's top 11 states out of 50 when it comes to GDP, their populations, and COVID deaths[18, 19]. Interestingly 56% of the country's COVID-19 deaths occurred in these 11 states. The same states have 55% of the total population with 59% of the country's GDP. The top five COVID-19 deaths-producing states track well with their population ranking and also their GDP ranking.

Table 5. USA's States' GDP, Population, and COVID Deaths[18,19]

USA	GDP (Trillion) $25.74	Population M 340	COVID Deaths M 1.218	GDP Rank	Population Rank	COVID Deaths Rank
California	3.64	39.5	0.112	1	1	1
Texas	2.4	29	0.105	2	2	2
Florida	1.44	21.5	0.095	4	3	3
New York	2.05	19.5	0.083	3	4	4

USA	GDP (Trillion) $25.74	Population M 340	COVID Deaths M 1.218	GDP Rank	Population Rank	COVID Deaths Rank
Pennsylvania	0.91	12.8	0.052	6	5	5
Michigan	0.62	10	0.045	11	10	6
Georgia	0.77	10.6	0.044	8	8	7
Ohio	0.83	11.7	0.044	7	7	8
Illinois	1.03	12.7	0.042	5	6	9
New Jersey	0.75	8.9	0.037	9	11	10
North Carolina	0.72	10.5	0.029	10	9	11

5.2 ANALYSIS OF GDP, POPULATION, AND COVID-19 DEATHS AT THE STATE LEVEL FOR BRAZIL

Brazil ranks number 11 in the world with its GDP of $1.9 Trillion and has a population of 216M. The country experienced the second highest COVID-19 deaths in the world. Table 6 shows Brazil's top 11 states when it comes to GDP, population, and COVID-19 deaths[20-22]. 80% of the country's COVID-19 deaths occurred in these 11 states out of the country's 26 and one federal district. The same states have 70% of the total population and create 65% of Brazil's GDP. The top five COVID-19 deaths-producing states follow well with their population ranking and also their GDP ranking.

Table 6. Brazil's States' GDP, Population, and COVID Deaths[20-22]

Brazil	GDP USD Billion $1,920	Population M 216	COVID Deaths 709,000	GDP Ranking	Population Ranking	COVID Deaths Ranking
São Paulo	475.6	44.4	180,887	1	1	1
Rio de Janeiro	152.0	16.1	77,344	2	3	2
Minas Gerais	136.6	20.5	65,740	3	2	3
Paraná	97.6	11.4	46,441	4	5	4
Rio Grande do Sul	94.2	10.9	42,417	5	6	5
Bahia	61.0	14.1	31,677	7	4	6
Goiás	44.8	7.1	28,297	9	10	7
Ceará	33.4	8.8	28,210	13	8	8
Pernambuco	38.6	9.1	23,004	11	7	9
Santa Catarina	69.8	7.6	22,856	6	9	10
Pará	43.2	0.8	22,856	10	25	11

5.3 ANALYSIS OF GDP, POPULATION, AND COVID-19 DEATHS AT THE STATE LEVEL FOR INDIA

India, the world's most populated country with a population of 1.34 Billion, ranks number 5 in the world when it comes to its GDP of $3.4 Trillion. The country experienced the third-highest COVID-19 deaths in the world. Table 7 shows India's top 14 states with their COVID deaths, population, urban population, and median age[20-22]. 87% of the country's COVID-19 deaths occurred in these 14 states out of 28 and 8 Union territories. These 14 states have 85% of the total population producing 89% of the country's GDP. The top five COVID-19 deaths producing states experienced 60% of India's COVID-19 deaths.

In Table 8 we share the rankings for GDP, Population, Urbanization, Median Age, and COVID-19 Deaths for these 14 states. The state of Maharashtra, with the highest GDP ranking, second in population, first in Urban population, and 5th in median age, experienced the most (and 28% of the total) deaths in India. The state of Kerala experienced the second most COVID deaths in the country but is ranked 11th in the GDP, and 9th in both population including urbanization. The prominent reason Kerala experienced the second most deaths in the country is because its population is ranked first in median age, in other words, it has the oldest population in the country. The state of Bihar is second in population as Maharashtra but ranks 11th for urban population. The state with the country's youngest population (median age of only 22) ranked 11th for the COVID deaths in the country. A combination of GDP, total population, urban population, and median age are thus important drivers for India's COVID-19 deaths.

Table 7. India's States' Rankings for GDP, Population, and COVID Deaths[23-27]

India	GDP $3385B	Population M 1,340	Urban Population, M 426.1	Median Age Years 28	COVID Deaths 533,535	% of COVID Deaths
Maharashtra	$531	127	58.2	31.3	148,594	27.85%
Kerala	$159	36	18.9	35.1	72,104	13.51%
Karnataka	$210	68	26.9	31.4	40,399	7.57%
Tamil Nadu	$308	81	39.9	34.2	38,086	7.14%
Delhi	$156	21	20.6	30	26,689	5.00%
Uttar Pradesh	$311	237	53.6	24.7	23,723	4.45%
West Bengal	$254	99	32.4	31.5	21,558	4.04%
Punjab	$105	30	11.5	32	20,583	3.86%
Andhra Pradesh	$166	53	16.2	32.5	14,733	2.76%
Chhattisgarh	$70	30	7.2	26.9	14,200	2.66%
Bihar	$119	127	14.6	22	12,315	2.31%
Gujarat	$278	72	31.4	29.3	11,096	2.08%
Madhya Pradesh	$156	87	24.3	26	10,786	2.02%
Rajasthan	$186	77	19.4	25.6	9,746	1.83%

Table 8. India's States' Rankings for GDP, Population, and COVID Deaths[23-27]

India	GDP State Rank	Population Rank	Urban Population Rank	Median Age Rank	COVID Deaths Rank
Maharashtra	1	2	1	5	1
Kerala	11	9	9	1	2
Karnataka	6	8	6	7	3
Tamil Nadu	3	5	3	2	4
Delhi	10	19	8	6	5
Uttar Pradesh	2	1	2	11	6
West Bengal	5	3	4	5	7
Punjab	12	10	12	4	8
Andhra Pradesh	8	8	10	3	9
Chhattisgarh	14	10	13	8	10
Bihar	13	2	11	28	11
Gujarat	4	7	5	6	12
Madhya Pradesh	9	4	7	10	13
Rajasthan	7	6	9	9	14

6. Discussion

The Lancet studies discovered that US states with greater poverty, lesser education, and to a lesser extent availability for quality health care felt excessively higher rates of COVID-19 deaths[28]. For the US, by September 2023, COVID-19 deaths have already exceeded 1.12M. Demographic factors of age, race, and residence state were found to be significant in our analyses. The ages of 55 years and above saw 90% of overall COVID-19 underlying deaths while the 0-17 years age group saw insignificant (only 0.15%) of total virus-related deaths. Race/ethnicity seems to have played an important role also, as the Whites' death proportion is higher than their population proportion while both the Asians' and Hispanic death proportions are lower than their respective population proportions. Our analyses parallel the meta-analyses based on 59 studies containing 36K patients exhibited that patients belonging to the 70 years and above age group had a higher risk for COVID-19 death[29].

Brazil's COVID-19 mortality can be explained by its socio-economic and healthcare inequalities which include weaknesses of its universal healthcare system[30]. Brazil experienced the second highest COVID-19 deaths in the world. 80% of Brazil's COVID-19 deaths occurred in 11 states out of its 26. These 11 states have 70% of the country's population and create 65% of its GDP. Brazil's top five COVID-19 deaths-producing states followed well with their population ranking as well as their GDP ranking. Our analysis is in line with the conclusions of a 3-year COVID-19 epidemiological study in Brazil by Martins et al. about the regional differences that are present in the national territory[31].

Ghosh et al. May 2020 in India discovered that Maharashtra, Delhi, Gujarat, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh, and West Bengal were in the stern category for COVID-19 deaths. Tamil Nadu, Rajasthan, Punjab, and Bihar saw a modest number of deaths. On the other hand populations of Kerala, Karnataka, and Telangana states had relatively lowest COVID-19 deaths[32]. India, with a population of 1.34 Billion, experienced the third-highest number of COVID-19 deaths in the world. About 90% of India's COVID-19 deaths occurred in half of its states. These 14 states have 85% of the country's population and produce about 90% of its GDP. The state of Maharashtra, with the highest GDP rank, second in population, first in Urban population, and 5th in median age, experienced the most COVID-19 deaths in the country. The key reason the state of Kerala experiencing the second most deaths in India is because its population is the oldest in the country. Individual states' GDP, urban population, and median age were prominent factors for India's COVID-19 deaths. Swain et al.'s study for the Indian population found that males and the older age groups were more vulnerable to the influence of COVID-19[33]. The age-related COVID-19 death results match well with our analyses. However, our study did not focus on gender.

Chaturvedi et al. in early 2021 performed a predictive analysis of COVID-19 vaccines for the USA, India, and Brazil. Their model estimated COVID-19 to stay under control in the three countries since the expected 'effective reproduction term' was less than 1. Also, the US population will necessitate an enormous number of vaccination shots to eliminate COVID-19 compared to Brazil and India and Brazil because of its highest number of active cases[34].

7. Conclusions

Age of the population, economic activity in the country, and degree of urbanization were the main drivers for the top three COVID-19 death-producing countries in the world. COVID-19 vaccinations have helped the world in combating the deaths caused by the virus. India's population has the lowest vaccination percentage compared to both the USA and Brazil. However, it had the lowest COVID-19 death percentage of its population compared to the other two countries. India with the lowest median age compared to the USA and Brazil also has the lowest GNP/Capita which explains the importance of age and economic activity driving COVID-19 underlying deaths.

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